**ARCHITECTURE**

**Transitioning Students to Teacher-Researchers (TSTR)**

The project’s premise is that by learning the nature of science through authentic research experiences, preservice science teachers (PSTs) will strengthen their science literacy skills and be better equipped to engage their future students in science and engineering practices. This project will provide PSTs with multiple opportunities to conduct scientific research during their science methods courses. These new or modified science methods courses will be designed to enhance PSTs’ skills in conducting research and teaching others to conduct scientific research. The PSTs will receive extensive mentoring from faculty and graduate students from multiple science and engineering disciplines across the university.

**Sponsor:** National Science Foundation

**PI/PDs:** Carissa Ramming

Education: Julie Angle

College of Arts & Sciences: Andrew Doust, Donald French

**CENTER FOR LOCAL GOVERNMENT TECHNOLOGY (CLGT)**

**Implementing Safe Work Zone Operations Strategies**

Oklahoma State University’s Center for Local Government Technology will provide 210 courses including worker courses, management courses and instructor courses over 3 fiscal years to improve operational understanding and planning for flagged, mobile, short duration and short term operations for public, tribal, private and educational sector employees including utilities (public and private), emergency response, towing and insurance personnel.

**Sponsor:** United States Department of Transportation – Federal Highway Administration

**PI/PD:** Shannon Sheffert

**Local Technical Assistance Program**

Since its inception in 1982, Oklahoma LTAP’s mission has been to provide training, technology transfer and technical assistance to local government agencies responsible for transportation systems. The Center is one of four original LTAP centers in the nation. Oklahoma LTAP addresses four focus areas: Safety, Infrastructure, Innovation, and Accountability. LTAP offers Road Scholar and Core Courses to meet its clients’ needs, covering a wide array of topics such as aggregate road maintenance, testing for soil properties, CDL training, and many others. LTAP also provides a Transportation Intern Program that places student interns with local government agencies in paid summer internships.

**Sponsor:** Oklahoma Department of Transportation for Federal Highway Administration

**PI/PD:** Shannon Sheffert

**The Assessor Training and Assistance Program and the County Computer Assistance Program**

These programs, authorized by state statute, provide for the Assessor Accreditation Program, training for county Board of Equalization members, and County Computer support and training. CLGT will excute 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. CLGT will also maintain official records for the accreditation program and provide the Oklahoma Tax Commission with pass/fail results so they can issue accreditations to all persons who qualify.

**Sponsor:** Oklahoma Tax Commission

**PI/PDs:** Gary Snyder, Scott Warren

**CHEMICAL ENGINEERING**

**CAREER: Computation-Enabled Rational Design of Cytochrome P450 for Ionic Liquid Biodegradation**

The objective is to close the gap in our scientific understanding of P450-mediated hydroxylation of ionic liquids, which can then be leveraged to engineer cytochrome P450 for ionic liquid biodegradation. The central hypothesis is that the recalcitrant nature of ionic liquids arises due to thermodynamic limitations and/or kinetic barriers to hydroxylation, while kinetic barriers are responsible for limited ionic liquid hydroxylation. Identifying amino acid residues in the P450 binding pocket and substrate access channel that present such barriers to the reaction and substituting residues with those able to lift such limitations will trigger and speed up the ionic liquid hydroxylation.

**Sponsor:** National Science Foundation

**PI/PDs:** Jindal Shah

**Evaluation of COVAS Effectiveness on the Clearance of the COVID-19 Aerosols in a Patient Room**

The goal of the project is to evaluate the efficiency of the novel COVID air sanitizer (COVAS) in clearing the suspending cough droplets in a COVID-19 patient room. Recommendations on the optimized COVAS position and operational flow rate will be provided based on the computational fluid-particle dynamics simulation results at the end of the project.

**Sponsor:** Darren Leung

**PI/PDs:** Yu Feng

**Development of Open Access Version of Applied Numerical Computing Course**

The objective is to develop an open access version of the Applied Numerical Computing course with screencasts and course materials available online for asynchronous learning of course modules by learners beyond the OSU classroom-based course offerings. The open access course will be disseminated as a series of modules on topics including but not limited to solving systems of differential equations, estimating parameters for models using regression, writing manuscripts and dissertations, and developing graphical user interfaces.

**Sponsor:** Computer Aids for Chemical Engineering (CACHE) Corporation

**PI/PDs:** Ashlee Ford-Versypt

**Solar Thermal Desalination Technology Development**

This project will develop a cogeneration cycle that will utilize harvested heat to power a mechanical vapor compression cycle to desalinate produced water (PW). The heat flux and the energy efficiencies will be compared with the current industry standards. This thermal distillation system is intended to reduce net energy consumption, lower the cost of desalination, and reduce the volume of PW disposal.

**Sponsor:** Nitro-Lift Technologies, LLC

**PI/PDs:** Prem Bikkina, Khaled Sallam

**NASA Oklahoma EPSCoR Research Infrastructure Development: In Situ Characterization of Chemo-Mechanical Instabilities in Solid-State Batteries**

The primary objective of the study is to develop a rational basis to design novel solid electrolyte structures that exhibit robust mechanical stability and desirable fast-charging performance required for aviation and NASA space missions. Solid electrolytes offer significant opportunities to advance electrochemical energy storage technologies, however utilization of the benefits of solid electrolytes is limited by the lack of understanding of their operation mechanisms. This project seeks to create a fundamental understanding of electrochemically-driven mechanical instabilities in electrified solid-solid interfaces.

**Sponsor:** National Aeronautics and Space Administration, Oklahoma State Regents for Higher Education

**PI/PD:** Ozgur Capraz

**Advanced Methods for Characterization of Heterogeneous Catalysts**

The overall purpose of this project is to design new and assess existing high-field magnetic resonance methods for non-destructive evaluations of heterogeneous solid-acid or solid-base catalysts. In addition, post-synthetic modifications of catalysts, e.g., temperature, moisture, and cation exchange, will be used to elucidate catalyst structure-function relationships. Catalytically-relevant probe molecules will also be identified for in-situ studies of reactivity, selectivity, and deactivation. The overall experimental protocol will include those previously published by the PI. Actual materials for research will be identified in collaboration with Phillips 66 researchers.

