



STRATEGIC RESEARCH PLAN

The Strategic Research Plan for the Cockrell School identifies the vision, priority areas and roadmap for success of the school's research enterprise over the next 10 years. The priority areas and crosscutting themes align with both the mission of the school and the major challenges facing society. The Strategic Research Plan will inform the school's long-term funding decisions and infrastructure investments, guide engagement with industry, influence faculty hiring and help Texas Engineering researchers organize teams for major initiatives.

PRIORITY RESEARCH AREAS

These areas are designed for multidisciplinary collaboration that addresses the pressing societal problems of the 21st century and beyond:

1. **Reinventing Human Health Through Engineering:** As we continue to explore the basic science of diseases and therapeutics, we will focus on areas that affect outcomes and improve efficiencies in health care.
2. **Leading the Revolution in Manufacturing:** The emergence of optimal manufacturing systems is creating countless opportunities for localized, on-demand manufacturing.
3. **Innovating for Energy, Environment and Sustainability:** Major societal realities impacting our future will require new approaches to finding, generating and storing energy and water.
4. **Advancing Intelligent Systems and Man-Machine Symbiosis:** There will be extraordinary opportunities to enhance and re-envision interconnected technologies and systems to help people make better decisions in real time.

CROSSCUTTING THEMES

These themes span the spectrum of engineering and fluidly link our disciplines and researchers:

1. **Empowering 21st Century Learners and Innovators:** The need to educate more engineers in an increasingly competitive and cross-disciplinary environment will require us to transform the way we educate and prepare our students.
2. **Designing and Developing New Materials:** We will focus on advancing material innovations that will move society forward and create opportunities for products and processes to improve the quality of life.
3. **Modeling and Simulation of Complex Systems and Networks:** Computational modeling has revolutionized the engineering enterprise, and we will continue to explore possibilities to accelerate developments in simulation and visualization.



TEXAS ENGINEERING: UNIQUELY POSITIONED

Situated in the heart of one of America's fastest-growing and most technology-driven cities, the Cockrell School is advantageously positioned and brings a breadth and diversity of research expertise. We are fostering a culture that supports risk-taking and multidisciplinary innovation. Our community of recognized engineering thought leaders spans nearly every technical area critical to the economic competitiveness of Texas and the United States, and our organizational model allows for quick action and unique partnerships with industry.



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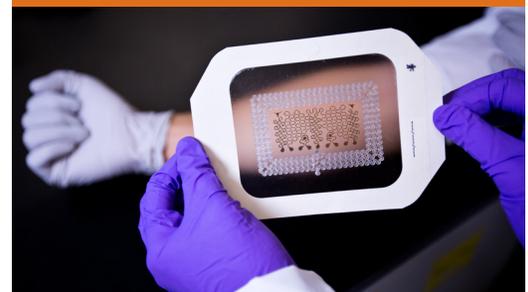
Priority Research Areas

Reinventing Human Health Through Engineering

Now more than ever, engineering research is fundamental to the advancement and improvement of human health. As we continue to explore the basic science of diseases and therapeutics, treatments for injuries and clinically translatable solutions, we will focus our efforts on areas that affect outcomes and improve efficiencies in health care. By applying multidisciplinary engineering innovation to biomedical and health solutions, we will drive the future of health care technology development and health informatics.

Research Focus Areas

- Engineering innovation in population health and health care
- Accessible technologies to improve and sustain health
- Health informatics and analytics to help patients and health care providers make better decisions



WORLD-CHANGING TEXAS ENGINEERING RESEARCH BREAKTHROUGHS

The **smallest, fastest and longest-running nanomotor** is a major step toward development of miniature machines that can move through the body to deliver drugs to patients.

HARMONY, a first-of-its-kind, full-upper-body rehabilitation robot, provides advanced treatment and data-driven therapy to patients with spinal and neurological injuries.

The **revolutionary 3-in-1 skin cancer detection device** combines spectroscopic techniques to reveal melanoma and lesions noninvasively.

A **groundbreaking monoclonal antibody** to combat pertussis (whooping cough), which until now has caused an estimated 294,000 deaths every year, has the potential to save the lives of thousands of young children around the world.



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Priority Research Areas

Leading the Revolution in Manufacturing

We have seen major changes in manufacturing in the 21st century, with streamlined systems and on-demand platforms growing exponentially in recent years. The emergence of optimal manufacturing systems, such as smart manufacturing, digital manufacturing, agile manufacturing, sustainable manufacturing and recycle-by-design, is creating countless opportunities for localized manufacturing industries. These new paradigms will change global manufacturing platforms and impact facility infrastructure and supply chains, intellectual property and enterprise economics — as society shifts toward increased personalization of products and services.

