TRANSFORMING ENGINEERING EDUCATION
LEADERS IN ENGINEERING

The Department of Mechanical Engineering is one of 14 departments in the Texas A&M University College of Engineering (the biggest college on the Texas A&M campus). Among public institutions in the nation, our undergraduate and graduate programs are each currently ranked 8th. Our faculty members are internationally recognized in research areas including: thermal and fluid sciences, materials and manufacturing, mechanics and design, and systems and controls.

HIGH IMPACT

The department’s research encompasses a wealth of mechanical engineering disciplines and houses both state-of-the-art turbomachinery and energy systems laboratories. Active research efforts within the department are in the areas of combustion, energy systems mechanics, fluid mechanics, heat transfer, polymers, systems and controls, tribology and turbomachinery. Research within the department has resulted in improved processes in various industries, new companies and increased economic activity.

STUDENTS

Students within the department receive a broad education in basic theory courses complemented by laboratory experiences in dynamic systems and controls, design, experimentation, fluid mechanics, heat transfer, manufacturing and materials. Graduates of the department’s undergraduate and graduate programs are recruited by manufacturers, healthcare providers, transportation companies, engineering consulting firms and national laboratories.
Greetings from Aggieland!

We have had an exciting year in the Department of Mechanical Engineering. Our faculty continue to have success in obtaining major research grants in areas of national importance and receive recognition from their peers as recipients of prestigious awards. We welcomed seven new tenured/tenure-track faculty, including NAE member Dr. Richard Miles from Princeton University (jointly with aerospace engineering) and are now screening top-notch candidates for recruitment next year. We know their contributions to the department and the field of mechanical engineering will help propel our department toward preeminence.

The department hosted four distinguished lectures this year. We had the pleasure of hosting Dr. Huajian Gao (Brown), Dr. Frank Talke (UC-San Diego), and Dr. M. Cynthia Hipwell (Buehler, Inc.) as presenters of the Fowler Distinguished Lectures during the fall and spring semesters, and Dr. Kenneth C. Hall (Duke) as the Turbomachinery Distinguished Lecture last fall.

For another year, the mechanical engineering undergraduate and graduate programs are each ranked 8th among mechanical engineering programs at public institutions by U.S. News and World Report. We are excited to continue to expand our Master’s in Engineering (M.Eng.) and distance learning programs after their successful launches. There are so many undergraduate and graduate students in our program who exemplify the standard of excellence in education and research we hold in the department, and it is my pleasure to introduce some of them featured in this issue.

I would like to offer a sincere thank you to the donors who generously support programs in our department through significant contributions in support of faculty, students and facilities. Your support enables us to continue enhancing the quality of education we provide to our students.

Andreas A. Polycarpou, Ph.D.
Department Head
James J. Cain Chair in Mechanical Engineering
Meinhard H. Kotzebue ’14 Professor

LEADERS IN ENGINEERING
DEPARTMENT OVERVIEW

ENDOWMENTS • $52.7 MILLION

- Chairs/professorships: $22.5 million
- Undergraduate scholarships: $10.9 million
- Excellence fund/other: $3.1 million
- Graduate fellowships: $12.8 million
- Planned giving: $3.4 million

ENROLLMENT • 1,583

- Undergraduate: 1,144
  - 227 Ph.D.
  - 145 M.S.
  - 67 M.Eng.
- Undergraduate excluding freshmen: 1,144
- M.S.: 53
- M.Eng.: 33
- Ph.D.: 24

DEGREES AWARDED THIS YEAR • 358

- Undergraduate: 248
  - 53 M.S.
  - 33 M.Eng.
  - 24 Ph.D.
- M.S.: 53
- M.Eng.: 33
- Ph.D.: 24

FACULTY

- Tenured/tenure track: 58
- Full professors: 29
- Associate professors: 15
- Assistant professors: 14
- Academic professional track: 15
- Professors of practice: 5
- Texas A&M at Qatar faculty: 12
- Emeritus faculty: 16
- National Academy members: 2

ENDOWED POSITIONS

- Chairs: 6
- Professorships: 13
- Faculty fellowships: 11
- Career development professorships: 4

AREAS OF FOCUS

- Thermal & Fluid Sciences
- Materials & Manufacturing
- Mechanics & Design
- Systems & Controls

FACILITIES & CENTERS

- Turbomachinery Laboratory
- Energy Systems Laboratory

DIRECT EXPENDITURES

in millions • excludes overhead

- Federal: $8.2
- Private: $4.1
- Foreign: $3.8
- Other: $2.9
- State: $1
- Total allotted: $20
NEW FACULTY
TENURED/TENURE TRACK

Adolfo Delgado, Ph.D.
Associate Professor
Rotordynamics, structural vibration, energy dissipation mechanisms, thin film lubrication and fluid-structure interaction applied to the design, modeling and improvement of rotating machinery systems and components.

Matt Pharr, Ph.D.
Assistant Professor

Astrid Layton, Ph.D.
Assistant Professor
Bio-inspired design problems focusing on the use of bio-inspired network analysis techniques to design sustainable complex human networks and systems, including but not limited to, industrial resource networks and complex energy systems.

Srikanth Saripalli, Ph.D.
Associate Professor
Developing necessary foundations in perception, planning and control for autonomous vehicles and deploying them on autonomous cars and unmanned aerial vehicles.

Richard Miles, Ph.D.
TEES Distinguished Research Professor
Hypersonics and advanced laser diagnostics with particular attention to the use of lasers, microwaves and electron beams for energy transfer and flow control — joint appointment with aerospace engineering.

Vinayak, Ph.D.
Assistant Professor
Geometric modeling, human-computer interactions and design research; creativity support tools for design; computer-aided geometric design; human-computer interactions; and visualization techniques for design.