**Sponsor:** Phillips 66

**PI/PD:** Jeffery White

**Continuous Large-scale Functionalized Silver Nanowire (AgNW)-Based Transparent Conductive Films (TCFs) Manufacturing**

The objective is the discovery of reaction conditions in a millifluidic reactor to produce high-quality, low-cost AgNW inks that can be continuously printed onto flexible substrates to create low-cost transparent conductive films (TCFs) for Internet of Nano Things (IoNT) application. To accomplish this, the research aims are: 1) AgNW millifluidic reaction mechanism investigation and synthesis optimization to find the optimum reaction conditions; 2) Large-scale millifluidic synthesis of functionalized AgNW; and 3) Continuous preparation and writing of AgNW inks onto flexible substrates to create TCFs for IoNT.

**Sponsor:** National Science Foundation

**PI/PDs:** Shohreh Hemmati

Materials Science and Engineering: James Smay

**Solar Thermal Distillation Technology Development for Desalination and Produced Water Treatment Applications**

The objective is to develop cost-effective high-efficiency solar thermal distillation technology for desalination and produced water treatment: 1) A solar collector coating will be identified for its efficiency of converting incident radiation into heat, cost, ease of application and longevity; 2) A heating surface compatible with the solar collector coating will be engineered to prevent ‘boiling crisis’; 3) A boiling surface that can boil the feed water at very low wall superheat and help prevent boiling crisis will be engineered; 4) A condensing surface that can condense water vapor at the similar rate of water vapor generation will be engineered.

**Sponsor:** United States Department of the Interior, Bureau of Reclamation

**PI/PD:** Prem Bikkina

**RII Track-4: Deciphering the Role of Polarization on Ion Transport in Ionic Liquid Batteries**

The fellowship will enable the PI to transition to the next level in modeling ionic liquids (ILs) by developing capability in the PI’s research group for conducting first principles molecular dynamics (FPMD) simulations based on density functional theory. As the first step, FPMD simulations of room temperature ILs and IL-IL mixture, and solvation of Li+ ion will be carried out to understand the impact of polarization on the structure and dynamics of ILs. Polarization-induced effects will also be probed by conducting FPMD simulation of ILs under an applied electric field. Pacific Northwest National Laboratory will be the host site.

**Sponsor:** National Science Foundation

**PI/PD:** Jindal K. Shah

**Understanding the Effects of Sphero-cylinder Drug Particle Shape to Enhance Small-airway Drug Delivery for Better Emphysema Treatment Outcomes**

Dry powder inhalers (DPI) are used to deliver micro-sized medication via pulmonary routes to treat emphysema. However, DPI methods are not as effective as they could be because a large amount of medication deposits in the mouth-throat region. The goal is to develop a computational model to predict particle interactions and transport dynamics, and determine how particle shape features can enhance drug deposition in emphysematous small airways. The hypothesis is that sphero-cylinder drug particles with high surface roughness and hollow structure can reduce the inter-particulate cohesion, avoid deposition in the upper airway, and reach small airways in a higher dose.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Yu Feng

**Field Evaluation of the Caney Shale as an Emerging Unconventional Play, Southern Oklahoma**

The Caney Shale is in the oil window, but its resource potential has not been adequately assessed. The Caney reservoir is about 60-300 m thick, is rich in total organic carbon, contains a large oil resource base, and has a strong natural gas drive; however, development has been hampered by high clay content and reactivity of the formation with water. A Caney Shale Field Laboratory will be established to: 1) conduct a comprehensive field characterization, 2) perform field experiments, and 3) validate cost-effective technologies that will lead to a comprehensive and efficient development strategy for the Caney Shale.

**Sponsor:** Department of Energy

**PI/PDs:** Mileva Radonjic, Geir Hareland, Prem Bikkina

Geology: Jim Puckette, Michael Grammer, Jack Pashin

Lawrence Berkeley National Lab: Jonny Rutqvist, Christine Doughty

Oklahoma Geological Survey: Brian Cardott, Abbas Seyedolali, Ming Suriamin

**MRI: Acquisition of a High Resolution Confocal Laser Scanning Microscope for the Advancement of Materials and Biological Research at Oklahoma State University**

This award will enable acquisition of a Carl Zeiss LSM 880 confocal laser scanning microscope with high resolution and modules for live-cell imaging. The new instrument is needed to meet the requirements of OSU researchers for high resolution scanning, live-cell imaging and 3D reconstruction since the current confocal microscope lacks these capabilities. The LSM 880 will be placed in the OSU Microscopy Laboratory, where the LSM 880 will have a high level of exposure and will be available at low cost not only to all OSU faculty, staff, postdocs, and graduate and undergraduate students, but also to researchers across Oklahoma.

**Sponsor:** National Science Foundation

**PI/PDs:** Heather Fahlenkamp, Josh Ramsey

Chemistry: Yolanda Vasquez

College of Veterinary Medicine: Shitao Li

**Targeted Delivery of a Reactive Oxygen Species Generator for Treatment of Hormone Refractory Prostate Cancer**

Glucose oxidase (GOX) and other reactive oxygen species (ROS) forming enzymes are of significant interest as anticancer agents due to the potent cytotoxicity of ROS. A nanoparticle delivery system will be used to target delivery of GOX to prostate cancer cells. A library of copolymers will be screened to identify promising nanoparticle candidates that will be tested in a mouse prostate cancer tumor model. The nanoparticles will be evaluated based on their ability to reduce the tumor volume and remain within the tumor. The immune response will also be characterized to determine which nanoparticles could be used for repeated dosing.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Josh Ramsey

**Unraveling the Link Between Mechanical and Chemical Properties of Deposited Species in Li-O2 Batteries, Using In-operando Techniques**

Further mechanistic insights on the interface of the electrode/electrolyte during electrochemical reactions will be provided, which are necessary to develop sufficient design rules for optimized cell components and their interfaces. The design of the cathode and catalyst with desired properties for oxygen reduction/evolution reactions (ORR/OER) depends on understanding of cathode stability in the Li/O2 cell. The project will combine *in situ* surface stress measurement techniques and *in* *operando* online electrochemical mass spectroscopy in order to characterize the governing surface reaction steps for the surface instabilities by analyzing both solid and gaseous phases of OER products during typical operation conditions.

**Sponsor:** US-Israel Binational Science Foundation

**PI/PD:** Ozgur Capraz

**DPI In-Silico Modeling – Predict Dry Powder Performance and Subsequent Depositions in a Whole-Lung Model**

There is a large gap in fundamental understanding of how design and human factors influence de-agglomeration and agglomeration in dry powder inhalers (DPIs). Thus, an in-silico model utilizing airflow dynamics (Computational Fluid Dynamics) and modeling of drug interactions properties in the flow channels of DPIs will be developed to accurately model, predict and hence improve the performance of DPIs.

