

VISION 2030

CHEMICAL ENGINEERING *RESEARCH STRATEGY*



TEXAS A&M UNIVERSITY

Artie McFerrin Department of
Chemical Engineering



DR. FAISAL KHAN

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A WORD FROM THE DEPARTMENT HEAD



Chemical engineering at Texas A&M University is built on a proud and enduring legacy. What inspires me most is our unwavering commitment to discovery, innovation and the education of outstanding undergraduate and graduate students. Our nationally recognized faculty lead the largest chemical engineering program in the nation, advancing bold ideas grounded in deep technical excellence. The Vision 2030 Research Strategy captures both our strong foundation and our exciting path forward. I am proud to share our collective dedication to developing new bioprocess, materials and processes with safety at the forefront. At the same time, we remain deeply committed to educating our students in the Aggie Core Values of Excellence, Integrity, Leadership, Loyalty, Respect, and Selfless Service. Together, we will continue to advance chemical engineering as a force for good.



DR. PERLA BALBUENA

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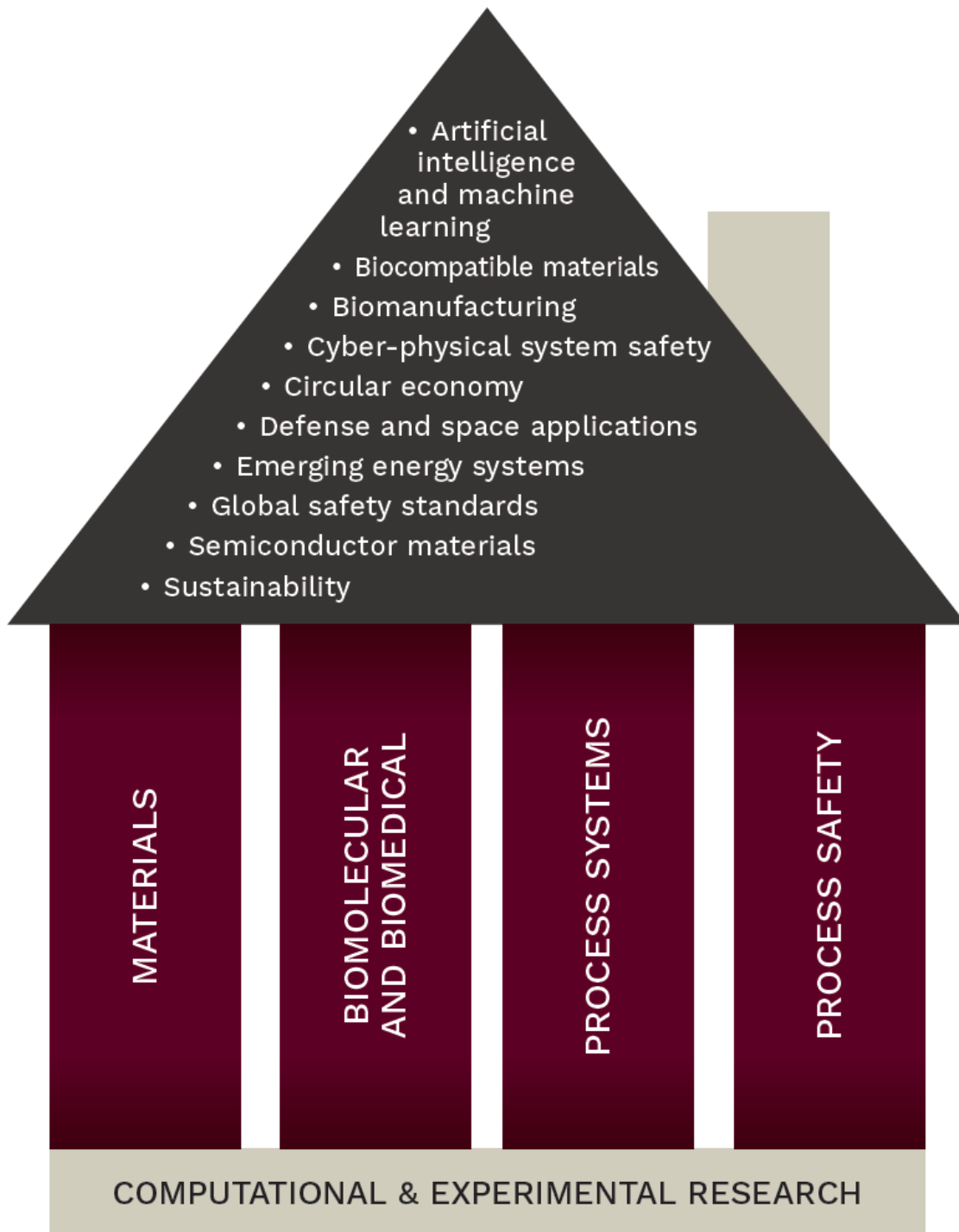
A WORD FROM THE DIRECTOR OF RESEARCH



