College of Engineering, Architecture, and Technology – FY 2012 Research Abstracts

SCHOOL OF CHEMICAL ENGINEERING

A 3D Vascular Tissue Model for Studying Cell Migration in Atherosclerosis
Atherosclerosis is a condition in which plaque builds up on the inner lining in arteries. The plaque is formed from a process that begins with specific immune cells called monocytes that infiltrate the vessel wall. Currently, many two-dimensional cell culture models of cells grown on flat plastic surfaces are used to investigate these early cellular mechanisms involved with atherosclerosis, but they may not be suitable predictors of what occurs in more complex three-dimensional (3D) systems such as the human body. The main objective of this study is to measure the formation of monocyte chemoattractant protein-1 (MCP-1) concentration gradients within a 3D vascular tissue model and determine the effect on monocyte migration.
Sponsor: National Institutes of Health
PI/PD: Heather Fahlenkamp

EPRI: Impact of Filming Amines on Polishing Ion Exchange Resins
This project will identify the effects of filming amines on the physical and chemical properties of ion exchange resins, based on the measured impacts of a selected proprietary filming amine product(s). Measured impacts will include the loss of effective and total capacity and reduction in ionic mass transfer coefficient. These properties for both short term (single regeneration cycle) and long term impact will be evaluated. The need for performance recovery methods will be determined through identification of the ease and efficiency of regenerability.
Sponsor: Electric Power Research Institute
PI/PD: Gary Foutch

The Coal-Seq III Consortium: Advancing the Science of CO2 Sequestration in Coal Seam and Gas Shale Reservoirs
The goal of the research proposed herein is to develop improved algorithms and reliable coal-structure-based generalized adsorption models to facilitate realistic simulation of CO_2 sequestration in coal seams. Such models will be capable of: 1) describing adsorption equilibrium of CO_2 sequestration in wet coal seams and shales, and rigorous accounting for moisture effects in adsorption equilibrium calculations, as well as being an improved generalized method to estimate coal (or shale) capacity for coalbed gases based solely on readily accessible coal (or shale) characterization parameters.
Sponsor: Advanced Resources International, Inc. for Department of Energy
PI/PD: Gasem, K.A.M

Center for Interfacial Reaction Engineering
The primary goal of this portion of the project is to develop reliable thermodynamic property models for the chemical components and the mixtures formed in the oily phase and the water phase of the bi-phasic catalytic reactor. Successful completion of this research will provide us with the required modeling capability to develop effective optimum bi-phasic catalytic processes for upgrading and refining of bio-oils.
Sponsor: University of Oklahoma for Department of Energy
PI/PD: Gasem, K.A.M.

Iraq University Linkages Programs
The University Linkages Program is designed to facilitate the development of long-term, bilateral partnerships between U.S. and Iraqi universities. These linkages are built through the collaborative efforts of faculty and staff at the partnering institutions, following a framework of timelines and benchmarks managed by AED. In addition, AED will develop a model career center at each of the five participating Iraqi institutions to include equipment and resources and will provide guidance and training for career center staff. The ULP works to modernize specific fields of study in higher education curriculum in Iraq, including English, Education, Information Technology, Civil Engineering, Computer Engineering, Petroleum Sciences, Economics, Business Management, Accounting, and Finance. This allows participating institutions to build mutual understanding through focused exchanges, online course offerings, jointly taught courses, video conferencing, and other person-to- person interactions. Furthermore, it promotes the role of academia as a pillar of stability and community development. However, the ultimate goal of the ULP is to guide the partners to establish self-sustaining, mutually beneficial relationships that will endure independently.
Sponsors: Center for Academic Partnerships, Academy for Educational Developmental for U.S. Department of State.
PI/PDs: Gasem, K.A.M., Wagner, J.

CCLI: A National Model for Engineering Mathematics Education
The inability of incoming students to successfully advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. As a result, this project seeks to effect a transformative and nationwide change in engineering mathematics education, with the goal of increased student retention, motivation and success in engineering.
Sponsor: Wright State University for the National Science Foundation
PI/PDs: Karen A. High
Electrical and Computer Engineering: Charles F. Bunting, Alan Cheville

Transitioning Engineering Research to Middle Schools (TERMS)
This Research Experiences for Teachers (RET) in Engineering Site involves a total of 21, 6th-9th grade teachers from three local public school districts, 7 each year for three years, and two REU students per year in combined research and K-12 content development. The program consists of pre-visit preparation, a six week summer research experience for the teachers, a twelve week summer research experience for the REU students and follow up academic interactions between RET teachers, OSU faculty, REU students, and middle school students.
Sponsor: National Science Foundation
PI/PDs: Karen A. High, Sundararajan V. Madihally, James E. Smay
Electrical and Computer Engineering: Alan Cheville, Charles F. Bunting.
College of Education: Juliana Utley

GSE/RES: Red Light, Green Light Signals? Defining Family and School Influences on Rural, American Indian Girls' Early STEM Interests
The research goal is to determine significant predictors of low-income, rural American Indian boys' and girls' early interests in science and mathematics that can provide guidance for classroom practices that encourage young girls' STEM interests. Specifically, this research will (1) determine and examine family and school influences related to changes in students' science and math interests and achievement from 3rd – 5th grade among rural, largely American Indian populations in Oklahoma and (2) generate narrative stories that illustrate positive and negative influences on girls' STEM interests within this special population.

Sponsor: National Science Foundation
PI/PDs: Thomas, J.A.; High, K.A., Smay, J.E.; Van Delinder, J.L., Page, M.C.

UTeachEngineering: Training Secondary Teachers to Deliver Design-Based Engineering Instruction
UTeachEngineering was established in 2008 with support from the Math and Science Partnership program (MSP) of the National Science Foundation to address an emerging need for well-prepared high school engineering teachers. Texas has decided to offer a one year engineering course as one of fewer than 20 courses statewide that high school students may take to satisfy a fourth year science requirement. This creates an urgent situation in that between 1995 and 2010 only 44 high school teachers became certified in engineering. With the new 4th year science course opportunity in Texas, the state will need as many as 500 teachers of engineering in the next few years. In addition to teacher training opportunities, a new High School Engineering Course needs to be developed. This course needs to be high-quality yet low cost and aligned to the TEKS (Texas Essential Knowledge and Skills) state standards with additional, supportive professional development for teachers. To this end, the UTEACH*Engineering* program has established the following goals.

- To attract and retain more students from diverse backgrounds in K-12 science, technology, engineering and math (STEM) education career paths.
- To prepare current and future secondary science and math teachers to become effective teachers of high school engineering courses.
- To develop, pilot, and refine an exceptional year-long high school engineering course that can be deployed at low cost in a variety of high school settings.
- To build partnerships that will enable school districts across Texas to offer high-quality engineering courses.
- To carry out cutting-edge research that contributes to an understanding of how people learn engineering.
- To develop a viable national model for preparing and supporting secondary engineering educators.

Sponsor: The University of Texas at Austin for National Sciences Foundation
PI/PD: High, K.A.

Ethics for Researchers: Helping Moral People Act Ethically
Standard Research Ethics classes neglect the topic of *moral psychology*. Specifically, these classes do not teach students *why* people act unethically, and they do not provide students with strategies that they can use in order to increase the likelihood that they will act in accord with their own ethical commitments and/or the ethical codes of their professions. The goal of this proposal is to develop a class, Ethics for Researchers: Helping Moral People Act Ethically, which will meet this need. The class, which will be electronically delivered and can stand alone as a seminar or be added to the curriculum of traditional Research Ethics classes, will expose students to video clips containing re-enactments of published empirical studies that demonstrate why people act unethically.
Sponsor: National Science Foundation
PI/PD: High, M.S

OK-INBRE Summer Undergraduate Research Program - 2011
Tissue engineering focuses on restoring tissue and organ function using porous structures made of biodegradable materials. Porous structures are molded into the desired shape of the tissue and are used to support/guide cells to colonize, organize and produce their own extracellular matrix (ECM) elements. Our laboratory focuses on understanding the cell organization and behavior on porous structures which

control three-dimensional spatial architecture. Fundamental question we would like to evaluate and compare is the usefulness of different cell sources including stem cells and adult cells.
Sponsor: University of Oklahoma Health Sciences Center for NIH
PI/PD: Madihally, S.V.

Characterization and Mediation of Microbial Deterioration of Concrete Infrastructure
The Federal Highway Administration has estimated that as many as one quarter of the bridges in the US are in a state of disrepair, and there is growing concern, especially in southern states, that microorganisms growing on the surface of concrete bridge supports are contributing to the problem. The aims of this proposal will be achieved by meeting the following specific objectives:
• Conduct field studies to collect microbes and characterize the surrounding environment at sites of microbial deterioration.
• Culture, identify, and evaluate the environmental response of microbes responsible for concrete deterioration.
• Evaluate techniques to prevent and repair microbial damage.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ramsey, J
CIVEN: Ley, M.T., Wilber, G.G.
A&S: Fathepure, B.

Design and Development of Hybrid Gene Delivery Vectors
Gene therapy offers the potential to treat most acquired and genetic human diseases. The challenges associated with safe and efficient delivery of genetic material to diseased tissue, however, have limited the advancement of gene therapy beyond clinical trials. The research presented in this proposal aims to develop a hybrid gene therapy vector that overcomes these challenges by combining the advantages often associated with viral and nonviral vectors while avoiding the drawbacks. Our purpose, through designing novel gene delivery vectors, is to transition gene therapy into a viable treatment for the millions of patients that would benefit.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Joshua D. Ramsey

Cell-Penetrating Peptide/Adenovirus Nanoparticles for Improved Gene Delivery to Vascular Tissue
Therapeutic angiogenesis provides hope for the increasing number of patients suffering from coronary or peripheral vascular disease where mechanical revascularization is not an option. Treatment using recombinant protein forms of cytokines or growth factors specific to vascular development has been the conventional approach, but issues with dose, short circulation half-life, and production costs have limited recombinant protein therapy. Gene therapy offers an alternative to this approach and promises to revolutionize how we treat cardiovascular disease. In spite of its potential, however, the lack of a safe and efficient gene delivery vector hinders advancement of gene therapy beyond the clinical trial stages. This research aims to address these drawbacks by formulating an improved vector based on fiberless/knobless adenovirus particles where the function of the fiber and knob particles has been replaced with peptides.
Sponsor: American Heart Association
PI/PD: Ramsey, J.

Procurement of Novel Microanalysis Equipment for Construction Materials
The goal of this proposal is to purchase three major pieces of analytical equipment for all OTC researchers to use in their projects. A short description of each piece of equipment is given below:

1. X-ray Florescent (XRF) Microscope – A microscope that allows automated surface and chemical mapping of large areas.
2. Automated Scanning Electron Microscope (SEM) –An SEM that has been specifically designed to measure the shape, size, and chemistry for a large number of micro and nano particles
3. Replacement Tube for the Micro Computed Tomography (MCT) Scanner – A replacement tube for a piece of equipment allows for 3D mapping of materials at the micron scale

By funding this research proposal it will allow the OTC to be at the forefront of Construction Materials research. This will allow the OTC pier institutions to complete highly innovative research and compete in national funding competitions for decades to come.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Smay, J.E

Critical Processing Issues for On-Farm Production of Ethanol from Sweet Sorghum
In order to meet the increasing demand for ethanol, all potential sources of ethanol should be pursued. Most current and planned ethanol production facilities involve the conversion of starch-based commodities such as corn, but extensive use of grain for ethanol production has caused some concern. The major issues include significant impacts on food and feed markets, a relatively low energy balance (energy derived compared to energy required to produce), and large water requirements both in production and processing. Reliance on corn to fulfill expanding ethanol needs is clearly not sustainable. The goal of this project is to develop and demonstrate a decentralized, on-farm process for conversion of sweet sorghum into ethanol.
Sponsor: Oklahoma Department of Commerce for the Oklahoma Bioenergy Center
PI/PDs: James R. Whiteley
Division of Agricultural Sciences and National Resources: Danielle Bellmer

Bioethanol De-Watering Demonstration and Research Facility
The proposed work will create a state-of-the-art, farm-scale bioethanol dewatering system capable of processing up to 250 gallons per hour (gph) of fermentation broth to produce 190 proof ethanol and the associated byproducts. The new dewatering facility will be used to: 1) evaluate, optimize, and document the design and cost of farm-scale bioethanol dewatering using best-available distillation technology, 2) provide a test bed to develop best practices for on-farm dewatering equipment operation and maintenance, 3) evaluate the chemical composition of the waste stillage (vinasse) from distillation of fermented sweet sorghum juice.
Sponsor: Oklahoma Department of Commerce for the Oklahoma Bioenergy Center
PI/PDs: Whiteley, J.R.
DASNR: Bellmer, D.

FRI/Literature Packing Correlations Project
FRI developed, and possesses, correlations regarding random packings and structured packings. Those correlations can be used to predict liquid hold-ups, pressure drops, capacities and efficiencies (i.e., HETP's). Typically, FRI's correlations do not employ literature data. By avoiding literature data, FRI's correlations are independent (but not completely) of literature correlations. If FRI's correlations and if literature correlations were all based on the same data, all of those correlations might end up consistently giving the very same results – all right or all wrong. Nevertheless, FRI's members regularly wonder whether FRI's correlations are capable of predicting literature data. Similarly, those members wonder how well literature correlations predict the FRI data.
Sponsor: Fractionation Research, Inc.
PI/PD: Madihally, S.V.

SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Motorcycle Crash Causation Study
The purpose of this study is to conduct a comprehensive, in-depth motorcycle crash causation study that employs the common international methodology for in-depth motorcycle accident investigation. This research aims to address the following; 1) Determine the main human, vehicular, environmental and roadway factors that contribute to motorcycle crashes and impact crash avoidance, 2) Identify the types of motorcycle crashes, 3) Assess the effectiveness of existing countermeasures including protective gear and rider training/education, 4) Identify additional feasible countermeasures/interventions that can reduce motorcycle crashes and crash injuries, and 5) Estimate the risk factors for motorcycle crash involvement.
Sponsor: United States Department of Transportation - Federal Highway Administration
PI/PD: Ahmed, M.S.

Motorcycle Crash Causation Study Industry Support
Oklahoma State University (OSU) has entered into a cooperative agreement with the Federal Highway Administration to conduct a "comprehensive, in-depth motorcycle crash causation study that employs the common international methodology for in-depth motorcycle accident investigation of the Organization for Economic Cooperation and Development."
Sponsor: American Motorcyclist Association
PI/PD: Samir A. Ahmed

Safety Culture of the US Transit Industry
The objective of the proposed additional work is to assist the FTA's Office of Transit Safety and Security in assessing and enhancing the existing safety culture of transit agencies.
Sponsor: University of Oklahoma for the Federal Transit Administration
PI/PD: Ahmed, M.S.

WMA Pavements in Oklahoma: Moisture Damage and Performance Issues
The specific objectives of the combined laboratory and field study are: (1) to evaluate the moisture damage potential of WMA (Warm Mix Asphalt) mixes using both traditional and mechanics-based approaches, and (2) to evaluate the rutting and fatigue behavior of both lab and field compacted WMA specimens. The proposed study will advance the fundamental understanding of the moisture damage process by carefully considering the mechanisms that influence the bonding interface between aggregate and asphalt binder.
Sponsor: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PDs: Rifat Bulut, Steve Cross

Drying Shrinkage Problems in High PI Subgrade Soils
The formations and network of the shrinkage cracks in soil will be investigated in the light unsaturated soil mechanics and fracture mechanics, so that the moisture diffusion into the cracked soil can be analyzed more rationally.
Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Bulut, R.

Rapid Determination of Unsaturated Moisture Diffusivity for Soils during the Frost Heave
Frost heave and thaw weakening are typical problems in northern regions. It is well known that frost heave is caused by water flow through capillary zone to a freezing front where it forms ice lenses.

Investigation of soil behavior in the capillary zone is in the range of unsaturated soil mechanics and the unsaturated transmission of water is the key to understand the frost heave problem.
The magnitude and rate of transient moisture flow in an unsaturated soil in response to suction changes is controlled by the unsaturated moisture diffusion coefficient. It is well-known that unsaturated soil properties such as moisture diffusivity are significantly different from those when the soil is fully saturated with positive pore water pressure. Although significant progress has been made in unsaturated soil mechanics in the past two decades, not enough advancements have been made to apply this new field to practical, yet very important, problems such as the frost heave and thaw weakening problems. As part of an Oklahoma Transportation Center (OkTC, one of the ten National University Transportation Centers) sponsored research project, Mabirizi and Bulut (2010) developed unified, simple, and practical testing equipment and a method to measure both the drying and wetting unsaturated soil moisture diffusivity coefficients in a laboratory. Compared with the existing methods, the method significantly reduces the time and efforts for measuring the drying and wetting unsaturated soil moisture parameters by exposing the cylindrical soil specimens to drying and wetting cycles, respectively. The same concept can be applied to measuring the unsaturated diffusivity of soils during one dimensional frost heave in Alaska. The objective of this research is to implement the most recent advances made in unsaturated soil mechanics to investigate the frost heave problem. The objective will be achieved through equipment development, laboratory testing, model development, and numerical simulation.
Sponsor: University of Alaska-Fairbanks for the Alaska University Transportation Center for the United States Department of Transportation-RITA
PI/PD: Bulut, R.

Evaluation of the Enhanced Integrated Climatic Model for Modulus-Based Construction Specifications for Oklahoma Pavements
This research study will focus on improving our understanding of environmental interactions with pavement systems in Oklahoma to better predict the changes in pavement material properties over time. This will allow accurate calculations of climatic trends in Oklahoma so that pavement designs will be more realistic.
Sponsor: Oklahoma Transportation Center for the Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Bulut, R.

The Effects of Soil Suction on Shallow Slope Stability
The study will primarily involve laboratory testing of soil suction and unsaturated soil moisture diffusivity coefficient measurements. The research team will collect soil specimens with the help of ODOT personnel from the sites where the shallow landslides have already occurred. The research team anticipates the forensic investigation of at least two shallow slope sites for this project. The number of specimens to be collected and tested will depend on the size and nature of the slopes. The research team in collaboration with the ODOT engineers will decide on the number of tests for suction and diffusion parameter measurements. The Shelby tube size soil specimens will be sampled from the sites and wrapped against any moisture loss or gain, and will be delivered/carried to laboratory for testing. The OSU research team will help OU researchers for conducting field investigations, soil sampling, and data analysis in this project.
Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the United States Department of Transportation-RITA
PI/PD: Bulut, R.

Develop Draft Chip Seal Cover Aggregate Specifications Based on Aggregate Imaging System (AIMS) Angularity, Shape and Texture Test Results

The proposed research study will focus on developing draft chip seal specifications for Oklahoma that are not only connected to aggregate gradations and hardness in a novel way but also address aggregate shape and texture in a quantitative manner. The project also addresses aggregate-binder compatibility through cohesion and adhesion properties evaluated by surface free energy measurements. In this project, the OSU team will work with the OU team in the selection of aggregates and binder, evaluate aggregate-binder compatibility through evaluation of surface free energy and cohesion and adhesion properties. The OSU team will perform surface energy measurements on aggregate and binder materials using the sessile drop device, and as well as the measurements of the aggregates coated with binder. The OSU team will help the OU team with obtaining performance data from the PMS database maintained by ODOT, help with the review of literature, correlating chip seal performance with cohesion/adhesion values, and other pertinent tasks.

Sponsor: University of Oklahoma for the Oklahoma Department of Transportation

PI/PD: Bulut, R.

Improved Cover Aggregate Specifications to Enhance Chip Seal Performance

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Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the United States Department of Transportation-RITA

PI/PD: Bulut, R.

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Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the Oklahoma Department of Transportation for the Federal Highway Administration

PI/PD: Bulut, R.

Drying Shrinkage Problems in High-Plastic Clay Soils in Oklahoma
Longitudinal cracking in pavements due to drying shrinkage of high-plastic subgrade clay soils has been a major problem in Oklahoma. It has been well established in the literature that the mechanism of shrinkage cracks due to high-plastic clay soils are governed by the principles of unsaturated soil mechanics, the suction stress being the major part of the cracking mechanism. These longitudinal cracks occur usually within the so-called edge moisture variation distance, where the climate plays a significant role in terms of changes in water content (or suction). Therefore, the drying shrinkage problem should be investigated based on the unsaturated soil mechanics principles and the climatic surface and subsurface boundary conditions. This research project will need to evaluate the current Enhanced Integrated Climatic Model (EICM) of the Mechanistic Empirical Pavement Design Guide (MEPDG), and other more sophisticated and fully integrated climatic models for analyzing the moisture regimes underneath the pavement. The formations and network of the shrinkage cracks will be investigated in the light unsaturated soil mechanics and fracture mechanics, and so the moisture diffusion into the cracked soil could be analyzed more rationally. The study will include laboratory soil testing, and field forensic investigation of the problem sites, and modeling. The whole study can lead to practical analysis and recommendations for design of pavements on potentially shrinking clay soils.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Bulut, R.

Laser Characterization of Fine Aggregate Properties
The primary goal of this research effort is to pursue the development of an “automated technology” that can monitor and control the quality of products used in highway pavements.
The main aim of this proposal is to develop a laser-spectrographic technology, using Laser-Induced Breakdown Spectroscopy (LIBS), to provide a means to pattern match and identify aggregates used in highway construction. LISB is a rapid method laser-scanning technique in which a very short-duration pulse of energy from a high-power laser is optically focused at a point, instantaneously heating the target sample to cause vaporization and atomization of nanograms of material within a microplasma.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Cross, S.A.

QCQA Testing Differences Between Hot Mix Asphalt (HMA) and Warm Mix Asphalt (WMA)
The objectives of this study are to develop testing protocols for the different WMA additives for mix design and QC/QA procedures. For mix design, testing protocols need to be developed for rut testing and moisture sensitivity testing. For QC/QA, protocols need to be developed for lab-molded void properties and asphalt content. To meet the objectives, equivalent compaction temperatures and/or compactive efforts need to be established for WMA additives. Once this is established, the effect of WMA additives on lab-molded volumetric results from Superpave Gyratory Compactor (SGC) samples (QC/QA properties) and mix design results (moisture sensitivity and rutting) could be determined. Test protocols could be dependent upon the specific WMA technology.
Sponsor: Oklahoma Department of Transportation
PI/PD: Cross, S.A.

Evaluation of Hamburg Rut Tester for Field Control of HMA
The objective of this study is to gather sufficient AASHTO T 283 and OHD L-55 data from laboratory prepared (mix design) samples and field produced mix from across Oklahoma to determine if OHD L-55 can be implemented to monitor field produced mixtures for rutting and/or moisture susceptibility and to develop draft implementation plans (draft test methods /specifications) if test results warrant implementation.

Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Cross, S.A.

Enhancing Laboratory Facilities for Asphalt Research and Education: Sharing to Gain
Although our combined asphalt research and education programs have been fairly successful from the view point of external research and training funds, workforce development, intellectual property and international collaboration, some key pieces of equipment are needed to sustain and enhance our growth and to become nationally competitive. Specifically, equipment is needed for performance testing (fatigue and creep) of mixes/pavements, testing of overlays, extraction of binders from RAP, production of foamed asphalt in the laboratory and evaluation of moisture sensitivity. Asphalt teams from all three OTC institutions have decided to engage in long-term collaborations, creating a culture of sharing each other's facilities for common gain, hence the theme of this project "*sharing to gain*."
Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Cross, S.A.
OU: Zaman, M.