TEACHING/RESEARCH FACULTY

Swaminathan Gopalswamy, Ph.D.
Professor of Practice
Model-based control, embedded systems and software engineering for mechatronic systems, mechatronic system safety and reliability. Application interests: autonomous vehicle systems (ground and aerial vehicles), energy systems, robotics.

Joanna Tsenn, Ph.D.
Assistant Professor of Instruction
Senior Capstone Design Projects Coordinator
Engineering education, capstone design, design theory and methodology.
FACULTY AWARDS

Douglas Allaire, Ph.D.
Assistant Professor
College of Engineering, Dean of Engineering Excellence Award
Department of Mechanical Engineering, James J. Cain Graduate Teaching Award

John Haglund, Ph.D.
Lecturer
College of Engineering, Instructional Faculty Teaching Award
Texas A&M American Society of Mechanical Engineers (ASME) Student Chapter, Best Teacher Award

Jerald Caton, Ph.D.
Gulf Oil/Thomas A. Dietz Professor
College of Engineering, Charles Crawford Distinguished Service Award

Je-Chin Han, Ph.D.
Distinguished Professor-Marcus C. Esterling Chair
ASME International Gas Turbine Institute, Aircraft Engine Technology Award
The American Institute of Aeronautics and Astronautics (AIAA), Fellow

Alan Freed, Ph.D.
Professor
Department of Mechanical Engineering, Peggy L. & Charles Brittan ’65 Teaching Award

Timothy Jacobs, Ph.D.
Associate Professor-Steve Brauer Jr. ’02 Faculty Fellow
Director/Interdisciplinary Engineering for Undergraduate and Graduate Programs
ASME Internal Combustion Engine Division, ASME Special Recognition Award for Services to the ICE Division

Jaime Grunlan, Ph.D.
Linda & Ralph Schmidt ’68 Professor
Department of Mechanical Engineering
Linda & Ralph Schmidt ’68 Professorship (Investiture)
Texas A&M Engineering Experiment Station (TEES), Faculty Fellow

Sungyon Lee, Ph.D.
Assistant Professor
Department of Mechanical Engineering, Peggy L. & Charles Brittan ’65 Teaching Award for Outstanding Undergraduate Teaching
LEADERS IN ENGINEERING

FACULTY AWARDS

Richard Malak, Ph.D.
Associate Professor · Morris E. Foster Faculty Fellow
National Science Foundation (NSF), Civil, Mechanical and Manufacturing Innovation (CMMI) Division Program Director

Michael Moreno, Ph.D.
Assistant Professor
College of Engineering, Dean of Engineering Excellence Award
TEES, Young Faculty Fellow

Daniel McAdams, Ph.D.
Professor · Associate Department Head for Graduate Programs
College of Engineering, Herbert H. Richardson Faculty Fellow
Department of Mechanical Engineering, Industry Advisory Council Faculty Mentoring Award

Anastasia Muliana, Ph.D.
Professor · Cain Faculty Fellow I
ASME, Fellow
College of Engineering, William Keeler Memorial Award
TEES, Faculty Fellow
Department of Mechanical Engineering, Cain Faculty Fellow I

Tillie McVay, Ph.D.
Undergraduate Program Director
Associate Professor of Instruction
College of Engineering, Instructional Faculty Teaching Award

Tanil Ozkan, Ph.D.
Assistant Professor of Instruction
Shell, Ideas 30 Finalist

Partha Mukherjee, Ph.D.
Assistant Professor · Morris E. Foster Faculty Fellow II
The Minerals, Metals and Materials Society (TMS), Young Leaders Professional Development Award
Applied Institute of Physics (AIP) Materials Research Express Journal, Emerging Investigator Distinction
Department of Mechanical Engineering, Morris E. Foster Faculty Fellow II
TEES, Young Faculty Fellow

Prabhakar Pagilla, Ph.D.
James J. Cain Professor II in Mechanical Engineering
Department of Mechanical Engineering, James J. Cain Professorship II
Alan Palazzolo, Ph.D.  
James J. Cain Professor in Mechanical Engineering  
Department of Mechanical Engineering, James J. Cain Professorship I

Sivakumar Rathinam, Ph.D.  
Associate Professor  
Journal of Guidance, Control and Dynamics, Excellent Reviewer

Eric Petersen, Ph.D.  
Nelson-Jackson Professor  
Academic Analytics, Top 3% cited

J.N. Reddy, Ph.D.  
Oscar S. Wyatt Jr. Chair-Regents Professor-Distinguished Professor-National Academy of Engineering Member  
ASME, ASME Medal  
Society of Engineering Science (SES), William Prager Medal  
Northwestern University, Simpson Distinguished Visiting Professor  
Thompson Reuters IP and Science's Web of Science, Highly Cited Researcher

Andreas A. Polycarpou, Ph.D.  
Department Head-James J. Cain Chair in Mechanical Engineering  
Meinhard H. Kotzebue '14 Professor  
Department of Mechanical Engineering, James J. Cain Chair in Mechanical Engineering

Luis San Andrés, Ph.D.  
Mast-Childs Chair  
ASME, Turbo Expo, Structures & Dynamics Committee, Best Paper Award

Kumbakonam Rajagopal, Ph.D.  
J.M. Forsyth Chair-Regents Professor-Distinguished Professor  
Biomedical Engineering (BMEN) Society and Springer Nature, Cardiovascular Engineering Technologies (CVET) Most Cited Article Award  
Academic Analytics, Top 3% Cited  
Ben Gurion University, Beer Sheva, Israel, President's Award for Distinguished Visitors

Arun Srinivasa, Ph.D.  
Associate Department Head-Holdredge/Paul Professor  
ASME, Fellow
The Department of Mechanical Engineering’s faculty and staff award winners gather at the 2017 Spring Awards Banquet.
STAFF AWARDS
JAMES J. CAIN STAFF EXCELLENCE AWARD

Lindy Boss
Administrative Associate IV

Jason Charanza
Technician II

Sharli Nucker
Administrator I

Kasey Sims
Academic Advisor II

STAFF HIGHLIGHT NICOLE LATHAM
College of Engineering Team Award for The Employee Engagement Initiative

Nicole Latham has served as an administrative coordinator for the Department of Mechanical Engineering since 2013. Her love for people and desire to create a positive atmosphere in the department makes her a beloved and dedicated member of the team.