Our department is moving into a new paradigm aligned with the expanding role chemical engineers play in addressing current and future societal challenges. Our faculty is organized into four scientifically and technologically relevant emerging areas: materials, biomolecular and biomedical, process systems, and process safety. Within each field, research focus and content evolve dynamically, supporting the development of technologies and tools that enable chemical engineers to respond to emerging trends and sustain an integrated, multidisciplinary program encompassing both fundamental and applied research. We are also committed to improving undergraduate and graduate courses so our graduates are competitively prepared for the evolving research challenges of their careers. In closing, I thank my colleagues for their enthusiasm, positive attitudes, and bright ideas that continuously enrich our portfolio.

RESEARCH VISION 2030

The diagram below summarizes the CHEN department's research vision. Grounded in excellent computational and experimental research, the faculty will expand knowledge in four key areas; materials, biomolecular and biomedical, process systems and process safety. As the knowledge is transformed into practical applications, the research will impact rising and contemporary challenges.





MISSION STATEMENT

The Artie McFerrin Department of Chemical Engineering at Texas A&M University is the largest fully-accredited program in the country. Besides classroom instruction, many outlets exist for real-world experience such as research, internships and co-op education. Faculty are engaged in a wide spectrum of studies ranging from research in the areas of biomass utilization, process safety, process systems engineering, hydrocarbon processing, nanotechnology, polymer and materials engineering, biomolecular engineering and molecular modeling and simulation. The ultimate goal of our research is to positively influence society by providing new knowledge, to develop students into independent researchers who will continue to advance the forefront of science and technology.

VISION STATEMENT

By 2030, the Artie McFerrin Department of Chemical Engineering will build on its national reputation for excellence by leading advances in the art and science of chemical engineering through the creation and dissemination of knowledge. This will be accomplished through:

- **Sustaining growth** by promoting center-level grants and engaging with other academic institutions, industry organizations, and national laboratories.
- **Increasing multidisciplinary expertise** by encouraging faculty and students to learn through multidisciplinary coursework and projects.
- **Prioritizing targeted hiring**, especially of faculty in emergent fields such as AI, advanced materials, personalized medicine, electronic materials and biotechnology.
- **Enhancing faculty retention** to support world-class faculty and their research.
- **Recruiting top domestic and international students** through faculty outreach, especially to former students who enter academia.
- **Expanding the Advisory Council** to include representatives from materials and bioengineering research and manufacturing as well as academia and the public sector.
- **Improving visibility** through national awards, research exposure and website enhancement.

RESEARCH VISION 2030 DEVELOPMENT PROCESS

To develop Research Vision 2030, the faculty engaged in a collaborative strategic planning process to identify the research fields that define the department's current strengths and form the foundation for future growth. Following the identification of four thematic research areas, faculty self-organized into four working groups and met to define shared strengths, weaknesses, opportunities and threats (SWOT). This document is based on a faculty retreat held on January 15, 2026, during which the SWOT analyses from each thematic area were presented, discussed and finalized, ensuring broad faculty input and alignment with Texas A&M University's mission of excellence, impact and service.