Research Focus Areas

- Intelligent, personalized and small-lot manufacturing
- Transformational manufacturing systems
- At-scale manufacturing of nanosystems



WORLD-CHANGING TEXAS ENGINEERING RESEARCH BREAKTHROUGHS

A game-changing **honeycomb-shaped structure that “bounces back”** can be embedded in car bumpers, helmets and more to minimize the effects of impacts.

Selective laser sintering, one of the world's first 3-D printing processes that was invented at the Cockrell School, has helped to reduce costs and drive innovation in advanced manufacturing for decades.

The **Laser Additive Manufacturing Pilot System**, a revolutionary new SLS-based machine, allows for exact, repeatable manufacturing in mass production.



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Priority Research Areas

Innovating for Energy, Environment and Sustainability

Major societal realities impacting our future include an increased global demand for energy and resources, the emergence of megacities, an aging and deteriorating built infrastructure and insufficient access to water. These challenges will require new oil and gas exploration and production technologies; new energy generation, storage, distribution and conservation technologies that both maintain our economic competitiveness and protect the environment; better approaches for water reuse and development of new water sources; safe, efficient, reliable and resilient built environments; and responsible, effective responses to climate change that promote sustainability and help preserve our environment.

Research Focus Areas

- New technologies to support sustainable growth of cities
- Innovation in water, transportation, energy and the environment
- Novel approaches for evaluating and extending the service life of infrastructure systems
- New technologies to expand and enhance the extraction of hydrocarbons



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An **innovative new downhole tool**, developed for use in fracture diagnostics to improve oil and gas recovery, could significantly reduce costs and minimize the environmental footprint of hydraulic fracturing.

A **new mutant yeast strain**, developed by combining metabolic engineering with directed evolution to significantly enhance lipid production, has uncovered a future source of biofuel production.

A **technology that reduces heat from ultrahot surfaces** while consuming low levels of power is poised to bring about safety and cost-saving benefits for steam-generating power plants around the world.



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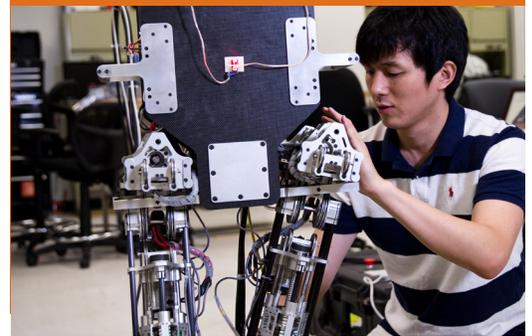
Priority Research Areas

Advancing Intelligent Systems and Man-Machine Symbiosis

The interconnectedness of humans, devices and machines is omnipresent in everyday life. Devices and machines are informing and affecting the abilities we once knew as innately human — perception, rationalization and intellect — creating powerful technologies and intelligent systems that allow for better decision-making in dynamic and complex environments. Rapid developments in sensing and autonomous technologies are transforming the industries. Moving forward, there will be extraordinary research opportunities to enhance and re-envision these technologies and systems to harness their potential and help make real-time decisions based on combinations of quantitative and qualitative data.

Research Focus Areas

- Information and decision science
- Cyber security
- Universal information systems
- Cyber-human-physical systems
- Ubiquitous sensing
- Communications
- Autonomous and connected systems
- Intelligent devices
- Internet of Things



WORLD-CHANGING TEXAS ENGINEERING RESEARCH BREAKTHROUGHS

A new **centimeter-accurate GPS system** — now the most accurate geolocation technology in existence — is poised to revolutionize mobile device capabilities and expand future industries.

Toopher, a two-factor password authentication system, creates a significant reduction in password fraud by using the physical location of a user's phone, a novel approach to this type of authentication.

A **radically smaller, more efficient radio wave circulator** that can be embedded in cell phones and other wireless devices could advance modern telecommunications technologies by doubling existing data bandwidth.



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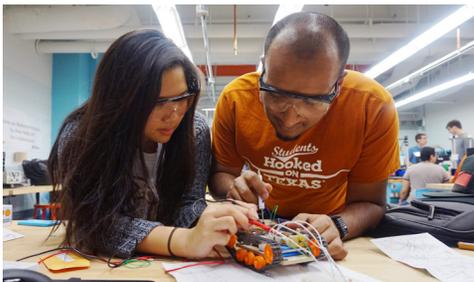
Crosscutting Themes

Empowering 21st Century Learners and Innovators

The need to educate more engineers in an environment that is increasingly competitive globally and places a premium on cross-disciplinary solutions will require us to advance learning models and transform the way we educate and prepare our students.