Creating a positive environment
“Administrative staff know that there are problems before anyone else does. We really are a lot of the behind the scenes work that happens for the department. One of my favorite things about working here is getting to see all the different students and faculty members — I just always try to make a positive environment for them. Our faculty members are preparing great content for their classes and students, of course, are studying and always have the pressure of student life. Knowing that if someone came to me and needed help and that I was able to provide that for them — that’s what gives me my fulfillment here in this job,” Latham said.

Defining department success
“We have award-winning faculty here. We have some of the smartest students I’ve seen. We had students who went to South by Southwest this year for Aggies Invent and as part of our Formula Society of Automotive Engineering team, and the projects they’re putting out are just mind blowing. I really think that’s a testament to our success. The students coming out of our department and going into industry are such a great representation of what this department is and what it stands for. Just being able to have that fulfillment of, ‘Hey I helped somebody get what they needed,’ is a motivator for me,” she said.

Nicole was the 2015 recipient of the James J. Cain ’51 outstanding support staff award, serves as team leader for three administrative staff members and is the vice chair for the Engineering Staff Advisory Council and its Employee Engagement subcommittee. She also serves on the Climate Committee, Faculty and Staff Interaction Team and the Employee Engagement Crew.
3-D printing has come a long way in the past 30 years; however the technology still has many limitations. To successfully make complex 3-D objects, support structures that act similar to building scaffolding are often used, especially for soft materials. These structures are removed by hand trimming, high-pressure water blasting or solvent solution after printing.

The ability to print soft silicone materials presents a challenge due to the low stiffness and the difficulty of creating and removing support structures.

Dr. Bruce Tai, assistant professor in the Department of Mechanical Engineering and director of the Manufacturing Innovation Laboratory at Texas A&M University, and his students are developing a technology that can minimize the need for support structures, allowing them to 3-D print soft silicones. This technology is modified from the existing stereolithography to further achieve an in-liquid fabrication creating a hydrostatic liquid support to the cured object. They named this technology “hydrostatic 3-D printing.”

Being able to print silicone materials will create a wide variety of applications in biomechanical and biomedical research due to their biocompatibility, superior elasticity, corrosion and high-temperature resistance, and tissue-mimicking characteristics.

“This is a cross-disciplinary research project involving polymer science, optics and machine design,” Tai said. “The challenge for our team as mechanical engineers was to integrate all the knowledge from the multiple concentrations to test, design and ultimately develop a new low-cost manufacturing process.”

A challenge the team faced was to accurately and precisely control the curing inside the silicone resin. The team had to achieve low one-photon polymerization (LOPP), the key phenomenon behind this technology, which required the cooperation among the silicone material, light source and machine motion. If successful, the liquid pressure around the cured object then holds the shape in position against the gravity effects.

“An example similar to our technology is created when an individual dives into a swimming pool,” Tai said. “The zero-gravity environment created in the water causes the individual to feel
weightless, lose no body mass and maintain form.”

Tai worked with Dr. Melissa Grunlan in the Department of Biomedical Engineering to synthesize different silicone systems with the optical properties specifically tuned for his technology. In addition, the team had to find the accurate UV wavelength, intensity and exposure time needed to accurately cure the resin at the desired spot.

“An improper setting caused the resin to cure either too fast, too slow or at a wrong position,” Tai said. “We had to figure out how to accurately create LOPP in the silicone resin.”

So far Tai’s research has proved the feasibility of in-liquid curing of silicone materials and he is currently working on the process parameters for 3-D printing applications.

“There are currently commercial printers which have the capabilities to fabricate soft silicones,” Tai said. “These printing techniques are either limited to low-profile shapes or require support structures. Our research provides a starting point for the future of unsupported 3-D printing.”

**Featured Researcher**

**Dr. Bruce Tai**

**Assistant Professor**
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Funding for Tai’s research is provided by Texas A&M startup funds and partially by Los Alamos National Lab.
We all lose our balance sometimes; we slip, we fall, we get back up. But for some, life is a balance beam, and merely walking around poses great risks of tripping, slipping or falling. Dr. Pilwon Hur, an assistant professor in the Department of Mechanical Engineering at Texas A&M University, has set out to help people with balance issues walk through life with ease. Using biomechanics and neuromechanics, Hur and his team in the Human Rehabilitation Group at Texas A&M are developing robotic prosthetics and therapy devices to restore balance to those who have lost it through injury, illness or age.

Hur’s prior research helped him answer two questions: “Can we predict a fall? Can we then reduce the number of falls?” The data he gathered from test subjects, which he put into his own mathematical model, led him to conclude that a person’s fall risk could be predicted.
rehabilitation setting using a different population of data for the research.

“Human walking and balancing are extremely robust and optimal considering the significant neural delays and information processing times. There are abundant insights that we can learn from human behaviors and motor controls. Bridging the gaps between bioneuromechanics and robotics is one of the most crucial steps that my research is focusing on to maximize the outcomes from rehabilitation robotics,” Hur said.

Hur and his team work with subjects with normal walking and balancing ability who are put into an environment where they experience a controlled fall by walking across an oily surface which causes them to slip and fall. Sensors attached to each muscle collect data on the falls and recoveries by measuring muscle activity.