**Sponsor:** CIPLA Ltd

**PI/PD:** Yu Feng

**Quantitative Systems Biomedicine and Pharmacology for Multiscale Tissue Damage**

Building multiscale computational models for the chemical and biological processes that result in structural addition or depletion of extracellular matrix, which damages various tissues, will increase fundamental mechanistic understanding of human tissues and lay the foundation for advances in disease treatment and prevention. The research addresses the critical need to compile the multiple processes that contribute to the onset and progression of chronic tissue damage into user-friendly systematic computational frameworks capable of taking the interconnected chemical, physical, and biological factors into account in a coupled fashion and in the appropriate magnitudes and sequences to make testable predictions.

**Sponsor:** National Institutes of Health

**PI/PD:** Ashlee Ford-Versypt

**Rational Design of Solar-Energy-Combined Desalination Systems for Treatment of Produced Water**

Produced waters (PW) from oil and gas operations pose risks to the environment and must either be treated or disposed of via underground injection. PW often exhibit high levels of dissolved solids (salts) and organic pollutants that must be separated from the water prior to reuse. The goal of the research is to develop novel, energy-efficient solar-energy-combined membrane processes for treating PW to levels suitable for reuse. Research objectives include: 1) Design chemical pretreatment process (Dr. Lampert), 2) Develop solar evaporation and condensation system (Dr. Mcllroy), 3) Synthesize ceramic membranes for desalination and organics rejection (Dr. Kim and Dr. Aichele).

**Sponsor:** United States Geological Survey

**PI/PDs:** Seok-Jhin Kim, Clint Aichele

Civil & Environmental Engineering: David Lampert

Physics: Dave McIlroy

**Ionic Liquid-Assisted Extractive Distillation for the Removal of Dimethylsilanediol**

This project adopts an entirely novel approach using ionic liquids in an extractive distillation process to remove dimethylsilanediol (DMSD) from wastewater consisting of humidity condensate and urine distillate to produce contaminant-free water for recycle and reuse aboard the space shuttle for deep space exploration and the ISS. Our research will be guided by the hypothesis that the presence of ionic liquids will increase the volatility of DMSD over water, enabling the separation of DMSD using distillation. To achieve the objective and test the hypothesis, a complementary approach involving molecular simulation (PI Shah) and experiments (co-PI Brennecke) will be carried out.

**Sponsor:** National Aeronautics and Space Administration

**PI/PDs:** Jindal Shah

University of Texas at Austin: Joan Brennecke

**Sucker Rod Guide Flow Simulations Using a CFD Model**

Sucker rod guides are an injection molded product commonly used in the oilfield. The goal of this project is to evaluate and optimize the sucker rod design using computational fluid dynamics (CFD) techniques, to minimize the flow drag rates and turbulence intensities. The optimized design also needs to stay above the minimum erodible wear volume values (EWV=4.3 in3) and below the maximum guide length (9.0 in).

**Sponsor:** US Rod Company

**PI/PD:** Yu Feng

**CAREER: Multiscale Modeling of a Virtual Kidney During the Onset and Progression of Diabetic Kidney Disease**

The objective is to predict progression of diabetic kidney disease (DKD) using a realistic computational model of kidney injury. The PI will construct a virtual kidney model for the structural and biochemical components affected during DKD in the glomeruli where most of the DKD damage is focused. The virtual kidney platform will use multiscale computational modeling to connect effects at different length scales from smaller to larger: inside cells, between adjacent cells, across a single glomerulus, and among collections of glomeruli. The virtual kidney will be used like a powerful microscope to detect and monitor damage to the glomeruli.

**Sponsor:** National Science Foundation

**PI/PD:** Ashlee Ford Versypt

**Development of Nitrogen-Assisted Fluid Systems for Improved/Enhanced Oil Recovery in Candidate Reservoirs**

The primary objective of this research study is to develop efficient and cost-effective Nitrogen-Assisted fluid systems for improved/enhanced oil recovery in candidate reservoirs. Towards the primary objective: 1. Interfacial tension (IFT), and advancing and receding contact angle measurements will be conducted for model/crude oil-water/brine-gas-sandstone/carbonate systems; 2. Continuous gas flooding (CGI) and huff-and-puff (Hn’F) microfluidic and coreflood experiments will be performed; and 3. The experimental data will be analyzed.

**Sponsor:** Nitro-Lift Technologies LLC

**PI/PDs:** Prem Bikkina, Clint Aichele

**Real-Time Drilling Optimization System for Improved Overall Rate of Penetration and Reduced Cost/Ft in Geothermal Drilling**

In this project the objective is to develop a real-time drilling optimization system for geothermal drilling. To reach this objective, the system will couple three individual components while drilling. The first component is a drill stem vibration analysis while drilling, the second component is to analyze mechanical specific energy (MSE) for optimum rotational speed (RPM) and weight on bit (WOB) combinations, and the third component is a detailed polycrystalline diamond compact PDC drill bit model.

**Sponsor:** Department of Energy

**PI/PDs:** Geir Hareland, Mohammed Al Dushaishi

Sandia National Lab: Doug Blankenship

**Self-Diffusion and Interactions of Multicomponent Fluids in Model Reservoir Solids**

Model nanoporous glasses with one-dimensional channels, and aluminosilicates with 2D and 3D channels, will be used to create controlled nanoporous hosts with either organic-rich or organic-poor channel walls, and oil-rich versus water-rich fluids will be used to elucidate how diffusion, adsorption, and chemical interactions depend upon the chemical nature of the solid host. Unique to the work is the combination of new experimental capabilities allowing measurements at pressures as high as ca. 1000 atm, and with gradient strengths as high as 2.9 kG/cm.

**Sponsor:** American Chemical Society Petroleum Research Fund

**PI/PDs:** Jeff White, Clint Aichele

**A 3D Human Tissue-Engineered Lung Model to Study Immune Responses to Respiratory Syncytial Virus**

Dr. Fahlenkamp and Dr. Kovats will divide up the work according to their relative expertise. Dr. Fahlenkamp is a tissue engineer and has developed the 3D Human Tissue-Engineered Lung Model (3D-HTLM) to be used. Dr. Fahlenkamp will be responsible for setting up the 3D-HTLM, RSV infection and monitoring responses of epithelial cells. Dr. Kovats will be responsible for procurement of myeloid cells from laboratory or clinical sources, and for characterizing and monitoring innate immune responses of myeloid cells. Drs. Kovats and Fahlenkamp will jointly oversee and evaluate all cellular and molecular analyses of antiviral responses in the project.