Development of an Interactive Website on Asphalt Recycling
Hot and cold in-place recycling techniques recycle 100 percent of a hot mix asphalt (HMA) pavement in place, without the application of heat during the rehabilitation process. Numerous studies have shown in-place recycling to be a cost-effective procedure for rehabilitation of HMA pavements. However, many states do not use these viable, environmentally friendly procedures for pavement rehabilitation. The three most common agency reported drawbacks to hot and cold in-place recycling usage are: 1) lack of long term performance data, 2) lack of familiarity with or lack of guidelines on construction procedures, and 3) limited information on input parameters for pavement thickness design. In 2002 the Asphalt Recycling and Reclaiming Association (ARRA), a trade association of hot and cold in-place recycling contractors, published the Basic Asphalt Recycling Manual (BARM). The intent of this project is to take and revise the BARM and develop an interactive website that will serve as a Basic Recycling Primer for Hot In-place Recycling, Cold In-place Recycling and Full Depth Reclamation. Users will be able to navigate through written topics with embedded videos on the processes, supporting graphs, figures and photos. Optional self-tests will be available for the user to test their knowledge and obtain a printout as proof of the mastery of the subject overview as a precursor to more advanced courses.
Implementation of the proposed interactive web site would provide transportation officials with general information on hot and cold recycling techniques as well as guidance on best practices for project selection, design considerations, construction, construction specifications and environmental benefits to recycling
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Cross, S.A.

Education Modules: Evaluation, Repair, and Strengthening of Transportation Structures
Under the currently proposed project historic, conventional and state-of-the-art bridge inspection and repair methods will be compiled for educational purposes. An extensive literature review will be performed for this compilation. Reinforced concrete, prestressed concrete, steel, and timber will all be included.
Sponsors: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PD: Robert Emerson

Developing County Bridge Repair and Retrofit Techniques
Oklahoma ranks first in the Nation in the percentage of bridges that are structurally deficient or functionally obsolete. The Oklahoma Department of Transportation (ODOT) estimated that it would cost $3.4 billion to replace these bridges. Obviously, any methods that can successfully extend the life of these bridges will be of great benefit to the safety of the users as well as the pocketbooks of the taxpaying citizens. The project will start with collaboration between the OSU research team and county and tribal officials concerned with bridge repair. Common as well as difficult bridge repair problems will be identified and reviewed. Decisions will be made on which of these bridge problems have the biggest repair/retrofit needs to be addressed. Commonly available repair materials and repair equipment and personnel will be identified and reviewed. Bridge repair and retrofit techniques will then be developed for the critical bridge problems using commonly available materials, equipment, and personnel. The developed bridge repair/retrofit techniques will be investigated both analytically and experimentally. Straightforward design guidelines will be written for each successfully developed repair/retrofit technique.

The project will have numerous beneficial impacts to help build our collective abilities in extending the life of existing bridges. Techniques will be developed for the repair and retrofit of deficient off system bridges. The proposed collaborative effort between the OSU research team, CLGT, and county, city, and tribal officials will open the door for future collaborative problem solving. Successful completion of the project will also lead to continued development of educational opportunities at OSU focusing on inspection and repair of our deficient and obsolete bridges. The subsequent education provided to practicing engineers, state government personnel, local and tribal government personnel, and engineering students will help to improve the safety of these bridges while extending the value of the transportation dollars provided by the taxpayers.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Emerson, R.N.

Analysis on Applicability of a Robot-based Automated Building Construction System to High-Rise Building
A new construction method, called the robot-based construction automation system (RCA), is being studied and developed and RCA will be soon applied to real building construction in a pilot project. The main objective of this project is to analyze the applicability of a robot-based automated building construction system to high-rise building. Because the ultimate goal of RCA is to build high-rise buildings, data from the pilot project will allow experts or a professional research group to assess the systems' utility for high-rise buildings.
Sponsor: Korea University Research and Business Foundation
PI/PD: Jeong, H.S.

Procedures and Models for Estimating Preliminary Engineering Costs of Highway Projects
This study attempts to develop practical tools to help ODOT engineers in estimating PE costs in a more consistent and reliable manner. The main goal of this research project is to develop a framework for estimating preliminary engineering costs of highway projects.
Sponsors: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PD: David Jeong

Alternate Bidding Strategies for Asphalt and Concrete Pavement Projects Utilizing Life Cycle Cost Analysis (LCCA)
The ultimate goal of the proposed study is to develop alternate bidding procedures for pavement type selection utilizing LCCA. This new procedure will promote a more cost effective use of highway construction funds through enhanced fair competition among pavement industries.
Sponsors: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PD: David Jeong

End of Asset Life Reinvestment Decision Making Process Tool
The main aim of this proposal is to identify readily available asset management methodologies and literature on end of asset life triggers developed through research funding by USEPA, WERF, CSIRO and other sources.
Sponsor: GHD, Inc. for Water Environment Research Foundation for the U.S. Environmental Protection Agency
PI/PD: Jeong, H.S.

Development of a Next Generation Smart Project Management Information System (PMIS)
Kwangwoon University (KWU), Oklahoma State University (OSU) and Sangah Management Consulting Company (Sangah) submitted a proposal to develop a next generation smart project management information system (PMIS) to the Small and Medium Business Administration (SMBA) in South Korea. OSU will analyze the data flow of the smart PMIS running on a Tablet PC that will be developed by the KWU and Sangah and make recommendations for data flow improvement and conduct real scale case studies of the smart PMIS on Tablet PC at various construction sites and evaluate the performance and recommend areas to improve the smart PMIS. In addition, OSU will work together with KWU and Sangah to develop strategies for this new generation of PMIS to enter into the global market.
Sponsor: Korea Association of Industry, Academy and Research Institutes (KAIARI)
PI/PD: Jeong, H.S.

Data and Information Integration Framework for Highway Project Decision Makings
The rapid information technology advancements in data collection methods, digital data storage technologies, and database management systems have allowed State Departments of Transportation (DOTs) to experience huge growth in its capability to both generate and store highway project data. The Oklahoma Department of Transportation (ODOT) along with other state DOTs stores a large amount of highway project data throughout the life cycle of highway projects. These data collection efforts require a significant amount of resources in terms of employees' time and costs. However, the current usage of this data is limited and minimal to support reliable and informed decisions at various stages of a highway project life cycle. This research project will diagnose the current level of use of collected data by ODOT and it will develop an innovative data and information integration framework which can ultimately support various decisions over the life cycle of highway projects. This framework will be able to show what types of data should be collected in what formats, and also what methods can be used to convert the data into meaningful information and knowledge to support various highway project decisions. The framework developed in this study will be able to help develop an active utilization plan of currently existing databases. It will also help develop a new data collection and information/knowledge generation plan to support key decisions which historically were not well supported with information and data.

The research team envisions that the outputs of this project will tremendously influence how efficiently and economically highway projects are planned, designed, executed, and managed throughout the life

cycle of the projects. Reliable and informed decisions on highway projects will translate into more accurate accountability of project developments and management. The outputs of this study will be immediately available to ODOT engineers.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Jeong, H.S.

Calibration of Controlling Input Models for Pavement Management System
The American Society of Civil Engineers (ASCE) estimates that $2.2 trillion is needed over a five-year period to bring the nation's infrastructure to a good condition (ASCE 2009a). This research project will use the proven Knowledge Discovery in Database (KDD) approach to investigate pavement condition assessment data in a structured manner in order to evaluate the performance of current input models and if necessary, develop new models or calibrate the existing models for more accurate and reliable planning for pavement maintenance and rehabilitation activities. The performance of newly developed or calibrated input models will be compared with the performance of current input models.
The successful completion of this research project will meet the immediate technical need of the pavement management unit. The actual data driven models developed in this project will provide confidence to the pavement management team in developing short-term and long-term pavement management strategies and realistic pavement budget estimation and allocation. One of the primary outputs of this research project will be a spreadsheet based tool that will assist pavement management engineers in updating the input models in the current PMS. Thus, the output of this project will be immediately available to ODOT. The results of this project will also be able to answer skeptical questions about the returns on continuous pavement data collection investment of ODOT which is now over $600,000 annually.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Jeong, H.S.

Passive Wireless Corrosion Sensors for Transportation Infrastructure
Many industrial segments including utilities, manufacturing, government and infrastructure have an urgent need for a means to detect corrosion before significant damage occurs. Transportation infrastructure relies on reinforced and prestressed concrete for structural reliability but corrosion of the reinforcing steel in structural concrete can significantly lower structural capacity. The advent of an inexpensive wireless corrosion sensor that does not require any external power supply would be a very useful tool to evaluate the structural health of the nation’s infrastructure and in turn make our highway travel safer. This project aims to develop and validate such sensors based on radio-frequency identification (RFID) tags that are used to track consumer goods and are extremely low-cost.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Tyler Ley
College of Arts and Sciences: Nicholas Materer, Allen Apblett

Development of a Structural Health Monitoring (SHM) Guidebook for Critical Bridge Structures
The overall objective for this project is to produce a practical, economic minded, and easily implementable guidebook for owners and design engineers to inform and assist in the decision making process of when SHM is useful. The following topics will be covered in the guide book: (i) case studies with a description of which sensor networks have been shown to be successful, (ii) the optimal location and number of sensors to monitor structural health, and (iii) how to interpret and analyze data obtained by the SHM system.

Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T.
IEM: Kong, Z., Liu, T.

Development of a Robust Field Technique to Quantify the Air-Void Distribution in Fresh Concrete
The main aim of this proposal is that the use of micro computed tomography (MCT) in combination with an evaluation of the chemical and physical properties of the air-void wall will allow a new understanding of how different size air-voids respond to pressure and if the air-void system will change in volume with time. The specific aims of this project are; 1) to determine the correlation between the volume change of individual air-entrained voids and the surrounding fluid pressure, 2) Investigate the impact of pressure increases on the bulk volume change of the air-void system, 3) develop a procedure to estimate the air-void distribution in fresh concrete and, 4) determine the characteristics of an air-void wall.

By completing this research a technique will be created that satisfies a great need in the transportation industry.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T.;
A&S: Apblett, A.

Recycled Carpet Materials for Infrastructure Applications
The central hypothesis of this proposal is that new recommendations for the required air content of modern mixtures can be made by compiling the performance of modern concrete mixtures and their subsequent air content and mixture proportions in actual or simulated frost durability tests. This research will look at the mixtures in laboratory freeze thaw testing (ASTM C 666) and hardened air-void analysis (ASTM C 457) to provide quantifiable measurements of performance and justify updated recommendations to reflect modern materials. The results of this work will produce recommendations for the air content in concrete for modern mixtures based on the mixture proportions.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T.
NPDC: Vaidyanathan, Ranji
MAE: Singh, R.P.

Investigation of the Inputs for the MEPDG for Rigid Pavements
It is the goal of this proposal to supplement the ongoing research work and further investigate these variables as they appear to yield a significant impact on the results from the program and so the current MEPDG parameters need to be the most accurate in the model.
Sponsor: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PD: Tyler Ley

Innovative Prediction of Fly Ash Performance in Concrete
It is the hypothesis of this proposal that if this information was understood, then the performance of fly ash concrete could be better predicted allowing for a larger volume of replacement, better performing mixtures, and more durable structures.
Sponsor: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PDs: Tyler Ley, Jay Hanan

Implementation of Alternatives to Asphalt Concrete Subbases for Concrete Pavement
As part of the HFL project efforts a comparison is being made between the durability, strength, sustainability, and economy of concrete made with and without continuous graded aggregates.
Sponsor: Texas Tech University for the Texas Department of Transportation
PI/PD: Ley, M.T.

Automated and Accurate Bridge Deck Crack Inspection and Mapping
This project aims to develop a smart mobile sensing system equipped with advanced sensors such as cameras, laser range finders, inertial measurement units, and innovative software algorithms to conduct accurate crack inspection and mapping for bridge decks. It is expected that such a system can significantly improve the state of the art of bridge deck structural inspection. The project consists of three major tasks: 1) the development of a platform for robotic crack inspection and mapping (ROCIM); 2) the development of robot autonomous navigation for inspection; 3) the development of crack detection and crack map generation. The developed system can also be applied in a much wider spectrum of structure health monitoring (SHM) applications.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T.
A&S: Ge, J.
ECEN: Sheng, Weihua

Development and Implementation of a Mechanistic and Empirical Pavement Design Guide (MEPDG) for Rigid Pavements
There are great advantages in the design of infrastructure if the design procedures are based on mechanisms and variables that determine the performance of the element in service. The Oklahoma Department of Transportation (ODOT) is investigating implementation of the mechanistic and empirical pavement design guide MEPDG to accomplish this, but the designs would benefit from using material inputs that are typical of those used in ODOT construction projects. This project will help determine inputs for the MEPDG that are representative of Oklahoma materials, construction methods, and weather. This will improve the economy, durability and performance of rigid pavements in Oklahoma.
Sponsor: Oklahoma Department of Transportation
PI/PD: Tyler Ley

Effect of Y-Cracking on CRCP Performance
Y-cracking in continuously reinforced concrete pavements (CRCP) has been observed on several Oklahoma pavements. Most notable is I-40 near Ardmore, Oklahoma. Y-cracking has been associated with spalling and punchouts, increasing maintenance costs, and decreasing ride quality. Some have suggested that CRCP Y-crack patterns are formed during the early age period, and are influenced by the materials used, percentage of steel, base type and preparation, and curing conditions. This project will determine if a correlation exists between y-cracking and the subsequent performance of CRCP in Oklahoma. Work will also be done to correlate the y-cracking and design and construction variables.
Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Ley, M.T.

Expected Life of Silane Water Repellant Treatments on Bridge Decks
The Oklahoma Department of Transportation (ODOT) commonly uses a silane or siloxane chemical sealer on new bridge decks to reduce the penetration of external chemicals and help extend the life of the bridge. Currently, it is unknown how long these sealers are effective, and if these sealers can be reapplied to continue to help protect the concrete. The research team will evaluate the effectiveness of

silane coatings of bridge decks at different ages through laboratory and non-destructive field techniques to determine their effective life. Methods to reapply the silanes to mature concrete will also be investigated.
Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PDs: Ley, M.T.
A&S: Apblett, A., Materer, N.

Procurement of Novel Microanalysis Equipment for Construction Materials
The goal of this proposal is to purchase three major pieces of analytical equipment for all OTC researchers to use in their projects. A short description of each piece of equipment is given below:

1. X-ray Florescent (XRF) Microscope
2. Automated Scanning Electron Microscope (SEM)
3. Replacement Tube for the Micro Computed Tomography (CT) Scanner

By funding this research proposal it will allow the OTC to be at the forefront of Construction Materials research. This will allow the OTC pier institutions to complete highly innovative research and compete in national funding competitions for decades to come.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T., Bulut, R., Veenstra, J.N.
CHE: Smay, J.E.
MAE: Hanan, J.C.,
A&S: Apblett, A., Cruse, A.
GU: Ownby, C.
HE: Smith, Brenda

Concrete Pavement Mixture Design and Analysis: Frost Durability of Concrete with Modern Mixtures
The central hypothesis of this proposal is that new recommendations for the required air content of modern mixtures can be made by compiling the performance of modern concrete mixtures and their subsequent air content and mixture proportions in actual or simulated frost durability tests. This research will look at the mixtures in laboratory freeze thaw testing (ASTM C 666) and hardened air-void analysis (ASTM C 457) to provide quantifiable measurements of performance and justify updated recommendations to reflect modern materials. The results of this work will produce recommendations for the air content in concrete for modern mixtures based on the mixture proportions.
Sponsor: Iowa State University of Science and Technology for the United States Department of Transportation, Federal Highway Administration
PI/PD: Ley, M.T.

Investigation of Optimized Graded Concrete for Oklahoma
Oklahoma has started to implement optimized graded concrete to be used for concrete pavements. These concrete mixtures are designed to contain increased amounts of coarse aggregate with a continuous distribution of size ranges. By doing this it allows a concrete mixture to achieve increased workability and strength through using less mortar (sand, cement and water). Despite this technology being successfully implemented, a number of questions still remain such as; determining how to specify, maintain quality, and determine pay factors for concrete using optimized gradation.
Sponsor: Oklahoma Transportation Center for the Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Ley, M.T.

Evaluation of Chloride Concentration Profiles of Concrete Cores using MicroXRF
This is a proposal to use a XRF microscope to investigate cores from concrete structures for the Virginia Department of Transportation to determine the chloride concentration profile. The work in this proposal will specifically compare the results from the XRF microscope to the traditional ASTM C1152 methodology. The long term goal of the investigators is to establish a peer accepted procedure for the use of a XRF microscope to determine the chloride levels from a drilled core and to offer another means of testing than the current powder collection and chloride titration methodology described in ASTM C1152.
Sponsor: Virginia Center for Transportation Innovation and Research
PI/PD: Ley, M.T.

MDA: Effect of Aggregate System on Workability
The goal of this project is to investigate the impact of the aggregate gradation and surface characteristics on the workability of concrete paving mixtures with a fixed paste content. Oklahoma State University will be serving as a subcontractor to Trinity Construction Management Services, Inc. In this project mixtures will be created with a water to cement ratio of 0.45 with a ratio of the volume of paste to voids to be 175%. There will be no AEA and no fly ash. A type A WR will be used to get the slump desired of around 2".

The variables investigated will be a gravel and crushed coarse aggregate and a river and manufactured fine aggregate. Four different gradations will be investigated (gap, too much fine, too much coarse, middle of zone 2 of the Shilstone Box). This will be a total of 16 mixtures. For these tests the following items will be measured: slump, performance in the ISU "bucket test", and cylinder strength and Wenner probe data at 7 and 28 days.
In addition the following will be reported:

1. Individual aggregate gradations and type – tabular and graphic
2. Combined gradation percent passing, percent retained by sieve, 0.45 power chart and coarseness/workability (adjust for cementitious content) – tabular and graphic
3. Mixture proportions
4. Tabular test data
5. Photos of bucket tests
6. Photos of cylinders used for Wenner probe testing

Sponsor: Trinity Construction Management Services for Iowa State University of Science & Technology for the Federal Highway Administration
PI/PD: Ley, M.T.

NSF Career: Increasing the Effectiveness of Mineral Additives in Concrete with Novel Particle Characterization
The aims of this proposal are i) develop a strong research program focused on increasing the use of supplementary cementitious materials (SCMs) as construction binders in concrete through new levels of chemical characterization, ii) involve underrepresented undergraduates in research and mentoring, and iii) increase awareness of science and engineering by underrepresented elementary students in low income schools.
Sponsor: National Science Foundation
PI/PD: Tyler Ley

Investigation of Optimized Graded Concrete for Oklahoma
Oklahoma has started to implement optimized graded concrete to be used for concrete pavements. This allows the concrete mixture to achieve increased workability and strength through using less mortar (sand, cement and water). Several design methods have been developed for optimized graded concrete, however, little guidance is given to address the mixture design. Because of this, DOTs still struggle with determining how to specify, maintain quality, and determine pay factors. Through conversations with ODOT engineers, it has been mentioned that guidance is needed on how to modify current specifications to implement optimized graded concrete.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Ley, M.T.

Analysis of Class F fly ashes
Grace is interested in investigating two different class F fly ash samples with the automated SEM. This technique provides the chemical composition versus the particle size. A clustering analysis can be used on the data to chemically group the particles. This is the only technique that is capable of rapidly comparing the chemistry of the small and large particles. These comparisons can also be made between different types of fly ash particles. All samples will be prepared and provided by W.R. Grace. After the sample is provided data should be available within a month. A spreadsheet will be provided with all of the raw data (particle size, and estimated elemental concentration for the volume investigated). We will also use some data clustering techniques to group the data. That information can then be used to decide what the different chemical groups are and look at their size range. Samples will be investigated for $300/sample. This technique can also be used after fly ash particles have been treated or soaked in simulated pore solution. Investigation of these samples would also cost $300/sample and the same information will be provided.
Sponsor: W.R. Grace & Co.-Conn.
PI/PD: Tyler Lay

NIST Summer Undergraduate Research Fellowship 2012
For the summer of 2010, Oklahoma State University would like to request that Danielle Artmayer receive funding from Summer Undergraduate Research Fellowship program at the National Institute of Standards and Technology.

Danielle has a desire to learn and is a well rounded student at OSU where she is involved in various academic and volunteer organizations in which she has taken leadership roles. Danielle is an excellent student with a superb academic background to show for her hard work and commitment to civil engineering. Danielle has worked as an undergraduate researcher for Dr. Tyler Ley in the development of new concrete admixtures, and the testing of novel corrosion sensors. After graduation, she plans to attend graduate school. Her area of interest lies in the Microanalysis Research group.
The NIST program will be beneficial to Danielle and OSU. Danielle will be exposed to state-of-the-art technology and cutting edge research. Danielle will also have to opportunity to learn from some of the leading experts in their field of research. She will no doubt gain a great deal of knowledge throughout the summer which she will be able to bring back and use at OSU.
Sponsor: United States Department of Commerce
PI/PD: Tyler Ley

Development and Implementation of a Mechanistic and Empirical Pavement Design Guide (MEPDG) for Rigid Pavements Phase II

There are great advantages in the design of infrastructure if design procedures are used that are based on mechanisms and variables that determine the performance of the element in service. The American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the National Cooperative Highway Research Program (NCHRP) have published a new design guide that combines mechanistic and empirical pavement design for flexible and rigid pavements which aims to accomplish this. The latest version of the software that builds on this mechanistic and empirical design approach is called DARWin-ME. Under this project the Oklahoma Department of Transportation (ODOT) is investigating the implementation of this software, but the designs would benefit from using material inputs and local calibration of the software that is more applicable to ODOT materials and construction processes.

Currently, DARWin-ME provides the user with several default input values for the material properties, construction methods, and weather information for rigid pavements that are based on average values obtained from literature or national averages. It has been reported in several publications, including the DARWin-ME user manual, that the designs produced can be improved if realistic inputs are used in the analysis.

Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Tyler Ley

Static Tests of Parallel Wire Cables

For this project, testing will be completed for Wilolamb construction on their patented pre-manufactured parallel wire cables. As part of this project, three sets of tests will be completed. These will consist of testing individual wires (5 to 10 tests), 7 wire bundles (5 to 7 different tests), and 100 wire bundles (3 tests). These specimens will be loaded to failure and their stress strain relationship will be found. To do these tests unique grips will have to be made for each of the tests. These grips will be designed so that they are fatigue resistant for possible future testing. The final reporting will be done by submitting a draft for a journal paper manuscript for Wilolamb Construction to review.

Sponsor: Wilolamb International Corporation
PI/PD: Ley, M.T.

Characterization and Mediation of Microbial Deterioration of Concrete Infrastructure

The Federal Highway Administration has estimated that as many as one quarter of the bridges in the US are in a state of disrepair, and there is growing concern, especially in southern states, that microorganisms growing on the surface of concrete bridge supports are contributing to the problem. The aims of this proposal will be achieved by meeting the following specific objectives: 1) Conduct field studies to collect microbes, 2) Culture, identify, and evaluate the environmental response of microbes and 3) Evaluate techniques to prevent and repair microbial damage. These repairs will allow the service life of these bridges to be extended which will more than justify the expense of the project.

Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Ley, M.T., Wilber, G.G.
A&S: Fathepure, B.
CHEN: Ramsey, J.

Acquisition of a LIDAR Laser Scanner for Bridge Inspection

To purchase a Riegl LIDAR scanner that will significantly enhance the capability of the research community in Oklahoma in the area of structural health monitoring and structural analysis for bridges.