Because researchers believe it is a neurological command that regulates balance, using this data will help them separate the activity into several subcomponents helping Hur’s group to program assistive devices to fit each individual’s walking habits.

Hur is one of only a few researchers investigating the possibility of creating robotics that not only can walk like a human — which can be done — but that can also help in the event of an unexpected slip or trip based on customized algorithms the device “learns” from the human’s behavior. Many exoskeleton robotics have been developed to help patients walk normally, but they are bulky and unable to assist a person with an unexpected loss of balance, which means they are not tailored to suit a patient’s unique needs. Hur’s developments will correct both of these issues.

“I am not limiting myself to only rehab because there are many other areas to which I can apply my knowledge. At this moment however, I want to focus on the rehabilitation side so we can have better, more human-friendly, lightweight and robust robotic prosthetics and exoskeletons,” Hur said.

The project is called AMPRO, which stands for A&M Prosthesis. Hur’s research group has also completed developing a new prosthesis that is biomechanically more efficient and lightweight. In addition to this project, the group is also working on a balance device. Using similar biomechanical and neuromechanical understanding, this device retrains the balance of patients who are prone to falls. It uses a handheld control which stimulates the skin when the body becomes unbalanced, training the brain to recognize imbalance and correct it.

Hur’s current research has partially been funded by the National Science Foundation, National Institute of Occupational Safety and Health, American Heart Association, Texas A&M PESCA and his startup funding.
A researcher with the Department of Mechanical Engineering at Texas A&M University is working to create the next generation of computer-aided tools for enabling conceptual design – an undertaking instrumental in catering to the ever-increasing demand for product innovation.

Dr. Vinayak, assistant professor of mechanical engineering, is developing “mixed-initiative” software interfaces that would allow human designers to collaborate seamlessly with the computer to design products that function. These software interfaces are intended to help many kinds of specialized professionals, from industrial designers and architects to prosthetic specialists, understand and take into account design constraints for a better end product.

“Design is a key component of so many disciplines,” Vinayak said. “If you’re doing electronics, computer science, computer engineering, arts, architecture—anything—design is a common component. The designers in these cases are domain experts in their specific field who need to account for so many different constraints and needs that they may not even be aware of.”

For example, in fitting an amputee with a new artificial limb a physician becomes an unwilling designer who, while knowing the medical constraints of the patient, is not entirely aware of the engineering aspects (the exact shape of the amputee’s limb, material selection and loads on the limb) affecting the
design of the device. Making the device becomes a trial and error process for the doctor and the patient, often resulting in failed products.

“Our goal is to make software tools that help account for mechanical information such as stresses, materials and so on, while being able to present that information to the medical professional in a language that they best understand,” Vinayak said. “This greatly improves the favorability of the outcomes for both the medical professional as the designer and the patient as the customer.”

Another example is that of an architect who is designing the form and feel of a staircase without being completely aware of how to systematically incorporate the mechanics and kinematics of the staircase within its artistic elements. Vinayak hopes his mixed-initiative design approach will address this problem by providing designers with a computer system that participates in the design process as a partner, supplies missing information, questions the designer’s decisions and ultimately “talks” to them, working toward getting a useful and functional product.

While the research is currently in the fundamental stages, Vinayak is hopeful about the interdisciplinary benefits it may bring.

“As we move forward, design tools need to accommodate the experts who want to create complex functional products for their users as well as the end users who want to build useful things for themselves,” Vinayak said. “So we are doing this to empower the designer and the customer.”
Researchers with the Departments of Mechanical Engineering and Aerospace Engineering at Texas A&M University are taking complex interactions between drops of water and material surfaces and conducting fundamental research to understand why some droplets adhere to surfaces and why others don’t.

The research has applications in many industries, and the team hopes that by using the fundamental understanding they have gained, their findings have the potential to be applied to a variety of scenarios to improve the efficiency, safety and effectiveness of industrial machines and equipment.

“The underlying principle we are seeking to study with this is very commonplace and yet very complex,” said Dr. Sungyon Lee, an assistant professor in mechanical engineering. “On a rainy day, you can just look out the window and see the water droplets and wonder, ‘Why do some of the droplets run down the window and others don’t?’ We are studying ways to answer this fundamental concept because of the applications it can have elsewhere.”

Lee explains that this common phenomenon has applications in...
industries like transportation, oil and gas, engineering construction, color ink jet printing and many others. For example, a key challenge that faces aircraft engineers is that because of the altitude and speed at which aircraft operate, water droplets that remain on the wings during flight are able to freeze over on the wing and endanger the craft. Lee’s research can provide a better fundamental understanding of why droplets may still adhere to an aircraft wing in those conditions and allow designers and engineers to create the wings in such a way that the droplets will no longer stick, making the plane safer.

“It isn’t an easy question to answer,” Lee said, “but if we take this scenario with a bunch of droplets on a wing surface and now you have wind pushing those droplets, it becomes even more complicated as the forces and factors that cause these phenomena are increased. It turns out that predicting that threshold between what makes a droplet stick and what makes it run off a surface is not trivial at all, so there are a lot of fundamental questions we can ask even in a simple scenario.”

Lee co-authored an article, “Droplet Depinning in a Wake,” which was published as a rapid communication in the journal Physical Review Fluids.

The research is part of a project funded by the National Science Foundation and is being co-investigated by Dr. Edward White, associate department head and associate professor in the aerospace engineering department. White and his students had been exploring at what point droplets roll off at exposure to different wind speeds, interested in aircraft applications. Lee was able to bring her knowledge of interfacial phenomena in fluid mechanics, or how two phases like water and a surface meet and interact, to help White in his research and they became co-investigators on the project. Lee is the principal investigator and is excited to see how the team’s research can be applied more broadly.

