Fall 2014/Spring 2015 HERE Projects

Enhancing Green Paving in Oklahoma Using Recycled Asphalt Shingles
Prof. Musharraf Zaman
School of Civil Engineering and Environmental Science
Each year, an estimated 11 million tons of old asphalt shingles from roofs are disposed of in the United States. In Oklahoma, it costs between $50 and $150 per ton, depending on size and kind of debris, to dispose of these materials in landfills. Recent studies have shown that recycled asphalt shingles (RAS) contain hard crushed aggregates, viscous binders, and fibers that are desirable for the production of hot mix asphalt (HMA) for paving applications. Using only 5% RAS in HMA can save $1 - $2.80 per ton and improve the quality of the mix. The proposed study will investigate the volumetric properties and performance (moisture damage potential, rutting and fatigue) characteristics of HMA mixes containing RAS. One commonly used asphalt shingle in Oklahoma and one commonly used aggregate and virgin binder will be used. The proposed study will enhance "green paving" in Oklahoma.

Inter-vehicle communication for increased safety
Prof. Mohammed Atiquzzaman
School of Computer Science
Modern vehicles are equipped with lots of sensors for measurement of vehicle operating conditions and the surrounding weather conditions. The sensors collect information about the vehicle, such as location, speed, braking intensity, road traction, etc., some of which can represent road weather conditions. The objective of this project is to reduce vehicle crashes, fatalities and injuries due to adverse weather conditions, by alerting drivers in real-time of potentially hazardous road conditions in the region based on information from neighboring vehicles. The dissemination of vehicle and road condition information will be carried out in this project by an Ad Hoc network which will connect the vehicles in the neighborhood.
An experimental testbed will be constructed using vehicles outfitted with communication capability to wirelessly communicate with neighboring vehicles using the industry-standard communication protocol for vehicular communications. A safety application will analyze the information from neighboring vehicles and develop a threat map to alert the driver of potentially hazardous road conditions. The undergraduate student will help the faculty to implement a testbed vehicular communication network using off-the-shelf components.

Computer Monitoring of Rapid Thermal Processing in the University Cleanroom
Prof. Patrick McCann and Prof. Ian Sellers
School of Electrical and Computer Engineering and Department of Physics and Astronomy
The University Cleanroom (UC) supports a number of research projects at OU. Many of these projects require rapid thermal processing (RTP) where samples (typically a semiconductor chip) need to be heated quickly to a high temperature (as high as 1000°C) in a controlled atmosphere (typically nitrogen, argon, or oxygen). The UC has acquired an RTP tool, but it does not have a provision to record the processing temperature. We are looking for a student who has an aptitude for working with computers and is interested in working in a cleanroom environment. The work will involve analog-to-digital conversion of thermocouple voltages and developing a user interface that displays temperature as a function of time. In addition, this student can also use this enhanced RTP system to help process samples such as electrically conductive ZnO thin films, and GaInNAs materials that are being investigated for use in next generation photovoltaic devices.

Anechoic Chamber Start-Up
Profs. Caleb Fulton and Jessica Ruyle
School of Electrical and Computer Engineering
The Advanced Radar Research Center's (ARRC's) new building, the Radar Innovation Laboratory, will officially open at the beginning of the Fall 2014 semester. This building houses a wide variety of high-tech design, fabrication, and testing equipment for various radar, antenna, and wireless circuits and systems. Central to these capabilities is a nearly $2 million pair of anechoic chambers for characterizing the radiation properties of antennas. Beginning in the Fall semester, the ARRC will be starting a number of research projects that revolve around the characterization of these chambers and associated equipment to better understand the limitations to measurement accuracy and flexibility. This will also include advanced antenna measurements using a reconfigurable antenna driver and a near-field antenna scanner. These effort will require a wide range of support from faculty, engineering staff, and students. Drs. Fulton and Ruyle are looking for approximately two highly-motivated junior/senior ECE or Engineering Physics students with a passion for learning about applied electromagnetics to participate in the 2014 HERE program by assisting with this overall campaign.