**Sponsor:** Oklahoma Medical Research Foundation for the National Institutes of Health

**PI/PD:** Heather Fahlenkamp

Oklahoma Medical Research Foundation: Susan Kovats

**Mitigating Risks to Hydrocarbon Release through Integrative Advanced Materials for Wellbore Plugging and Remediation**

The project aims to advance capabilities for the prevention and remediation of wellbore leakage in offshore wells after the permanent Plugging and Abandonment stage. The fundamental goal is expressed as understanding the trigger of wellbore leakage at deep-water condition, developing the new barrier materials considering material science fundamentals to identify properties critical for long-term integrity, and ensuring adequate placing is achieved. Finally, through rigorous experiments and modeling and simulation, the team will characterize performance of the entire wellbore system and its surrounding subsurface environment, in order to provide prediction of long-term behavior and prevent wellbore leakage.

**Sponsor:** National Academy of Sciences

**PI/PD:** Mileva Radonjic

**Commercialization of a novel single-use bioreactor**

Specific aims include: 1) Design and fabricate a 2 to 200 L, two-chamber bioreactor from flexible, pharmaceutical grade plastic film, 2) Perform a ‘design for manufacturing’ analysis of the bioreactor and incorporate design changes necessary to accommodate large scale manufacturing, 3) Develop an operating procedure and evaluate the performance of the 2 to 200 L bioreactor by growing a Chinese hamster ovary cell line that produces the recombinant protein IgG, 4) Build a manufacturing process to produce multi-chamber bioreactors.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Josh Ramsey

New Product Development Center: Robert Taylor

**Copper Nanocatalyst as Efficient Heterogeneous Photocatalyst for Continuous Syntheses of Pharmaceuticals through Cross-Coupling Reactions**

In this project, the investigator proposes to develop inexpensive, earth abundant and less toxic copper (Cu) based heterogeneous photocatalyst with activity superior to that of traditionally used expensive, rare-earth and toxic homogeneous Pd catalysts for cross-coupling reactions. The project involves two specific aims: 1) Develop an in-operando spectroscopic technique to identify stable Cu nanocatalysts and green solvents for cross couplings, 2) Evaluate the performance of Cu nanocatalysts of different sizes under visible-light irradiation to identify Cu nanocatalysts with activity superior to Pd based catalysts for cross couplings.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Marimuthu Andiappan

**Collaborative Research: Understanding an Active and Beneficial Role for Water in Solid-Acid Catalyzed Hydrocarbon Chemistry**

The collaborative team will address the question of whether water can enhance activity for hydrocarbon reactions in solid-acid catalysts, determine if the phenomenon is general or limited to only a few reagents, and attempt to elucidate the mechanistic origins of water’s active role. A combination of synthesis, in-situ spectroscopy, reactor, and computational experiments will be used to verify how water acts mechanistically as a function of water concentration in the reaction mixture, and if previously proposed proton-hopping or Grotthuss theories, transition-state solvation, or synergistic effects afforded by water-reagent clusters at the active site are operative when activity increases are measured.

**Sponsor:** National Science Foundation

**PI/PD:** J.L. White

**GOALI: Using Tapered Copolymers to Understand Nanoscale Interfaces within Polymeric Materials and Their Influence on Macroscale Properties**

The PI will collaborate with scientists at Chevron Phillips Chemical Co. to investigate the design of and morphological properties in tapered copolymers. The project will include design of a matrix of tapered copolymer chain architectures, and design of non-invasive and non destructive magnetic resonance experiments to identify differential interface chain composition and dynamics with chemical specificity. Styrene and butadiene monomers are used in this study to demonstrate that a novel range of chain-level and macroscopic properties are accessible using common monomer feeds, especially when starting with monomers whose homopolymers have a 200 degree difference in their respective glass transition temperatures.

**Sponsor:** National Science Foundation

**PI/PD:** J.L. White

**Evaluation of Surface Wettability as a Parameter in Preferential Separation of Multi-Component Dissolved Gas Systems and Bubble Points of Pure Liquids**

This work proposes a systematic experimental investigation on the influence of wettability on pressure-driven bubble nucleation. Experiments will be conducted to determine whether a specific gas can be preferentially liberated from a liquid solution containing multiple dissolved gases. Combinations of gases, aqueous and organic liquid phases will be used to test this hypothesis at a molecular scale using test facilities integrated with gas analysis. Well-controlled experiments will also be conducted to understand the effect of reservoir wettability on required supersaturation levels for bubble nucleation. The basic knowledge derived will be useful to control gas evolution rates from supersaturated liquids.

**Sponsor:** American Chemical Society Petroleum Research Fund

**PI/PD:** Prem Bikkina

**Advanced Cement Characterization and Modeling to Evaluate Novel Additives to Improve Wellbore Integrity**

The main deliverable from this project is to design new cement mixtures with nano-particle sized additives that have superior properties to prevent wellbore leakage. This will be reached by evaluating cement mixtures in the laboratory and incorporating the results in the FEM well integrity design software which can be used to determine the optimum additives for a given well design. The laboratory study will investigate cement slurry properties including dynamic fluid losses and thickening time, as well as advanced characterization of the cement compressive strength and bonding strength to rock and casing, and deformation properties including shrinkage.

**Sponsor:** National Academy of Sciences

**PI/PD:** Geir Hareland

**Joint Industry Project for the Quantification of Fluid Phase Kinetics in Hydrocarbons Phase 2**

Phase 2 will consist of two research aims: 1) Quantify the impact of inlet conditioning on gas evolution rates, 2) Quantify the effect of production chemicals on gas evolution rates. For both research aims, the impact of temperature on gas evolution rates will also be evaluated. These research aims build on the Phase 1 work that showed the importance of both shear and crude oil heterogeneity on gas evolution rates.