“I like fundamental, beautiful problems like this and it is just the tip of the iceberg,” Lee said. “Fundamental research is another way of changing the world by understanding the world better and gaining something much deeper that can be applied to a variety of areas in a much broader sense.”
Researchers with the Department of Mechanical Engineering at Texas A&M University are making the best use of our energy waste — turning one of our most potent pollutants and greenhouse gasses, carbon dioxide (CO₂), into hydrocarbon fuels that can help the environment and solve growing energy needs.

“We’re essentially trying to convert CO₂ and water, with the use of the sun, into solar fuels in a process called artificial photosynthesis,” said Dr. Ying Li, associate professor of mechanical engineering and principal investigator.

In this process, the photo-catalyst material has some unique properties and acts as a semiconductor, absorbing the sunlight which excites the electrons in the semiconductor and gives them the electric potential to reduce water and CO₂ into carbon monoxide and hydrogen, which together can be converted to liquid hydrocarbon fuels.”

Capturing and Reconverting CO₂

The first step of the process involves capturing CO₂ from emissions sources such as power plants that contribute to one-third of the global carbon emissions. As of yet, there is no technology capable of capturing the CO₂ and at the same time reconverting it back into a fuel source that isn’t expensive. The material, which is a hybrid of titanium oxide and magnesium oxide, uses the magnesium oxide to absorb the CO₂ and the titanium oxide to act as the photo-catalyst, generating electrons through sunlight that interact with the absorbed CO₂ and water to generate the fuel.

The project is still in the fundamental research stage. One of the challenges with this technology is that the current conversion efficiency of converting CO₂ and water into renewable solar fuels remains low, less than a few percent. According to Li, the conversion process also takes considerable time and the material can only absorb a fraction of the emitted sunlight. For Li and his team, solving these issues revolves
around engineering more efficient materials with nano-scale structures and advancing the reactor design so that the materials placed within the reactor can absorb sunlight in the most efficient manner.

Efficiency

“There are also other considerations,” said doctoral student Huilei Zhao, a student contributing to the ongoing research in Li’s research group. “Concentrated sunlight exposure can lead to a higher conversion efficiency and we’ve found that if we operate at a higher temperature with this reaction, the conversion efficiency can be dramatically increased.”

The project is a part of a five-year research grant and CAREER Award for Li from the National Science Foundation, and is currently in its third year. By the end of the project, Li hopes to have developed a higher level of conversion efficiency and determine if the process can be commercially viable.

“There are two different ways to quantify the efficiency,” said Li. “What is the fraction of the solar energy we are storing into fuels, or what is the fraction of CO₂ being converted to fuels? In either case, we need to achieve a near 10-percent efficiency to make the process economically competitive.”

Outliving Fossil Fuels

Li explained that the commercial viability of this material is crucial, and while fossil fuels such as oil and natural gas remain cheap, low conversion rates do not serve to make the material attractive in meeting national energy needs. He said, however, that too many people are thinking in the short term.

“We may think in the current stage that this technology is not competitive with fossil fuels,” Li said. “But if we think in the long run, our fossil fuels can only support our energy needs for maybe a couple hundred years if we use them at the current rate. What will happen after that? We will still need these liquid hydrocarbon fuels to power our machines, vehicles and airplanes. Electricity made through renewable resources alone will not be enough because we cannot store and transport it effectively. Therefore, we believe this new technology of producing renewable hydrocarbon fuels is important in dealing with both global climate issues and our need for sustainable energy.”
Dr. Choongho Yu, Gulf Oil/Thomas A. Dietz Career Development Professor II in the Department of Mechanical Engineering at Texas A&M University, and his graduate student group have developed a new concept of electrical energy storage: Thermally Chargeable Solid-state Supercapacitor.

This innovative supercapacitor allows charging to be completed using thermal energy in addition to the traditional electrical charging method for capacitors.

“This is the first time that it has been discovered that a solid-state polymer electrolyte can produce large thermally induced voltage,” Yu said. “The voltage can then be used to initiate an electrochemical reaction in electrodes for charging.”

The Thermally Chargeable Solid-state Supercapacitor works by converting thermal energy into electrical energy and then storing it in the device at the same time. For example, human body heat, or any heat dissipating objects that create temperature differences from their surroundings, can be used to charge the capacitor without external electrical power sources.

“This is the first time that it has been discovered that a solid-state polymer electrolyte can produce large thermally induced voltage.”
The supercapacitor is also flexible in that it can be used as a power supply for wearable electronics, and can be integrated into wireless data transmission systems to operate IoT (internet of things) sensors. IoT is a concept of connecting various electronic devices and sensors for data communication and exchange, which is particularly useful in real-time monitoring.

Yu and his Ph.D. student Suk Lae Kim used a physical phenomenon known as the Soret effect — using a solid-state polymer electrolyte in which a temperature gradient along the supercapacitor moves the ions from the hot side to the cold side — to generate high thermally induced voltage.

A novel thermally chargeable solid-state supercapacitor can simultaneously harvest thermal energy and then store electrical energy without external electrical power supply using thermo-diffusion of ions in solid-state electrolytes and electrochemical redox reactions.

“This thermally self-chargeable flexible supercapacitor powered by thermally diffused ions holds great potential to power electronic devices in a whole new way — without the traditional external power supply or battery replacement,” Yu said.

Yu and his team of students’ work was recently published in the journal Advanced Energy Materials. The research is funded by the U.S. Air Force Office of Scientific Research.
POLYMER NANOCOMPOSITES IMPROVE SOLAR CELL DURABILITY

The Polymer Nanocomposites Laboratory at Texas A&M University, directed by Dr. Jaime Grunlan, is working with the Sandia National Laboratory to reduce or eliminate arc faults and corrosion in solar cells. Corrosion in photovoltaic cells can damage connections and reduce or destroy the ability to generate electricity.