1. Faculty identified thematic areas



2. Groups formed and met to perform and document SWOT analyses



3. Faculty discussed each area, culminating in the Research Vision 2030

VISION 2030 RESULTS

The Artie McFerrin Department of Chemical Engineering is dedicated to fostering excellence and impact through four thematic areas of engineering research:

- **Materials**
- **Biomolecular** and **biomedical**
- **Process Systems**
- **Process Safety**

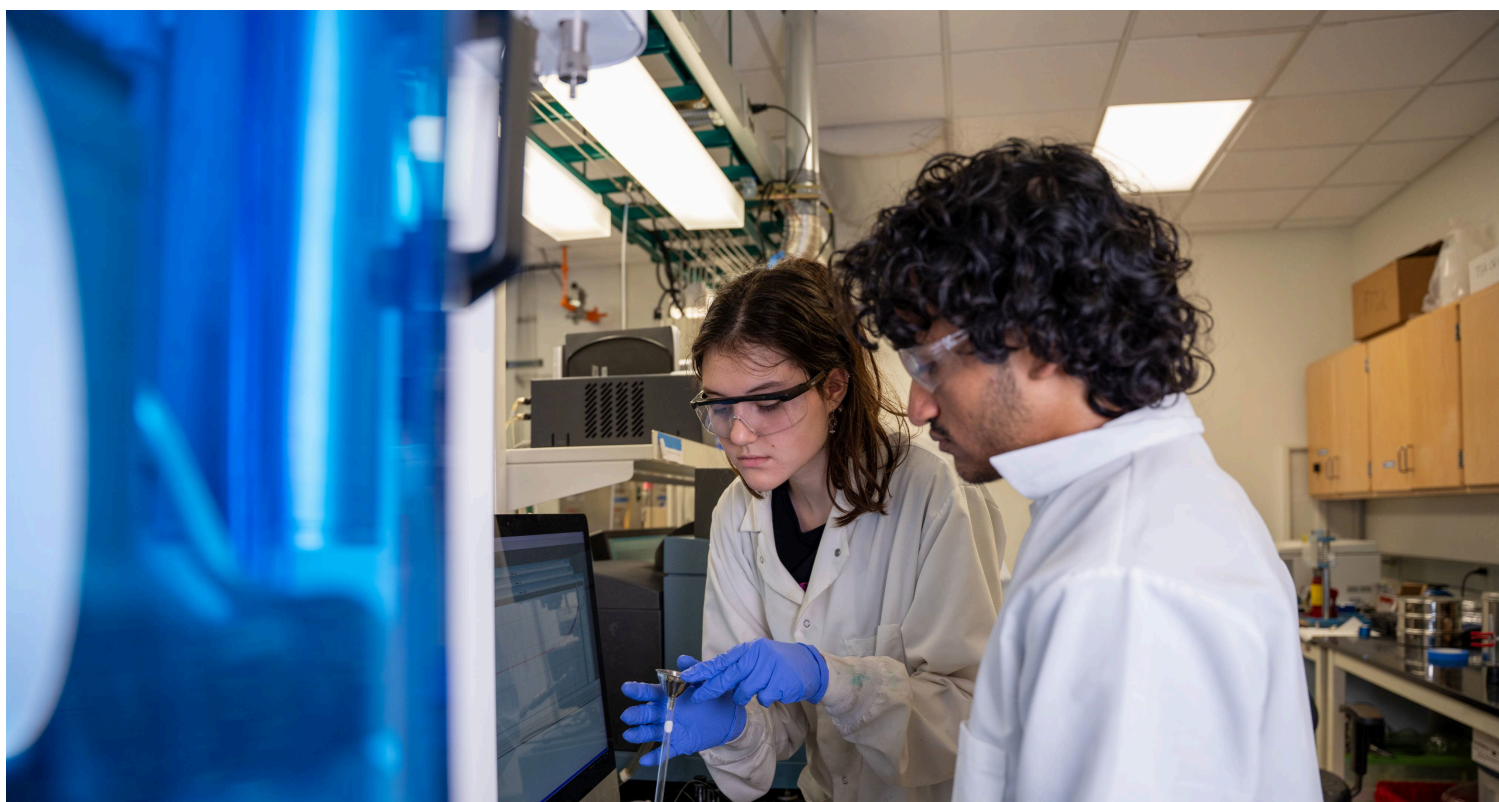
WHY THESE AREAS?