Analysis of ZnO Schottky diode solar cells
Prof. Ian R. Sellers
Department of Physics and Astronomy
ZnO is an interesting material with potential for applications in several areas of optoelectronics including high power transistors, UV emitters and detectors, and photovoltaics (PV). Currently, the PV materials and devices group at OU is working to investigate these wide band gap materials for solar cell applications in space in collaboration with the University of Tulsa (TU) and Oklahoma State University, through a NASA funded project. The TU group have supplied OU with cobalt-doped ZnO with the aim to extend the absoprtion band of the ZnO into the visible region of the solar spectrum. As such, a student is needed who is interested in experimental PV research, specifically to undertake a project that will involve fabricating ZnO Schottky diodes using thermal evaporation, along with PV characterization using: quantum efficiency, current-voltage, and capacitance-voltage spectroscopy in the Department of Physics & Astronomy.

Novel Shape Memory Deployable Nanocomposites: design, fabrication, and characterization
Prof. Yingtao Liu
Department of Aerospace and Mechanical Engineering
Shape-memory polymers (SMPs) have the shape-memory effect as if they can be deformed and fixed into a temporary shape, and then recover their permanent shape by external stimulus. Epoxy based SMPs and other nanomaterials will be integrated within fiber reinforced composites for the design, fabrication, and characterization of novel deployable nanocomposites. This research project will investigate the shape memory mechanism of SMP as well as SMP based nanocomposites. The research outcomes will have a strong impact on the development of next generation deployable space vehicles.

Wireless communication for in-situ structural health monitoring
Prof. Yingtao Liu
Department of Aerospace and Mechanical Engineering
In recent years, there has been an increasing awareness of the importance of damage prognosis systems in civil, mechanical and aerospace structures. It is envisaged that a structural health monitoring (SHM) system in a structure would apprise the user of the structure's health, inform the user about any incipient damage in real time and provide an estimate of the remaining useful life of the structure. One bottleneck of current SHM techniques is that the wired communication between sensors and controllers are expensive and unreliable. A novel wireless communication approach will be investigated in this project using a single board Raspberry PI system. The student will gain hands-on experience in developing new wireless communication techniques using the cutting edge technology.

Advanced Cylindrical Polarimetric Phased Array Radar Testing
Prof. Caleb Fulton
School of Electrical and Computer Engineering
The OU Advanced Radar Research Center, in partnership with the National Severe Storms Laboratory, has spent the last year constructing a Cylindrical Polarimetric Phased Array Radar (CPPAR) to demonstrate a wide range of advanced techniques for satisfying next-generation weather radar sensing requirements. This mobile system consists of a 2m x 2m cylindrical phased array mounted on top of a trailer in which is housed an array of electronics that amount to 96 independent digital radar systems that will work together to form highly-accurate, polarimetric (dual polarization) observations of Oklahoma's exciting weather events. Critically important in achieving this accuracy will be efforts to calibrate each of these systems to maintain the correct amplitudes and phases to synthesize high-quality beams. A number of different techniques (near-field, far-field, mutual coupling, and more) are being investigated to help support the overall calibration goals, and the CPPAR team is looking for approximately two highly-motivated junior/senior students with a passion for learning about applied electromagnetics to participate in the 2014 HERE program by assisting with these efforts."

Engineering Design for a Green Tricycle
Prof. Kuang-Hua Chang
Department of Aerospace and Mechanical Engineering
With the increasing awareness in environmental protection and energy preservation, the demand on green energy powered vehicles is on the rise. Electric or hybrid vehicles are gaining momentum and becoming more popular among consumers. However, battery technology (such as energy capacity), infrastructure (such as charging stations) and high product cost remain challenging in bringing electric cars to household in the U.S. A viable alternative for short-range transportation is green tricycle of low cost, powered by green energy (such as solar) and human power (peddling). This project aims at designing a green tricycle with a sale price less than $2,000, which involves (1) concept design, in which size and weight of the tricycle, green energy acquisition and use, transmission and steering systems are to be determined and analyzed; (2) detailed design, in which major components are to be modeled, suspension performance is to be simulated, and structural integrity of load carrying components are to be analyzed using advanced computer simulation tool and technology; and (3) cost estimating, including detailed cost breakdown, overhead, and desired profit margin.