Sponsor: Oklahoma Transportation Center (OTC), Civil and Environmental Engineering
PI/PDs: Robert Emerson, Tyler Ley

Development of Precast, Posttensioned Concrete Pavement for Bridge Underpasses
The objectives of this project are to identify and conduct concrete research at OSU, to evaluate the current technology related to precast pavements, to analyze the theory and identify potential improvements to the designs, and conduct research studies and laboratory tests to verify the findings, all in order to make highway pavement repairs and reconstruction faster, and longer lasting.
Sponsor: United States Department of Transportation – Federal Highway Administration
PI/PD: Bruce W. Russell

Laboratory Modeling of Energy Dissipation in Broken-Back Culverts
Studies indicate that there are 121 scour-critical culverts on the Interstate System (ISTAT), the National Highway System (NHS), and the State Transportation Program (STP) in Oklahoma. Replacement cost of these culverts is about $121M. Advantages of this research are to maximize energy loss within the culvert, and thus, minimize the scour around the culvert. This will reduce construction and rehabilitation costs involving culverts in Oklahoma. The purpose of this project is to develop a methodology to analyze broken-back culverts in Oklahoma so energy is mostly dissipated within the culverts or just downstream of the culverts in order to minimize the degradation downstream.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Avdhesh K. Tyagi

Analysis of Existing Water Quality Data in Enid Wellfields - Phase I
This research investigates the variation of nitrates in all wells of the five wellfields used to pump groundwater for the City of Enid. The five wellfields include Ames, Cleo Springs, Drummond, Ringwood, and Enid wellfields. There are a total of 134 wells pumping groundwater at varying rates. The concentration of nitrates fluctuates in the wellfields, and in some wells it can exceed more than the maximum concentration level (MCL) allowed by the Oklahoma Department of Environmental Quality (ODEQ) and the Environmental Protection Agency (EPA). In 2011 many wells have also exceeded nitrate levels above the MCL. The purpose of this project is to analyze the existing nitrates over the last twenty years. The analysis contains plots of nitrate concentration with time and then develops nitrate contours over space in each wellfield.
Sponsor: City of Enid
PI/PD: Tyagi, A.K.

Energy Dissipation in Eighteen-foot Broken-Back Culverts Using Laboratory Models
The purpose is to develop a method to study broken-back culverts (device used to channel water) in Oklahoma such that the energy is mostly reduced within the culverts or downstream of the culverts in order to minimize the degradation downstream. This research maximizes the energy loss within the culvert, and thus, minimizes the scour around the culvert. This will reduce the construction and rehabilitation costs of culverts in Oklahoma and the United States.
Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Tyagi, A.K.

ADVANCE Partnerships for Adaptation, Implementation, and Dissemination (PAID) Award: Gender Equity in STEM at Oklahoma State University
Oklahoma State University (OSU) proposes to adapt the MIZZOU ADVANCE mentoring plan in order to increase the retention and advancement of women in science and engineering. The long term goal of

this is project is aimed at identifying and developing changes to university policies and practices to better serve and represent its changing academic workers in terms of gender and ethnicity. The goals of the program are to bring awareness of barriers to women's and underrepresented groups advancement across STEM fields.
Sponsor: National Science Foundation
PI/PDs: John N. Veenstra
College of Arts and Sciences: Jean Van Delinder, Robert V. Miller., James P. Wicksted
Provost and Senior Vice President Office: Marlene I. Strathe

Traffic and Data Preparation for AASHTO Darwin-ME Analysis and Design
The newly released DARWin-ME system by AASHTO is a significant advancement in pavement design, but requires significantly more inputs from pavement designers. Through research activities sponsored by the Arkansas highway department and the Office of Pavement Technology of the Federal Highway Administration (FHWA), a software program called Prep-ME has been developed with comprehensive database features to store and process climate, traffic and materials data for the DARWin-ME predecessor, the Mechanistic-Empirical Pavement Design Guide (MEPDG). The objective of the Prep-ME software through the pooled-fund project is to assist participating state DOTs in the data preparation for DARWin-ME and improve the management and workflow of the DARWin-ME databases.
Sponsor: Louisiana Transportation Research Center for the Louisiana Department of Transportation
PI/PD: Wang, C.P.

Distress Modeling for DARWin-ME, Phase I
To investigate data needs for distress models in the new DARWin-ME (the acronym of pavement Design, Analysis and Rehabilitation for Windows), based on past ODOT research work to establish a workflow in using local level data sets on cracking, rutting, and roughness for DARWin-ME prediction models, and to assist ODOT in implementing DARWin-ME in the next decade as part of ODOT long-term plan in studying and deploying DARWin-ME in a production environment.
Sponsor: Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Wang, C.P.

Ground Penetrating Radar (GPR) for Pavement Evaluation
The University of Arkansas currently has an ongoing research contract with the Arkansas State Highway & Transportation Department (AHTD) titled "Ground Penetrating Radar (GPR) for Pavement Evaluation, TRC-1001". The research is entering its final year of research. The bulk of the technical work will be conducted by the staff and students at the University of Arkansas. Dr. Wang will continue supervising the technical team to carry out the tasks outlined in the revised proposal to AHTD by UA. Dr. Wang will be responsible for the completion of the project and fulfill the reporting requirements by AHTD
Sponsor: University of Arkansas for the Arkansas State Highway and Transportation Department
PI/PD: Wang, C.P.

Investigating the Use of Algaecides for Removal of Geosmin and Methylisoborneol
This project addresses issues that are of current concern to these utilities specifically, but also to many water utilities nationwide. It will also make use of existing data generated in the municipalities' efforts to control the release of taste and odor compounds, geosmin in particular, at their treatment plants or in their source waters. These control efforts currently center on the use of an algaecide that appears to minimize the release of geosmin during periods when algae concentrations are particularly high. The proposed project is intended, in part, to provide information needed to better understand, and

eventually optimize, this control technique, as well as to evaluate its usefulness in controlling other compounds of concern.
Sponsor: Water Research Foundation
PI/PD: Wilber, G.G., Sanders, D., Veenstra, J.N.

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

Thin-film Piezoelectric-on-Silicon Resonators for Commercial Oscillator Application
Thin-film piezoelectric-on-silicon (TPoS) technology is a platform developed at Georgia Tech that can be used for realization of micromachined dispersed-frequency high-Q resonators. These resonators are very attractive candidates for implementation of high-performance oscillators in a small package. The mechanical design and the material used for fabrication of these devices can greatly alter the characteristic of a TPoS resonator and consequently the performance of the oscillator built based on the device. The objective in this project is to create comprehensive guidelines for design and fabrication of high-Q TPoS resonators in a wide frequency range that can be used for implementation of high-performance stable oscillators.
Sponsor: Integrated Device Technology, Inc.
PI/PD: Reza Abdolvand

Nano-Engineered Infrared Sensors
In this proposal novel fabrication techniques are combined with application of material with enhanced thermal properties in an optimized pixel structure which potentially enables thermoelectric IR imaging units with unprecedented performance. The proposed devices are expected to significantly close the gap between the two IR imaging techniques (thermal and photon detection) while offering significant advantages in size, cost and power consumption.
Sponsor: Amethyst Research, Inc., School of Electrical and Computer Engineering
PI/PDs: Reza Abdolvand, Daryoosh Vashaee

EPMD: Lateral-Mode MEMS Filter Arrays on Ultrananocrystalline Diamond for Multi-Band Communication
Many years after the introduction of its concept, the single-chip multi-frequency MEMS filter platform, a technology believed to revolutionize the RF industry, has come short of delivering all that was promised. The objective of the proposed research is to significantly advance the field of MEMS filters by putting forward innovative solutions that tackle the issues hindering widespread deployment of MEMS filters such as high insertion loss, extremely low power handling, and limited bandwidth. Our approach is to exploit high-coupling-factor thin-film piezoelectric materials such as lead-zirconium-titanate (PZT) in combination with novel impedance matching techniques to improve the insertion loss and the bandwidth of the filters. We expect to realize arrays of low-loss MEMS filters with adjustable bandwidths (up to 2.5% of the center frequency) at frequencies ranging from 30MHz to 6GHz, which are fabricated on ultra-nanocrystalline diamond (UNCD) substrates. UNCD is chosen for its very unique mechanical properties such as highest acoustic velocity found in nature, excellent wear-resistance, low temperature coefficient of frequency, and highly linear elastic coefficients, which guarantees stable operation at high frequencies and high power levels.

As part of this GOALI proposal, Advanced Diamond Technologies (ADT) Corp. will support the project through in-kind services such as: (i) providing polished UNCD-coated silicon wafers for fabrication of the filters, (ii) supporting an on-site workshop for graduate students to learn about ADT's UNCD production

process, (iii) assigning about 10% of an engineer's/scientist's time to work and monitor the progress of the research, and (iv) pursuing technology transfer and implementation of the research findings.
Sponsor: National Science Foundation
PI/PD: Abdolvand, R.

Stochastic Characterization of Naval Aircraft Electromagnetic Vulnerability: ElectroMagnetic Susceptibility Threshold Analysis Techniques by Estimation and Statistics (EMSTATES)
The work to be performed for this project includes: 1) development of a detailed description of the scope of the electromagnetic vulnerability problem and determination of the feasibility of computational electromagnetic tools employed to stochastically characterize the fields within cockpits, cabins and equipment bays of Naval aircraft, and 2) assessing the required fidelity aircraft geometry models in order to adequately characterize the fields and currents in a statistical sense.
Sponsor: ANDRO Computational Solutions, LLC for Naval Air Warfare Center - AD
PI/PD: Charles F. Bunting

New Methodologies for System-Level Electromagnetic Compatibility (EMC) Analysis of Electronic Systems
This project aims at formulating, implementing and testing new methodologies with a potential for enabling significantly enhanced EMI/EMC design of electronic systems. The proposed CAD methodologies offer a generalized perspective in terms of analyzing EMI coupling scenarios routinely faced by EMC engineers. The methodologies and the framework are independent of computational tools or techniques. Instead, they provide new ideas based on Artificial Neural Networks (ANNs) for integrating the existing methods in order to handle problems of higher complexities, while significantly reducing the computational overhead. The proposed study aims at identifying sensitive parameters (source location, size/orientation of cavity apertures, etc.) in a given EM environment using statistical analysis, to decide, for a given EMI coupling scenario, whether deterministic tools are required in the overall analysis of electronic systems.
Sponsor: The University of Toledo for the National Science Foundation
PI/PD: Charles F. Bunting

Characterization of the Space Power Facility Reverberation Chamber
Oklahoma State University shall provide engineering research services to design and implement a Stirrer Assembly to be fabricated by GRC and used in the SPF Test Chamber to facilitate reverberation testing. The stirrer design shall satisfy the testing requirements of MIL-STD-461F. The stirrer will be excited by a transmitting antenna located as close as possible to the Door 5 position in SPF. OSU will assist NASA GRC with the following activities; review prototype Tuner test plan & design, perform / assist in Tuner prototype performance testing, evaluate Tuner prototype performance testing, participate and provide support for briefings and establish calibration procedure parameters.
Sponsor: Qinetiq North America / Analex for NASA
PI/PD: Charles F. Bunting

CCLI: A National Model for Engineering Mathematics Education
The inability of incoming students to successfully advance past the traditional freshman calculus sequence is a primary cause of attrition in engineering programs across the country. As a result, this project seeks to effect a transformative and nationwide change in engineering mathematics education, with the goal of increased student retention, motivation and success in engineering.

Sponsor: Wright State University for the National Science Foundation
PI/PDs: Charles F. Bunting, Alan Cheville
Chemical Engineering: Karen A. High

CIF:RI:Small:Content-Based Strategies of Image and Video Quality Assessment
The research objective of this proposal is to investigate new techniques of image and video quality assessment which use content-adaptive models of the human visual system. The ability to quantify the quality of an image is a crucial step for any system that processes digital images and video. Yet, determining quality in a manner that agrees with human perception remains one of the greatest ongoing challenges in signal processing. The proposed research will not only lead to more accurate and robust methods of quality assessment, but it will also lay the groundwork for next generation perceptual models which take into account the adaptive nature of human vision.
Sponsor: National Science Foundation
PI/PD: Chandler, D.

Enabling Battlefield Situational Awareness through a Cooperative and Intelligent Video Sensor Network
The principal objective of this project is to provide the Army with anytime, anywhere, rapid video surveillance capabilities by transforming the state-of-the-art in wireless video sensor networks (WVSNs). A WVSN requires more battery power and more communication bandwidth than is realistically available. By automatically identifying the most important regions of the video, and by stripping away irrelevant portions, we believe that it is possible to (1) reduce bandwidth requirements, (2) improve accuracy, and (3) facilitate autonomous system calibration. Thus, the proposed technique has the potential to simultaneously overcome the limitation of resources, meet the desire for easy system setup, and achieve high accuracy.
Sponsor: United States Army Research, Development and Engineering Command
PI/PDs: Chandler, D., Cheng, Qi, Sheng, Weihua, Teague, K.A.

CAREER: Content-Based Image and Video Coding Using Higher-Level Models of Human Vision
Current methods of image and video coding are effective largely because they capitalize on low-level aspects of the human visual system (HVS). The single most predominant strategy is to place the errors into regions which can better hide the compression artifacts, an approach which can be guided by computational models of early/low-level HVS processing. In this project, the investigator researches how compression artifacts influence the HVS's ability to process and interpret images and video. Three main areas are investigated: (1) new models of visual masking which take into account image recognition; (2) appearance-preserving strategies of data quantization; and (3) analysis and quantization strategies which honor rules of visual cognition derived from quality-rating experiments coupled with eye-tracking. This research is integrated with an educational component that promotes student development in applying knowledge of human vision to engineering problems**.**
Sponsor: National Science Foundation
PI/PDs: ECEN: Chandler, D.

Visually Optimal Digital Watermarking for IA of Medical Images
We propose to study and implement an image-adaptive method of digital watermarking which can guarantee data confidentiality, image authenticity, and ownership. We will specifically capitalize on the perceptual property of visual masking, which describes the ability of an image to reduce the visibility of a watermark.

Sponsor: Bureau of Justice Assistance, School of Electrical and Computer Engineering
PI/PD: Damon Chandler

OKCARS: Oklahoma Collision Analysis and Response System

Safety and security are paramount to our transportation infrastructure. Recently there has been growing interest in developing a system for coordinated efforts to deal with emergencies arising from severe accidents, and to improve emergency response preparedness, advancement of decision support tools for risk assessment, management and recovery. In this three-year project, we propose and design an automatic traffic scene analysis and response system with computational intelligence. It is anticipated that at the end of the project we will have a complete working system for autonomous traffic monitoring and accident detection and response. The proposed project is anticipated to provide 24/7 monitoring, provide more accurate situation-awareness, and can respond more promptly.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Cheng, Q., Chandler, D., Sheng, W.

CPS:Small: A Unified Distributed Spatiotemporal Signal Processing Framework for Structural Health Monitoring

Structural anomalies/failures due to improper maintenance and fatigue are significant causes and contributing factors in critical infrastructure disasters. It is an urgent global need to improve accuracy and confidence in structural health state assessment and life-time prediction. With the advances of sensing technology, large numbers of *in situ* sensors can be deployed inside the structure for non-destructive health monitoring purposes.
The objective of this project is to develop collaborative signal processing techniques by coupling spatial-temporal sensing data with physics-based and data-driven models by;

1) Investigate the feasibility of statistical modeling of dynamic structures to address the spatial and temporal correlation of sensing data.
2) Develop efficient distributed algorithms to ascertain whether a significant damage of a certain magnitude exists and its exact location.
3) Investigate how to enhance the network through the strategic placement of sensors.
4) Address optimal sensor collaboration.

Sponsor: National Science Foundation
PI/PD: Cheng, Qi

Evaluation of the Enhanced Integrated Climatic Model for Modulus-Based Construction Specifications for Oklahoma Pavements

The performance of a pavement depends on many factors such as the structural adequacy, the properties of the materials used, traffic loading, climatic conditions and the construction methods. Since unbound materials (subgrade soils and base course) are significant portions of the construction of pavements, much of the distress, particularly for flexible pavements, can be traced to problems in these materials. The performance specifications of pavements should be based on the short and long-term behavior of unbound materials in terms of the principals of unsaturated soil mechanics and seasonal variation of material properties. The Enhanced Integrated Climatic Model (EICM), which is an integral component of the Mechanistic Empirical Pavement Design Guide (MEPDG), plays an important role in defining the short and long-term pavement materials properties used in the design guide. The proposed study will help us to determine the appropriateness of the EICM for the Oklahoma climatic conditions. This study will lead to the estimation of site specific variation in environmental factors that are used in predicting seasonal variation and long-term resilient modulus of unbound materials.

Sponsor: Oklahoma Transportation Center for the Oklahoma Department of Transportation for the Federal Highway Administration
PI/PD: Cheng, Qi

Evaluation of the Enhanced Integrated Climatic Model for Modulus-Based Construction Specifications for Oklahoma Pavements
The Enhanced Integrated Climatic Model (EICM) is an integral component of the Mechanistic Empirical Pavement Design Guide (MEPDG) that involves analysis of water and heat flow through pavement layers in response to climatic, soil, and boundary conditions above and below the ground surface in pavement structures. The performance of a pavement depends on many factors as the structural integrity, the material properties, traffic loading, construction method, and climatic conditions. Since unbound materials (subgrade soils and base course) are a significant portion of the construction of pavements, much of the distress can be traced to problems in these materials. The goal of the MEPDG is to provide a quantitative and site-specific assessment of the pavement section needed to resist the traffic loading for a design lifetime. The EICM plays a significant role in defining the material properties in the design guide. In that regard, the moisture and temperature variations are the paramount parameters in the behavior of pavement structures. AASHTO has recommended that the MEPDG be adopted by state departments of transportation in pavement design. However, the Oklahoma Department of Transportation (ODOT) has noticed that the EICM model in the MEPDG does not contain sufficient, and site-specific, climatic data information for realistic predictions of moisture and temperature changes in pavement layers in Oklahoma. This research study is specifically focused on a detailed evaluation of the EICM for Oklahoma in order to reduce the sources of uncertainty in the MEPDG design. The study will help us to determine the appropriateness of the EICM for the Oklahoma climatic conditions. The study will lead to the estimation of site specific variation in environmental factors that are used in predicting seasonal and long-term variations of moduli of unbound materials.
Sponsor: Oklahoma Transportation Center for the U.S Department of Transportation
PI/PD: Qi Cheng

Multiple Domain Particle Filters for Integrated Tracking and Recognition in IR Imagery
In this project, Drs. Joseph Havlicek (OU) and Dr. Guoliang Fan (OSU) will work together to study a new target tracking recognition system. Dr. Fan will. 1) incorporate relevant 3D contextual information for target tracking and recognition in order to handle the uncertainty and incompleteness in the observed 2D IR data, including a camera model, a 3D background representation, and 3D target representation/motion models and 2) develop a generative graphical model to integrate tracking, recognition and learning seamlessly in one computational flow where a target motion-appearance model is involved.
Sponsor: University of Oklahoma for DEPSCoR U.S. Army
PI/PD: Guoliang Fan

Vision-Based Gait Analysis for Early Fall-Risk Detection
This project seeks a vision-based motion analysis approach that is able to assess gait instability in a clinical setting with normal video cameras. Falls among the elderly population are prevalent, dangerous, and costly. The proposed research is cross-disciplinary since it incorporates the most recent advancements in both biomechanics for gait instability analysis and vision-based markerless motion capture. It is also translational in the sense that it tends to bridge the gap between lab and clinic for fall risk assessment. The success of this research may also have tremendous value for monitoring safe ambulation and recognizing accidental falls in a video surveillance environment.

Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Fan, G.

THz Surface Waves, Waveguide THz-TDS and the 2D-TEM Plane
This program explores fundamental optical physics and applications using far-infrared terahertz (THz) radiation. The PI has previously extended the concept and utility of parallel-plate waveguides to that of a much larger two-dimensional plane. Within this plane two-dimensional quasi-optical elements have demonstrated THz guiding and diffraction. This project investigates optical physics with recently designed two-dimensional quasi-optical components with negative index of refraction. In addition, the program experimentally measures and theoretically studies the propagation of THz surface electromagnetic waves (plasmons) on planar subwavelength arrays of holes in thin metal films.
Sponsor: National Science Foundation
PI/PD: Daniel R. Grischkowsky

New THz Molecular Recognition Signatures of Threat Materials, using Waveguide THz-TDS and Long-Path THz-TDS
A collaborative basic research program is proposed to advance current capabilities to measure terahertz (THz) vibrational fingerprint lines of explosives solids, and to enhance the THz detection sensitivity of threat vapors.
The objectives of this proposal are;
1) Create new waveguide-based THz spectroscopic methods to fully resolve underlying THz vibrational fingerprint spectra of explosives solids,
2) Advance fundamental understandings of the THz vibrational properties of explosive solids,
3) Create new methods to boost THz detection sensitivity of threat vapors.
Achieving these objectives will advance DoD capabilities to detect WMD threat materials based on spectroscopic identification of fingerprints.
Sponsor: Naval Research Laboratory
PI/PD: Grischkowsky, D.R.

Highly Directional Photo-Switched Terahertz Source
To develop and to demonstrate a narrow-band THz source for terrestrial communications with a frequency within the atmospheric window centered at 350 GHz, we will do the following work in our well-equipped and operating THz Laboratories : We will convert one of our complete and operating optoelectronic THz systems (THz transmitter, receiver and quasi-optic THz beam train) into a test-bed for more powerful THz sources, utilizing
higher optical pumping power up to 800 mW; we will test a large variety of on-hand antenna chips of different design to verify the efficacy of different design concepts, including different type foci (circular to elliptical to line-focus) of the optical pumping beam; we will design and procure new lithographic masks incorporating new antenna designs, and phased arrays of previous and new approaches. These new masks together with some previously untested ideas in our relatively large library of on-hand lithographic masks would be used to fabricate new transmitter chips.
Sponsor: Sci-Eng Solutions, LLC, School of Electrical and Computer Engineering
PI/PD: Daniel Grischkowsky

Smart Cars Summer Academy
The purpose of this academy is to use the smart sensor concept to stimulate students' interest in science, math and technology, and to encourage them to pursue their interests by attending an institution of higher education.

Sponsor: Oklahoma State Regents for Higher Education (OSRHE)
PI/PDs: ECEN: Martin Hagan, Carl Latino
General University, Institutional Diversity: Jovette Dew

A Distributed Wireless Neural Interface System
This grant proposes the development and testing of a highly advanced neural probe that incorporates the best features of modern neural interfaces into a single system. The Micro Neural Interface (MNI) system is comprised of up to 100 independent, wireless, biological sensors with on-board signal conditioning and spike detection. Each probe communicates with and is powered via a 0.9 to 2.4 GHz wireless RF transceiver.
Sponsor: University of Texas at Dallas, School of Electrical and Computer Engineering
PI/PDs: Chris Hutchens, Louis Johnson

Mixed Signal Design Group
NGenovation has developed a design methodology for the implementation of programmable analog circuits. This methodology uses programmable circuit elements constructed of switched arrays of basic elements. Other programmable circuit elements could be constructed in a similar fashion but this project will focus on these two elements. Programmable analog circuits can be comprised of such elements along with fixed elements.
Sponsor: Ngenovation
PI/PD: Hutchens, C.G.

Amethyst Research -- VLSI Array
This project will sponsor a student to assist Amethyst Research in the development of the VLSI electronics for the forthcoming sensor array. The work will require the student to come to Amethyst to plan for MINTE production and work with Amethyst's staff. The initial task is to learn the processes to make MINTE detector MEMS structures to help set up that process in Ardmore in 2012. Another important task will be the need to learn about electronic signals coming from the MINTE silicon nanowires. There will be many challenges in developing MINTE arrays so the goal will be to learn a wide range of technology areas.
Sponsor: Amethyst Research, Inc.
PI/PD: Hutchens, C.G.