**Sponsors:** Exxon-Mobil Upstream Research Company, Anadarko Petroleum Company, Chevron U.S.A. Inc., Equinor AS

**PI/PDs:** Clint Aichele, Sayeed Mohammad

Mechanical and Aerospace Engineering: J.P. Conner

**Computational Modeling of the Onset of Diabetic Kidney Disease**

The primary outcome of the project will be a computational model that incorporates biological uncertainty into the biochemical reaction networks involved in diabetic kidney disease (DKD). Simulation results using the computational model will be useful for understanding the synchrony of key events that lead to glomerular injury in DKD. This improved understanding has the potential to advance treatment options for diabetes and prevent the serious complication of end-stage kidney failure.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Ashlee Ford Versypt

**Generating Nonnative Structures in Binary Ionic Liquid Mixtures for Tunable Phase Equilibria Properties**

At present, there is a lack of fundamental knowledge regarding the rules that can be applied to determine a priori if binary ionic liquid mixtures will exhibit molecular structure different from their pure ionic liquid counterparts and how the nonideal behavior manifests itself in the phase equilibria properties of ionic liquid with gases and solvents. This research project seeks to fulfill this gap in the ionic liquid field so that practically limitless opportunities offered by a large number of binary ionic liquid mixtures to design environmentally friendly chemical processes could be taken advantage of. REU supplement funding was also received.

**Sponsor:** National Science Foundation

**PI/PD:** Jindal Shah

**Ex Vivo Generation of Dendritic Cells from an Advanced Vascular Tissue Construct**

The researcher’s long-term goal is to develop dendritic cells (DCs)-based therapeutics to treat a variety of diseases and that can be custom made to meet the needs of an individual patient. The objective of this project, as an initial step to reach that goal, is to develop a novel method that can produce functional DCs to be used for further research of DCs and eventually for therapeutic treatment of disease. The research will include use of a novel tissue-engineered construct within a bioreactor with flow conditions.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Heather Fahlenkamp

**Multi-Scale Mechanisms for Wettability Alteration: Insight in the Development of Wettability Inversion Strategies**

This project addresses reservoir wettability focusing on the impact of external factors such as salinity, surfactants, and CO2 on reservoir wettability. Reservoir wettability is a critical parameter for determining production potential of a field, and accurate prediction of this behavior is critical for predicting ultimate production. Objectives include: 1) Obtain high pressure/temperature contact angle and interfacial tension data to elucidate reservoir wettability at reservoir conditions for reservoirs of interest to ADNOC, 2) Elucidate wettability mechanisms as a function of salinity, CO2 concentration, surfactants, temperature, and pressure at reservoir conditions, 3) Incorporate the data into models to predict reservoir wettability.

**Sponsor:** Rice University for Abu Dhabi National Oil Company

**PI/PDs:** Clint Aichele, Prem Bikkina

**FRI Viscous Distillation**

The project will quantify the impact of viscosity on mass transfer efficiency. An Oldershaw column will be constructed and operated in order to obtain efficiency data of viscous systems.

**Sponsor:** Fractionation Research, Inc.

**PI/PDs:** Clint Aichele, Sayeed Mohammad, James Whiteley

**UNS: Collaborative Research: Non-Membrane, Low Temperature and Low Emission Water Desalination Using Directional Solvent**

The objectives in this project are to: 1) design highly efficient directional solvents (DS) for a novel water desalination technology, and 2) based on these solvents, design and demonstrate a continuous desalination system which is clean, membrane-free and can utilize very low temperature heat sources. The research will be driven by the hypothesis that the water solubility in DSs can be tuned by varying their molecular structures. Monte Carlo and molecular dynamics simulations will be performed to calculate the phase-equilibria of DSs with salt and water as a function of temperature.

**Sponsor:** National Science Foundation

**PI/PD:** Jindal Shah

**Gas Evolution Rates in Hydrocarbons as a Function of Flow, Temperature, and Pressure for Gas/Liquid Separator Applications**

The long range goal is to develop a methodology to measure gas evolution rates in the field for gas/liquid separator design and troubleshooting applications. This project is the first step toward achieving this goal. The work objectives are to establish an experimental protocol to measure gas evolution rates in flowing conditions, create a milestone roadmap for developing a gas evolution test program, and propose a commercially viable experimental methodology for further field testing. Completion of this work will provide the necessary information to perform the longer range work for a larger project that might include the establishment of a JIP.

**Sponsor:** Chevron U.S.A., Inc.

**PI/PDs:** Clint Aichele, Sayeed Mohammad, Rob Whiteley

**CAREER: Multifunctional Polymer Coatings of Virus Particles for Safer and More Efficient Gene Delivery**

The study will investigate the effects of both PEG and PLL on overall gene delivery efficiency of a targeted polymer/adenovirus hybrid vector by exploring a library of grafted copolymers with varying polymer molecular weights and grafting ratios. The study also aims to better understand why some of the PEG-PLL copolymers perform better than others by elucidating the limiting step(s) in the gene delivery process. The investigator will study and compare the mechanisms by which the hybrid vectors and native adenovirus transform cells and compare the efficiency and rate at which the viral and hybrid vectors overcome barriers to gene delivery.

**Sponsor:** National Science Foundation

**PI/PD:** Josh Ramsey

**Resource Recovery from Produced Water using Forward Osmosis and Membrane-assisted Regeneration of Draw Solutions**

The objective is to identify and develop novel, feasible, cost effective produced water treatment processes that are comparable in cost to the disposal of produced water by underground injection. Specifically, the research will optimize a newly developed produced water treatment technology based on a Forward Osmosis process to recover valuable materials, purified water and recyclable brine from an integrated operation that can be used as a trailer mounted modular field unit.

**Sponsor:** Frosty Cooling Systems, LLC

**PI/PDs:** Seok-Jhin Kim

Civil and Environmental Engineering: Mark Krzmarzick

**CIVIL AND ENVIRONMENTAL ENGINEERING**

**Civil Engineering Education Outreach: Transportation Infrastructure Activities**

This broad outreach program includes three major activities: K-12 outreach activities, OSU Summer Bridge program (incoming freshmen), and the Oklahoma Summer Transportation Symposium. These program include various levels of service including, but not limited to, face-to-face site visits at OSU and remote site, workshops, camps, and networking opportunities.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Greg Wilber, Joshua Li, Robert Emerson

**Laboratory and Field Testing of Geocell-Reinforced Aggregate Layers**

The OSU research team will be carrying out laboratory and field testing to study the pressure dissipation (in the lab) underneath, as well as the stiffness (in the lab as well as in the field) of open-graded aggregate layers constructed with and without geocells. Results from this study will help Presto Geosystems understand the compaction behavior of geocells filled with open-graded aggregates for applications such as those in permeable pavements.