Engineering Device for Impact Energy Mitigation
Prof. Kuang-Hua Chang
Department of Aerospace and Mechanical Engineering
When a projectile impacts another solid surface, severe damages may be caused on both sides as high-pressure stress waves are generated. To protect personnel and important infrastructures and devices, protection or damping materials are often employed to "absorb" the mechanical energy. Such an energy absorption process is essential in almost every aspect of human activities, and the important factors that govern the generation, propagation, transmission, and reflection of intense stress waves have been an active area of research for decades. In the past, energy absorption of protection/damping materials is mainly based on energy dissipation, which causes a fundamental conflict between the requirements of safety/comfort and efficiency. In recent study, a nanofluidic "energy capture" system is reported, which is based on nanoporous materials and nonwetting liquid. Both molecular dynamics simulations and experiments show that as the liquid overcomes the capillary effect and infiltrates into the nanopores, the mechanical energy of a stress wave could be temporarily stored by the confined liquid phase and isolated from the wave energy transmission path. This project aims at (1) understanding the basic physics of the impact wave and energy and theory of energy capture, and (2) designing an impact energy capturing device and carrying out physics-based analysis and simulations to characterize the performance of such a device.

Computational Homogenization for Multi-Scale Analysis of Engineering Materials
Prof. Kuang-Hua Chang
Department of Aerospace and Mechanical Engineering
Research in exploring high strength, durable, and light-weight materials has been conducted for many years. Many approaches are being developed, including bio-mimicking, in which micro-structure of nature and/or bio-materials, such as spider silk, were studied extensively. One of the approaches that have been proven effective in characterizing the mechanical properties at the macro-scale level from its micro-cells is computational homogenization. Homogenization supports exploration of micro-cell designs such that the resulting macroscopic behavior exhibits the required characteristics. In this project, we will go down to the very bottom level by using modular dynamic (MD) simulation to design material cell and employing homogenization method to characterize macroscopic material behavior. This project aims at: (1) understanding basic theories in computational homogenization and MD simulation, and (2) developing theoretical and computational techniques that support the design of high-strength, durable, and light weight material by creating material microstructure at the atomistic level.

Rock & Roll during Earthquakes
Prof. Scott Harvey
School of Civil Engineering and Environmental Science
The floor motion in an earthquake-excited structure may cause toppling of free-standing objects, such as essential equipment or valuable property. Equipment isolation is a promising solution for protecting such objects from earthquake hazards. In particular, rolling isolation systems have been installed within buildings worldwide. However, the rocking response of equipment resting on an isolated base has not been analyzed to date. This research project will (i) investigate the nonlinear dynamic response through simulations and experimental measurements and (ii) assess the performance of these systems. Applicants from Civil Engineering & Environmental Science or Aerospace & Mechanical Engineering are encouraged to apply. Experience with Matlab is helpful but not required.

Ceramic Circuit Board Implementation using 3D Printing:
Prof. Hjalti Sigmarsson
School of Electrical and Computer Engineering
Traditional, glass-woven epoxy circuit boards are not suitable for harsh environments. An alternative is using ceramic-based boards. Several methods are available for realizing such boards and the most commonly used is called low temperature co-fired ceramics (LTCC). The method is based on creating multi-layer boards consisting of so-called LTCC tape, which consists of glass and ceramic powder impregnated into organic binder material. Individual layers of tape are processed sequentially with via through connections and multiple materials for generating functional circuits using selective masks. These materials can include: conductors, dielectrics, and ferromagnetics. One of the benefits of LTCC, compared to other ceramic circuit board methods, is the fact that gold, silver, and copper can be used for the conductive portions of the circuit, which results in improved overall performance. This is due to the high conductivity of these metals. The individual layers of tape are then collated and laminated to form a solid, multi-layer board. Finally, the board is subjected to a firing process which burns out the organic materials and leaving only the ceramic and the functional circuit materials.
This process is commonly used in industry, but is of limited use to universities and relatively small scale laboratories due to the expensive equipment required and the highly skilled engineers that are needed to carry out the process correctly. Therefore, an alternative, relatively cheap, and simple implementation of LTCC could enable widespread prototyping of ceramic circuits and expose a far greater number of students to this type of processing than ever before.
In this project a new method for rapid prototyping of LTCC will be investigated. This method consists of using a 3D printer to put down multiple LTCC materials as paste and thus bypassing the screening stage and all the tape processing. Prototypes circuits will be fabricated and characterized.