Therapeutic Evaluation of Magnetic Nanoprobes Specific for Malignant Tumor Markers
This project is focused on developing and assessing tumor marker specific magnetite or iron oxide (IO) nanoprobes in their ability to: (1) detect tumor markers, such as c-Met and VEGF-R2, *in vivo,* and in addition (2) act as anti-cancer therapeutic agents.
Sponsor: Oklahoma Medical Research Foundation for the National Institutes of Health
PI/PD: Piao, Daqing

Challenges of Zinc-Specific Transrectal Fluorescence Tomography to Detect Prostate Cancer
The objective of this research is to develop a novel ionic-sensitivity prostate cancer imaging capability by utilizing zinc-based cancer biomarker to detect malignant prostate tissue with trans-rectal fluorescence diffuse optical tomography (FDOT).
This training project is to prepare the applicant for an academic career in computational analysis and instrumentation development important to prostate cancer diagnosis and therapy management, by investigating trans-rectal fluorescence diffuse optical tomography with zinc specificity.

Sponsor: United States Army Medical Research Acquisition Activity
PI/PD: Piao, Daqing

Photonic-needle assessment of hepatic steatosis
The long term goal of this research is to establish a rapid, objective, and minimally-invasive deep-tissue sensing technology to quantify the intensity of hepatic steatosis as well as to differentiate macro-steatosis from micro-steatosis of the donor-liver, the assessments vital to the outcome of many liver transplants. The objective in the current study is to develop a method based on an ultra-fine fiber-needle that combines near-infrared (NIR) reflectance spectroscopy with low coherence interferometry (LCI), and to test the sensitivity and specificity of this method in quantifying the volume-content as well as the size-distribution of fat vacuolae in phantom and animal model of hepatic steatosis. This high-risk research is expected to demonstrate that the proposed technology is reliable and rapid in quantifying lipid concentrations and size-profiling of lipid droplets in a donor liver.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Piao, Daqing

CIF: Small: Collaborative Research: Cooperative Sensing and Communications for Cognitive Radio Networks
The emerging cognitive radio network (CRN) technology has the great potential to solve what seems to be a spectrum crisis, by allowing the secondary (unlicensed) users to opportunistically and dynamically utilize the white spaces within the licensed bands, without causing harmful interference to the primary (licensed) users. Efficient design of CRNs is still in its infancy stages. This proposal addresses two essential components of a CRN: spectrum sensing and spectrum access and sharing. Through an interweaved plan for research and educational activities we propose: 1) novel integrated signal processing and communication designs for data fusion in cooperative spectrum sensing, and 2) new communications and networking schemes based on a mutualistic cooperation paradigm.
Sponsor: National Science Foundation
PI/PD: Rahnavard, N.

CAREER: A Generalized Compressive Sensing Approach to Data Acquisition and Ad-Hoc Sensor Networking
The reliable operation of the emerging large-scale networking paradigms such as WSNs is susceptible to their overwhelming communication, computation, and sensing complexities. Efficient protocols for reducing such complexities are in serious demand to enable their widespread applications. To overcome this problem, it is vital to devise new communication and sensing schemes that ensure reliability, while offering a reduced load of communication and computation. The design of such schemes has to be problem specific. The integration of these features into the adopted design can result in significant reductions in the cost of sensing and communication and provide us with potential trade-offs between sophistication of the design and performance.
Sponsor: National Science Foundation
PI/PD: Rahnavard, N.

Control and Operation of Large-Scale Wind Farms in the Power System
This project is jointly proposed by the University of Oklahoma and Oklahoma State University. The OSU group is responsible for the following project tasks:

1. *Modeling of large-scale wind farms for power system operation*: constructing mathematical models of large-scale wind farms for power system operation.

2. *Seamless control and operation of large-scale wind farms*: assessing the efficacy and practicality of the controller developed by the OU group, aimed at seamlessly controlling both the active and reactive power outputs of such wind farms in both the maximum power tracking (MPT) and power regulation (PR) modes.
3. *Derivation of dynamic output characteristics of large-scale wind farms*: evaluating the dynamic output characteristics of large-scale wind farms, operating under the controller.
4. *Industrial collaboration*: facilitate the collaboration between OU/OSU and the supporting power companies.

Sponsor: University of Oklahoma for the National Science Foundation
PI/PD: Ramakumar, R.G.

Chemical Detector Signal Processing
To date there is no solid state refrigerator that can cool from room temperature down to the transition temperature of superconductors or that can provide sufficient cooling for high performance infrared (IR) detectors. A material system that provides such a capability would make superconductor devices practical, and enable a new generation of electronic and optoelectronic devices and integrated circuits not limited by heat generation. A solid state cooler of the type to be developed in this program would be available for immediate application to DoD systems.
Sponsor: Sandia National Laboratories
PI/PDs: Scheets, G.M., Yarlagadda, R.

RF Physical Layer Authentication via Watermarking
The purpose of this project is to test the viability of several physical layer authentication schemes in both simulated and real-world scenarios in order to inform further development of those methods that may be of interest to the U.S. Navy. This project will perform testing of the impact of these schemes on both watermark aware & non-watermark aware receivers. A WACR should be able to reliably process a physical layer authentication signal. Ideally the performance of a standard non-WACR receiver should not be degraded by that same signal and the presence of the authentication signal should remain unknown. Practically, depending on the technique used, there may be some degradation of performance.
Sponsor: Exelis
PI/PD: George Scheets

MRI: Acquisition of an Optical Motion Capture System for Human-Centered Computing Research
Pervasive computing, especially wearable computing has changed the relationship between human and computer from traditional desktop-user model to a more interactive and more coupled one. In this proposal, we will address two basic questions that are central to understanding the interplay between human and computing:
1) How do we understand human context (such as behavior, location) through embedded computing?
2) How do we explore the knowledge of human context to improve embedded computing applications?
Both projects require a motion capture system that can provide location ground truth, allow performance comparison and facilitate system calibration.
This proposal requests the fund from NSF to purchase a state-of-the-art optical motion capture system, a 12-camera *Qualisys* motion capture system from *Qualisys* North America, Inc.
This instrument will be used in research projects aiming at the understanding of the new relationship between human and computing.

Sponsor: National Science Foundation
PI/PDs: Sheng, Weihua, Cheng, Qi, Rahnavard, N.
A&S: Kak, Subhash

CSR: Small: Infrastructure-free Human Context Awareness with a Wearable Sensing and Computing System
Context is a very important and fundamental concept in pervasive computing, especially in wearable computing. The major objective of this project is to develop the fundamental theoretical framework and algorithms that realize human context awareness in an *infrastructure-free* fashion and validate them through physical experiments using a prototype body sensor network. The central problem that this project solves is the simultaneous tracking and activity recognition of a human subject in indoor environments by using wearable sensors and computers only. The underlying theoretical framework is developed based on novel dynamic Bayesian modeling and probabilistic reasoning.
Sponsor: National Science Foundation
PI/PD: Sheng, Weihua

Automated and Accurate Bridge Deck Crack Inspection and Mapping
This project aims to develop a smart mobile sensing system equipped with advanced sensors such as cameras, laser range finders, inertial measurement units, and innovative software algorithms to conduct accurate crack inspection and mapping for bridge decks. We expect that such a system can significantly improve the state of the art of bridge deck structural inspection. The developed system can also be applied in a much wider spectrum of structure health monitoring (SHM) applications. The project consists of three major tasks: 1) the development of a platform for robotic crack inspection and mapping (ROCIM); 2) the development of robot autonomous navigation for inspection; 3) the development of crack detection and crack map generation. This project will be conducted by a team of interdisciplinary researchers with expertise in the area of mobile robotics, remote sensing and civil engineering.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Sheng, Weihua

RIGEE: Progressive Learning Platform for Computer Engineering
The long-term vision for the Computer Engineering Progressive Learning Platform (PLP) is to transform the way computer engineering is taught by establishing the computer engineering curriculum around a carefully designed learning platform. PLP provides a common development platform using a Field Programmable Gate Array (FPGA) board for a number of computer engineering courses and provides curricular elements like tutorials, projects, and quizzes based around the platform. With an overarching system like PLP, where different aspects of it are taught and operated on in different courses, students will be able to directly see how concepts in different computer engineering courses are related to each other. The research questions that this project aims to answer are:
1) How effective is PLP in changing student motivation?
2) How does PLP improve student learning as a material anchor in a community of practice?
3) How does examining students' language in written and oral reports help to explain their conceptual understanding and their attitude/mindset?

Sponsor: National Science Foundation
PI/PD: Sohoni, S.A.

MRI: Acquisition of a High Performance Computer Cluster for Multidisciplinary Research
Oklahoma State University High Performance Computing Center (OSUHPCC) will acquire, deploy and maintain an HPC cluster supercomputer, to be named Cowboy, that will support computing-intensive

research and research training across a broad variety of Science, Technology, Engineering and Mathematics (STEM) disciplines. As a campus-wide shared resource, Cowboy will be available not only to all of OSU's faculty, staff, postdocs, graduate students and undergraduates, but to researchers across Oklahoma.
Sponsor: National Science Foundation
PI/PD: Sohoni, S.A.

Exploration of Cognitive Reasoning VLSI Computer Architectures
For computer architectures which demand high amounts of performance, silicon structures - as opposed to those created in Field Programmable Gate Arrays (FPGAs) - are the choice for today's engineer. The major research emphasis in this proposal is placed on designing a complex Very Large Scale Integration (VLSI) architecture using an elaborate design flow or sequence of steps. The research objectives of this project are to design, develop, and evaluate multi-core hardware support for computer architectures at the VLSI level.
Sponsor: United States Air Force
PI/PD: James E. Stine

Iraq University Linkages Program
The University Linkages Program is designed to facilitate the development of long-term, bilateral partnerships between U.S. and Iraqi universities. These linkages are built through the collaborative efforts of faculty and staff at the partnering institutions, following a framework of timelines and benchmarks managed by AED. In addition, AED will develop a model career center at each of the five participating Iraqi institutions to include equipment and resources and will provide guidance and training for career center staff. This allows participating institutions to build mutual understanding through focused exchanges, online course offerings, jointly taught courses, video conferencing, and other person-to-person interactions. The ultimate goal of the ULP is to guide the partners to establish self-sustaining, mutually beneficial relationships that will endure independently.
Sponsor: Center for Academic Partnerships, Academy for Educational Development for U.S. Department of State
PI/PDs: Stine, J.E.
SSB: Weiser, M., Poloncheck, J., Rao, R.
CHE: Gasem, K.A.M., Wagner, J.

Exploration and Evaluation of Nanometer Low-Power Multi-Core VLSi Computer Architectures
Earlier computer architectures were created through vast layers of silicon substrate currently, computer architectures have been able to be integrated on silicon through Field Programmable Gate Arrays (FPGAs). As the complexity of computer architectures increases, engineers resort to efficient streams of computer programs or design flows to accomplish the task of producing Very Large Scale Integration (VLSI) architectures. The major research emphasis in this proposal is placed on designing a complex VLSI multi-core architecture using an elaborate design flow or sequence of steps. Also, the major concern of this design flow is whether this project can create a design which can be implemented that outperforms other similar architectures in terms of propagation delay and area consumption, yet still produces a significant savings in terms of the amount of power consumed.
Sponsor: United States Air Force
PI/PD: Stine, J.E.

NSF IPA Agreement for Richard Alan Cheville
The IPA position allows faculty to serve as temporary program officers at NSF while remaining full-time faculty at their university.
Sponsor: National Science Foundation
PI/PD: Teague, K.A.

(Energy Harvesting) Thermoelectric Nanocomposite Materials for Medium to High Temperature Range
In an aircraft there is a broad range of temperatures at different locations. Energy harvesting from low temperature regions suffers from the small thermodynamic limit set by Carnot efficiency. However, thermoelectric materials that can work efficiently in the medium to high temperature range will benefit from large Carnot efficiency. Despite recent developments in advanced thermoelectric materials, there is an apparent lack of materials that can work efficiently from 500°C to 900°C. Our objective in this proposal is to develop efficient nanocomposite thermoelectric materials suitable for this entire range of temperature in a combined theoretical and experimental effort.
Sponsor: Air Force Office of Scientific Research
PI/PD: Vashaee, D.

Synthetic Aperture Radar Processing for Change Detection
The proposed work is to address the processing of synthetic aperture radar imagery to detect changes of a land environment over time. The work is associated with coherent imaging radar systems developed by Sandia National Laboratories in support of the US military and the war on terrorism.
The contractor shall perform the following tasks:

(1) Investigate automated methods to apply accurate phase-error autofocus functions to all pixels in radar images.
(2) Investigate image-registration algorithms used in determining the coherent change between images.

Sponsor: Sandia National Laboratories
PI/PD: Jim West

Terahertz Response of Unique Composite Metamaterials
Metamaterials, with both negative permittivity and negative permeability, have opened up an entirely new world of devices that may lead to breakthrough applications in a broad range of disciplines. Terahertz (THz) radiation (0.1 – 10 THz) has high signal-to- noise ratio, good transmission through many optically opaque materials, is non-ionizing radiation, shows signatures of chemical and biological threat molecules, and has extensive applications in a broad range of disciplines. This program will investigate composite subwavelength-structured metamaterials using techniques of THz spectroscopy. Novel THz metamaterial configurations will be investigated toward the establishment of negative index of refraction. The longer-term goal of this program is to develop integrated and efficient THz circuit elements capable of being integrated into compact platforms for applications in aerospace communications and surveillance systems, optoelectronics, and biosensing.
Sponsor: National Science Foundation
PI/PDs: Weili Zhang
College of Arts and Sciences: Xincheng Xie

Services Necessary in Support of LANL Project: "Harnessing Nonlinearity for Transformative Metamaterial Technology
This research proposes to develop electromagnetic models and device designs; more specifically, OSU will provide Los Alamos National Laboratory (LANL) with theoretical models and numerical simulation

work designed to enhance the understanding of nonlinear metamaterials. Predominately, this will involve the development of a modal analysis software tool whereby nonlinear metamaterial resonator behavior is determined at an "atomic" level, in contrast to current metamaterial analysis methods. OSU will work in collaboration with the LANL team to;

1) Develop the electromagnetic theory.
2) Implement the theory in software.
3) Assist in validation of the theory/software in conjunction with LANL experimental efforts.
4) Collaborate with the LANL experimental team to develop the electromagnetic source outlined in the LANL project.
5) Provide general expertise as well as suggest design strategies for success.
6) Participate in the LANL project reviews and progress reports.

Sponsor: Los Alamos National Security, LLC for the Department of Energy National Nuclear Security Administration
PI/PD: Zhang, W.

Time-domain Spectroscopy Characterization of Novel Terahertz Devices and Structures
The main aim of this proposal is to carry out characterizations (testing) of terahertz components and devices, including transmitter and receiver modules and novel subwavelength terahertz structures using terahertz time-domain spectroscopy for Petawave Networks, Inc., Lenexa, Kansas. Within this project, only testing will be done. The major equipment that will be used in this project includes:

1) Terahertz transmission spectroscopy system;
2) Terahertz reflection spectroscopy system;
3) Terahertz cryo spectroscopy system;
4) Coherent Verdi pumping laser (532 nm, 6 W);
5) KM Labs Ti:sapphire femtosecond laser (800 nm, 500 mW, 26 fs)

Sponsor: Petawave Networks, Inc.
PI/PD: Zhang, W.

SCHOOL OF INDUSTRIAL ENGINEERING AND MANAGEMENT

Proactive approach to transportation resource allocation under severe winter weather emergencies
Ice storms accompanied by excessive winter precipitation are high-impact weather events for the Oklahoma Department of Transportation (ODOT). Such hazardous conditions dramatically reduce road transportation infrastructure serviceability and decrease safety. This requires ODOT to monitor road conditions across the state in order to treat slick roadways and bridges, move power generators and supply potable water to regions suffering from power outages, manage debris removal in case of ice storms, assist traffic control in case of accidents, among other activities. The proposed decision-support software tool combines forecasting, risk-analysis, and optimization to predict impending severe winter emergencies such as ice storms and icy roads, allocate available resources to mitigate ongoing winter weather emergencies, and attenuate the risk of near-future hazards by deploying resources in anticipation.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Balasundaram, B., Kong, Z., Bukkapatnam, S.T.S.;
OU: Hong, Yang

Robust Optimization for Connectivity and Flows in Dynamic Complex Networks
The goal of this project is to study robust connectivity and flow patterns of complex multi-scale systems modeled as networks. Networks provide effective ways to study global, system level properties, as well as local, multi-scale interactions at a component level. Numerous applications from power systems, telecommunication, transportation, biology, social science, and other areas have benefitted from novel network-based models and their analysis. Modeling and optimization techniques that employ appropriate measures of risk will be developed for identifying robust network designs that assure reliable connectivity and efficient flow distribution patterns in networks under uncertainty.
Sponsor: United States Department of Energy
PI/PD: Balasundaram, B.

Heterogeneous Wireless Sensing and Modeling of Chemical-Mechanical Interactions in Chemical Mechanical Planarization Process for Microelectronic Applications
The objective of the proposed research is to address the following issues involved in the predictive modeling and real-time monitoring of chemical mechanical planarization/polishing (CMP) process used in the finishing of semiconductor chips: the interaction of chemical and mechanical phenomena at the silicon wafer-pad interface, the effect of machine vibrations, forces, temperature profiles, and acoustic emission signals, and the modeling of nonlinear stochastic process-machine interactions that capture the dynamic relationships between the wafer-pad interactions and the response of the sensor signals. Both experimental and analytical investigations will be undertaken to address these issues.
Sponsor: National Science Foundation
PI/PDs: Satish T.S. Bukkapatnam
Mechanical and Aerospace Engineering: Ranga Komanduri, Zhen Bin Hou

GOALI: Real-time Performance Prediction of Multi-Stage Manufacturing Systems using Nonlinear Stochastic Differential Equation Models
Manufacturing enterprises are investing in a variety of sensors and IT infrastructure to increase plant floor systems visibility. This offers an unprecedented opportunity to track performance of a manufacturing system from a dynamic, as opposed to a static sense. Conventional static models are inadequate for predicting performance variables in real-time from these large data sources. Dynamic models are necessary to compactly capture information from vast data sources for real-time performance prediction. Among the relevant approaches, flow modeling offers an effective balance between accuracy and speed. This approach treats the part movement in a manufacturing system as a fluid flow and models the dynamics in the form of differential equations. This approach is suitable to capture dynamics of manufacturing systems where part inter-release time-scales are much shorter than those for other events. They are faster to simulate and they capture the dynamic patterns better than discrete-event simulation (DES) models.
Sponsors: National Science Foundation, General Motors Corporation
PI/PD: Satish T.S. Bukkapatnam

Characterization and Real Time Defect Mitigation in Chemical/Mechanical Polishing of Microelectronic Wafers Using Decision Theory and MultiSensor Fusion
The semiconductor industry now relies heavily on the CMP process to meet the surface planarity and finishing needs to sustain the trend of increasing density on small feature-size (~30nm) devices. In this context, the defects generated during CMP, such as scratch, dishing, and chatter marks, etc. have emerged as the top wafer yield inhibitors. Due to the complexity of the process and poor specificity of the current sensor-based approaches, the defects are currently detected only after the polishing process, resulting in low wafer yield. These defects significantly deteriorate the wafer yield in the CMP,

especially of soft and compliant (e.g., Cu and low-k) materials. The objective of this proposal is to invoke a new bottom-up multi-sensor fusion and decision theory to derive quantitative relationships connecting the force- and vibration- signal features with specific defect patterns in chemical mechanical planarization (CMP) of microelectronic wafers for real-time surface defect mitigation in this process.
Sponsor: National Science Foundation
PI/PDs: Bukkapatnam, S.T.S., Kong, Z.
MAE: Komanduri, R.

Customer-Driven Dynamic Vehicle Portfolio Development -- Phase 2
Currently GM uses a self-explicated conjoint model to capture the customers' needs and preferences, and estimates the Willingness to Pay for various attributes and attribute levels based on this self-explicated conjoint model.
As the concept-to-release time takes around 36-48 months, the customer preferences tend to change over this period of time. The problem exists because of ambiguity, uncertainty and risk involved in performing a complex adaptive process in design environment including air unknown future value of variables. The approach of capturing these evolving dynamics over time will have the advantage of the time to react to a new technology in the market as some of the impending events can be proactively captured.
Sponsor: General Motors Corporation (India Pvt. Ltd.)
PI/PD: Bukkapatnam, S.T.S.

Investigation on the Potential Failure of Fuel Cladding due to Cracking in Advanced Nuclear Fuels
Nuclear fuel cladding is made of materials such as stainless steels and ferritic steels with various alloying elements added to increase its stability under irradiation conditions and hence durability. Fuel cladding is subjected to water, chemicals, fission gas, pressure, high temperatures, and irradiation in service. Understanding fuel cladding behavior is essential for the improvement in the performance and life of fuel cladding which will increase the fuel burnup. Investigation of the failure of the fuel cladding is a complex problem, due to such issues as: (1) grain boundary or texture evolution due to diffusion of materials under stress and temperature; (2) non-uniform alloy distribution (segregation) in different regions due to diffusion; thinning of the cladding wall due to elevated temperature exposure; (3) swelling of cladding in axial and circumferential directions due to irradiation resulting in embrittlement and drastic change in material behavior; (4) anisotropy in properties in the axial and circumferential directions; (5) coupled multiphysics phenomena involving thermal, mechanical, irradiation, fluid (liquefied fuel/cladding, fission gas); (6) large scale computations and complex experimental setups involved. This project will address some of the problems associated with the failure of the fuel cladding by simulation and validation by experiments.

Specific tasks proposed by OSU on this project are the following:
<u>Numerical Simulations</u>

1. Conduct molecular dynamics (MD) simulations to investigate crack nucleation and growth of clad material under different conditions of operation, materials, and irradiation
2. Conduct molecular dynamics (MD)/Monte Carlo (MC) simulations to investigate crack propagation of clad material under the conditions subjected in practice. We will model mode I crack propagation in some clad materials containing nanoscale clusters or impurities located in the vicinity of the crack tip. Effect of grain size will also be investigated.
3. Conduct MD/MC studies to follow crack growth leading to failure of the material.

4. Investigate atomistic simulations of crack propagation, dislocation generation from the crack tips, brittle to ductile transition (BDT) in crack propagation, dynamic fracture and bifurcation. Materials of interest include some special ferrous alloys for nuclear applications, and zirconia.
5. The atomistic simulations conducted will be checked with the simulation of dynamic crack growth using the generalized interpolation material point (GIMP) method reported earlier by Daphalapurkar *et al*. [2007] and the GIMP studies to be conducted at UNT, Denton, TX.

Sponsor: University of Texas at Dallas for Battelle Energy Alliance for Dept. of Energy
PI/PD: Bukkapatnam, S.T.S.

NSF/CONACyT: Gripping and Assembly of Micro Devices
School students from Mescalero Apaches and Anthony schools are introduced to the domain of micro assembly through use of the virtual environments created in this project. REU students are working on several research activities related to this project including modeling of van der Waals forces, design of grippers, etc. School teachers involved in RET activities through NSF grants use the findings and deliverables of this grant such as the work cell to be introduced to research activities. Major focus was on the development of taxonomy of terms for micro assembly and on the development of a sphere packing approach to model van der Waals forces. A work cell has been developed to evaluate and validate research approaches. The components include; XYZ Micro-positioning stage, single axis micro-positioner, video cameras and monitors and a computer. Research activities addressed the design and development of virtual reality based modeling of micro assembly cells. These models were built using VRML 2.0 language. Subsequently, Coin3D and Open Inventor were used to build additional environments as well.
Sponsor: National Science Foundation
PI/PD: Cecil, J.A.