**Sponsor:** Reynolds Presto Products, Inc.

**PI/PD:** Debakanta Mishra

**Investigating Project Bundling Practices for Roadway Construction Projects**

FHWA recently developed a guidebook on project bundling with a focus on bridge projects. However, roadway (such as added travel lanes, resurfacing, intersection improvement, interchange work, shoulder rehabilitation and repair, etc.) construction project bundling was not part of that guidebook. Although many lessons can be learned from bridge bundling, unique aspects may exist in roadway construction bundling and have not been studied thoroughly. This project will include a review and synthesis of state DOTs’ current experiences with project bundling for roadway construction projects. The report will provide a compilation of the documentation including RFPS and sample contracts.

**Sponsor:** University of Colorado-Boulder for the Colorado Department of Transportation

**PI/PD:** Yongwei Shan

**Developing Recommendations for Allowable RAP Contents in Idaho Asphalt Mixes**

The objective is to help Idaho Transportation Department (ITD) determine whether or not a direct correlation exists between the RAP content in an asphalt mix and the performance of a pavement section constructed with this asphalt mix. Additionally, this study will also identify and recommend testing and material processing protocols that need to be adopted to allow different RAP contents in an asphalt mix, considering the performance-based mix design framework. The information and deliverables generated from the project will immediately help ITD decide regarding the feasibility of allowing high RAP contents (higher than 30%) in surface layers for flexible pavements.

**Sponsor:** Idaho Transportation Department for the Federal Highway Administration

**PI/PD:** Debakanta Mishra

**Verification and Correlation of 0.1 mm 3D Safety Sensor with Traditional Texture and Friction Devices**

The project will determine existing practices across the United States used for pavement safety data collection and benefits of using emerging non-contact/non-water based 3D sensors to collect both texture and friction information. The new 0.1mm 3D sensor hardware will be used for correlation and comparison study with traditional texture and friction devices at ODOT (locked-wheel) and OSU (grip-tester and dynamic friction tester). Results of design experiments will be included in the report regarding benefits of using non-contact technology and recommended further work on both hardware and software solutions of using the 0.1mm 3D sensors in Oklahoma.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PDs:** Kelvin Wang, Joshua Li

**Work Order 5: Accelerated Construction Techniques**

The aim of this work is to discuss the science and strategy behind current practices related to deciding when new pavement surfaces can be trafficked and how this can be accelerated when necessary. Deliverables shall include a 58-compliant report that covers the basic information, including case studies, associated with concrete pavement optimal opening to traffic.

**Sponsor:** Iowa State University for the United States Federal Highway Administration

**PI/PD:** Norbert Delatte

**Statistical Analysis of HMA Production and Construction Data to Improve Quality Assurance and Acceptance Practices in Idaho**

Through this subaward, the OSU investigator will be responsible for the following tasks: 1) Statistical analysis of the project data collected in collaboration with Idaho Transportation Department (ITD) engineers. The analysis will focus on unexpected trends observed in Hot-Mix Asphalt production and construction data, 2) In coordination with the Boise State University PI, draft and finalize the final project report summarizing all project findings, 3) Development of statistical training modules for ITD engineers to improve ITD’s Quality Control /Quality Assurance (QC/QA) practices.

**Sponsor:** Boise State University for the Idaho Transportation Department

**PI/PD:** Debakanta Mishra

**Evaluation of the Effectiveness of Surface Applied Corrosion Inhibitors for Treatment of Reinforced Concrete Substructures in Poor Condition**

Patching materials, especially high strength rapid setting materials, tend to shrink resulting in cracks to the new concrete patches potentially compromising the durability of the patch. While the inhibitor products typically do well in the FHWA cracked beam tests, it is questionable whether these products adequately penetrate. To evaluate the penetration, small reinforced concrete beams will be created and then cracked to different sizes. These beams will be treated with typical surface applied inhibitor products. The depth of penetration will be determined by taking small scores and then checking for penetration in the cracks.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Tyler Ley

**Development of Construction Specifications for Cold In-Place (CIR) and Cold Central Plant Recycling (CCPR)**

CIR is a process that recycles, in-place, the upper three to four inches of an existing asphalt pavement. CIR is an excellent treatment for rehabilitation of cracked pavements with sound bases. CCPR uses a similar process as CIR but uses existing stockpiles of RAP to produce an asphalt base layer. Both processes are cost effective, sustainable techniques. The project will review agency specifications and trade association best practices for CIR and CCPR, and a draft special provision/specification will be prepared for review and comments by ODOT.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Joshua Li

**Passive Samplers for Monitoring Perfluoroalkyl Substances at Contaminated Sites**

The study will determine the equilibrium partitioning relationships for per- and polyfluoroalkyl substances (PFAS) between pore water, sediments and sampling material, including competitive sorption effects between the various phases on the sampling material, and sorption kinetics for the PFAS in the sampler, and demonstrate the technology efficacy at PFAS-contaminated areas in Oklahoma. The research is expected to develop and demonstrate a standard operating procedure to assess PFAS concentrations in soils and sediments to protect water quality. The sampler will also be used to assess PFAS at air force bases and other areas in Oklahoma to infer potential PFAS exposure routes.

**Sponsor:** United States Geological Survey

**PI/PD:** David Lampert

**Work Order 2: Performance Engineered Mixtures (PEMs)/AASHTO PP84-19 and Precision and Bias Statements**

OSU will be responsible in supporting the precision and bias testing for fresh and hardened property tests. The fresh property tests include the Super Air Meter, Box Test, and V‐Kelly. These will be evaluated in the first year of the study. The research team at OSU will provide technical guidance to this testing. The second year of the project will be to evaluate hardened tests such as the surface resistivity. Again, OSU will provide support for these tests.