The 2022 Report from the National Academies of Sciences, Engineering, and Medicine discusses future directions for Chemical Engineering*:

- Decarbonization of energy systems
- Sustainable engineering solutions for environmental systems
- Engineering targeted and accessible medicine
- Flexible manufacturing and the circular economy
- Novel and improved materials for the 21st century
- Tools to enable the future of chemical engineering

Our thematic areas are aligned with these directions, as our key competencies are associated with energy, safety and sustainability, manufacturing and health.

**<https://nap.nationalacademies.org/resource/26342/interactive/index.html>*

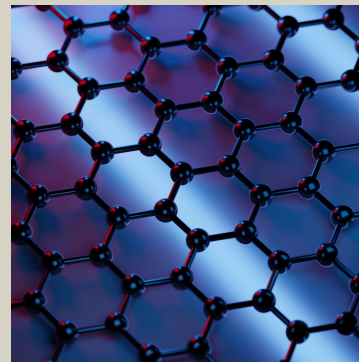


THEMATIC RESEARCH GROUPS

as of Spring 2026; lists are updated at <https://engineering.tamu.edu/chemical/research/index.html>

Materials

- Mustafa Akbulut
- Perla Balbuena
- Mark Barteau
- Abdoulaye Djire
- Joe Elabd
- Micah Green
- Hae-Kwon Jeong
- Jodie Lutkenhaus
- Jorge Seminario
- Manish Shetty
- Jiho Shin
- Sreeram Vaddiraju
- Shuyi Xie



Biomolecular and Biomedical

- Mustafa Akbulut
- Aristos Aristidou
- Ahmad Hilaly
- Mark Holtzapple
- Chelsea Hu
- Arul Jayaraman
- Pushkar Lele
- Tanmay Lele
- Jeetai Mittal
- Gregory Reeves
- Qing Sun
- Phanourios Tamamis
- Victor Ugaz
- Hung-Jen Wu
- Xuejun Zhu



Process Systems

- Mahmoud El-Halwagi
- Chad Mashuga
- M.M. Faruque Hasan
- Chelsea Hu
- Faisal Khan
- Costas Kravaris
- Estratios Pistikopoulos
- Benjamin Wilhite



Process Safety

- Rouzbeh Abbassi
- Mahmoud El-Halwagi
- Faisal Khan
- Costas Kravaris
- Chad Mashuga
- Efstratios Pistikopoulos
- Nazrul Rahmani
- Sreeram Vaddiraju
- Qingsheng Wang



RESEARCH SUMMARY

Materials	Biomolecular & Biomedical	Process Systems	Process Safety	
<ul style="list-style-type: none"> • Hard materials • Soft materials • 2D materials • Industry connections • Theory and computation; multiscale simulations • Internal and external collaboration • Facilities 	<ul style="list-style-type: none"> • Computational biophysics • Synthetic and systems biology • Multiscale modeling • Critical mass of faculty and students • Translational applications to health and biotechnology 	<ul style="list-style-type: none"> • Multiscale modeling • Optimization • AI/ML • Integration • Design • Control • Multiscale approach 	<ul style="list-style-type: none"> • Modeling • Optimization • Integration • Design • Control • Risk engineering • Multiscale approach 	Strengths
<ul style="list-style-type: none"> • Center-scale funding • Opportunities for crosscuts • Faculty hiring priorities • Greater visibility and targeted audiences 	<ul style="list-style-type: none"> • Visibility • Shared lab facilities • Advisory Council expansion • Grants • Faculty recruitment • Graduate BIO-track • Shared BIO identity • Scientific round tables and retreats 	<ul style="list-style-type: none"> • Faculty hiring • Establishing centers and institutes • Preserve core identity while innovating • Educational programs and workforce development • Building visibility and influence 	<ul style="list-style-type: none"> • Safety innovation • Workforce development • Educational excellence • Collaborative leadership 	Targets
<ul style="list-style-type: none"> • Catalysis • Energy storage • AI/ML in materials science • Electronic materials and sensors 	<ul style="list-style-type: none"> • AI/ML applications • Protein-RNA interactions • Novel biomaterials and biocatalysts • Device platforms • Immune mechanoplasticity 	<ul style="list-style-type: none"> • Foundational AI/ML methods for chemical engineering • Multiscale process systems engineering • Defense and space applications • Emerging energy systems • Circular economy and sustainability • Interdisciplinary engagement 	<ul style="list-style-type: none"> • Safety and risk management • Safety in emerging energy technologies • AI and cyber-physical system safety • Safety of analytical data infrastructure 	Future Research
<ul style="list-style-type: none"> • Sustainability • Circular economy • Improving product quality and energy efficiency • Performance enhancement • Formation of leaders in key areas of STEM 	<ul style="list-style-type: none"> • Improved human health outcomes • Unlocked biological systems • Sustainable biomanufacturing • Development of platform technologies • Improved biocompatible materials 	<ul style="list-style-type: none"> • Global impact • Leadership in emerging areas • Industry engagement • Graduate student success • Educational innovation • Visibility and reputation 	<ul style="list-style-type: none"> • Global research • Industry-engaged impact • Safety standards influence • Aggie leader development 	Motivations

