THERMAL/FLUID AND ENERGY SYSTEMS

Overview of the Research Focus
This specialty area involve the application of basic fundamental laws of fluid flow, heat transfer and thermodynamics to the development and understanding of many engineering and naturally occurring systems. Application to systems can vary based on the interest of the faculty members and students. At this moment faculty in the department are focusing on:

- Building Energy

This research topic focuses on research in building energy simulation, system building technology integration, building systems controls, and building technology deployment. Although residential and commercial buildings will be of interest, efforts will be focused on residential buildings.

This research area can be developed in a synergetic approach with educational and service activities. Educational activities includes curriculum courses and professional training. Curriculum courses include MENG 4312 – System Dynamics and Control, MENG 4316 – Introduction to Building Energy Simulation and MENG 5341 – Energy Management, along with MENG 5340 – Advanced Topic of Mechanical Engineering, which has a topic focus in Solar Energy. Professional training may be offered through workshops as well as participation in programs at the Training and Test Center of the Building Performance Institute. Service can be offered through programs as the Home Energy Scoring of the Department of Energy.

Need for the Research

- Building Energy

According to the U.S. Energy Information Administration, the residential sector (23%) and commercial sector (19%) comprise 42% of the total energy consumption in the United States. Energy consumption from buildings has a direct impact on the environment, with the emission of greenhouse gases being the main concern around the world as it drives global warming. Although energy efficient and renewable energy technologies are available, and energy conservation strategies are promoted through programs such as Energy Star of the U.S. Environmental Protection Agency, the economic “first-cost” versus “return-on-investment” aspects of many of these technologies are still not easily characterized or well understood.

Modeling the performance of a building enables building professionals to optimize the building design to use less energy and water. Approaches for building energy modeling can be classified as statistical or black-box, hybrid or gray-box, and engineering or white-box. Statistical approaches need measured data but not buildings characteristics, while the engineering approaches need building characteristics, but not data. Engineering approaches have the shortcoming that most of the time building information is limited or not cost-effective to find. Statistical approaches have the shortcoming that requires abundant data to reproduce accurate results, which is not always available or complete; besides the fact that the parameters of the model lack of physical significance and energy efficiency measures cannot be properly assessed without retraining the model. In the search of balancing the advantages and disadvantages of engineering and statistical approaches, it seems that hybrid approaches may offer models with equivalent simpler physical equations with regression parameters that can be obtained with less data.

The CECS has the TXAIRE Research and Demonstration Houses, which are a key asset to leverage research on energy analysis for residential buildings.
Publications

Supporting Facilities
The TxAIRE research and demonstration houses were designed and built focused upon multidisciplinary building systems applications engineering. The two houses serve as realistic test facilities for identification, development, demonstration, evaluation and promotion of technologies related to energy efficiency, indoor air quality, and sustainable construction materials and methods.

Research by Graduate Students

Impact of Past Research
The research program in Energy has not been formally established in the Mechanical Engineering Department. Individual initiatives has been conducted by interested faculty members without a structure of a research group in the search of common goals. Therefore, at this point there is no relevant impact to be reported.

Possible Sources of Funding
UT Tyler Office of Sponsored Research and CECS.
National Science Foundation.
Department of Energy.
American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

Faculty
Dr. Nelson Fumo, Dr. Fredericka Brown, and Dr. Mohammad Biswas
BIOMECHANICS AND BIOMATERIALS

SYNOPSIS OF RESEARCH FOCUS

Overview of the Research Focus
Stability and sustainability are the most critical issues for the design and processing of biomedical implants. The multiscale relative motions between modular components will damage the counter surfaces. The mechanical damage will be accelerated by the corrosive body fluid. Therefore it is very important to understand the complex mechanical and biological phenomena to challenge the implant design and manufacturing.

Need for the Research
The development of research program in Biomechanics and Biomaterials, with their potential for increased biocompatibility, optimum design solution, and reduced processing costs, are a greatest triumph of biomedical technology. Department of Mechanical Engineering has developed to exploit the biomedical implant systems and their sustainable performance. The research program focuses on understanding and manipulating biological-mechanical interfaces in various biomedical devices, including total joint replacements and cervical discs. The research team is conducting a series of experimental works to inspect artificial joint lubrication, design innovations, and biomechanical modeling of prosthetic joint performance.

Publications
- J.J. Ryu and P. Shrotriya “Influence of Roughness on Surface Instability of Medical Grade Cobalt-Chromium Alloy (CoCrMo) during Contact Corrosion-Fatigue”, Applied Surface Science, 2013, 273, 536-541

Supporting Facilities
Scanning Electron Microscope (Jeol JSM 6510LV Scanning Electron Microscope) with Low Vacuum is available to inspect the surface morphology and chemical composition of bioimplant materials. The Materials Science Laboratory Equipment houses:

(i) General mechanical property characterization instruments: Rockwell Hardness Tester (Wilson), Charpy Impact Tester (Tinuis Olsen), 100 kN Universal Testing Machine (Tinius Olsen).
(ii) The sample preparation devices: include metallurgical cut off machine, grinders and polishers (Buehler), Specimen mounting facilities and etchant facilities
(iii) Optical microscopies: Trinocular bright-field microscope (Nikon) and an inverted, Trinocular bright-field microscope (Unitron) with computer capture video camera micrography for the microscopes, Spectrometer for measuring alloy composition of ferrous alloys (Spectrolab)
Undergraduate Research

Undergraduate research opportunities have been offered in the past two years. Their research works have been reported at 2013 USMA Capstone Conference and presented at 2014 Annual conference of Society for Experimental and Applied Mechanics and 2014 Annual Conference of World Congress of Biomechanics.

Impact of Past Research

Several research proposals were submitted to the major research grant agencies such as US Army, NIH, and NSF. Research collaboration has been built in between Mechanical Engineering, Chemistry (Shawn Black) and Biology (Ali Azghani) departments.

Possible Sources of Funding

It is expected to have research grant opportunities from US Army, National Institute of Health (NIH), National Science Foundation (NIH) and Norman Hackerman Advanced Research Program (NHARP)

Faculty

Dr. Thomas Crippen, Dr. Fredericka Brown and Dr. Sara McCaslin