Micro and Nano Systems Assembly using Virtual and Physical Environments
Input for design of course and lab module, design the lab based micro assembly related environments.
Sponsor: Science Foundation (NSF)
PI/PD: Joe Cecil

International Workshop on Information Centric Engineering (ICE) in Nano Engineering and other Emerging Process Domains; Hersonissos, Crete, Greece; October 19-20, 2011
The impact of cyber technologies and collaborative techniques on innovative engineering approaches and practices have been significant worldwide. Rapid advances in Internet technologies and Virtual Reality based engineering approaches have catalyzed the evolution of this new interdisciplinary field called 'Information Centric Engineering' (ICE). This workshop's objectives are to bring together leading researchers to discuss the challenges and opportunities in ICE in the context of emerging and traditional engineering process domains. The objectives of this ICE workshop include the following:

i) Assess and discuss the state of the art and impact of information centric cyber engineering on nano/micro manufacturing, biomedical engineering and other emerging process domains.
ii) Identify specific 'bottleneck' areas which need to be addressed by further research as well as explore ideas for future collaborative research in ICE in the context of identified process domains; subsequently, develop white papers related to these findings for submission to NSF.
iii) Discuss the creation of advanced ICE oriented Test Beds and 'collaboratories' which will foster closer collaborative ties among the workshop participants.

Sponsor: National Science Foundation
PI/PD: Cecil, J.A.

CELDi (Collaborative Research: Center for Engineering Logistics and Distribution)
A new Industry/University Cooperative Research Center (I/UCRC), called the Center for Engineering Logistics and Distribution (CELDi), has been formed. The vision for the center is to provide integrated solutions to logistics problems through modeling, analysis, and intelligent systems technologies.
Sponsor: National Science Foundation
PI/PD: Ricki G. Ingalls

Oklahoma Center for Transportation and Logistics Research, Education, and Outreach
This project is to propose an Oklahoma Laboratory for Advanced Research, Education, and Outreach in Transportation and Logistics. If funded, this lab will carry out a wide range of activities that will greatly benefit the Oklahoma researchers and scholars in conducting cutting- edge and practical research, student education and work force training, and outreach services to both the public and private sectors.

We essentially propose to establish a computer-based laboratory equipped with the state-of-the art hardware and software to conduct complex computation, modeling, simulation, visualization, and decision support in transportation engineering and planning, logistics and supply chain management, and infrastructure related public policy studies. This lab will have 24 high performance computers installed with a complete suite of important transportation and logistics software for most technically demanding transportation and logistics problems. In addition, the lab will have 4 large high-definition LCDs connected to two advanced virtual system through high-speed Internet for real-time distance research collaboration and classroom instruction. The lab will have a common set of missions, goals, operation procedures, and management structure, but its equipment will be 50-50 split and spatially located in the University of Oklahoma with an emphasis in transportation and in Oklahoma State University with a focus on logistics and supply chain management.

Specifically, the equipment to be requested at each campus includes:

- Twelve high performance and virtually connected desktop computers
- 2 52" LCD screens; 1 will be used for a real-time teleconferencing system
- Twelve copies of TransCAD transportation planning software
- 5 (shared) accounts of SimFlex logistics and supply chain software
- A suite of important site-licensed computer programs

Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Ingalls, R.G.

Optimization and Simulation of Large Scale Supply Chain Networks
In this project, one of our principals will be directing the research of Chinnatat Methapatara in the performance aspects of supply chain optimization and simulation algorithms on actual large-scale supply chain networks.
Sponsor: Diamond Head Associates, Inc.
PI/PD: Ingalls, R.G.

A Design Optimization Tool for Supply Chains (DOTS)
This proposed *Design Optimization Tool for Supply Chains (DOTS)* project will allow CELDi members to have access to new technology, cloud computing, and two supply chain design tools. The methodology for this project involves the following steps:

1. Understand supply chain simulation model and develop the data structures necessary to integrate the data of the two systems.
2. Make changes in the supply chain optimization model to reflect the new data structures.
3. Understand cloud computing technologies and help develop the strategy for deploying both the supply chain optimization and supply chain simulation on the cloud computing platform.
4. Deploy the supply chain optimization model on the cloud computing platform.
5. Integrate the supply chain optimization model with the supply chain simulation model on the cloud computing platform.

When completed, this project will result in an integrated cloud computing tool set that performs both supply chain optimization and supply chain simulation.
Sponsor: University of Arkansas for the National Science Foundation
PI/PDs: Ingalls, R.G., Balasundaram, B., Kamath, M.

A Decision Support System for Transportation Infrastructure and Supply Chain System Planning
Built upon the team's previous and ongoing research on Freight Movement Model (FMM) for the State of Oklahoma, this project will develop a state-of-the-art decision support system (DSS) to facilitate critical decisions related to transportation infrastructure planning in the public sector and supply chain system planning in the private sector. The DSS will also support training and education of transportation and supply chain professionals and classroom instruction through associated case studies in disciplines such as industrial engineering, civil engineering and regional & city planning.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Manjunath Kamath, Ricki G. Ingalls

Developing Cutting-Edge Educational, Outreach and Diversity Programs in Transportation and Logistics for Oklahoma
Built upon the team's previous and ongoing research and teaching in transportation and logistics, particularly freight transportation and supply chain management and the recently funded "*The Advanced Lab for Research, Education, and Outreach in Transportation and Logistics in Oklahoma*", this project proposes integrated education (i.e., certificate), outreach (i.e., summer institute), and diversity (i.e., summer camp) programs in transportation and logistics that will concretely support the mission and goals of OkTC/UTC, meet the high demand of transportation and logistics workforces, and utilize the recently funded transportation and logistics labs at OU and OSU.
Sponsor: University of Oklahoma for the Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Kamath, M.

Industrial Assessment Center (IAC)
The mission of the IAC is to assess energy, waste, and productivity practices with the purpose of enhancing the management of the same within the clients enterprise and to share best practices with other IACs, while educating and training the next generation of energy, waste, and productivity professionals. The IAC will focus on IOFs and small and medium-sized manufacturers located within Oklahoma, Kansas, western Missouri, western Arkansas, eastern New Mexico, and beyond in special cases, as coordinated by our field managers. The latest technology will be employed to perform assessments that focus on energy, waste, and productivity issues in the clients facilities. In addition, the

IAC will partner with the Oklahoma Applications Engineers, power companies, and local business and professional associations to better service clients and to gain higher visibility for the IAC Program.
Sponsor: U.S. Department of Energy
PI/PDs: William J. Kolarik, Wayne C. Turner

Development of a Structural Health Monitoring (SHM) Guidebook for Critical Bridge Structures
A recently completed study suggests that approximately about 25% of them are either structurally deficient or functionally obsolete. The condition of these bridges poses a threat to public safety and the local economy. Therefore, the Federal Highway Administration (FHWA) and the Oklahoma Transportation Center (OTC) have made it a priority to seek new methods to economically and effectively inspect and monitor bridges. To address these challenges, the overall objective for this project is to produce a practical, economic minded, and easily implementable guidebook for owners and design engineers to inform and assist in the decision making process of when SHM is useful. This guidebook will be especially focused on providing SHM guidance for large or critical bridge structures that serve as a major lifeline for the community as these structures are currently the most economically justifiable to instrument. The following topics will be covered in the guide book: (i) case studies with a description of which sensor networks have been shown to be successful, (ii) the optimal location and number of sensors to monitor structural health, and (iii) how to interpret and analyze data obtained by the SHM system.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Kong, Z., Liu, T.
CIVEN: Ley, M.T., Goode, J.S.
A&S: Li, X.

GOALI/Collaborative Research: A Mode-Based Tolerance Model and Enabling Methodologies for Geometric Variation and Tolerance Control in Design and Manufacturing
Probabilistic design that takes into account manufacturing induced variability is vital to ensure desirable quality/reliability of products in many industries, ranging from conventional (e.g., automobile and aerospace) to emerging areas (e.g., fuel cell and MEMS). As inputs to probabilistic design, tolerances link the design and manufacturing by defining allowable variations on part geometric features. Thus, it is imperative to create a tolerance model that is capable of simulating the random variations and incorporating them into product function models for probabilistic design. In spite of the recent advances in tolerance model research and Geometric Dimensioning & Tolerancing (GD&T) standards, the existing tolerance techniques lack the capability of modeling GD&T tolerances and simulating manufactured features for probabilistic design. This is due to the challenges in complex GD&T design requirements; rich feature variability, and intensive numerical computation. To address the above challenges, the objectives of this proposal are to establish (1) a mode-based GD&T tolerance model to enable effective GD&T design simulation, (2) Bayesian statistical GD&T model estimation, and (3) probabilistic GD&T tolerance analysis and synthesis methodology.
Sponsor*:* National Science Foundation
PI/PD: Kong, Z.

Acquisition of a LIDAR Laser Scanner for Bridge Inspection
To purchase a Riegl LIDAR scanner that will significantly enhance the capability of the research community in Oklahoma in the area of structural health monitoring and structural analysis for bridges.
Sponsor: Oklahoma Transportation Center (OTC)

PI/PDs: Baski Balasundaram, Terry Collins, James Kong, Tieming Liu
Civil and Environmental Engineering: Tyler Ley, R. Emerson

A Nested Recurrent Bayesian Non-parametric Model for Real Time Monitoring of Pattern Dependent Surface Topography in Micro-electronic Fabrication Operations
This proposal will generate significant contributions toward promoting the technological advances in process monitoring and control for semiconductor industry, leading to better product (IC) quality and higher process productivity for the CMP (Chemical Mechanical Planarization) process. The outcome from this research will provide significant economic impact and benefits to society. Integrating the research and educational activities will cultivate a diverse and qualified workforce in manufacturing. The new curricula, REU, combined with undergraduate and graduate student mentoring programs, will attract potential students, especially from underrepresented groups, to engineering-related research and education by exposing students to both fundamental research and industry practices.
Sponsor: National Science Foundation
PI/PD: Kong, Z.

Development of an Available-to-Promise Decision Support System for Webco Industries
The overall objective of this project is to develop an Available-To-Promise Decision Support System *(ATP-DSS)* for Webco Industries. ATP-DSS will have the following functions,
• Calculate for each order if the client specified due date could be met;
• If not, provide the earliest available delivery date subject to other commitments;
• Suggest optimal allocations of tube inventory to satisfy orders.
The system will provide multiple solutions for the manager to choose. Solutions will be provided with considerations of Webco's available inventory, production plan, and customer order specifications.
Sponsor: Webco Industries, Inc.
PI/PDs: Liu, Tieming, Balasundaram, B.

Decision Support System for Road Closures in Flash Flood Emergencies
Floods are the most common and widespread natural disasters. Due to the changing climate, "100-year floods" now happen every 20 years or less. Among all natural hazards, flash flood ranks as the No. 1 weather-related killer in U.S. According to the National Weather Service Report in 2005, more people die yearly in floods than in any other natural hazards and more than half of the deaths in flash floods are caused by drowning victims in a traffic environment. The southwestern U.S. (including Oklahoma) is especially dangerous for both people and vehicles encountering the sudden onslaught of water from isolated thunderstorms. Effective road closure control is critical to save lives facing flash flood emergencies. However, flash floods provide a very short time window (3~6 hours) for authorities to respond the threats. In such a short period, emergency management resources are stretched to the limit. The existing static roadside TADD (Turn Around Don't Drown) signs simply could not draw enough attention from travelers, as this roadside signage is permanently fixed at potential flood zones. These static signs are hardly visible at night, when flash floods become even more dangerous. The objective of the proposed project is to develop a novel decision support system (DSS) to predict the roads in threats, assist local emergency management officers in making prompt and effective decisions at road closure control, and remotely close the TADD Gates or turn on TADD Red flash lights to close the roads to dangerous sections in flash flood emergencies.

The decision support system will have the following major functions that are not currently available in the existing related system:

- Interactivity: The DSS will integrate the newly established Oklahoma Flash Flood Database and GIS Spatial Database. Flood areas and roads under threats will be shown in a GIS-based interface, with interactive viewing capability.
- Promptness and Effectiveness: The DSS will automatically pinpoint and highlight areas under flood threats. The DSS can be programmed to send control signals to close the TADD Gates or turn on TADD Red Lights to close the roads into the dangerous areas.

Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PD: Liu, T.

Motorcycle Crash Causation Study
The following are the objectives of this study:

1. Determine the main human, vehicular, environmental and roadway factors that contribute to motorcycle crashes and impact crash avoidance,
2. Identify the types of motorcycle crashes,
3. Assess the effectiveness of existing countermeasures including protective gear and rider training/education,
4. Identify additional feasible countermeasures/interventions that can reduce motorcycle crashes and crash injuries, and
5. Estimate the risk factors for motorcycle crash involvement.

This planned study will be the first on-scene, in-depth study of motorcycle crashes in the US since the Hurt study. It comes amid developments that took place during the three decades following the USC study including changes in the styling and performance of motorcycle; design and legislative improvements for helmet usage; modified traffic and roadway environment, and rapidly increasing rates of fatalities among motorcycle operators. Continued lobbying for a new motorcycle crash research project by motorcycle enthusiast organizations such as the American Motorcyclist Association has helped make this study possible.

Sponsor: United States Department of Transportation - Federal Highway Administration
PI/PD: Nazemetz, J.W.

SCHOOL OF GENERAL ENGINEERING

Recycled Carpet Materials for Infrastructure Applications
This OTC-REOS project will develop and commercialize innovative engineered composite materials with tailored mechanical and physical properties from discarded waste carpet reducing its impact on the environment. These composite laminates can be used for building materials, transportation infrastructure, and other structural applications including franchising the technology to small manufacturers across the country. For this project, the New Product Development Center (NPDC) at Oklahoma State University will team with Liberty Plastics, LLC, in Tulsa, Oklahoma, to design and fabricate sound-barrier walls from recycled carpet panels. This project will support the `green manufacturing' economy in Oklahoma and it is envisioned that the results of this project could be leveraged to generate federal support from new `green-collar' job initiatives.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs:
NPDC: Vaidyanathan, R.
MAE: Singh, R.
CIVEN: Ley, M.T.

High Temperature Electronic Devices Based on Wide Bandgap Thin Films
High temperature electronics has emerged as a very important area because the dominant silicon electronics provides low reliability or fails to function altogether at elevated temperatures. The primary scientific objectives of this research project are to: (1) synthesize diamond thin films suitable for fabricating devices useful at high temperatures, and (2) fabrication and characterization of devices made from diamond thin films. In addition, education and training of post docs, graduate and undergraduate students are also an essential objective of this project.
Sponsor: NSF
PI/PD: Raj Singh

Nano-modified Composite Tanks for Natural Gas and Fuels
This project will develop next-generation composite material systems that exhibit enhanced long-term durability, toughness and barrier properties through the incorporation of nano-scale and molecular changes to existing polymer-matrix resins, and address critical issues of barrier properties and composite bonding. The nano-scale modification of polymer resin systems will be achieved through films and coatings applied to currently qualified composite systems for fabricating composite pressure vessels, leading to manufacturing processes that are easily transitioned to commercial manufacturing.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PDs:
NPDC: Vaidyanathan, R.
MAE: Singh, R.
A&S: Ausman, K.
DASNR: Tilley, D.S.

Composite Tanks for Compressed Natural Gas
The main aims of this proposal are;

1. Oklahoma State University Next Generation Materials Laboratory (NGML) at the Helmerich Research Center (HRC) will provide storage space in the refridgerated composite materials container in room 124 at HRC. This will be provided for the materials supplied by CleanNG.
2. Personnel at the NGML/HRC will develop a CAD filament winding profile for the composite tanks to be fabricated for CleanNG. The dimensions of the tank will be provided by Clean NG.
3. NGML/HRC personnel will fabricate flat samples from prepreg supplied by CleanNG for tensile testing and flexural tests. A minimum of 4 samples each will be prepared.
4. NGML/HRC personnel will collaborate with CleanNG for procuring the necessary water-soluble tooling for fabricating the sub-scale prototype composite tanks.
5. NGML/HRC personnel will prepare two preliminary cylinder prototypes based on the fiber-tow prepreg supplied by CleanNG. This will be based on a best-effort basis.
6. NGML/HRC personnel will cure the composite cylinder samples and wash out the tooling from inside the the cylinder.
7. Clean NG will provide feedback regarding any questions that may arise during the project and provide clarifications to NGML/HRC personnel.

Sponsor: CleanNG for EDGE
PI/PD: Vaidyanathan, R.

Composite Over-wrapped Pressure Vessels
Develop technology for composite over-wrapped storage containers capable of storing or transporting alternative fuels including compressed natural gas, hydrogen, or LPG under pressures up to 3600 psi. Safety and cost are two factors that have prevented significant natural gas vehicle penetration in the

automotive market. Composite over-wrapped tanks that can operate effectively under pressure are desirable because they generally weigh less than metal, can be fabricated in a variety of shapes and sizes, and will make alternative fuels more cost effective.
Sponsor: Oklahoma Center for the Advancement of Science and Technology (OCAST), School of General Engineering
PI/PD: Ranji Vaidyanathan

Nano-Modified Composite Tanks For Natural Gas and Fuels - Cost Share
This project is for in-kind services for Nano-modified composite tanks for natural gas and fuels.
Sponsor: Wilco Machine & Fab, Inc., School of General Engineering
PI/PD: Ranji Vaidyanathan

SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING

Investigation of Tissue Equivalent Detectors for Space Crew Dosimetry & Characterization of the Space Radiation Environment
The research team proposes to develop, fabricate, and test a progressively sophisticated and capable series of compact, self-contained tissue-equivalent ionization chambers and proportional counters for use in characterizing ionizing radiation environments in space and the upper atmosphere, and for monitoring astronaut exposure to radiation during long duration space flight.
Sponsor: University of Oklahoma for Oklahoma State Regents for Higher Education
PI/PDs: Andrew S. Arena, Jr.
College of Arts and Sciences: Eric Benton, Eduardo Yukihara

The Integrated Computational Environment for Airbreathing Hypersonic Flight Vehicle Modeling and Design Evaluation
The innovation of the proposed project is in development of novel computational methods and tools for multidisciplinary, multi-physics simulation and analyses – integrated aero-propulsion, thermo-elastic and aeroelastic - of the class of airbreathing hypersonic flight vehicles (AHFVs). These vehicles are among the most promising alternatives for the next generation of Highly Reliable Reusable Launch Systems (HRRLS). This project will enable development of models with varying fidelity, incorporating the coupled dynamic elements resulting from the tightly integrated airframe-engine configuration to be used for control design, analysis and evaluation; characterization of modeling uncertainty and control robustness evaluation.
Sponsor: Advanced Engineering Solutions for NASA
PI/PD: Andrew S. Arena, Jr.

EDGE Unmanned Aerial Systems Research and Training
The UML shall maintain a unique set of regional capabilities that are only available in Oklahoma. These capabilities are attractive not only to unmanned aircraft manufacturers and academia, but to payload (such as sensors) manufacturer requiring Unmanned Aerial Systems (UAS) product testing. These capabilities include preflight testing, systems design, manufacturing, various airstrips and ground support facilities, etc. In addition to this, it shall also establish and support workforce development for education and training designed to advance the overall capability of an Oklahoma workforce to support current and future UAS requirements that may include personnel with management, design, manufacturing, sales, training, education, logistics and maintenance skill sets.

Sponsor: University Multispectral Laboratories for Oklahoma EDGE
PI/PDs: Arena, A.S., Jacob, J.D.

Oklahoma Space Grant Consortium
This project is supported by the Oklahoma Space Grant Consortium (OSGC), which has its headquarters at the University of Oklahoma. Congress authorized the National Space Grant College and Fellowship Program to develop and/or enhance university research infrastructure to support basic and applied NASA-related research and technology development. In 1991, NASA awarded the State of Oklahoma a grant for OSGC consisting of the University of Oklahoma, Langston University, Cameron University, and Oklahoma State University. Since then, more than $100,000 in fellowships has been awarded at these universities to promote the goals of the National Space Grant College and Fellowship Program.
Sponsor: University of Oklahoma for NASA
PI/PD: Andrew S. Arena, Jr.

GOALI/RUI Collaborative Proposal - Measurements and Modeling for Improved Performance of Batch Slurry Processes
Slurries are widely used in important chemical and pharmaceutical manufacturing processes, yet capabilities for their characterization and control are primitive compared with those for homogeneous reactions. This collaborative GOALI research program of Prof. Paul Gemperline of East Carolina University, Prof. Frank Chambers of Oklahoma State University and Prof. Liguo Song of the University of Tennessee seeks to improve understanding of and measurement capabilities for the complex dynamics of slurries, via development of sampling, analysis, and data handling approaches to chemical monitoring of batch slurry reactions. Ideally, the resultant technology will approach the performance with which homogeneous reaction mixtures can be monitored.
Sponsor: National Science Foundation
PI/PD: Frank W. Chambers

Waterside Fouling Performance of Brazed-Plate Type Condensers in Cooling Tower Applications
Brazed plate heat exchangers (PHEs) are among the most common equipment used in today's cooling tower applications. Their heat transfer characteristics under clean conditions are well known but their long-term thermal and hydraulic performances under fouling conditions have not been systematically investigated. In spite of their long use, few calculation methods have been proposed for predicting the heat transfer and pressure drops during fouling conditions. The proposed research will provide insights into the propensity for fouling in PHEs used in cooling tower applications. Improved or novel experimentally validated fouling resistance correlations and pressure drop correlations will be developed. Recommendations for the field fouling allowances with small leaving temperature differences, typical of this type of exchangers, will be proposed.
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PDs: Lorenzo Cremaschi, Jeffrey D. Spitler

Methodology to Measure Thermal Performance of Pipe Insulation at Below-Ambient Temperatures
The overall objective of the proposed research is to design an experimental apparatus capable of measuring the effective thermal conductivity of pipe insulation systems at below-ambient temperature. A total number of 86 tests will be conducted to demonstrate that the test apparatus operates successfully and to further demonstrate the flexibility of the test apparatus. The experimental data will be used to develop empirical correlations for effective thermal conductivity as function of the mean temperature of the insulation specimen.

Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PDs: Lorenzo Cremaschi, Afshin J. Ghajar

Effect of Fin Design on Frost and Defrost Thermal Performances of Microchannel Heat Exchangers
Microchannel-type heat exchangers have been recently adopted by the heat pump industry because of their compactness and efficiency for heating and cooling in residential and commercial applications. If these heat exchangers are used in outdoor coils, they are subjected to significant frost growth and frequent defrost cycles, which ultimately limit their heating performance during winter. During frosting conditions an overall heat transfer coefficient is often employed for the design and analysis of these coils due to the difficulty of separating the air-side behavior from the refrigerant-side characteristics. This proposal aims to study the effect of fin design modifications on frost and defrost thermal performance of microchannel and fins heat exchangers. Transients cases of initial frost accumulation, defrost, and subsequent re-frost cycles are going to be experimentally investigated in our test laboratory.
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PDs: Cremaschi, L., Fisher, D.E.

Comparison of the Energy Performance and Capacity of an Air Conditioning System that Uses Low GWP Refrigerants
The overall scope of this research project is to study the energy efficiency and cooling performance of an air conditioning (AC) system that uses new low GWP refrigerants manufactured by DuPont. OSU will conduct the performance tests in its large scale climate control chamber and will experimentally measure the energetic coefficient of performance (COP), cooling capacity, evaporator and condensers heat transfer capacity, and the refrigerant thermodynamic state points for the vapor compression cycle. A commercially available air-source AC system will be used in these experiments. The AC unit will have a nominal capacity of 3 to 5 tons and it will be selected from commercially available R410A units dedicated for ducted installation in the U.S. First a baseline test will be performed using refrigerant R410A in the AC unit. Then, three (3) low GWP refrigerants will be tested in sequence inside the same identical AC unit. DuPont will provide the refrigerant sample of R410A and will lend OSU three new low GWP refrigerant samples for the comparison of the energy performance. DuPont will provide MSDS and Safe Handling Guidelines for review with OSU staff and students working on this project. During the duration of the project DuPont will also provide technical service as needed. The testing conditions will be (1) cooling test at A condition (95°F outdoor DB) and (2) cooling test at B condition (82°F outdoor DB) of the AHRI 210 performance rating test standards. A refrigerant charge optimization will be conducted for each test.
Sponsor: E.I. du Pont de Nemours and Company
PI/PD: Cremaschi, L.