AI = Artificial Intelligence ML = Machine Learning

MATERIALS RESEARCH VISION 2030

Strategies

Center-Scale Research Leadership: Focus on center-scale funding in established strengths aligned with state and system priorities to enhance competitiveness for major extramural awards and elevate national prominence.

Visibility and Global Engagement: Expand deep engagement with national and international audiences to amplify visibility and strengthen leadership in materials research.

Crosscutting Innovation: Foster intentional interdisciplinary collaboration to lead in emerging areas spanning biomedical materials, AI-enabled laboratories, and energy and sustainability solutions.

Strategic Talent Development: Implement a focused faculty hiring strategy in high-impact and emerging areas such as artificial intelligence, catalysis, energy storage, and electronic materials to sustain long-term excellence

Expertise Domains and Descriptions

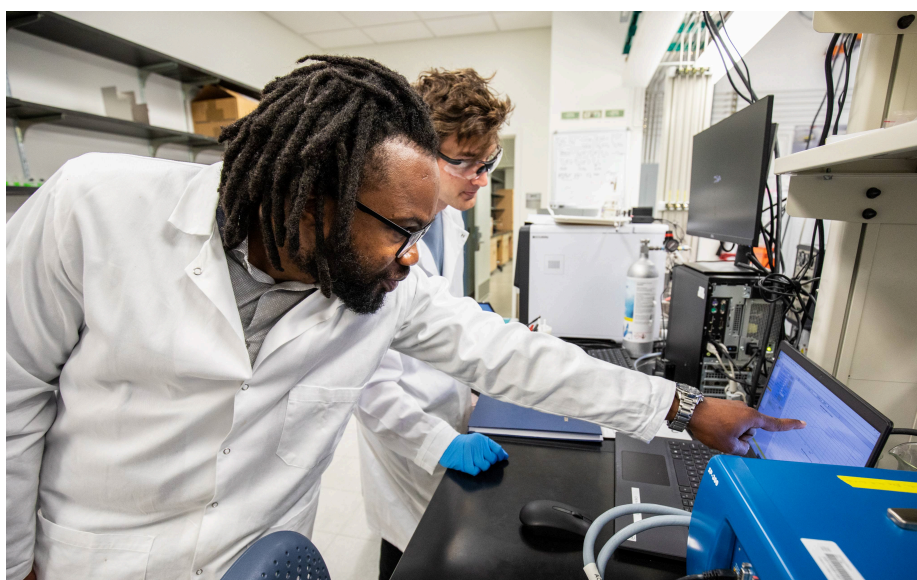
Catalysis and Energy Storage: Advanced experimental and computational catalysis and energy storage research, development of fundamental understanding and design of innovative materials for efficient and durable energy systems.

AI and Machine Learning in Materials Science: Accelerated materials discovery, design, and optimization through AI- and ML-enabled approaches, supported by strategic hiring and integration with institutional AI/ML strengths to drive data-informed innovation.

Electronic Materials and Sensors: Research in electronic materials and sensor technologies aligned with national semiconductor priorities, leveraging institutional partnerships and recruiting research leaders to enable large-scale initiatives. Fundamental and applied research of novel materials emulating neuronal behavior, for next generation analog computing.