Kinetics and reaction mechanisms in the upgrading of biofuels
Prof. Daniel Resasco
School of Chemical, Biological, and Materials Engineering
Bio-oil produced by fast pyrolysis of lignocellulosic biomass has attracted considerable attention as an intermediate liquid product towards the production of fuels. However its chemical instability, high viscosity, and corrosiveness limit their processability and storage. One of the greatest challenges in the upgrading of bio-oil is the accelerated degradation that occurs when the condensed liquid is subsequently heated for fractionation or other processing. Catalytic upgrading is an attractive strategy that can be used to optimize carbon efficiency and minimize hydrogen usage. Important reactions for this upgrading include: (a) formation of C-C bonds to extend the carbon backbone of short oxygenates to the desired gasoline/diesel range via aldol condensation and ketonization in aqueous phase; (b) incorporation of short carbon fragments (C1-C3) into the aromatic ring of phenolic compounds via alkylation in biphasic systems; (c) deoxygenation of the resulting products to monofunctional compounds or hydrocarbons in the liquid phase.
The goal of this research is to conduct one or more of these reactions in high-pressure batch reactors and develop heterogeneous kinetic models to experimentally test (negate or verify) reaction mechanisms previously proposed on the basis of theoretical concepts or preliminary experiments.

Competition Team Experiences
Prof. Deborah Trytten
School of Computer Science
"Our success as a nation depends on strengthening America's role as the world's engine of discovery and innovation" (President Obama, September 2010). This quote is from the President's announcement of a new innovative industry partnership aimed to fill the "opportunity gap" among women and students of color (changetheequation.org). This announcement sparked new attention to the need to improve recruiting and retention of underrepresented groups in STEM disciplines, particularly engineering. The Research Institute for STEM Education (RISE) at OU has focused on this issue for more than 10 years through research and development of models of success for underrepresented groups in engineering. Development of these models is framed by interdisciplinary methods and requires multi-dimensional analysis of student's complex experiences as engineering students. One highly touted component of experiential learning is the engineering design competition teams. This research project will explore existing data sets of student surveys and interviews to develop recommendations for the College and Nation in response to the research question: "How do engineering competition teams function, why do students participate, and what factors help teams achieve success?"

Sulfur in gasoline and diesel: computational simulations to solve the problem
Prof. Bin Wang
School of Chemical, Biological, and Materials Engineering
For health and environmental reasons, clear fuels are more and more required. In gasoline, diesel fuels and jet fuels, the sulfur content has to be reduced from the current level, because sulfur reacts to form SOx during combustion, which not only contributes to acid rain, but also poisons the catalytic converter for exhaust emission treatment. There are various sulfur-containing molecules such as thiophene, benzothiophene (BT), dibenzothiophene (DBT) and their derivatives. The chemical reactivity of these molecules is very different, and therefore, the difficulty of removing these sulfur-containing molecules varies significantly in industrial processes.
In this project, the student will learn the basic computational techniques and software. The second step is to calculate the molecular properties and demonstrate their relationship to sizes and structures. Then the student will compare the energy cost between to remove the sulfur from these molecules and to hydrogenate the molecules. Through the step-by-step investigation, the student should be able to apply basic computational methods and explain the origin of the different chemical reactivity of these sulfur-containing molecules.

Characterization of Tissue Mechanical Change in Post-Blast Exposure Ear
Prof. Rong Gan
School of AME and OUBC
Sound transmission pathway from the environment to the ear canal, middle ear, and inner ear relies on structures and properties of the ear tissues such as the eardrum, ossicular joints, and suspensory ligaments. Mechanical properties of these soft tissues may change after blast exposure in combat operations. However, the tissue mechanical changes associated with the blast exposure are largely unstudied. This research project will use the human ear tissues and our high intensity sound chamber to investigate the change of mechanical properties of tissues in acoustically injured ears. The dynamic mechanical analyzer (DMA) will be used for experimental measurement on tissue samples from normal and post-exposure ears.