**Sponsor:** Iowa State University for the United States Federal Highway Administration

**PI/PD:** Tyler Ley

**Evaluation of AASHTO T 324**

The AASHTO T 324 Standard Test Method for Hamburg Wheel-Track Testing of compacted asphalt mixtures went through a major revision in 2019. The revision calls for a hardware upgrade. This upgrade is estimated at $20,000 per vehicle and ODOT has two machines for a total of $40,000. This task order will investigate the actual differences between the new method and the method ODOT was using. ODOT has used the previous method for several years and has an extensive database.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Debakanta Mishra

**Sub-mm 3D Laser Imaging for Bridge Deck Surveys**

The project includes surveying the outside lane once every 6 months on approximately 50 mainline bridge decks for a section of I-35 extending from Logan County to Kay County while traveling at highway speeds. Using Next-Gen 3D laser imaging technology, the research team will determine a base line deck condition documenting cracks, spalls, patches, and joint condition. The research will demonstrate the *feasibility* of using sub-mm 3D laser surveys to 1) document cracks, spalls, patches, and joint conditions, 2) determine skid numbers and hydroplaning risk, and 3) evaluate deck smoothness. The research will provide guidance for deck replacements or overlays.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PDs:** Kelvin Wang, Joshua Li

**Instrumentation in End Regions of Prestressed Concrete (PC) Bridge Girders**

OSU will perform the following work: 1) Purchase instrumentation, multiplexers and data loggers for retrieval and monitoring of the data. Instrumentation will include strain gages for reinforcing steel at prescribed locations, thermocouples and thermistors, and vibrating wire gages. 2) Apply the instrumentation and install data acquisition systems on no more than two prestressed concrete girders. 3) Collect and store data, Analyze the data and provide conclusions and recommendations to the ODOT based on experimental results. 4) Provide reporting as required including both monthly progress reports and a final report.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Bruce Russell

**Evaluating the Expected Life and Recoating of Silane Water Repellant Treatments on Bridge Decks**

Tasks include: 1) Increase the number of samples taken from bridges in service with silane coatings, 2) Investigate how cracking, change in w/cm, and different depths of penetration impact performance of silane coatings, 3) Determine the effectiveness of applying silane to extend existing silane coatings, 4) Investigate the performance of unique surface sealers, 5) Develop a decision flow chart for crack sealing and silane application for ODOT specifications. The study will provide an understanding of how silane sealers perform in multiple environments with multiple concrete qualities, which will help ODOT make sound investments in the long-term performance of its bridges.

**Sponsor:** Oklahoma Department of Transportation

**PI/PD:** Tyler Ley

**Identifying Existing Opportunities to Reduce the Environmental Impacts of Transportation Infrastructure Construction**

The project will determine existing practices across the U.S. used for mitigating impacts of construction and transportation infrastructure on relocated streams and habitats. Performance data on various turf reinforcement mats and other erosion control methods will be compiled for potential applicability. A final report will list best management practices for slope stabilization and channel realignment, as well as how turf reinforcement mats are organized. The information will be used to aid ODOT in determining the best approaches to meet the Clean Water Act Section 404 requirements.

**Sponsor:** Oklahoma Department of Transportation

**PI/PD:** David Lampert

**Task Order #01 Track Structure Modeling Support**

The objective is for the OSU faculty member, as the contractor, to provide track structure modeling services to support development and evaluation of new inspection approaches and technologies. The investigator will build a track structure 3D element model that includes rail, ties, ballast and subgrade to assess stress and deformation environment under various loads. The model will be used to calculate deflection basins under track loading vehicle on various track support conditions to aid development of comprehensive vertical deflection measurement. The contractor will also provide additional track structure modeling services on an as needed basis.

**Sponsor:** ENSCO Inc.

**PI/PD:** Deb Mishra

**Safety of Vulnerable Road Users (VRUs) in Light-Rail Transit (LRT) Environment**

This research will include surveying LRT agencies and synthesizing best practices for reducing crashes involving VRUs in LRT systems. The research will examine the effects of alignment decisions, geometric design features, and risky pedestrian behavior on crash experience. It will identify the most effective traffic engineering treatments, traffic control devices, public education techniques, and ITS technologies that can be integrated into LRT operations to reduce crashes and incidents. A toolkit of best practices will be developed that can be incorporated in transit safety courses/workshops, as well as a slide show for use by ODOT in making presentations at educational events.

**Sponsor:** Oklahoma Department of Transportation

**PI/PD:** Samir Ahmed

**Measuring Transport Properties of Portland Cement Concrete Using Electrical Resistivity**

The purpose is to develop a body of knowledge through an exhaustive literature review and experimental program to provide recommendations on the best approach for implementing resistivity testing and/or other means of measuring transport properties in the state of Illinois. The research aims of the study are: 1) Study the effects on resistivity testing of common materials used in the making of concrete mixtures in Illinois; 2) Investigate the existence of correlations between resistivity testing and other known means of characterizing transport properties; 3) Investigate the existence of correlations between resistivity testing and standardized methods for durability testing of concrete.

**Sponsor:** The Board of Trustees of the University of Illinois for the Illinois Department of Transportation for the United States Department of Transportation

**PI/PD:** Julie Ann Hartell

**OSU Task Order Contract – Administrative Support**

The work covered under this Task Order includes coordination with ODOT engineers and OSU faculty on the preparation of Task Orders, and management of successfully funded projects in relation to reporting, deliverables and other performance related matters; and promotion of ODOT and OSU research on transportation topics at both state and national levels.

**Sponsor:** Oklahoma Department of Transportation

**PI/PD:** Kelvin Wang

**Collaborative Research: Impacts of Metals on Disinfection Byproduct Precursor Formation in Bacteria**

Disinfection by-products (DBPs) are formed upon reactions of organic matter with disinfectants during water treatment. The research goal is to characterize how trace metals affect DBP precursor production from biofilms under conditions relevant to chloraminated drinking water distribution networks. The specific research objectives are to: (1) determine the influence of metals on DBP formation potential from bacterial isolates, (2) characterize the effects of metal exposure on changes in the composition and reactivity of biofilm-derived DBP precursors, and (3) determine the underlying mechanisms of increased DBP formation potential in bacterial isolates and biofilms through transcriptomic and proteomic approaches.

**Sponsor:** National Science Foundation

**PI/PD:** Mark Krzmarzick

**MEGASLAB RSA with S3 Concrete Technologies**

A concrete mixture will be completed for slab on grade with different water reducer. The mixture will be completed without additive, with additive + spray, and with additive + fibers + spray. Compression testing, flexural testing, freeze thaw testing, and ion permeability testing will be completed for all three mixtures. Additional tests of the additives and spray will also be conducted, such as testing a concrete beam with spray on only one side, and investigation of the combination of additive and saturated calcium hydroxide solution.