Measures of Success

- **Research Impact and Recognition:** High-impact publications, patents, and national and international awards reflecting leadership in materials research.
- **Strategic Leadership and Innovation:** Demonstrated ability to anticipate emerging trends and deliver breakthrough innovations in materials science and engineering.
- **Industrial and Societal Impact:** Translation of research into advanced materials and processes that improve performance, scalability, and environmental sustainability.
- **Graduate Education and Placement:** Strong student outcomes, including awards, interdisciplinary training and placement in leading academic, industry and government roles.
- **Educational Innovation and Reputation:** Modernized curricula integrating emerging materials topics, enhancing departmental visibility and academic reputation.



BIO RESEARCH VISION 2030

Strategies

Multidisciplinary identity: the bio group integrates core chemical engineering strengths across transport, reactions, materials, computation and microfabrication within a cohesive bio-research identity.

Visibility and engagement: national visibility will be elevated through coordinated marketing, conference presence, expanded student participation and a distinguished seminar series in bio-related research.

Infrastructure and partnerships: sustained growth will be supported by reinvestment in shared bio-research infrastructure and strengthened engagement with industry, alumni and advisory council leadership.

Talent and research growth: strategic faculty hiring, a dedicated graduate bio track, seed funding, and support for center-level grants will position the bio group for leadership in biomanufacturing, AI-enabled biotechnology and translational health research.

Expertise Domains and Descriptions

Artificial intelligence and machine-learning powered cancer diagnostics, therapeutics for Alzheimer's, and pathogen detection platforms.

Studies of protein-RNA interactions via multiscale modeling and simulations.

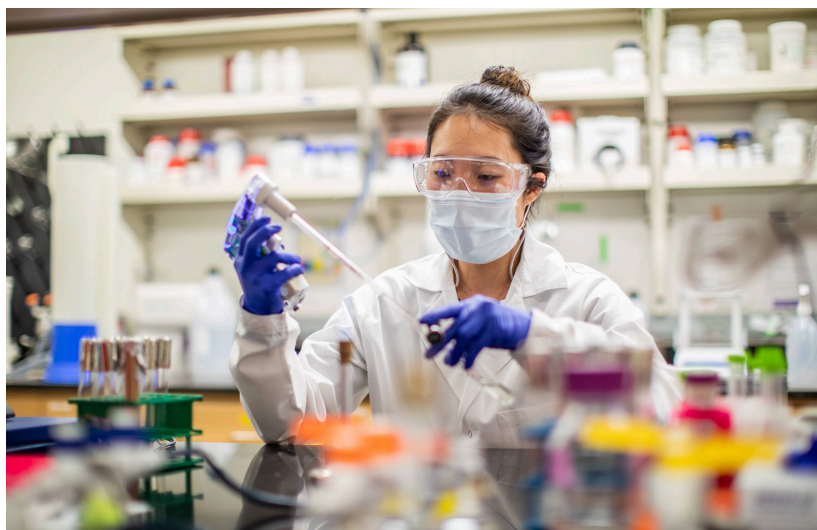
Investigations of neurodegeneration and circadian biology.

Studies of immune mechanoplasticity against infectious pathogens and their role in chronic conditions such as Crohn's disease and inflammatory bowel disease (IBD).

Development of novel biomaterials, biocatalysts, and cutting-edge device platforms spanning microfluidic disease models, nucleic acid amplification technologies, nanoporous separations, hyperspectral imaging and brain-machine interfaces.

Measures of Success

- **Impact on interdisciplinary and technological integration:** excellence in publications and breakthrough innovations, combining diverse fields like AI, nanotechnology, and genomics to accelerate drug discovery, personalized medicine and advanced diagnostics.
- **Strategic collaboration and funding:** demonstrate the transition from early-stage discovery to commercialized therapies and biomaterials development facilitated through strategic partnerships.
- **Enhanced visibility:** faculty and student awards, presentations in conferences, invited and keynote talks and excellence in student placement.
- **Educational innovation:** introduce key aspects of advanced bioresearch into graduate student curricula via elective courses that emphasize essential components of the research and prepare students for academic environments and future placement.



PROCESS SYSTEMS RESEARCH VISION 2030

Strategies

Establishing centers and institutes: launch a branded research center with four divisions: design, operations and control, optimization and data analytics. Position the center as a hub for interdisciplinary collaboration and a point-of-reference for PSS excellence.