Simulation of Muscle Active Response to Blast Exposure in a Finite Element Model of Human Ear
Prof. Rong Gan
School of AME and OUBC
When exposed to a blast, the human auditory system is vulnerable to both peripheral and central damage from the overpressure. Rupture of the eardrum is the most frequent injury of the ear. However, middle ear also has protective function through two muscles' active response to high intensity sound. This research project will investigate the middle ear protection mechanisms during blast exposure through two approaches: 1) simulation of active muscle function (e.g., stapedius muscle) in a finite element model of the human ear; 2) experimental measurement of acoustic reflex of middle ear muscles in an animal model.

3D FE Model of Guinea Pig Ear for Sound Transmission from the Ear Canal to Cochlea
Prof. Rong Gan
School of AME and OUBC
A 3D solid model of guinea pig ear including the external ear canal, eardrum, ossicular chain, middle ear cavity, and cochlea is first constructed based on the μ-CT images at a resolution of 10 μm using Amira software. The next step is to develop the finite element (FE) model of the guinea pig ear and simulate sound transmission from the ear canal to cochlea. The acoustic-structure-fluid coupled analysis will be conducted in the FE model over the frequency range of 0.2-40 kHz in ANSYS. The FE model will be validated by comparing the model-derived vibration of the eardrum with the experimental measurements obtained in both normal and diseased ears.

Build your own Google Image Search
Prof. Samuel Cheng
School of Electrical and Computer Engineering
Content-based image retrieval aims to recover similar images of an input image from a database based on image features only (http://en.wikipedia.org/wiki/Content-based_image_retrieval). It is an active research area and there are still many open issues. However, open source content based image retrieval engines do available publicly. In this project, you will have a chance to build a testbed for a content-based image retrieval application using one of the well-documented engines, Golden Retriever-Image Retrieval Engine (http://www.grire.net/).

Finding restroom in Hong Kong
Prof. Samuel Cheng
School of Electrical and Computer Engineering
Even though there are lots of public restrooms in the city of Hong Kong, it is not easy for tourists to find one nearby. However, locations of restrooms are available at the Hong Kong government website (http://www.fehd.gov.hk/english/map/fehd_map_e.xml). In this project, you were asked to take advantage of this info and build an android app to help tourists to find what they need in the city. You may use App Inventor 2 (http://ai2.appinventor.mit.edu/) for this project to simplify the programming task.

Where am I?
Prof. Samuel Cheng
School of Electrical and Computer Engineering
We can easily tell where we are. But it is much more difficult for robots. In this project, we will try to figure out where a robot is given a video clip captured by it. Is it a classroom? A restaurant? Or a sport stadium?

Data Analytics and Data Visualization in Resilient Supply Chain Networks:
Professors Janet K. Allen (ISE) and Farrokh Mistree (AME) and Amirhossein Khosrojerdi (PhD Candidate ISE)
Alternate energy sources are critically important for curbing greenhouse gas emissions and creating a more independent energy economy. Plug-in Hybrid Electric Vehicles (PHEVs) is one feasible approach towards significantly lowering the consumption of oil and improving fuel economy in the transportation sector in this country. Reliable access to charging infrastructures is one of the key barriers to achieving the spread of PHEVs. This necessitates the development of a method for designing a system of electric charging stations by considering different and conflicting system goals. In this project, we develop a supply chain perspective for a network of electric charging stations in which charging stations and PHEVs are considered as supplier nodes and customer nodes, respectively. Some decisions such as locating charging stations, specifying capacity of the battery storage and number of stands at stations, usage of renewable energies and managing disruptions are considered in this project.
By working with Amirhossein Khosrojerdi (Doctoral candidate in ISE) and faculty mentors (Professors Allen and Mistree) the HERE Scholar will have the opportunity to learn how to:
- deep read papers and identify questions worthy of investigation in decision-based systems realization,
- explore the solution space to account for uncertainty and complexity,
- verify and present data and then draw conclusions, and
- craft an outline for a paper on which he/she is a co-author.

Experience in using R or Python and willingness to learn are desired.