Measurements of Oil Retention in Micro-channel Heat Exchangers
In HVAC and refrigeration systems, the lubricant exists only because the compressor requires it for lubrication and sealing. A small portion of the oil circulates with the refrigerant flow through the cycle components, while most of the oil stays in the compressor. The circulating oil, which is missing from the compressor, can form a fairly homogeneous mixture with the liquid refrigerant, or it can exist as a separate oil film inside the small tubes and headers of a microchannel heat exchanger; the amount of oil is affected by the system conditions. Each heat exchanger in the refrigeration cycle has different oil retention characteristics, and large amounts of oil retention cause a decrease in heat transfer and an increase of pressure drop. As a result, proper oil management is necessary in order to improve

compressor reliability, increase overall efficiency of the system, and minimize system cost by avoiding redundancy and waste of energy.

This research proposal focuses on measuring the volume of oil that is held up in microchannel heat exchangers adopted in systems for commercial refrigeration and air conditioning applications. The proposal represents experience in oil retention measurements for fin-and-tube heat exchangers. A refined test set up for injecting the lubricant into microchannel heat exchangers in a controlled fashion will be designed, built, and calibrated. Then, oil retention will be directly measured for microchannel heat exchangers working at different temperatures. The saturation temperatures of the refrigerant inside the heat exchangers will vary from 95 to 130°F (35 to 54°C) for condenser applications and from -40 to 60°F (-40 to 15°C) for evaporator applications. Other operating parameters will be controlled according to the AHRI standards 210, 420, and 520. The refrigerants in this work will be R134a and R410A and they will be mixed with polyol ester (POE) oil. At least five (5) levels of oil mass fraction (OMF) will be investigated, such as of OMF of 0.0, 0.5, 2, 5, and 10 percent by weight, and each measurement will be repeated three times to verify repeatability and consistency of the oil retention volumes. The experimental work will be conducted in our new large-scale psychrometric chamber, which will be used to accurately control the ambient air surrounding the microchannel heat exchangers and for data acquisition and data recording during the measurements.
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PD: Cremaschi, L.

Measurements of Pipe Insulation Thermal Conductivity
Mechanical insulation systems are installed around such cold pipes to limit the heat gain and to prevent moisture condensation on the pipe wall surface. Insulation jackets, vapor retarders, and vapor sealing of the joints and fittings are normally adopted to create a barrier to the moisture ingress into permeable insulation. However, experience shows that mechanical pipe insulation systems are not completely vapor tight and inevitably moisture accumulates in permeable insulation. This research involves measuring the thermal conductivity of six pipe insulation systems at below-ambient temperature and in wet condensing conditions with moisture ingress allowed into the insulation material.
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PD: Cremaschi, L.

Interdisciplinary Innovation Education to Solve Real Business & Design Problems
Globalization of agricultural business, markets and trade requires US firms to be innovative and develop technologies and bio-based products to be competitive. This project addresses an immediate need for programs to teach future agricultural engineering, agribusiness specialists and agricultural communications major to address cross-function (interdisciplinary) innovation development problems faced by US small- to medium-sized agricultural manufacturers.
Sponsor: United States Department of Agriculture
PI/PDs: Ron Delahoussaye
Division of Agriculture and Natural Resources: Daniel S. Tilley, Shelly Sitton, Paul Weckler

Advancement of DOE's EnergyPlus Building Energy Simulation Program
This proposal includes a five-year plan to provide critical support to a broad EnergyPlus program development effort led by Florida Solar Energy Center. The Oklahoma State University research team provides model development and implementation expertise in the EnergyPlus zone, system and central plant simulations. Key deliverables include EnergyPlus source code and documentation, technical papers, and user support.

Sponsor: University of Central Florida for Department of Energy
PI/PD: Daniel E. Fisher

EnergyPlus Simulation Support
This proposal includes a 1 year plan to provide critical support to the EnergyPlus program development effort led by the Center for the Built Environment (CBE). The Oklahoma State University (OSU) research team provides model development and implementation expertise in the EnergyPlus zone, system and central plan simulations.
Sponsor: The Regents of the University of California for the California State Energy Resources Conservation and Development Commission
PI/PD: Fisher, D.E.

Development, Optimization and Support of the EnergyPlus Central Plant Simulation
This proposal includes a 5 year plan to provide critical support to a broad EnergyPlus program development effort led by Florida Solar Energy Center. The Oklahoma State University research team provides model development and implementation expertise in the EnergyPlus zone, system and central plant simulations. The proposal is organized by the following tasks; project management and maintenance, development and user support and training.
Sponsor: University of Central Florida for United States Department of Energy - National Renewable Energy Laboratory
PI/PD: Fisher, D.E.

Optimally Controlled Air-Conditioning Equipment for Sustainable Building Systems
Over the next decade, emerging building cooling techniques will play a significant role in achieving sustainable building systems. Building energy management systems (EMS) now make it possible to optimize both the process control algorithms for these devices and the supervisory control algorithm for the unit as a whole. The objective of this project is to develop and deploy optimal supervisory and process control algorithms in all of AAON's equipment. To achieve this goal a simulation testbed will be developed that merges a detailed physics based building model with a detailed, physics based vapor compression system model. This will allow development of both process and predictive supervisory control schemes that take into account such factors as building thermal mass and changing weather. In order to develop boards that will accommodate the new control schemes and in order to validate the performance of the new control algorithms, the simulation testbed will be interfaced with a modified AAON control panel to create a realistic controls testbed.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Fisher, D.E.

Study of Bubble Phenomena in a Vibrating Fluid Column
The aim of this proposal is to develop an experimental apparatus to test bubble motion in a controlled vibration environment. This shall be a liquid-filled column into which bubbles can be injected, then the entire apparatus shaken and the bubble response measured. The project includes determining an overall test matrix including, but not limited to, liquid properties, vibration characteristics, and overall system pressure, then running experiments covering the test matrix, and finally analyzing the data and writing the final report (deliverable).
Sponsor: Sandia National Laboratories for US Department of Energy
PI/PD: Ghajar, A.J.

Mechanical Behavior of a Web during Winding
The objective of this project is to develop algorithms for wound-on-tension for various types of winding in which nips are involved in the winding configuration, to study varying nip winding conditions and parameters so that the mechanics of nip winding can be quantified and incorporated into winding and defect models, and to study and develop models for nip related defects.
Sponsor: Web Handling Research Center
PI/PDs: Keith Good, John J. Shelton

Web Wrinkling Prediction and Failure Analysis
Web quality degradation can occur if wrinkling takes place across the rollers or inside (or upon) wound rolls. This research is concerned with determining how wrinkles form as a function of web line and web material parameters.
Sponsor: Web Handling Research Center
PI/PD: Keith Good

Innovative Prediction of Fly Ash Performance in Concrete
It is the hypothesis of this proposal that if this information was understood, then the performance of fly ash concrete could be better predicted allowing for a larger volume of replacement, better performing mixtures, and more durable structures.
Sponsors: Oklahoma Transportation Center (OTC), Mechanical and Aerospace Engineering
PI/PD: Jay Hanan

Procurement of Novel Microanalysis Equipment for Construction Materials
It is the goal of this proposal to purchase three major pieces of analytical equipment for all OTC researchers to use in their projects. A short description of each piece of equipment is given below:

1. X-ray Florescent (XRF) Microscope – A microscope that allows automated surface and chemical mapping of large areas (4" x 8") with very little sample preparation
2. Automated Scanning Electron Microscope (SEM) –An SEM that has been specifically designed to measure the shape, size, and chemistry for a large number of micro and nano particles
3. Replacement Tube for the Micro Computed Tomography (MCT) Scanner – A replacement tube for a piece of equipment allows for 3D mapping of materials at the micron scale

By funding this research proposal it will allow the OTC to be at the forefront of Construction Materials research. This will allow the OTC pier institutions to complete highly innovative research and compete in national funding competitions for decades to come.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Hanan, J.C.
CIVEN: Ley, M.T., Bulut, R., Veenstra, J.N.
CHE: Smay, J.E.
A&S: Apblett, A., Cruse, A.
GU: Ownby, C.
HE: Smith, Brenda

Composite Surfacing of Amorphous Materials by Laser Interference Nanopatterning
The primary objective of this research proposal is to develop a new class of laser surface engineered amorphous materials characterized by enhanced ductility.
Sponsors: National Science Foundation (NSF), Mechanical and Aerospace Engineering
PI/PD: Sandip Harimkar

EAGER: Spark Plasma Sintering of Bulk Nanostructured Thermoelectric Materials
Thermoelectric materials can directly convert thermal energy into electrical energy and, reversibly, electrical energy into thermal energy. These materials are attractive for many applications in solid-state cooling and power generation. However, actual utilization of these materials in devices has been limited due to low energy conversion efficiency. Major objective of this proposal is to investigate bulk fabrication of nanostructured thermoelectric materials with transformational enhancement in thermoelectric performance (ZT>3). The proposed plan is also designed to provide research experiences and training to graduate and undergraduate students, and prepare them for a future career in this important field of energy materials.
Sponsor: National Science Foundation
PI/PD: Harimkar, S.P.

Failure via Three-Dimensional Cracking in Fuel Clad for Advanced Nuclear Fuels
Nuclear fuel cladding is made of materials, such as stainless steels and ferritic steels with various alloying elements added to increase its stability under irradiation conditions and hence durability. Fuel cladding is subjected to water, chemicals, fission gas, pressure, high temperatures, and irradiation in service. Understanding fuel cladding behavior is essential for the improvement in the performance and life of fuel cladding which will increase the fuel burnup. Investigation of the failure of the fuel cladding is a complex problem, due to such issues as: (1) grain boundary or texture evolution due to diffusion of materials under stress and temperature; (2) non-uniform alloy distribution (segregation) in different regions due to diffusion; thinning of the cladding wall due to elevated temperature exposure; (3) swelling of cladding in axial and circumferential directions due to irradiation resulting in embrittlement and drastic change in material behavior; (4) anisotropy in properties in the axial and circumferential directions; (5) coupled multiphysics phenomena involving thermal, mechanical, irradiation, fluid (liquefied fuel/cladding, fission gas); (6) large scale computations and complex experimental setups involved. This project will address some of the problems associated with the failure of the fuel cladding by simulation and validation by experiments.
Sponsor: University of Texas at Dallas for Batelle Energy Alliance for Dept. of Energy
PI/PD: Komanduri, R.

CAREER: Fundamental Studies on Ultrasonic Vibration Assisted Laser Surface Modification (UV-LSM) of Materials
This career development proposal seeks to investigate basic phenomena associated with *ultrasonic vibration-assisted laser surface modifications* (UV-LSM) and advance this knowledge for engineering surface microstructures and properties of advanced materials. The central theme of this CAREER proposal is that the attenuation of ultrasonic vibrations in the melt pool created during laser-material interactions will induce microscopic (interdendritic) and macroscopic (within melt pool) hydrodynamic flows in the melt influencing subsequent microstructure evolution (grain refinement, homogeneity, and defect-free surfaces). A plan is proposed to investigate the effect of ultrasonic vibrations on rapid solidification behavior during three distinct laser surface engineering approaches:

1) *Laser surface melting*
2) *Laser composite surfacing*
3) *Laser surface densification*.

The *research objective* of this proposal is to discover the processing-microstructure-properties relationships in engineered surfaces produced using these UV-LSM approaches. The educational

objective of this proposal is to integrate the themes of proposed research on laser surface engineering with education at high school, undergraduate, and graduate levels.
Sponsor: National Science Foundation
PI/PD: Harimkar, S.P.

Enhancing the Oklahoma Alliance for Manufacturing Excellence with Applications Engineers in Rural Areas
The Applications Engineering Program works to increase the competitiveness of existing small and medium sized rural manufacturers by providing on-site, focused engineering assistance and technology transfer services. By placing a staff of engineers across the state, the program provides manufacturers with direct access to the latest in technology including access to the resources of Oklahoma State University's engineering faculty. The program is a cooperative effort between the University and the Oklahoma Manufacturing Alliance.
Sponsor: Oklahoma Alliance for Manufacturing Excellence (OAME)
PI/PDs: Larry Hoberock
School of Biosystems and Agricultural Engineering: Ron Elliott

SBIR Phase II: Perching Micro Air Weapon
The objective of this project was to demonstrate the feasibility of development of a Micro Air Vehicle (MAV) or *perching micro air weapon* to harvest alternative power/energy sources to remain "on call" and engage targets while perching on a structure. In order to accomplish the goals of the proposal, Design Intelligence Incorporated, LLC (DII) will require specific subcontract services from Oklahoma State University (OSU) to provide technical and engineering support, access to facilities and access to technical personnel.
Sponsor: Design Intelligence Incorporated, LLC for United States Air Force
PI/PD: Jacob, J.D.

X-Hab: Transitional Expandable Enclosure with Protection for Extreme Environments (TEEPEE)
We propose to design, develop and test a module for the *X-Hab Academic Innovation Challenge*. This will include both technical engineering and outreach efforts. The technical effort will begin with a point of departure design called TEEPEE: *Transitional Expandable Enclosure with Protection for Extreme Environments* and will evolve based upon student design decisions, analysis and testing. The technical portion of the effort will be led by OSU students in the School of Mechanical and Aerospace Engineering (MAE) as part of spacecraft and systems engineering design coursework. They will be assisted by students in architecture, architectural engineering, and technology as part of their senior design effort and graduate students both at OSU and Georgia Tech and mentored by world renowned companies.
Sponsor: National Space Grant Foundation for NASA
PI/PD: Jacob, J.D.

On-Demand Aircraft Conceptual Design and Development - Subtask 3.5
Wind energy has the potential to be a far more significant contributor to America's energy needs and is currently the most promising source of renewable energy. While large scale wind turbines in the central U.S. corridor will take advantage of average wind velocities of ~30 mph, there is also the potential for smaller scale wind energy systems to provide distributed, household or business based solutions in other parts of the country. Even at existing technology levels, the average household could meet all of its electricity needs (11,000 kW hr/year) with an 18' diameter wind turbine, as the majority of the U.S. has ~15 mph average winds available at an 80 m altitude.

For such energy harvesting systems to be successful, they must be cost effective and acceptable to the community. Current towered wind turbine systems do not meet either of these criteria. In addition, such systems need to be able to provide energy efficiently in winds as low as 5 mph, while tying into distributed energy storage systems. Tethered aerial based solutions with collector or focusing technologies may be able to meet these requirements.The potential of emergent low altitude wind turbine systems is the focus of this proposed effort, to establish a system analysis foundation for all concepts, while pioneering new fixed wing and buoyant platform types, and establishing the critical technology gaps for effective systems.

The proposed research will investigate the feasibility of distributed low altitude electric wind harvesting UAV platforms, while providing a comparison to the future potential of high altitude systems. This effort will determine the energy production potential, develop new tethered UAV energy harvesting concepts that focus on new concentrator technologies to limit the size and cost of the wind turbine, establish a Pareto front of critical technologies to promote feasibility (such as new buoyant skin materials, skin stiffened double wall inflatable structures that can reduce the number of layers for helium containment, lightweight and low drag tethering lines, lightweight alternators, etc), establish new partnerships with the innovative companies in this area along with initiating collaboration with the NREL (as these aerial systems are outside their technology discipline focus areas), and sub-scale demonstration to promote student involvement in this new field.
Sponsor: National Institute of Aerospace
PI/PD: Jamie Jacob

Horizontally-Oriented Deep Space Habitat (DSH) Mock-Up
The main purpose of this proposal is to design, develop, build and test a portable habitat system for the *X-Hab Academic Innovation Challenge*. This will include both technical engineering and outreach efforts. The technical effort will utilize a sequence of engineering and architectural design courses to develop the X-PoD (*X-Hab Portable Demonstrator)* based upon student design decisions, analysis and testing. The technical portion of the effort will be led by OSU students in the School of Mechanical and Aerospace Engineering (MAE) as part of spacecraft and capstone engineering design coursework while the architectural portion will be conducted by students in Architecture and Architectural Engineering and Human and Environmental Sciences. They will be assisted by students in architecture, architectural engineering, and technology as part of their senior design effort and graduate students both at OSU. We have assembled a team of industrial partners to mentor the student teams.
Sponsor: National Space Grant Foundation for NASA
PI/PD: Jacob, J.D.

Motion Capture Techniques in Microgravity
The objective of this project is to evaluate various motion capture systems and methodologies identify the optimal combination of methodology and data collection and analysis techniques to capture the full joint ranges of motion required to quantify isolated joint mobility and functional joint mobility as test subjects perform representative EVA tasks.

Factors to be considered when selecting the optimal combination include system accuracy, reliability, repeatability, ease of use in aircraft environment, post-processing time required, and extensibility of system and method to other reduced gravity simulators (e.g. Neutral Buoyancy Lab or ARGOS). The key aspects of the experiment design will be defining the motions and tasks to be performed that will indicate extreme limits to motion; defining relations between body segments that will define the joint

angles; and creating and locating stable mounting platforms for data recording devices of choice inside the aircraft.

The short goal of the project will be accomplished during the RIG, which includes testing aboard NASA's microgravity simulator. Long term goals will be to grow a continuing relationship with NASA and to provide expertise in motion capture to future missions, including aboard the International Space Station and other NASA manned spacecraft.
Sponsor: Oklahoma EPSCoR
PI/PD: Jamey Jacob

Investigation of Quiet Electric Propulsion as an Enabling Technology (Task 3.1.0)
Wind energy has the potential to be a far more significant contributor to America's energy needs and is currently the most promising source of bioenergy. While large scale wind turbines in the central U.S. corridor will take advantage of average wind velocities of ~30 mph, there is also the potential for smaller scale wind energy systems to provide distributed, household or business based solutions in other parts of the country. Even at existing technology levels, the average household could meet all of its electricity needs (11,000 kW hr/year) with an 18' diameter wind turbine, as the majority of the U.S. has ~15 mph average winds available at an 80 m altitude.

For such energy harvesting systems to be successful, they must be cost effective and acceptable to the community. Current towered wind turbine systems do not meet either of these criteria. In addition, such systems need to be able to provide energy efficiently in winds as low as 5 mph, while tieing into distributed energy storage systems. Tethered aerial based solutions with collector or focusing technologies may be able to meet these requirements.

The proposed research will investigate the feasibility of distributed low altitude electric wind harvesting UAV platforms, while providing a comparison to the future potential of high altitude systems. This effort will develop new tethered UAV energy harvesting concepts that focus on new concentrator technologies to limit the size and cost of the wind turbine and develop a subscale demonstration to demonstrate feasibility.
Sponsor: National Institute of Aerospace
PI/PD: Jacob, J.D.

Light-activated Single Molecule SERS Substrates
Despite its great promise for probing biomolecular structure and interactions at the single molecule level, single molecule surface-enhanced Raman scattering (SM-SERS) has found only limited practice since its first demonstration in 1997. This conflict is likely to result from the complications and irreproducibility associated with sample preparation. The proposed research will develop a high throughput and reliable SM-SERS substrate on the basis of an effect recently discovered by the PI: light-induced electrochemical Ostwald ripening (LIECOR) of metal nanoparticles on a nanotextured semiconductor. LIECOR will be exploited for the creation of nanoscopic gaps in between nanoparticles which are giant electromagnetic enhancement sites.
Sponsor: National Science Foundation
PI/PD: Kaan Kalkan

Low-Cost, Trace-Level Sulfur Sensor for Hydrogen Fuel Cells
The goal of the proposed investigation is to develop a novel miniature nanoparticle surface plasmon resonance sensor capable of detecting ppb levels of sulfur compounds present in the fuels utilized by

hydrogen fuel cells. The sensor development will employ a unique nanofabrication technique, "electroless reduction on silicon", combined with a novel sensing mechanism, "hybrid plasmon damping", both recently invented/discovered by the PI. The unique fabrication approach and sensing mechanism of the proposed sensor are critical to the outstanding performance expected of this sensor.
Sponsor: Techno-Sciences, Inc.
PI/PD: Kaan Kalkan

Next Generation Composite Materials for Aerospace and Exploration Systems
This NASA EPSCoR project will develop next-generation composite material systems that exhibit enhanced long-term durability under exposure to terrestrial and space environments. The project will develop composites that incorporate fundamental nanoscale and molecular changes to existing polymer-matrix resins, provide new strategies for improving the fiber-matrix interface, and address critical issues of barrier properties and composite bonding.
Sponsor: Oklahoma State Regents for Higher Education (OSRHE)
PI/PDs: Raman Singh, Kaan Kalkan
General Engineering: Ranji Vaidyanathan
College of Arts and Sciences: Kevin Ausman

Hybrid plasmon damping nanosensor
The proposed effort will exploit a unique sensing mechanism: "adsorbate-induced damping of hybrid plasmon resonance in nanoparticle monolayers" for the development and commercialization of a trace-level sensor. The sensor will report the width (damping factor) and intensity of the hybrid plasmon resonance associated with a monolayer of Ag nanoparticles. These two parameters, continuously measured by optical extinction, will be plugged in a theoretical relation (derived by the PI) to quantify the number of electrons gained or lost (by the plasmon) due to the adsorbed molecules or atoms. The change in the number of electrons will precisely "count" the number of adsorbates. The concentration level in turn will be computed from adsorption kinetics. Commercialization will involve a joint effort with AMETEK Oil & Gas to integrate the sensor with the current upstream oil (fuel) technology. The sensor will also be coupled with a hand-held spectrophotometer for easy and mobile use.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Kalkan, A.K.

Nanowire-Nanoparticle Photolytic Devices for Fuel Production
Storage of solar energy in chemical fuels by artificial photosynthesis has been a long-sought goal. In particular, significant research activity was stimulated towards photolytic cells producing hydrogen in1972, when Fujishima and Honda demonstrated water could be split to hydrogen and oxygen under sunlight (photolysis). The proposed research will pursue the development of a novel hydrogen-generating photolytic device, which consists of an oxide semiconductor nanowire decorated with metal nanoparticles. The project targets a low-cost technology, simply by fabricating and utilizing the nanowire-nanoparticle conjugate devices in the form of a suspension (e.g., in water). The nanowires and nanoparticles will be synthesized via sol-gel and reduction chemistries, respectively. The project also aims at high photolytic conversion energy and stability by making use of multifunctional nanostructures with unique electronic, photonic, and plasmonic attributes at the nanoscale. The proof of concept of the technology has demonstrated a reproducible internal conversion efficiency of 10.6% under 470 nm LED excitation for the first hour of photolysis. However, the efficiency of photolysis is found to degrade afterwards. The specific aim of the proposed NASA-EPSCoR Research Initiation Grant Project is to elucidate the mechanism responsible for this degradation and achieve sustainable hydrogen production through overcoming the degradation mechanism.