Initial testing suggests the thin clay-based nanocomposite coatings developed at Texas A&M could be used as anti-corrosive layers within the cells to improve durability/lifetime. The coatings developed within Grunlan’s group are being evaluated as barriers to moisture and corrosive gases. Testing is being done at Sandia as part of the larger Durable Module Materials National Lab Consortium, which aims to benefit the photovoltaic industry.

“It’s exciting to see how our long-term research in gas barrier and flame retardant coatings is being used to improve the efficiency and longevity of solar cells. We are solving complicated problems using low-cost and environmentally benign materials, which is an added bonus,” Grunlan said.

Erik Spoerke of Sandia’s Electronic, Optical and Nano Materials Department compared the development of these nanocomposite films, which can be 100 times thinner than a human hair, to building a house.

“It’s about assembling those structures in the right way so that you can use inexpensive materials and still get the benefits you want,” Spoerke said. “If you build a house, it’s not just piling together the drywall and two-by-fours and shingles. You’ve got to use the two-by-fours to make the frame, set the drywall on the two-by-fours and assemble the shingles on the roof.”

The research aims to bring down the long-term cost of solar panels and solar technology to help facilitate faster adoption.

Grunlan’s project with Sandia is an industry-sponsored project through the Texas A&M Engineering Experiment Station. Grunlan is the Linda & Ralph Schmidt ’68 Professor in the Texas A&M Department of Mechanical Engineering.
Texas A&M University graduate and astronaut Colonel Michael E. Fossum has been appointed as the new vice president and chief operating officer of Texas A&M University at Galveston.

Fossum, a 1980 Texas A&M mechanical engineering graduate, recently announced his retirement from the National Aeronautics & Space Administration (NASA). In 2013, Fossum received the Outstanding Alumni Honor Award from the college of engineering.

Fossum began working for NASA in 1983 and was selected as an astronaut in 1998. He is a veteran of three space flights, logging more than 194 days in space, including more than 48 hours in seven spacewalks. His most recent role at NASA was as assistant chief for the International Space Station.

Born in Sioux Falls, South Dakota, Fossum grew up in McAllen, Texas. He attended Texas A&M and was a member of the Corps of Cadets, earning a Bachelor of Science degree in mechanical engineering and receiving his commission in the U.S. Air Force in 1980.

After completing a Master of Science in systems engineering from the Air Force Institute of Technology, he was detailed to NASA Johnson Space Center, where he supported space shuttle flight operations.

In 1985, he graduated from Air Force Test Pilot School at Edwards Air Force Base and went on to serve first as a flight test engineer in the F-16 Test Squadron and later as a flight test manager at the Air Force Flight Test Center.

Fossum resigned from active duty in 1992 to work for NASA as a systems engineer. In 1997, he earned a Master of Science in physical science (space science) from the University of Houston — Clear Lake. He retired as a Colonel from the U.S. Air Force Reserves in 2010.

Among his many honors and awards, Fossum has received the NASA Exceptional Service Medal and two NASA Spaceflight Medals, as well as the U.S. Air Force Meritorious Service Medal with two Oak Leaf Clusters.

He is especially proud of his Boy Scout awards, which include Distinguished Eagle Scout, Silver Beaver and Vigil Member of the Order of the Arrow.
STUDENTS

FORMULA SAE UNVEILS RACE CAR AT SXSW
Formula SAE is an international design competition in which 500 student teams design, fabricate and compete with formula style racecars. The contest is driven under the concept of a fictional manufacturing company contracting a design team to develop small formula-style single-seater racecars that adhere to prescribed rules and regulations that promote innovation while maintaining safety. Students gain experience in communications, management and design with an emphasis on reliability and safety. The final product is a fully branded vehicle for rollout at South by Southwest. Previous corporate sponsorship has included GM, Yamaha, Schlumberger, Axalta and many more.

To close out the Texas A&M University College of Engineering's presence at SXSW, the 2016-17 Formula SAE team comprised of mechanical engineering students unveiled this year's car to a crowd of people outside the Texas A&M House.

Ahmed Mahmoud ’87, chief information officer at General Motors, spoke at the unveiling and said that sponsoring the Formula SAE team was an easy decision. In fact, several students from previous teams have gone on to work for General Motors, and this year's team leader Ryan Monheim will be going to work there after graduation.

“This was one of the things that General Motors looks for,” Mahmoud said. “We're looking for institutions that are into transformational learning. We're looking for institutions that have global reach. And this program, the fact that they sort of design the car from scratch every single year gives a competitive advantage for any of the hires. Because at the end of the day, for us, it's all about the students.”

Monheim, along with the team's business and communications lead Rebecca Novak, who will also be working in the auto industry next year, were interviewed by KBTX about their car. Between the interviews and the exposure the team received by being part of the event, Novak said their presence at SXSW was a successful undertaking.

“SXSW was an amazing opportunity for our team,” she said. “A lot of hard work went into getting the car designed, manufactured and ready for rollout so it was quite rewarding to see everything come together for the first time in such an extravagant way. Our team had been involved in planning this event since November and have worked hard to make the event a success. We are so pleased with how everything turned out and we are incredibly proud of all of our hard work.”

The Formula SAE team will now continue to test and work on the car leading up the championships this June in Omaha, Nebraska.
Shawanee’ Patrick isn’t in it for the glory or a paycheck. The Wilmer, Texas, native is currently working toward her Ph.D. in mechanical engineering at Texas A&M University, and while she doesn’t have her future career mapped out just yet, one thing is for sure — she wants to make a difference in the lives of people with disabilities.

Growing up in the countryside, some of Patrick’s fondest memories involve her grandmother — a woman whose brain aneurism decades before left her unable to walk and speak.

“It made me have an appreciation and to not think differently of people who have physical disabilities,” Patrick said. “It also made me want to help people who have those disabilities.”