Preserving core identity while innovating: balance growth in emerging areas with a commitment to preserve the science and fundamental components of PSS. Ensure the value-added proposition of PSS is clearly articulated in all initiatives.

Educational programs and workforce development: develop new certificate programs, a master's program in process systems engineering and an accelerated BS/MS track. Introduce an undergraduate track in process systems to broaden exposure at early stages.

Building visibility and influence: secure endowed positions and chairs to anchor strategic initiatives and attract top talent. Pursue large-scale, externally funded initiatives, leveraging internal seed funding and donor endowments where needed.

Expertise Domains and Descriptions

Fundamental research in multi-scale process systems engineering that builds on core strengths to tackle problems spanning systems from electrons and molecules to industrial processes and supply chains. This work advances optimization and control for real-time decision-making, integrates AI/ML methods, and enables improved process applications and data-driven operations. The research also includes computer-aided molecular and process design and process safety analysis for energy and environmental systems.

Emerging energy systems that encompass research in low-carbon and advanced energy systems such as nuclear, renewables, and hybrid energy grids while integrating reliability, resilience and safety considerations.

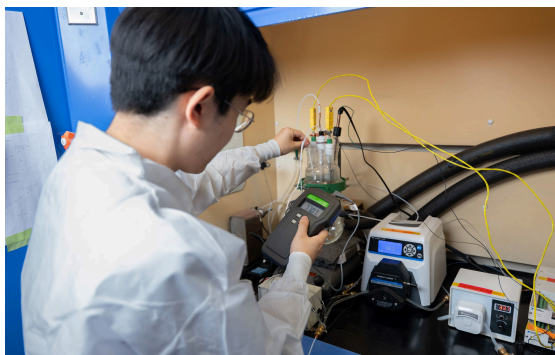
Circular economy and sustainability: design closed-loop, resource-efficient processes that minimize waste, recover materials and reduce environmental impact.

Defense and space applications to apply AI safety, reliability, and process systems engineering skills. Aligned with priorities set by the state of Texas in aerospace, AI, energy security and advanced manufacturing.

Multi- and inter- disciplinary approaches to explore interfaces with health engineering, personalized medicine and biomanufacturing systems, extending systems approaches beyond traditional chemical engineering.

Measures of Success

- **Globally recognized research excellence & impact:** high-quality publications, field-defining contributions and strong presence through invited talks, awards and editorial leadership.
- **Leadership in emerging areas:** initiation and leadership of new research frontiers (e.g., AI-enabled PSE, sustainability, hybrid energy systems) with active cross-disciplinary collaboration.
- **Industry engagement & translation:** strong and growing partnerships with industry, increased sponsored research and tangible translation through tools, patents and technology adoption.
- **Graduate student success & placement:** placement of students in top academia, industry and national labs, along with strong student achievements, publications and career progression.
- **Educational innovation:** development of modern curricula integrating AI, data science, and systems thinking with high student engagement and recognition in teaching excellence.
- **Visibility & reputation:** increased national and global recognition through leadership roles, conference organization, rankings and broad visibility of research and impact.



PROCESS SAFETY RESEARCH VISION 2030

Strategies

Advance process safety knowledge and innovation by developing new concepts, methods, models, tools, technologies and procedures for hazard identification, risk assessment, loss prevention and safer process design and operation.

Build process safety capability across the workforce by preparing engineers, operators, and future leaders with the knowledge and skills required to manage major hazards, strengthen safety culture and support safe and reliable industrial operations.

Lead excellence in process safety education and training by embedding process safety more strongly within chemical engineering education, supporting academics in delivering high-quality safety learning and providing targeted professional and on-site training for industry.

Strengthen process safety impact through collaboration and leadership by connecting industry, academia, and regulators to exchange knowledge, improve standards and practices, accelerate adoption of innovative safety solutions and support safer process industries globally.

Expertise Domains and Descriptions

Process safety and risk management: investigate hazard identification, risk assessment, resilience and human factors across process plants and industrial systems.

Safety in emerging energy technologies: investigate the safety of hydrogen, ammonia, renewable fuels, and CCUS systems with focus on release, ignition, fire and explosion risks.

Artificial intelligence and cyber-physical system safety: investigate AI-enabled safety, anomaly detection, autonomous response and resilience in industrial control and cyber-physical systems.