Sponsor: NASA-EPSCoR
PI/PD: Kaan Kalkan

Heterogeneous Wireless Sensing and Modeling of Chemical-Mechanical Interactions in Chemical Mechanical Planarization Process for Microelectronic Applications
The objective of the proposed research is to address the following issues involved in the predictive modeling and real-time monitoring of chemical mechanical planarization/polishing (CMP) process used in the finishing of semiconductor chips: the interaction of chemical and mechanical phenomena at the silicon wafer-pad interface, the effect of machine vibrations, forces, temperature profiles, and acoustic emission signals, and the modeling of nonlinear stochastic process-machine interactions that capture the dynamic relationships between the wafer-pad interactions and the response of the sensor signals. Both experimental and analytical investigations will be undertaken to address these issues.
Sponsor: National Science Foundation
PI/PDs: Ranga Komanduri, Zhen Bin Hou

Sensor Theory and Sensor Fusion Approach for Defect Detection in Chemical/Mechanical Polishing of Microelectronic Wafers
The semiconductor industry now relies heavily on the CMP process to meet the surface planarity and finishing needs to sustain the trend of increasing density on small feature-size (~30nm) devices. In this context, the defects generated during CMP, such as scratch, dishing, and chatter marks, etc. have emerged as the top wafer yield inhibitors. Due to the complexity of the process and poor specificity of the current sensor-based approaches, the defects are currently detected only after the polishing process, resulting in low wafer yield. These defects significantly deteriorates the wafer yield in the CMP, especially of soft and compliant (e.g., Cu and low-k) materials. While CMP variables that affect the defect count and geometry have been identified, the mechanisms of defect generation are not fully understood. There is a strong need to advance an approach for early detection and mitigation of these defects in a timely manner. The objective of this proposal is to invoke a new bottom-up multi-sensor fusion and decision theory to derive quantitative relationships connecting the force- and vibration-signal features with specific defect patterns in chemical mechanical planarization (CMP) of microelectronic wafers for real-time surface defect mitigation in this process.
Sponsor: National Science Foundation
PI/PDs: Komanduri, R.
IEM: Bukkapatnam, S.T.S., Kong, Z.

A Nested Recurrent Bayesian Non-parametric Model for Real Time Monitoring of Pattern Dependent Surface Topography in Micro-electronic Fabrication Operations
This proposal will generate significant contributions toward promoting the technological advances in process monitoring and control for semiconductor industry, leading to better product (IC) quality and higher process productivity for the CMP (Chemical Mechanical Planarization) process. The outcome from this research will provide significant economic impact and benefits to society. Integrating the research and educational activities will cultivate a diverse and qualified workforce in manufacturing. The new curricula, REU, combined with undergraduate and graduate student mentoring programs, will attract potential students, especially from underrepresented groups, to engineering-related research and education by exposing students to both fundamental research and industry practices.
Sponsor: National Science Foundation
PI/PD: Komanduri, R.

MRI: Acquisition of a High Performance Compute Cluster for Multidisciplinary Research
Oklahoma State University High Performance Computing Center (OSUHPCC) will acquire, deploy and maintain an HPC cluster supercomputer, to be named Cowboy, that will support computing-intensive research and research training across a broad variety of Science, Technology, Engineering and Mathematics (STEM) disciplines. As a campus-wide shared resource, Cowboy will be available not only to all of OSU's faculty, staff, postdocs, graduate students and undergraduates, but to researchers across Oklahoma.
Sponsor: National Science Foundation
PI/PD: Komanduri, R.

Collaborative Research: Atomic Plane Electrical Contacts
This proposed work seeks to develop an understanding of how nanoscale surface and subsurface material structure affects electrical contact resistance, surface adhesion, and mechanical wear. With this understanding, a deterministic performance model and manufacturing process can be developed for creating high-performance electrical contacts, starting from atomic plane surfaces with nanometer-scale surface roughness, and then applying thin-film coatings to control contact resistance, adhesion, and wear. We propose to develop a microelectromechanical systems (MEMS) test device for high-cycle contact testing along with a dedicated bench-level apparatus for screening of witness contacts.
Sponsor: National Science Foundation
PI/PDs: Don A. Lucca
Los Alamos National Laboratory: Michael Nastasi

Sensors: Synthesis of Active Quantum Dot Infra-Red (IR) Sensors
The objective of this research is to acquire an understanding of the effects of mechanical strain on the infrared absorption of semiconductor nanocrystals which exhibit quantum confinement, referred to as quantum dots, thereby enabling their potential use as active infrared sensors. The approach will be to synthesize by ion implantation a range of semiconductor quantum dots implanted into infrared transparent substrates. Spectral response will be tailored by varying the quantum dot size. Resulting size, structure, distribution and chemistry will be quantified by Rutherford backscattering spectrometry, high resolution transmission electron microscopy and photoluminescence spectroscopy. Fine-tuning about a particular spectral peak will then be performed by the application of strain accomplished by piezoactuator loading.
Sponsor: National Science Foundation
PI/PD: Don A. Lucca

US-Germany Cooperative Research: M4 - High Resolution Surface Zone Analysis and Ion Beam Processing
In previous phases of this research, the research team utilized a range of high resolution surface techniques to quantify the mechanical and chemical nature of newly developed mold coatings for use in optical component production. The team found that ion irradiation is an effective means to convert hybrid sol-gel films to their final hardened state. The research project focuses on the use of high resolution surface zone techniques to aid in the development of new advanced mold coatings based on ion irradiated sol-gel films, and to enable the near surface mechanical and chemical characterization of both mold surfaces and optical components.
Sponsor: Foundation Institute for Materials Science IWT - STB/TR4
PI/PD: Don A. Lucca

Subsurface Damage in Single Crystal YAG
Single crystal Nd-doped $Y_3Al_5O_{12}$ (Nd:YAG) is extensively used as a laser gain host and in addition, more recently has found application as a substrate for optical components. Limitations associated with subsurface damage in YAG from fine finishing operations, however persist. As an example, degradation of the fracture strength of the laser gain media caused by subsurface damage may be a limitation to the obtainable laser output power. The proposed studies will focus on surfaces created by ultrafine finishing including fine grinding with subsequent wet etching, mechanical polishing and chemomechanical polishing. Surface and near surface damage evolution in terms of lattice disorder, shifts in surface stoichiometry and changes in mechanical properties and residual stresses and will be investigated with the use of high resolution surface characterization techniques. The goal will be to advance the capability for the fabrication of this single crystal material by contributing to a basic understanding of the generation of crystalline defects and stoichiometry shifts in the near surface which results from finishing.
Sponsor: II-VI Foundation
PI/PD: Lucca, D.A.

Collaborative Research: Ion Irradiation-Induced Nanocrystallization of Metallic Glasses and Its Effects on Their Mechanical Properties
Metallic glasses have superior hardness and high resistance to wear and corrosion, however they are generally brittle due to the absence of internal obstacles to arrest shear band propagation. The research objective of the proposed work is to develop an understanding of the mechanisms responsible for nanocrystal phase formation when metallic glasses are subjected to ion irradiation, and to quantify the resulting effects on the materials' mechanical behavior.
Sponsor: National Science Foundation
PI/PD: Lucca, D.A.

Collaborative Research: Safe Coordination of Multiple Autonomous Vehicles
The focus of the project is on developing methods for safe coordination of groups of multiple vehicles accomplishing multiple tasks in the presence of a variety of physical, collision avoidance, and informational constraints. The main deliverable of this project is to provide methodologies that would lead to implementable control laws for coordination of a variety of vehicles in the presence of safety, motion, and communication constraints. The theoretical results will be tested on a number of experimental vehicle platforms.
Sponsor: National Science Foundation
PI/PD: Prabhakar R. Pagilla

GOALI: Modeling and Design of Composite Web Roll-to-Roll Systems
The main research goal is to develop fundamental dynamic models of web behavior for Roll-to-Roll (RTR) systems containing multiple unwind rolls, laminator rolls, and a single rewind roll. These RTR systems are required in applications where a composite web is formed from dissimilar individual flexible material layers or through application of a thick gel material onto a base layer. In addition to developing models, a related core objective is to design the configuration (selection of location of driven rollers, web guides, sensing systems, and process sections) of the RTR systems and associated coordinated control strategies that would enable manufacture of quality composite webs.
Sponsor: National Science Foundation
PI/PDs: Pagilla, P.R., Reid, K.N.

Frequency Response of Longitudinal Behavior and Sensing of Tension of a Web
The objective of this project is development and experimental validation of mathematical models of primitive elements of web transport systems. A significant part of the project activity also includes a user-friendly graphical software called “Web Transport System” that can be used to simulate web process lines and contains the state-of-the-art model and control developments.
Sponsor: Web Handling Research Center
PI/PDs: Prabhakar R. Pagilla, John J. Shelton

Modeling and Analysis of Composite Web Transport Systems
The project deals with a systematic investigation of the transport behavior of composite webs through Armstrong's processing machinery. The project activities include: 1) development of mathematical models for formation and transport behavior of composite webs, 2) determination of the mechanical and physical material properties of composite webs through testing, 3) analysis of models to determine machine and process changes required to improve regulation of key process variables that will result in elimination/reduction of material waste, 4) validation/refinement of models through extensive experiments, and 5) implementation of proposed changes and testing to evaluate the effectiveness of the developed guidelines and controller designs.
Sponsors: Oklahoma Center for the Advancement of Science and Technology, Armstrong World Industries
PI/PDs: Prabhakar R. Pagilla

SBIR Phase II: Commutational Ramp Load Disk Drive Actuator
The proposed research investigates the design and construction of a commutational ramp load disk drive actuator and associated control algorithms to improve servo controller performance while maintaining shock resistance, improving product quality, and providing cost reduction. The OSU portion of the proposed work involves computer simulations (3D modeling and FEA) and experimentation to evaluate certain aspects of the commutational ramp load actuator that are mimicked by a conventional commercial disk drive actuator. The Polytec vibrometer system and other optical instrumentation will be used to conduct disk drive experiments as discussed in the original proposal.
Sponsor: Bluewater Technology, LLC for National Science Foundation
PI/PD: Pagilla, P.R.

Web Transport Systems
The objectives of this research are: 1) to expand the range of static and dynamic models in WTS to include models for new elements identified by sponsors, 2) to refine the models for viscoelastic effects and web-roller slip effects, 3) to develop new models for the precise control of tension in each section in a multi-span web transport system, and 4) to develop guidelines for selection of the control algorithms which best meet the defined performance objectives for a given application.
Sponsor: Web Handling Research Center
PI/PD:
Office of the Dean: Karl N. Reid

Platelets & Endothelial Cells Induce Diabetic Pathologies
It is well known that patients who suffer from diabetes mellitus have an increased susceptibility for cardiovascular diseases, however what induces this predisposition is unknown. There is some evidence that suggests that glycated serum proteins, which are prevalent in the diabetic vasculature, can induce platelets and endothelial cells to activate.

Enhanced platelet and endothelial cell activation is intimately linked to cardiovascular disease initiation. However, there is a critical gap in understanding how a diabetic vasculature and the components of a diabetic vasculature initiate platelet and endothelial cell activation to instigate cardiovascular diseases. The objective of this proposal is to test the hypothesis that glycated serum albumin enhances platelet activation, endothelial cell activation and platelet-endothelial cell interactions to promote cardiovascular disease initiation.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PDs: Rubenstein, D.A., Yin, W.

Development of a Biomimetic Composite Scaffold to Promote Vascular Network Growth
The proposed project is important to the success of the tissue engineering field because after the successful completion of this project we will have developed a method to rapidly fabricate vascular networks within complex composite biocompatible biomimetic scaffolds. The proposed research has relevance to public health because we will gain the ability to tissue engineer multiple products with incorporated vascular networks and facilitate chronic wound healing.
Sponsor: National Institutes of Health
PI/PD: Rubenstein, D.A.

Recycled Carpet Materials for Infrastructure Applications
This project will develop and commercialize innovative engineered composite materials with tailored mechanical and physical properties from discarded waste carpet reducing its impact on the environment. These composite laminates can be used for building materials, transportation infrastructure, and other structural applications including franchising the technology to small manufacturers across the country. For this project, the New Product Development Center (NPDC) at Oklahoma State University will team with Liberty Plastics, LLC, in Tulsa, Oklahoma, to design and fabricate sound-barrier walls from recycled carpet panels. Our long-term goal is innovative use of advanced engineering materials in technologically relevant and high-value applications that will lead to reduced amount of carpet going to landfills and converted to engineering composites. This project will support the `green manufacturing' economy in Oklahoma and it is envisioned that the results of this project could be leveraged to generate federal support from new `green-collar' job initiatives.
Sponsor: Oklahoma Transportation Center for the U.S. Department of Transportation-RITA
PI/PDs: Singh, R
NPDC: Vaidyanathan, Ranji
CIVEN: Ley, M.T.

Next Generation Composite Materials for Aerospace and Exploration Systems
This NASA EPSCoR project will develop next-generation composite material systems that exhibit enhanced long-term durability under exposure to terrestrial and space environments. The project will develop composites that incorporate fundamental nanoscale and molecular changes to existing polymer-matrix resins, provide new strategies for improving the fiber-matrix interface, and address critical issues of barrier properties and composite bonding.
Sponsor: Oklahoma State Regents for Higher Education (OSRHE)
PI/PDs: Raman Singh, Kaan Kalkan
School of General Engineering: Ranji Vaidyanathan
College of Arts and Sciences: Kevin Ausman

Nano-modified Composite Tanks for Natural Gas and Fuels
This project will develop next-generation composite material systems that exhibit enhanced long-term durability, toughness and barrier properties through the incorporation of nano-scale and molecular changes to existing polymer-matrix resins, and address critical issues of barrier properties and composite bonding. The nano-scale modification of polymer resin systems will be achieved through films and coatings applied to currently qualified composite systems for fabricating composite pressure vessels, leading to manufacturing processes that are easily transitioned to commercial manufacturing.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PD: Singh, R.

High Pressure/High Temperature Quartz Transducer
Focus on fundamental material modeling and characterization of quartz as a function of crystallographic orientation.
Sponsors: Geophysical Research Company LLC (GRC)**,** Mechanical and Aerospace Engineering
PI/PD: Raman Singh

Multifunctional Composite Panels with Foam Core Sandwich
This proposal will commercialize composite panels made using foam core sandwich construction. This multifunctional material will be used for making ultra-light load-bearing structures that can simultaneously provide acoustic and RF shielding, among other characteristics. Applications include RF sensitive locations, acoustic damping in aerospace structures, and other DoD applications.
Sponsors: Oklahoma Center for the Advancement of Science and Technology, ETS-Lindgren
PI/PD: Raman P. Singh

Foundation Heat Exchanger Model and Design Tool - Development and Validation
The OSU research team will develop a foundation heat exchanger (FHX) model for use in EnergyPlus Building Energy Simulation Program, along with a separate design tool, which will incorporate an FHX model. The two models may vary in complexity, though it is likely that desired speed in both a design tool and EnergyPlus will push both models to be as simple as possible. Both models will be validated against experimental data collected by the prime Sponsor's research team.
Sponsor: Oak Ridge Associated Universities for UT-Battelle, LLC
PI/PDs: Jeffrey D. Spitler, Daniel E. Fisher

Development of Design Tools for Surface Water Heat Pump Systems (SWHP)
Surface Water Pump (SWHP) systems are widely used, yet there is a paucity of design data and documented design procedures. The most significant shortfalls are; determination of design water temperatures, exterior convection correlations for various heat exchanger types and the effects of tube-to-tube and bundle-to-bundle spacing on the convection. Currently existing design procedures provide a workable framework for most systems, if augmented by better knowledge of design water temperatures and convection correlations. However, in cases where the SWHP system has a significant impact on the water temperature, the procedures may need further augmentation. For the heat extraction and rejection from the heat exchanger it will be necessary to model, at some level, the surface heat exchange along with the heat extraction/rejection and perhaps inflows and outflows, in order to determine the design water temperature. The objectives of this proposal are to develop as accurate and usable set of design data and design tools as possible.
Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
PI/PD: Spitler, J.D.

Improved Design Tools for Surface Water and Standing Column Well Heat Pump Systems

The primary goal of this project is to improve the capability of engineers to design heat pump systems that utilize surface water or standing column wells (SCW) as their heat sources and sinks. The corresponding objectives of the project are to provide improved sizing tools for both systems, an improved EnergyPlus model for the surface water heat pump system, and an EnergyPlus model for the standing column well system.

Sponsors: Department of Energy, Mechanical and Aerospace Engineering

PI/PD: J. D. Spitler

Phase II DOE SBIR Program - Vortical-flow, Direct-Contact Heat Exchanger for Geothermal Cooling

Advanced Cooling Technologies, Inc. (ACT) is developing a Vortical-flow, Direct-contact Heat Exchanger (VDHX) for Heating, Ventilation, and Air Conditioning (HVAC) systems, particularly those coupled with Ground-Source Heat Pumps (GSHP), under a Department of Energy (DOE) Small Business Innovation Research (SBIR) program. The ultimate goal of the program is to reduce energy consumption of these systems by providing a heat exchanger that is more efficient than the finned-tube heat exchangers commonly used with HVAC systems. Preliminary testing and analysis conducted in Phase I indicate that the VDHX has the potential for significant power and cost savings.

In Phase II, ACT seeks to mature the VDHX concept developed in Phase I by completing the following objectives:

- Extend Phase I testing to cover full operating envelope
- Determine scalability to larger-scale applications such as commercial buildings
- Develop design tools based on the Phase I model
- Optimize the VDHX design for heating, cooling, and dual-use applications
- Design and fabricate a prototype for testing with a GSHP or simulated system
- Design and fabricate a conceptual commercial unit
- Validate commercial unit design through testing

Oklahoma State University (OSU), will support this effort by providing their expertise on GSHP systems and conducting testing at their facility. In support of the Phase II program, OSU will provide the following.

- Consultation regarding component design for GSHP systems and systems-level considerations
- Information regarding their testing requirements for design of the VDHX prototypes
- Testing of 2 VDHX prototypes with a GSHP or simulated system
- Modeling and energy analysis study of GSHP with integrated VDHX

Sponsor: Advanced Cooling Technologies, Inc.

PI/PD: Spitler, J.D.

Revise Load Calculation Applications Manual

It's highly desirable that the LCAM (Load Calculation Applications Manual) incorporate new data and new procedures from recent ASHRAE (Application Manual for Non-Residential Load Calculations) research as well as be consistent with the Fundamentals Handbook.

Accordingly, the primary objective of this project is to revise the LCAM and produce a second edition, in both IP and SI versions.

Sponsor: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

PI/PD: Spitler, J.D.

Surfactant-templated Polyurea–nanoencapsulated Macroporous Silica Aerogel, a Potential New Biomaterial

Traditional (native) silica aerogels are well known materials for their high porosity, low thermal conductivity, high acoustic impedance, and also for their low mechanical strength. Due to the latter, applications have been limited to highly specialized environments such as in space for thermal insulation of planetary rovers or in the core of certain nuclear reactors as Cherenkov radiation detectors. In 2002, Leventis developed a method to nanoencapsulate 3D silica nanostructures under a conformal polymer coating without clogging the pores. Using this method, a novel class of polyurea–nanoencapsulated surfactant-templated bi-continuous meso- and macro-porous silica aerogels was synthesized. The most impressive property of this new class of aerogels, termed X-aerogels, is their exceptional mechanical strength. Combined, these observations lead to the novel hypothesis of this proposal: X-aerogels have a good biocompatibility with the cardiovascular system and they can be used to manufacture blood implantable devices such as artificial heart valve leaflets. This hypothesis will be tested through three specific aims: 1) to examine the biocompatibility of X-aerogels towards plasma, blood cells and vascular endothelial cells; 2) to characterize the mechanical behavior and chemical stability of X-aerogel; and, 3) to manufacture a X-aerogel monoleaflet heart valve and test its hemodynamic performance in a dynamically similar flow chamber. The investigation of the biomedical applications of this newly developed material, and the design and manufacturing of an X-aerogel monoleaflet artificial heart valves will broaden the applications of this new class of materials, change the current biomaterial market and technology, improve the existing designs of prosthetic heart valves, and bring more choices to patients.

Sponsor: National Science Foundation

PI/PDs: Yin, W., Rubenstein, D.A.

Platelets and Endothelial Cell Responses to Coronary Blood Flow

Platelets and vascular endothelial cells (EC) play important roles in hemostasis and thrombosis. Their functions and activities are closely related to blood flow induced mechanical stresses. It is important to understand how the flow features and the stress field can affect the functions of platelets and vascular EC, as well as disease development. However, blood flow is time dependent and experimental measurements of shear stress applied to circulating platelets and vascular wall EC could be problematic. Numerical simulation provides an alternative way to obtain detailed flow patterns and shear stress distribution.

Sponsor: American Heart Association

PI/PDs: Wei Yin, David A. Rubenstein

Aspirin Protects Endothelial Cells from Secondhand Smoke

The goal of this study is to investigate how secondhand smoke affects endothelial functions and if the use of low-dose aspirin can sufficiently inhibit this adverse effect, especially for patients with pre-existed cardiovascular disease conditions. Results obtained from this study will not only help us better understand the relationship between secondhand smoke, pathological shear stress and cardiovascular diseases from a scientific point of view, but also lead to a new affordable way to protect nonsmokers from secondhand smoking, and in a long run, significantly save smoke-related health costs in Oklahoma and the nation.

Sponsor: Oklahoma Center for the Advancement of Science and Technology (OCAST), Mechanical and Aerospace Engineering

PI/PDs: David Rubenstein, Wei Yin

MRI: Acquisition of a SELDI ProteinChip Reader
We propose to acquire a Surface Enhanced Laser Desorption/Ionization ProteinChip reader from Bio-Rad Life Inc. This system is an extension of the conventional matrix-assisted laser desorption ionization time of flight mass spectrometry. With a minute sample volume, it can determine the precise molecular weights of multiple proteins from various biological samples.
Sponsor: National Science Foundation (NSF)
PI/PDs: Wei Yin, Kaan Kalkan, David Reubenstein
School of Chemical Engineering: Heather Fahlenkamp,
College of Veterinary Health Sciences: Pamela Lloyd, Carey Pope

CENTER FOR LOCAL GOVERNMENT TECHNOLOGY

Project Monitoring/Assessment Program for Oklahoma's Rural Transit Projects
The Oklahoma Department of Transportation's (ODOT) Transit Programs Division (TPD) is charged with the responsibility for administrating all Federal Transit Administration funds for areas with a population of fewer than 200,000 throughout the state. As a consequence of this large area of service and TPD's limited staff numbers, these projects receive an inadequate frequency of onsite project monitoring and assessments. The Center for Local Government Technology, (CLGT), assists ODOT by performing the monitoring functions through a comprehensive assessment program that: 1) assures project compliance with applicable federal and state laws and administrative rules, and 2) provides current information on the TPD website.
Sponsor: Oklahoma Department of Transportation
PI/PD: Kary Kiner

Oklahoma's Public Rural Transit Systems
The Rural Transportation Assistance Program (RTAP) provides training, technical assistance, and software applications to 21 rural public transportation systems in Oklahoma. RTAP is funded through a contract with the Federal Transit Authority (FTA) and ODOT. Training is presented in workshops, annual meetings, and "one-on-one" site visits. Current information supporting rural transit operations is provided on the CLGT website.
Sponsor: Oklahoma Department of Transportation
PI/PDs: Kary Kiner, Michael L. Hughes

Technology Transfer Program for Native American Tribal Governments in Texas, Oklahoma, Nebraska and Kansas
Funded by the Federal Highway Association and in cooperation with the Bureau of Indian Affairs, this program provides for a resource center to furnish information, training, and technical assistance related to road and bridge construction, repair, and maintenance to over 49 tribal governments in a four-state area. The TTAP mission is to meet the educational needs of tribal governments related to roads, bridges, public transit, transportation systems, inter-governmental coordination, and economic development. An important part of the mission is to provide training sessions, classes, and workshops geared to specific tribal needs. The TTAP center also maintains a mailing list, publishes a quarterly newsletter, keeps a library of technical literature and videotapes, and provides on-site assistance. The TTAP center at OSU is one of seven TTAP centers across the U.S. and part of a network of 58 technical assistance centers.
Sponsor: United States Department of Transportation - Federal Highway Administration
PI/PDs: Jim T. Self, Michael L. Hughes

Assessor Training and Assistance Program Income
With the oversight provided by the Oklahoma Tax Commission (OTC), the Association of County Assessors', and the Association of County Treasurers', the Center for Local Government Technology, in cooperation with the Tax Commission, the County Assessors' Association and the County Treasurers' Association will execute the PROGRAMS by providing computer software programs, support of software and hardware including installation, maintenance, data management and training, to counties currently using the services previously provided by the State Auditor and Inspector as mandated by legislation.