Concurrent production planning in the forward and after-sales supply chains against demand and propagated supply side uncertainties
Professors Janet K. Allen (ISE) and Farrokh Mistree (AME) and Shabnam Rezapour (PhD Candidate ISE)
A method for concurrent production planning in the forward and after-sales supply chains is being developed. Consider a company producing and supplying a durable product to its customers in its forward supply chain. After a while, a stochastic percentage of the company's product sale is returned by the customer as defective products which should be refurbished by the company. Replacements are produced and supplied through the after-sale supply chain. In this project we include both forward and after-market considerations together with supply side and demand side uncertainties. Not only do we consider the local effects of these uncertainties on the performance of their corresponding facilities, but also investigate their global effect on the performance of the whole company by following the propagation of uncertainties through the enterprise network.
By working with Shabnam Rezapour (Doctoral candidate in ISE) and faculty mentors (Professors Allen and Mistree) the HERE Scholar will have the opportunity to learn how to:
- identify and deep read papers related to forward and after-sale supply chains and identify the important interactions between forward and after-sale supply chains and important uncertainty resources affecting the performances of these two chains,
- explore the solution space to figure out the relationships between performance indices (such as service level, price and warranty strategies) of these two chains,
- verify the results and investigate their sensitivity with respect to disruptions, and
- craft an outline for a paper on which he/she is a co-author.

Experience in using Matlab (or Python) and Gurobi (or Splex, Gams and Lingo) and willingness to learn are desired.

Design and Solution Space Exploration: Design of a Shell and Tube Heat Exchanger
Professors Farrokh Mistree (AME) and Janet K. Allen (ISE) and Maryam Sabeghi (GRA AME)
A method for designing complex engineered systems is being developed using a Shell and Tube Heat Exchanger (STHX) as an example by members of the interdisciplinary Systems Realization Laboratory. The design involves selection of material and fluid for the shell and tube, tube layout, number of tube pass, etc. The compromise involves size, heat transfer, pressure drop, efficiency, etc. Also uncertainties and emergent properties come into play in the realization of such systems in industry. To manage complexity in design of such systems and predict the outcome of a decision in an uncertain situation, sensitivity and post solution analysis play significant roles.
By working with Maryam Sabeghi (GRA in AME) and faculty mentors (Professors Allen and Mistree) the HERE Scholar will have the opportunity to learn how to:
- deep read papers and identify questions worthy of investigation in decision-based systems realization,
- explore the solution space to account for uncertainty and complexity,
- verify and present data and then draw conclusions, and
- craft an outline for a paper on which he/she is a co-author.

Experience in using Excel and willingness to learn are desired.

Robust and Resilient Control of Multilayer Overlay in Lithography Processes
Professors Farrokh Mistree (AME) and Janet K. Allen (ISE) and Jelena Milisavljevic (GRA AME)
The multilayer overlay lithography process is a multistage manufacturing process in which errors are introduced in each stage. Upstream errors accumulate, propagate and affect downstream operations. Thus, variations in the previously deposited reference layers also affect the overlay errors in layers that are deposited later.

In this project, a systematic method is being developed to model the flow of overlay errors from layer to layer and to mitigate this effect using controllable process parameters. The problem of controlling the stack-up of overlay errors that occurs due to the cascading of overlay errors as multiple layers are produced, is formulated as a compromise Decision Support Problem with the objective of minimizing the expectation of the weighted sum of consecutive overlay errors and stack-up overlay errors.

By working with Jelena Milisavljevic (GRA in AME) and faculty mentors (Professors Allen and Mistree) the HERE Scholar will have the opportunity to learn:
- how different values of the weighted parameters influence overlay errors and stack-up overlay errors through different layers of lithography process in semiconductor manufacturing,
- how to explore the control space by showing how controllable and uncontrollable process parameters are influence the objective function,
- how to expand an existing stochastic control method for lithography process by considering uncertainties of the model parameters by utilizing model-based process control methods,
- how to manipulate and present results by creating ternary plots, and
- how to craft an outline for a paper on which he/she is a co-author.

Experience with Excel, Matlab or FORTRAN, and general knowledge about statistics is preferred.