Patrick received her bachelor’s degree in biomedical engineering from Texas A&M in 2012. That same year, she began working toward her master’s degree, completing her thesis project — designing and analyzing a robotic, prosthetic foot — in 2016.

Now, Patrick is working on her doctorate and the development of an exoskeleton device that could help paraplegics walk.

Matthew Zurcher at Central Texas Orthotics and Prosthetics approached Patrick and asked her to assist Dr. Kelly Lobb, medical director of St. Joseph’s Rehabilitation Center inpatient and outpatient physical therapy programs, with a new and improved device. Patrick readily agreed.

The exoskeleton device is still in the early design phase, but would allow a paraplegic to move in an upright position, using wheels for motion and one arm to control movements. This device could help someone with paralysis increase bone density and muscle mass, in turn decreasing the risk of other health problems arising as a result of immobility.

In her free time, Patrick assists with activities hosted by the Access and Inclusion Program in the college of engineering. The program seeks to increase the diversity of engineering students by recruiting, retaining and developing successful students from underrepresented populations. She is also a member of the National Society of Black Engineers.

Patrick said it’s important to encourage children to be themselves.

“Anything that you’re passionate about is not small,” she said. “I’m not necessarily trying to get everybody to be an engineer, but I want everybody to see it as an option and do what it is that they’re passionate about and not think they are constrained to something just because they don’t see someone like them doing it.

“You can be the first. Somebody had to be the first, and there’s no harm in being the first in whatever it is.”
Tyler Wooten was a freshman engineering student at Texas A&M University when he came up with an idea that could have a lasting impact on students with visual impairments.

Wooten, a sophomore mechanical engineering student, took a 3-D printing class at the Engineering Innovation Center (EIC) during his freshman year. He began thinking about different ways he could use his newly acquired 3-D printing skills to help others.

Then it came to him — create a three-dimensional map with raised buildings and braille for visually impaired people to use to orient themselves on campus.

Wooten reached out to Kaitlyn Kellermeyer, a Texas A&M student who had worked on other advocacy projects on campus for the visually impaired.

Kellermeyer, who is blind, was the perfect person to provide insight for Wooten. He emailed her and within two hours they met to discuss the project.

“She shrieked the first time she held it,” he said of Kellermeyer. “It was awesome to see it transform from an idea to something that could actually help.”

In August of 2016, Dave Schaller, account manager of SolidWorks licenses for Texas A&M, reached out to offer congratulations to Wooten after reading about his nonprofit in The Battalion, the university’s student-run newspaper.

This communication led to Wooten receiving an invitation to SolidWorks World 2017 in Los Angeles, where he spent four days visiting with industry experts, attending breakout sessions and gathering information that would later aid him in ironing out minor kinks in his project.

“I continue to learn more every day, but SolidWorks can be used as a tool to create and validate anything your mind can image,” Wooten said.

While there, Wooten said he spoke about new slicing software and soon-to-be released machines that could potentially produce better quality maps for his nonprofit.

Wooten and other nonprofit members, hoping to expand their team of engineers and reach more schools, produced a training video demonstrating how to create tactical maps for other campuses.

Tracey Foreman, assistant director of disability services at Texas A&M, said tactile graphics are used to aid people with visual disabilities to better understand graphs, maps and other diagrams. She said most tactile maps are created using braille embossers, Thermoform images or Swell paper.

“Having access to a tactile map allows a visually impaired individual to better understand the scale, size and proximity that cannot always be gathered solely by walking around or having something verbally described to the individual,” Foreman said.

Wanting to make a difference

After speaking with Kellermeyer, Wooten went home and downloaded SolidWorks, the software used to design 3-D-printed items. Wooten got to work right away, printing the first of many maps that week.

“I went from having a random idea to create a map, to now being able to go to L.A. for four days and learn about CAD, all thanks to all the helpful and amazing people at A&M,” Wooten said. “It was fun introducing myself to these industry professionals and saying I was a 19-year-old going to Texas A&M University.”
Researchers with the Department of Mechanical Engineering at Texas A&M University are making it easier for the visually impaired to read by manufacturing high quality adhesive labels through portable 3-D printers so that braille can be found on a variety of consumer products. The project, led by assistant professor of instruction Dr. Tanil Ozkan, is unique in not only the benefits it is providing for this specific population, but also in its high-impact instructional approach for undergraduate engineering students, giving them the ability to be actively engaged in research development and distribution.

“The goal was to have my undergraduate students engaged in every step of the project,” Ozkan said. “With any kind of product development or innovation, it is always the case that when you start learning things and get more experience, you kind of become rigid in terms of what you can and cannot do. Young minds don’t have these restrictions, and in many cases not knowing anything about the rules is exactly what you need for great innovation.”

Product-friendly Labels

The work Ozkan and his students are doing initially began with working to provide labels in braille directly on the packaging of everyday consumer products such as shampoo and eating utensils. According to Ozkan, due to the dynamics of the American consumer market, it has been difficult to get distributors to include braille labelling on their packaging. Additionally, the standard 3-D printing polymers used in applying the 3-D printed braille to the packaging is not reliable. To solve this problem, the team created durable adhesive labels to allow easy printing and adhesion to the packages.

“We’ve also had a former undergraduate and current graduate student here at Texas A&M, Yasushi Mizuno, develop a non-contact sensor technology which detects surface curvature and height differences on the plane of the labels so that optimal process parameters can be determined with the digitally generated surface...
within the software for the subsequent 3-D printing,” Ozkan said. “This allows the labels with the braille to fit the surface well.”

**Portable Printing**

Ozkan and his students were able to develop a portable and compact type of 3-D printer that allows the labels to be printed easily. A major concern, according to Ozkan, was to ensure that the technical expertise needed to operate the machine was not beyond that of the everyday person, which is uncommon among 3-D printers that are commercially available.