Focus Areas and Initiatives

- Decision-making
- Entrepreneurship
- New engineering educational models
- Project-based learning



Inside the new **Longhorn Maker Studio**, students learn by doing. With free access to 3-D printers and scanners, laser and plasma cutters, hand tools and much more, engineering students of all ages and disciplines can build and test their own prototypes.



Cockrell School professor of innovation **Bob Metcalfe, inventor of the Ethernet** and recipient of the National Medal of Technology and Innovation, serves as a teacher and mentor to Texas Engineering students and faculty, helping them to transform their ideas and research into successful companies.



"Energy 101," a first-of-its-kind, fully downloadable academic course app developed by professor Michael Webber, offers a world-class energy curriculum to anyone with an iTunes account. Since its launch, the app has been adopted by several universities, including Duke and Stanford, for their energy-related programs.



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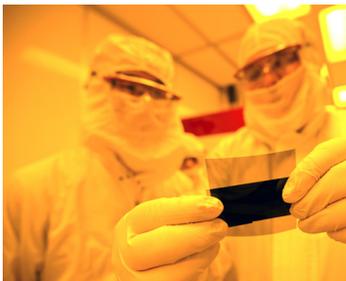
Crosscutting Themes

Designing and Developing New Materials

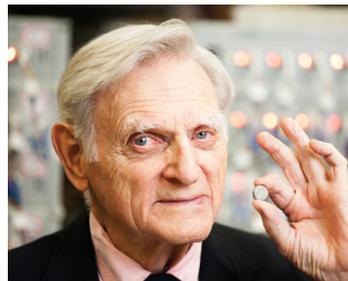
Throughout modern history, material innovations have influenced the progress of virtually every industry, advanced society and created opportunities for products and processes to improve quality of life and drive economic development.

Focus Areas and Initiatives

- Innovation in materials for energy, electronics, health care and infrastructure
- Manufacturing
- Materials chemistry
- Materials engineering
- Molecular and multi-scale design of efficient materials
- Nanoscience
- Solid-state physics



A nationally renowned center with multiple partner universities, the **Nanomanufacturing Systems for Mobile Computing and Mobile Energy Technologies (NASCENT)** center creates versatile, reliable nanomanufacturing systems by leveraging expertise across multiple disciplines.



Texas Engineering professor **John Goodenough**, recipient of the National Medal of Science, Japan Prize and NAE Draper Prize, invented the lithium ion rechargeable battery. His world-changing research in materials and energy storage continues today in his lab at the Cockrell School.



Chemical engineering department Chair **Tom Truskett**, along with a team of researchers and graduate students, are working with complex fluids to develop a new generation of at-home, injectable treatments for diseases.



Electrical and computer engineering professor **Deji Akinwande**, who created the world's smallest transistor by working with a material called silicene, continues to advance the capabilities of this thinnest form of silicon.



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Crosscutting Themes

Modeling and Simulation of Complex Systems and Networks

The increase in computer power and the development of advanced algorithms have enabled simulation of complex problems at scales never before envisioned. Computations are reducing the need for physical experimentation, producing faster and better product designs and enabling more sophisticated and accurate simulations. By accelerating simulation and potentially reducing research costs, computational modeling will enable extraordinary discoveries. Moreover, the combination of models and data is leading to significant advances in decision-making.

Focus Areas and Initiatives

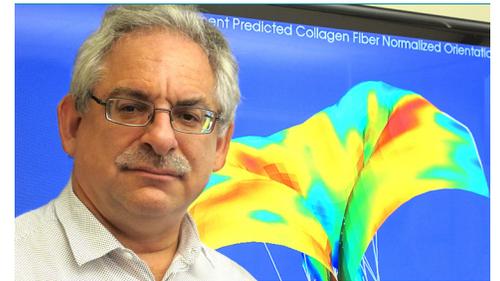
- Data analytics
- Decision analytics
- Multi-scale methods
- Uncertainty quantification
- Validation



Cockrell School professor **Mary Wheeler**, an expert in hydraulic fracturing and subsurface modeling, has led extensive research projects with the National Science Foundation, U.S. Department of Energy and numerous energy companies to formulate and analyze scalable algorithms that address subsurface phenomena.



Developed by professor **Clint Dawson**, innovative computer simulations that track, measure and predict hurricane storm surge will provide more accurate models that aid in disaster evacuation efforts and help save lives. His groundbreaking research is possible by utilizing two of the world's most powerful supercomputers, which are located at UT Austin.



Biomedical engineering professor **Michael Sacks**, a trailblazer in computational simulation and leader in applying it to biomedical experimentation, has made transformative discoveries that better treat heart and valvular disease.