The CLGT will:

- Provide hardware maintenance only to County Assessors utilizing the PROGRAM software systems.
- Provide software, software maintenance, and software support only to County Assessors utilizing the PROGRAM software systems.
- Provided technical support to County Assessors.
- Participate in 4-C meetings.
- Assist OTC in ongoing software system development, including development of long range plans regarding the interfacing and interoperability of the CAMA System and the AA System.
- For current users of the PROGRAM, provide training to County Assessors.
- Provide assistance with data extraction for OTC statutory and other agency requirements.

Semi-annual reporting of the work plan progress and financial data will be presented to the OTC, the Association of County Assessors at the Assessor's Advisory Board meetings, and the Association of County Treasurers. Advisory Board members consist of County Assessors and OTC officials.
Sponsor: Various Income
PI/PD: Snyder, G.

Computer Support and Assistance Program
With oversight provided by the Oklahoma Tax Commission (OTC), the Association of County Assessors, and the Association of County Treasurers the Center for Local Government Technology provides software programs, support of software and hardware including installation, maintenance of software and hardware, data management, conducting training programs and technical assistance for County Assessors and County Treasurers. CLGT also provide coordination with the Oklahoma Tax Commission Ad Valorem Division (OTC) in fulfilling mutual responsibilities to support State CAMA and Assessment Administration (AA) software systems.
Sponsors: Oklahoma Tax Commission, Oklahoma State Auditor and Inspector
PI/PD: Gary Snyder

The County Assessor Training and Accreditation Program
With the oversight provided by the Oklahoma Tax Commission and the Association of County Assessors, the Center for Local Government Technology conducts training programs and provides technical assistance for County Assessors and members of County Boards of Equalization.
Sponsor: Oklahoma Tax Commission
PI/PD: Gary Snyder

Local Government Agency Summer Internship
This project will facilitate experiential learning by placing undergraduate students of civil engineering, construction management, and other transportation related degree programs with local government agencies responsible for the maintenance and construction of roads and bridges.

Sponsor: Oklahoma Transportation Center (OTC) , Center for Local Government Technology
PI/PDs: Michael Hinkston, Doug Wright

2010 National LTAP Conference
The Local Technical Assistant Program (LTAP) is funded through a contract with the Oklahoma Department of Transportation. Since inception, the mission of Oklahoma LTAP has been to provide training, technology transfer and technical assistance to local government agencies responsible for transportation systems.
Sponsor: Oklahoma Department of Transportation (ODOT), Center for Local Government Technology
PI/PD: Doug Wright

Local Technical Assistance Program
The major tasks of the LTAP Center are: 1) to develop and conduct training, 2) to provide technical assistance, 3) to serve as Oklahoma APWA Chapter Headquarters, 4) to publish a quarterly newsletter, and 5) to provide technology transfer material. The Center offers a County Roads Scholar Certification program, and is one of four original LTAP centers in the nation.
Sponsor: Oklahoma Department of Transportation, Federal Highway Administration
PI/PD: Douglas A. Wright

FIRE PROTECTION PUBLICATIONS

OkAT Solutions 2011
The goal for Solutions 2011 is education that will improve the safety of Oklahomans with disabilities. To meet this goal, FPP will collaborate with Oklahoma ABLE Tech and provide technical support in two major projects:

1. Installation of specialized smoke alarms for individuals that are deaf or hard of hearing that reside in the Oklahoma City and Tulsa metro areas, and to update fire prevention and safety educational messages targeted for this population provided in various formats.
2. Retrofit the residence of an individual with severe disabilities with a home fire sprinkler system in order to produce educational materials that will outreach to the targeted population.

Sponsor: Oklahoma Assistive Technology Foundation for the United States Department of Homeland Security-FEMA
PI/PD: Trench, N.J.

International Fire Service Training Association (IFSTA) - Funding Alternatives Guide
The purpose of this cooperative agreement is to provide funding to study required information updates and revisions to the December 1999 edition of Funding Alternatives for Fire and Emergency Service (FA-141) and incorporate such changes into the document to provide the most up to date comprehensive information regarding sources of funding for local-level Emergency Medical Services (EMS) and fire departments. A key part of this project initiative will be the enhanced study of critical funding issues for EMS, both fire and non-fire service based. The United States Fire Administration (USFA) is seeking an application from the International Fire Service Training Association (IFSTA) for this initiative for the purpose of incorporating necessary updates into the Funding Alternatives for Fire and Emergency Service guide.
Sponsor: Federal Emergency Management Agency (FEMA), Fire Protection Publications
PI/PDs: Nancy Trench, Mark Wieder

Traffic Incident Management Systems (TIMS) Technical Research
The objective of this project is to partner with the International Fire Service Training Association (IFSTA) and involves research and development of effective technical guidance for fire and emergency services in Traffic Incident Management System (TIMS) for enhanced compliance with United States Department of Transportation (DOT) Manual of Uniform Traffic Control Devices (MUTCD) and soon-to-be released National Fire Service Incident Management System (IMS) Consortium Model Procedures Guide for Highway Incidents.
Sponsor: Federal Emergency Management Agency
PI/PDs: Nancy J. Trench, Michael A. Wieder

IFSTA - Study of Emergent Topics in Emergency Vehicle and Roadway Operations Safety for Law Enforcement and the Fire Service
This proposal is offered in response to the Scope of Work document for the *Study of Emergent Topics in Emergency Vehicle and Roadway Operations Safety for Law Enforcement and the Fire Service* that was forwarded to the International Fire Service Training Association (IFSTA) by a representative of the FEMA Office of the Chief Procurement Officer. This particular project represents collaboration between the United States Fire Administration (USFA), Department of Justice (DOJ), National Justice Institute (NIJ), and IFSTA.

IFSTA will develop and submit a detailed plan of work within 30 days of the implementation date/award of this project. IFSTA staff members will be available to consult with any or all of the participants in this project to ensure that the plan of work is acceptable. IFSTA will conduct all research associated with this task. IFSTA staff will develop a contact list for the various organizations that will be asked to provide input on and/or review this project.

Each organization will be contacted individually. Any input they provide will judged solely by IFSTA staff and the USFA Project Officer. There will be no formal meeting or consensus process involving the various participating organizations or their representatives. IFSTA will also conduct an extensive search and compilation of existing resources, reports, and data that are available from government, trade industry, research, and educational sources.

Current information will be used in the report. Actual vehicle crashes documented in the public domain, that the project is intended to prevent, will also be assessed. These resources and contact information will be provided in the appendix of the report. IFSTA will develop a summary of the data gathered in Task Two. The summary will present the resulting information in a meaningful way, identify best practices, and determine which information will be placed into the body of the report. A final outline for the report will be developed and the initial draft of the report will be written.
Sponsor: United States Department of Homeland Security - Federal Emergency Management Agency
PI/PD: Trench, N.J.

FIRE SERVICE TRAINING

National Fire Academy State Fire Training Grant
Fire Service Training will deliver a series of training programs in cooperation with the Federal Emergency Management Agency (FEMA) and the U.S. Fire Administration's National Fire Academy (NFA) to enhance the capabilities of the fire service in Oklahoma.

Sponsor: Department of Homeland Security Federal Emergency Management Agency
National Emergency Training Center
PI/PD: Allen, Bob

Health Department Revolving Fund Grant
The OSU Fire Service Training Center provides free training and educational services that enable Oklahoma Emergency Responders to safely meet recognized standards of professional competence. The courses provided include; Advanced Cardiac Life Support (ACLS), Pediatric Advanced Life Support (PALS) and Regional Mass Casualty Management. Due to the decrease in funding statewide, our funding to provide training is compromised, but the demand remains high. Our training equipment in particular needs immediate replacement and updating to meet new standards. Our goal with this grant is to expand our capacity to present advanced life support (ALS) training in types of care where actual experience is rare, such as pediatric care and disaster response.
Sponsor: Oklahoma State Department of Health
PI/PD: Duncan, Mike

State Homeland Security Program - Citizen Corp CERT Training Program
The Community Emergency Response Team (CERT) Program educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. Using the training learned in the classroom and during exercises, CERT members can assist others in their neighborhood or workplace following an event when professional responders are not immediately available to help. CERT members also are encouraged to support emergency response agencies by taking a more active role in emergency preparedness projects in their community.
Sponsor: Oklahoma Office of Homeland Security
PI/PD: George, Steve

Hazardous Material Emergency Preparedness (HMEP) FY 2011
In this proposal novel fabrication techniques are combined with application of material with enhanced thermal properties in an optimized pixel structure which potentially enables thermoelectric IR imaging units with unprecedented performance. The proposed devices are expected to significantly close the gap between the two IR imaging techniques (thermal and photon detection) while offering significant advantages in size, cost and power consumption.
Sponsor: Oklahoma Department of Emergency Management (OEM), Fire Service Training
PI/PD: Kirtley, C.E.

National Fire Academy State Fire Training Grant
The purpose of this Project Description is to provide guidance regarding the distribution and implementation of grants to the 50 State Fire Training Systems. In fiscal year 2012, the Federal Emergency Management Agency received $1,400,000 for distribution to be used as grants to each of the 50 States for implementation of U.S. Fire Administration's National Fire Academy (USFA/NFA) training courses and programs. Each State Fire Training System will receive a total of $26,000 with $21,000 earmarked for delivery of NFA training programs and $5,000 for marketing, administrative costs, and electronic feedback of student data. These grants support local training initiatives of NFA courses in four categories:

1. Delivery of NFA State sponsored courses in State and local areas
2. Delivery of selected NFA 6-day and 2-day off campus courses

3. Endorsement Program courses
4. Chief Officer Training Curriculum

Our project Goal is to improve access to the National Fire Academy courses for our Emergency Responders within the state of Oklahoma. We will improve access to these courses by providing them throughout the state in both conference settings as well as single course deliveries. They will be provided in rural and metropolitan settings in an effort to bring the training to the responder locally. This proposal clearly offers the people of Oklahoma improved emergency response capacity in a time of scarcity. This is an important project and should be funded.

Sponsor: Department of Homeland Security Federal Emergency Management Agency National Emergency Training Center
PI/PD: Kirtley, C.E.

JMEM

Joint Munitions Effectiveness Manual (JMEM) Program-2012
OSU has been the JMEM Production Contractor for the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME) since January 1967. JTCG/ME is a Department of Defense (DoD) program sponsored by the Secretary of Defense's Director of Operational Test and Evaluation. We provide research, analysis, and software engineering support to two major joint service groups within the JTCG/ME involved with the production and dissemination of classified conventional munitions effectiveness analyses. We also provide technical editing, graphics, and document design support to publish all JMEMs and JTCG/ME Special Reports according to military standards. The Oklahoma State University Field Office (OSUFO) is located on Eglin Air Force Base, FL with a satellite office at Aberdeen Proving Ground, MD. JTCG/ME provides nonnuclear munitions effectiveness information for DoD operational commanders; targeteers, weaponeers, analysts, and planners; weapon system designers; and logisticians. The information includes damage/effects probabilities for specific weapons and targets, physical and functional characteristics of munitions and weapon systems, target vulnerability, obscuration impact on weapon effectiveness, and analytical techniques and procedures for assessing munitions effectiveness. This effort has resulted in a library of classified and unclassified JMEMs and standardized methodologies capable of rapidly generating effectiveness data over a wide range of delivery parameters for air-to-surface, surface-to-surface, and antiair weapons. The JTCG/ME is organized with a program office and three major configuration control boards (CCB). The JTCG/ME Program Office is the focal point for all JTCG/ME efforts. They coordinate the efforts of all the groups while the execution of those efforts is the responsibility of the CCB chairperson. Two of the CCBs have their own JMEM CD-ROM: JMEM Weaponeering System (JWS) and Joint Antiair Combat Effectiveness (J-ACE), to cover the spectrum of weapon effects issues. In addition, Operational Users Working Groups support each JMEM CCB. JWS includes both the development of methodologies and analysis of data that assess the effectiveness of weapons launched from the air at targets on the ground as well as those delivered from the surface (land and water) at targets on the surface. J-ACE assesses weapons launched at air targets. The OSUFO weapons branches are aligned with the CCBs. The OSUFO Targets, Training, Publications, and Graphics Branches are functionally organized to give maximum support across all areas. OSUFO personnel coordinate on a daily basis with the CCBs, government analysts, and the Program Office. They answer questions from the warfighter. They also work with other JTCG/ME contractors who are developing methodologies or working on target vulnerability studies to ensure their efforts will support JMEM production schedules and needs. The OSUFO performs development and

weapons effectiveness analyses as well as supports the CCBs in their efforts to obtain weapons data from the government program offices and the weapons contractors. The OSUFO's major responsibility is to produce JMEMs on time, based on CCB schedules, with the capabilities and data required by the government.
Sponsor: U.S. Air Force
PI/PDs: Dr. Karl N. Reid, Arthur J. Rosenbaum

NEW PRODUCT DEVELOPMENT CENTER (NPDC)

Oklahoma Inventors' Assistance Service (IAS)
The Inventors' Assistance Service (IAS) provides information, education, and assistance to Oklahoma inventors navigating the process of transitioning an idea into a product. The IAS offers workshops; maintains a website, a resource database, and a roster of contacts; offers informational materials; and offers general assistance to persons navigating the invention process. The IAS operates the Selected Inventions Program to organize inventor efforts to successfully bring an invention to the point where the process transitions to licensing, manufacturing, or recruitment of capital. The IAS seeks to expand its service into that of a resource whose success with inventor assistance, education, and networking is well known throughout Oklahoma.
Sponsor: Oklahoma Center for the Advancement of Science and Technology
PI/PDs: Ranji Vaidyanathan
Inventors' Assistance Service: Thomas G. Bertenshaw

Next Generation Green and Sustainable Manufacturing in Oklahoma
The overarching objective of the project is to improve the top line growth, viability, profitability, and global competitiveness of Oklahoma manufacturers. This project will accelerate manufacturers' realized capacity to absorb new, and when appropriate, green technology. Manufacturers that successfully complete the new product development process will increase their capacity to continuously improve and produce new products, processes, and services that are better adapted to evolving market opportunities, address environmental issues, and enhance their global competitiveness.
Sponsor: Oklahoma Alliance for Manufacturing Excellence, Inc. for NIST
PI/PDs: Vaidyanathan, R.
DASNR: Tilley, D.S.

Internal Cylinder Combustion Pressure Sensor
Development of a real-time internal cylinder combustion pressure sensor that is integrated into the bottom of a common spark plug will increase the ability to optimize internal combustion engine performance. Firing spark plugs at optimal internal cylinder pressures will:

- Improve fuel economy;
- Increase power performance;
- Allow substantially better management of flex-fuel engine performance;
- Provide for real-time engine diagnostic capability;
- Allow increased power to weight ratios for engines;
- Reduce engine control system complexity;

- Reduce NOx emissions; and
- Reduce carbon emissions.

Perhaps more importantly, real-time internal cylinder combustion pressure information may allow prediction of impending failure of a cylinder and improve the safety of internal combustion engines in aircraft. Currently, internal combustion engine cylinders are fired based on the position of the cam shaft via mechanical timing. The timing of the firing pulse is generally set to provide good power performance while maintaining reasonable fuel efficiency yet not optimizing either condition. The ability to provide a real-time measure of internal cylinder combustion pressure will allow adjustment of the cylinder firing point at known internal pressures providing for the optimization of the cylinders performance for power and/or fuel efficiency when needed. Generally the timing optimization for engine power would be used during the need for acceleration while the timing optimization for fuel efficiency would be used during steady state operation. Estimates indicate that the fuel efficiency of a common engine could be increased by 17% under steady state operating conditions while the output power for an engine of a given size could be increased by 25% when conditions warrant. As a result, an engine's physical size (generally measured by cubic inch displacement) for a given power class could be reduced, thereby reducing weight, creating additional improvements in fuel efficiency and performance.
Sponsor: Oklahoma Economic Development Generating Excellence (EDGE)
PI/PD: Robert M. Taylor

Manufacturing Innovation and Revitalization Partnerships: Universities, Manufacturers, Government and K-12 Teachers (MIRP)
This proposal is a multidisciplinary project to transform innovation activities in the manufacturing sector. **MIRP** integrates three programs that address innovation education and implementation in manufacturing, universities, and K-12 education.

1. The Manufacturers Innovation Leadership Program (**MILP**) is designed for managers who have leadership potential within small- and medium-sized manufacturing (SMMs) firms. MILP participants will learn how to lead manufacturing innovation, write, and critique SBIR proposals, work with NSF innovation scholar teams from the university, and mentor K-12 teachers who will teach about innovation and careers in manufacturing.
2. The NSF Innovation Scholars (**NSFIS**) program will create multi-disciplinary teams of senior college students and faculty who will produce and process innovation projects with small manufacturers participating in **MILP**. Business, engineering, chemistry, physics, and other science majors, communications, and graphic design students will participate on the teams.
3. The Innovation Program for Teachers (**IPT**) provides K-12 teachers to take an internet-delivered class on manufacturing innovation. The class will provide the teachers with lesson plans to teach K-12 (particularly grades 9-12) students about innovation. MILP participants and NSFIS will serve as resources and mentors for the teachers.

The central hypothesis of this project is that institutional transformations like the NPDC at OSU and CETES at Cameron University can enhance the innovation culture of SMMs. The OSU NPDC-CETES model of university/industry technology transfer is an improvement over the Zahra and George model of innovation absorptive capacity (ACAP). MIRP will embrace a combination of experiential, problem-based, and research-based learning. Project participants will study innovation successes, learn innovation processes, perform research to evaluate alternative solutions to problems, and be mentored and interact with innovative leaders from SMMs as well as university faculty.

Sponsor: National Science Foundation
PI/PD: Taylor, Robert

OKLAHOMA TRANSPORTATION CENTER

Oklahoma Transportation Center
As a designated National University Transportation Center (UTC), the Oklahoma Transportation Center (OTC) will address the solution of critical transportation infrastructure problems using the collaborative efforts of the University of Oklahoma, Oklahoma State University and Langston University, in conjunction with transportation professionals in government and industry. The emphasis on transportation infrastructure will focus on service monitoring and life extension of bridge and foundation systems, vehicle-bridge interactions, pavement materials and mechanics, and intermodal freight logistics. The OTC's goals will be to find ways to mediate structural load limitations, increase traffic capacity and mobility, and enhance safety and security. By marshaling the best talent available to examine and advance innovative solutions to these problems the OTC will make contributions to the national transportation system that affects all Americans.
Sponsor: United States Department of Transportation - Research and Innovation Technology Administration
PI/PD: D. Alan Tree

OUTREACH DISTANCE EDUCATION

HAZWOPER for First Responders, FY 2012
The purpose of the contract proposal is to provide specialized Education and Preparedness training to hospital and EMS agencies with the knowledge and skills necessary to effectively respond, receive and decontaminate victims of terrorist attacks or other public health emergencies while protecting themselves from possible harmful effects.
Sponsor:
PI/PD: Brandy Mays

Division of Engineering Technology (TECH)
Recovery Act: National Certification Standard for the Geothermal Heat Pump Industry
The goal of this project is to create a national certification standard for all primary personnel involved in the installation of geothermal heat pump (GHP) systems, including drillers, plumbers, electricians, heating and air conditioning specialists, engineers and architects. The standard will be designed to increase customer confidence in the technology, reduce the potential for improperly installed systems, and assure product quality and performance.
Sponsor: Geothermal Heat Pump Consortium
PI/PDs: TECH: Bose, J.E., Clapp, J.E.

Development and Implementation of a Distance Education Course Sequence that Addresses the Need for Engineers Trained in Probabilistic Risk Assessment and Fire Protection
The OSU FPST faculty will build the fire protection offerings based on tested methods that integrate modeling with scenarios. The fire protection component of the second course will provide fundamentals of fire science essential to effective risk assessment. Applications of PRA will use output data from NUREG 1805 Tools, Fire Dynamics Simulator (FDS), CFAST, Smokeview, and related fire

modeling programs for nuclear facilities in PRA exercises that have been developed in collaboration with our partners at The University of Texas (Dept. Of Mechanical Engineering) and industrial partners. Fire modeling is a fundamental requirement in the transition to a risk informed approach to fire protection in nuclear facilities. As identified in a recent Government Office of Accountability report, the shortage of skilled personnel and the costs of performing risk analyses could slow the transition to risk based approaches to fire protection (GAO-08-747). Output data will be based upon scenarios using data from actual and simplified situations. The data from a variety of fire models will be integrated into risk assessment course work so that engineers will have familiarity with the capability and limitations involved in fire modeling. The data students generate from modeling exercises will be integrated into a scenario to illustrate the role that quantitative and qualitative engineering analysis are used to satisfy safety performance requirements, using NFPA standard 805 as the basis. Selection of appropriate models and limitations of the model will be based on NPA 805 Annex C. Animations and supporting materials will be developed using ITLE and other institutional resources to enhance classroom and distance delivery of the material.
Sponsor: Kansas State University for U.S. Nuclear Regulatory Commission
PI/PD: Brown, J.D.

Performance Assessment of a Folded Coaxial Ground Source Heat Exchanger
Ground Source Heat Pumps (GSHP) often exchange heat with the ground through the use of vertical boreholes. The Charles Machine Works, Inc. plans to submit a proposal under the OCAST Oklahoma Applied Research Proposal Support (OARS) program. The proposal is for research to develop a folded coaxial pipe ground heat exchanger. These long-term savings for GSHP systems are partially offset by higher installation costs, which are largely associated with the ground heat exchangers. The proposed new heat exchanger could potentially reduce installation costs and provide better heat exchange between the ground and the heat pump. The thermal performance of the proposed heat exchanger design will be compared to other heat exchanger types. New boreholes will be drilled and equipped at the Perry, OK site of The Charles Machine Works, Inc.
Sponsor: The Charles Machine Works, Inc. for OCAST
PI/PD: Beier, R.A.

Development of Coil-Type Geothermal Heat Exchangers and Installation System
KIT will conduct patent search and analyses, design and fabricate new coil-type geothermal heat exchangers, and send them to OSU for testing. A design calculation program will be developed based on the test results and installation guidelines that will be provided by OSU. The calculation program will be used by geothermal system designers to determine the required number of coil-type heat exchangers and their arrangement. KIT will also develop a new installation method (two-grout method) and assist EST to design an installation device.
Evaluation methods and categories for the development of technology

a. Patent search and analyses: One or more patents are expected to be filed during the research period. Completeness of our patent search and analyses will be indirectly evaluated by reviewers when they evaluate our patent applications.
b. Design and fabrication of coil-type geothermal heat exchangers: The effectiveness of our design and choice of pipe material will be evaluated via computational analyses and then reviewed by a Certified Geothermal Designer.
c. Development of a new installation method: The effectiveness of our installation idea, which is for improved heat transfer, will be evaluated by computational analyses and experiments.

Sponsor: Kumoh National Institute of Technology (KIT)
PI/PD: Chang, Y.B.