“We have developed some software and written our own code that would basically create these braille characters and then place them, with the desired size font, on the label,” Ozkan said. “This still requires some level of technical expertise, so what we are thinking is that if we combine this technology with a portable 3-D printer, this can be taken to schools, nursing homes and public libraries where the blind and visually impaired members of our society have access to other services.”

**Expiration Dates**

In addition to their work in braille 3-D printing, Ozkan and his students are also working on a unique method that will allow all consumers, including the visually impaired, to read expiration dates on products by touch. The method involves using a color changing polymer which is encased in gel. The permeability of the polymer will change and dissolve over time, allowing the visually impaired to determine the shelf life of a product based on how firm the gel is. For common consumers, the severity of discoloration would be the indication of the remaining shelf life before a product’s expiration date. The next step in circulating products like this and the 3-D printed labels will involve Ozkan and his students working with regulatory bodies and organizations that handle braille standardization and consumer health to increase the awareness of these issues and make the technology available to those who need it.
The Fowler Distinguished Lecture Series is endowed by Mr. Donald Fowler ’66 and Dr. Joe Fowler ’68. This endowment allows the Department of Mechanical Engineering to invite nationally recognized scientists, engineers and researchers to Texas A&M University to present lectures of interest to students, faculty and industry representatives.

**DR. FRANK E. TALKE**

Mechanics and Materials Problems in Medical Device Technology and Information Storage

The Department of Mechanical Engineering at Texas A&M University hosted Dr. Frank E. Talke, an endowed chair professor at the Center for Memory and Recording Research at University of California San Diego, for its Fowler Distinguished Lecture Series.

Talke was elected into the National Academy of Engineering in 1999 for his work in tribology and magnetic storage systems, and for bridging industrial and academic research. During his lecture, Talke described materials issues and manufacturing techniques and presented an overview of current and future problems in the mechanics and materials area of information storage on hard disks.

**DR. M. CYNTHIA HIPWELL**

From Megabits to Terabits: Innovation Practices to Drive Aggressive Technology Growth

Dr. M. Cynthia Hipwell has been working in the area of technology development based upon nanoscale phenomena for over 20 years. She received her Bachelor of Science in mechanical engineering from Rice University and her Master of Science and doctorate in mechanical engineering from the University of California, Berkeley, where she worked with Chang-Lin Tien.

She was elected to the National Academy of Engineering in 2016 for her leadership of the development of technology to enable reliable area density growth in hard disk drives. Hipwell discussed management and business process techniques she found most critical to leading teams to technology leadership in a competitive industry.
FOWLER DISTINGUISHED LECTURE SERIES  continued

DR. HUAJIAN GAO

Mechanics as an Enabling Tool in Bioinspired Materials and Biological Interactions of Low-Dimensional Nanomaterials

Dr. Huajian Gao studies the basic principles that control mechanical properties and behaviors of materials in both engineering and biology, and is known for his micromechanics research. He studies how metallic and semiconductor materials behave in thin-film and nanocrystalline forms and how biological materials achieve their mechanical robustness through structural hierarchy.

Gao earned a doctorate from Harvard University and was elected to the National Academy of Engineering in 2012. He is the Walter H. Annenberg Professor of Engineering in the School of Engineering at Brown University. He also serves as principal investigator for the Gao Research Group at Brown.

Gao is also a Faculty Fellow in the Hagler Institute for Advanced Study at Texas A&M University and collaborates with faculty researchers in the college of engineering.

TURBOMACHINERY DISTINGUISHED LECTURE SERIES

The Turbomachinery Distinguished Lecture Series was established in 2014. With this endowment, the Department of Mechanical Engineering invites prominent speakers in the area of turbomachinery to present lectures of interest to our students and faculty.

DR. KENNETH C. HALL

Nonlinear Analysis of Unsteady Flows in Multistage Turbomachines Using the Harmonic Balance Technique

Dr. Kenneth C. Hall received his S.B., S.M. and Sc.D. degrees from the Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology. Prior to coming to Duke University, he worked for United Technologies Research Center, the research and development arm of Pratt and Whitney Aircraft, Sikorsky Aircraft and other high technology divisions of United Technologies.

Hall’s research has focused primarily on novel methods for computing the unsteady aerodynamics, structural dynamics, aeroelasticity and aeroacoustics of aerospace vehicles and turbomachinery, and on the optimal propulsion of helicopters and birds in flight.

In his talk he presented a number of examples to illustrate the utility of the technique as well as some interesting steady flow problems.
The IAC consists of former students who volunteer their time to keep the department informed of the challenges they face each day in their respective fields.

Members of the IAC are selected for their leadership, accomplishments and willingness to support the mission of the council, which is to support the department and mechanical engineering students.

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Gifts to the department may be in the form of cash, securities, real estate or personal property. Many of our supporters have contributed using planned gifts, including, but not limited to: charitable remainder trusts, lead trusts, gift annuities, bequest provisions and life insurance. These are all excellent ways to benefit Texas A&M and the Department of Mechanical Engineering while fulfilling philanthropic goals and possibly achieving financial planning or tax benefits.

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Giving to the Department

Department Excellence Fund

This account enables the department head to enhance the mission of the department. This includes professional development for faculty, staff, students; student organization support; development activities; and award recognition.

Faculty Fellowships

The college of engineering and Texas A&M University have made significant investments in obtaining world-class faculty. Endowed faculty fellowships are needed to reward exemplary career achievement and retain these distinguished researchers and teachers in today’s competitive market.

Endowed Graduate Fellowships

Graduate fellowships help recruit and retain top-notch graduate students.

Jonathan Pozzi
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Martha Lou Broussard poses with recipients of the Mr. & Mrs. Douglas Broussard ’44 Scholarship.
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