Orchestrating an Authentic Immersive Learning Experience Through Scaffolding
Professors Zahed Siddique (AME) and Farrokh Mistree (AME). Lucas Balmer (GTA AME)
In AME4163 Principles of Design students are afforded, through an immersive and authentic learning experience, the opportunity to internalize the principles of design. Students are viewed as junior engineers in a company and empowered to learn by reflecting on their experience in designing, building and testing a mechanism under competition conditions.
Past classes were taught in the basic lecture and project form but now the course is heavily scaffolded putting the students in charge of their learning. Surveys have been conducted to ascertain the learning outcomes. The learning outcomes from the course offered in Fall 2014 will be compared to attainment of outcomes in the past thereby determining the efficacy of the scaffolding in Fall 2014.
By working with Lucas Balmer (MS student in AME) and faculty mentors (Professors Siddique and Mistree) the HERE Scholar will have the opportunity to learn how to:

- analyze, survey data using statistics,
- verify data and then draw conclusions,
- present data to facilitate understanding, and
- craft an outline for a paper on which he/she is a co-author.

People interested in engineering and education with experience in using Excel and willingness to learn are desired.

Data Modeling, Analysis and Visualization of Flat Learning Environment as a Social Network to Understand Effects of Peer-to-Peer Information Exchange
Professor Zahed Siddique
Department of Aerospace and Mechanical Engineering
Technology assisted flat learning environment can foster higher-order thinking through peer-learning. We are investigating a "flatter" instructional environment; all participants have dual roles as students and instructors who are embedded in a collaborative environment where all learn collectively from each other's experiences, even the instructor. The main objective is to understand flat learning environment as a social network. The focus is on peer learning mode, where students are instructors to share their experience and then learn from fellow student instructors. In this project we will use social network analysis and visualization tools to a flat learning environment, implemented at the University of Oklahoma, as a network.

Effect of Aggregate Size and Type on Internal Curing of Calcium Sulfoaluminate Cement Concrete
Prof. Royce Floyd
School of Civil Engineering and Environmental Science
Calcium sulfoaluminate cements require more water for complete hydration than typically used portland cement. Wet curing is needed for proper performance of calcium sulfoaluminate cement concrete, but the low permeability of the concrete mixtures may limit the effectiveness of traditional curing methods. Internal curing using saturated lightweight aggregates has been shown effective for use in improving the cement hydration in low permeability concrete mixtures, but the size and distribution of aggregates within the concrete influences the ability of the internally available water to reach the cement particles. The researcher will build on work done by other students by investigating the effects of lightweight aggregate size and type on compressive strength, expansion, and permeability of internally cured calcium sulfoaluminate cement concrete.

Biocorrosion of Carbon Steel Ballast Tanks by Dissolved Copper Complexes
Prof. Mark A. Nanny
School of Civil Engineering and Environmental Science
Blending biofuels with petroleum-based diesel fuel is part of the United States Navy's "Green Fleet" initiative to become more energy secure. However, depending upon the chemical composition, biofuels can be degraded by microbes, resulting in deterioration of fuel quality, biomass growth in fuel systems, and biocorrosion of carbon steel ballast tanks. Biocorrosion of carbon steel is particularly acute in compensated fuel-seawater ballast tanks where seawater is introduced as fuel is consumed because seawater provides dissolved oxygen, sulfates, and marine microbes, all of which facilitate biocorrosion.
This research topic focuses on a newly proposed biocorrosion mechanism facilitated by the unusually high dissolved copper concentrations found in the compensated fuel-seawater ballast tank waters collected from five US naval ships. The exact chemical nature of this dissolved copper is currently unknown, but it is hypothesized to originate from biocorrosion of Cu-Ni alloys used in sluices connecting compensated fuel-seawater ballast tanks. The positive reduction potential of cupric ions makes them capable of oxidizing iron in carbon steel, therefore it is hypothesized that the dissolved copper in the ballast tank waters may be significantly corrosive to the carbon steel infrastructure.
This research project will measure the corrosion rate of carbon steel by dissolved copper found in the ballast tanks waters using atomic absorption spectroscopy, electron microscopy, and electrochemical methods. If the dissolved copper is found to be corrosive to carbon steel, the hypothesis that it is an organic-copper complex produced by microbial corrosion of the Cu-Ni alloy will be challenged, with the goal of identifying the organic ligand and measuring its ability to corrode Cu-Ni alloys.