Safety of analytical data infrastructure: investigate safety of data systems, incident classification and analytics tools to support learning, prediction and better decision-making.

Measures of Success

- **Globally recognized research excellence and relevance**, reflected in high-quality publications and their use in advancing process safety knowledge, practice and education.
- **Demonstrated industry engagement and influence**, reflected in strong collaborations, sustained partnerships and the uptake of research outcomes in industrial practice.
- **Defining the safety related policy, standards, and procedures** reflected in contributions that shape guidance, improve operational practices and strengthen safety performance.
- **Development of highly qualified process safety leaders**, reflected in successful training outcomes, professional capability building and graduate placement across industry and academia.



DEPARTMENT METRICS

RANKINGS

(U.S. News & World Report, Public Institutions)

13th

Undergraduate (2025)

14th

Graduate (2026)

ENROLLMENT

(Fall 2025)

TOTAL

1056

UNDERGRADUATE

745

MASTER'S

131

DOCTORAL

180

DEGREES AWARDED

(Fall 2024, Spring 2025, Summer 2025)

BACHELOR'S

184

MASTER'S

69

DOCTORAL

21

TOTAL

274

FACULTY

Assistant Professors **6**

Associate Professors **6**

Full Professors **22**

Professors of Practice **9**

Lecturers **6**

Total Faculty 49

Endowed Chairs **9**

Endowed Professorships **6**

Endowed Fellowships **8**



PARTNERSHIPS



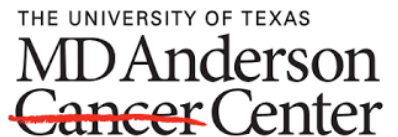
Mary Kay O'Connor
Process Safety Center
Texas A&M Engineering Experiment Station



Ocean Energy
Safety Institute



West Virginia University



Making Cancer History®

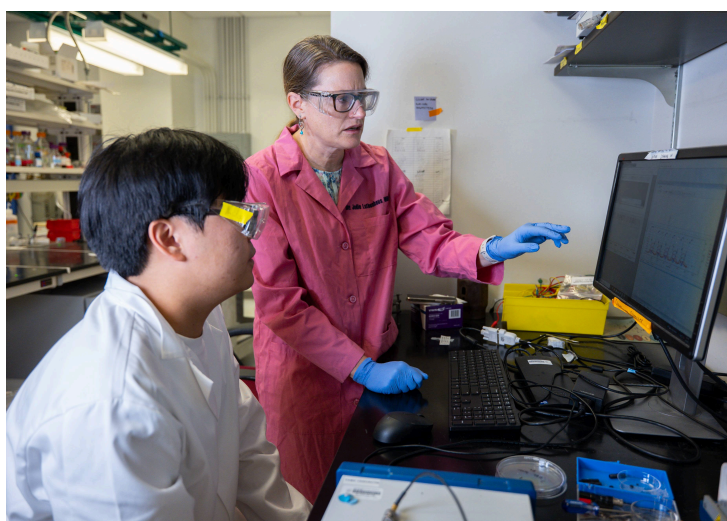


Quantum Forge



RESEARCH PARTNERSHIPS THAT MATTER

The Artie McFerrin Department of Chemical Engineering welcomes inquiries from faculty, industry partners, academic collaborators and other interested parties seeking to pursue collaborative efforts aligned with shared goals and impactful outcomes. Guided by the university's land-grant mission, the department actively seeks partnerships that translate discovery into real-world solutions and serve as a force for good, advancing knowledge, strengthening communities and addressing pressing global challenges. Prospective collaborators should contact the department to help identify aligned expertise, facilitate connections with faculty and support the development of meaningful, high-impact collaborations.



LOOKING FORWARD

Together, our research enterprises reflect Texas A&M University's land-grant mission and enduring commitment to engineering solutions that serve society. Research Vision 2030 was shaped through active engagement with all stakeholders and informed by decades of world-class expertise from the department's faculty. Through interdisciplinary collaboration, strong partnerships with industry and academia and the integration of research with student training, the department continues to address critical challenges in energy, health, sustainability, materials and manufacturing. Collectively, the research efforts of the department demonstrate how engineering excellence with purpose will shape society's wellbeing regionally, nationally and internationally.



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