Kinetics of Ruthenium (Ru) Mobility under Oxidizing Environments
Prof. Steven Crossley
School of Chemical, Biological and Materials Engineering
Ruthenium is an excellent catalyst for several reactions, such as the conversion of biomass to fuels. For several of these reactions, Ru demonstrates activity comparable to or better than others such as Pt that are an order of magnitude more expensive. One of the major reasons Ru is not used more industrially for these applications is due to its instability under oxidizing environments. After a chemical reaction has occurred for a long period of time, the catalyst must be regenerated to remove carbon deposits. Under these conditions, Ru is oxidized to a volatile compound and is lost from the catalyst support. We have recently found very interesting behavior upon studying Ru nanoparticles supported on various phases of titania. We have found that the interaction of Ru with TiO_2 is much stronger, and this leads to less mobility of the Ru under oxidizing environments. This ultimately leads to a more stable catalyst that has far greater potential for industrial application. This project aims to physically mix different oxides that can be used as supports for Ru nanoparticles, and study the rate of Ru mobility from particle under high temperatures in the presence of oxygen. This will allow us to both identify promising catlaysts, and better understand the mechanism for Ru stabilization over specific oxides such as titania. The resulting materials will be characterized in detail using electron microscopy and a variety of other techniques. They will then be tested for their potential as catalysts in collaboration with a graduate student.

Synthesis of Mesoporous Zeolites
Prof. Steven Crossley
School of Chemical, Biological and Materials Engineering
Zeolites are crystalline materials with high surface area with a broad range of applications ranging from water purification to catalysts for the production of gasoline. For many applications, the reason why zeolites are so effective is due to the high surface area and the microporous environment. In many cases, for example several applications related to catalytic upgrading, the diffusion of molecules into the micropores of the zeolite is often the slowest step in the catalytic reaction. By introducing larger pores, one essentially creates highways for molecules to quickly access the micropores of the zeolite. This project explores the synthesis of zeolites in the presence of cylindrical carbon nanotubes. By growing the zeolite around the nanotubes, and subsequently burning the nanotubes, these highways can be created that should lead to dramatically improved performance. This project will involve the synthesis as well as collaboration with two graduate students to carry out detailed characterization and catalytic reactions of the materials that are produced.

Creation of Bijels for Catalytic Reaction in Biphasic Systems
Prof. Steven Crossley
School of Chemical, Biological and Materials Engineering
Bicontinuous interfacially jammed emulsion gels (bijels) are a type of soft solid, which offer the possibility for selective reactions to be carried out in a continuous process. Currently bijels are formed when particles jam at the interface of two liquids which spinodially decompose when heated. The spinodal decomposition creates a flat interface that can be jammed by the particles creating a gel, which is capable of sustaining a force or flowing liquid. Selective reactions can be carried out with emulsions, but for separation of the chemical products from the catalyst the emulsion must be broken. Breaking the emulsion interrupts the reaction process, which is costly. The first goal of the project will be to tune the wettability of carbon nanotubes or silica to wet equally in both liquid phases, a requirement for successful bijel formation. Once a bijel is formed a metal catalyst will be deposited on the solid particles, allowing for chosen chemical reactants to be used to determine if selective reactions are possible and if a continuous process can be made.

Improved Design Guidelines for Reinforced Earthwork Structures
Prof. Kianoosh Hatami
School of Civil Engineering and Environmental Science
Departments of Transportation across the U.S. are faced with the problem of landslides and slope failures along highways. Repairs and maintenance work associated with these failures cost these agencies millions of dollars annually. A potentially cost-effective solution for slope reconstruction and repair is to reinforce locally available soils with geosynthetic materials. However, locally available soils are often of marginal quality and their shear strength and interaction with the geosynthetic reinforcement is significantly dependent on their moisture content. Students in this research program help build, instrument and test a large-scale model embankment (5 m × 2.5 m × 2.1 m) at the Fears laboratory on the OU south campus. The objective of this study is to develop design guidelines for reinforced soil slopes (RSS) to account for the influence of soil moisture content on the stability of RSS structures.

Important Dates for HERE

September 26th: Applications Due

October 1st-24th: Professor Interviews/Selections

October 31st: Notifications Emailed to Applicants

November 3rd: Enrollment Begins