**Sponsor:** S3 Concrete Technologies, Inc.

**PI/PD:** Tyler Ley

**Screening Tools for Considering Grade Separation of Rail-Highway Crossings in Oklahoma**

The Oklahoma Department of Transportation (ODOT) addresses grade crossing safety issues by allocating federal funding through the Railway-Highway Crossing Program. At-grade rail-highway crossings lead to economic losses due to vehicle delays and potential train-vehicle collisions. To consider the need and priorities for grade separation at crossings, data-driven screening methodology and tools are required. The project objective is to develop a data-driven evaluation process for ODOT to identify, evaluate, and prioritize road-rail crossings as candidates for grade separations. Tasks include literature review, screening methodology development, prioritization of crossings for grade separation, and development of a grade separation screening tool for ODOT.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Joshua Li

**Four-Step PW Desalination Process with Zeolite and a-Alumina Membranes**

Wastewater from oil and gas production, known as Produced Water (PW), has a high level of contamination with a complex chemical composition that depends on the recovery process and the geological formation. The goal of this project is to develop a process to decrease hardness, remove suspended solids, remove oil from PW and prepare it for the last step, which is desalination. The results will be used to assess energy efficiency and cost analysis of this method and compare with conventional PW management methods.

**Sponsor:** United States Geological Survey

**PI/PD:** David Lampert

**Understanding Air Content Measurement Techniques for Durability Prediction**

Dr. Ley will provide hands-on training at Oklahoma State University for the Super Air Meter. Additionally, Dr. Ley will provide training for the preparation and evaluation of ASTM C457 samples and results. Dr. Ley will assist with the evaluation of the data from the field collected samples. He will consult with Kansas State University project personnel and students on the possible re-calibration of Super Air Meter measurements for predicting spacing factor for typical Kansas paving mixtures. Additionally, Dr. Ley can share insights on the latest advancements for screening for accuracy in running the test.

**Sponsor:** Kansas State University for the Kansas Department of Transportation

**PI/PD:** Tyler Ley

**Review and Analysis of Current Environmental-DNA Methodologies Being Developed and Used**

ODOT projects must meet requirements to minimize and avoid disturbances to endangered and threatened species to comply with the Endangered Species Act. Current methods to determine endangered species presence are expensive, intrusive, and often have inconclusive results. Using environmental DNA to detect the presence in a non-intrusive, quick-yet-sensitive, and relatively inexpensive manner is relatively new. This task order will include compilation of complete review and analysis of environmental-DNA methodologies being developed and used. The review will determine where and by whom are these methods being developed, for what targets and purposes, and how are they being deployed in the field.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Mark Krzmarzick

**Non-Pavement-Intrusive Technologies for Vehicle Classification for Toll Collection**

The primary objective of this project is to provide OTA with detailed analysis of the fitness of various non-pavement-intrusive vehicle detection and classification technologies under different roadway, traffic, and environmental conditions to inform decision-makers of the accuracy, performance, and life-cycle-cost of these technologies.

**Sponsor:** Oklahoma Turnpike Authority

**PI/PDs:** Samir Ahmed

Electrical and Computer Engineering: Keith Teague

**ODOT Involvement with the NCAT Test Track and Task Groups**

The project will involve researching ODOT involvement and participation in the NCAT test Track and task groups. A comprehensive report will be provided detailing ODOT involvement from 2000 forward including the 2018-2020 test cycle.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PDs:** Joshua Li, Steve Cross, Kelvin Wang

**Updating ODOT’s Contract Time Determination System**

Establishing contract time is an integral part of the highway project development process as contract time plays a significant role in determining the expected project delivery date as well as the overall cost of a project. The 23 CFR requires State DOTs to have adequate written procedures for the determination of contract time. ODOT’s existing contract time determination system is no longer functioning because of the upgrade of computer operating systems and software updates as well as personnel turnover. Therefore, there is an urgent need to upgrade and improve the existing system.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PDs:** Yongwei Shan, Gouranga Banik

**Contraire: Wastewater Treatment Plant Testing & Aeration Control Services**

Contraire’s control system technology will enable an innovative alternative testing approach to the typical five-day testing method currently used at wastewater treatment plants by providing real-time feedback based off of key wastewater quality parameters and specialized algorithms. A Beta test will be implemented at the Stillwater, Oklahoma wastewater treatment plant.

**Sponsor:** National Collegiate Inventors & Innovators Alliance (NCIIA) d/b/a/ VentureWell

**PI/PD:** David Lampert

**Evaluating the Performance of Existing Reinforcement for Oklahoma Bridges**

Corrosion-related problems generally lead to significant maintenance expenditures. By identifying the optimum reinforcement design considerations, considerable savings in maintenance budgets can be achieved. The proposed activities include: 1) Perform a literature review on field corrosion performance of concrete material, 2) Conduct a detailed investigation of concrete panels reinforced with epoxy-coated rebar sampled from northbound I-35 bridge over Cow Creek.

**Sponsor:** University of Kansas Center for Research, Inc. for Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PD:** Julie A. Hartell

**Use of a Novel Controlled Release Surface Curing Agent for Bridge Decks – Phase 2**

The project will continue to investigate novel curing techniques that can be rapidly applied to the surface of fresh concrete and not cause deformations in the concrete surface. This material should show equal or better curing performance then typical wet curing methods and be sustainable and safe for the environment. Objectives include: 1) Evaluate the importance of timing when applying curing methods on bridge decks, 2) Develop field application methods and assessment of novel curing materials, 3) Develop specifications for quality control and usage of novel curing materials, 4) Work with contractors to implement this technology and evaluate the effectiveness.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Tyler Ley

**Development of Pay Item Categories and Special Provisions for Erosion and Sediment Control Devices to be Used by ODOT**

The project involves determining existing practices across the United States used for mitigating impacts of construction and transportation infrastructure on relocated streams and habitats. Literature review from sources including TRB, AASHTO and state DOTs for guidance documents and existing specifications will be used to determine potential approaches for ODOT. Performance data on various turf reinforcement mats and other erosion control methods will be compiled and accessed for potential applicability.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** David Lampert

**Utilizing Pavement Friction and Texture Data for the Reduction of Traffic Crashes and Delays**

The objective is to use pavement friction, surface texture, and other data to reduce traffic crashes and delays. The research aims to: 1) integrate pavement condition, road geometry, traffic flow, and crash data into a GIS database; 2) determine statistical significance of this data with roadway crash types; 3) develop friction model for non-contact pavement friction evaluation from raw texture profile using signal processing and deep learning techniques; 4) demonstrate the role of friction and texture data in selection of preventative maintenance strategies; 5) develop a framework on how friction and texture data are considered in pavement maintenance decision making.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Joshua Li, Kelvin Wang, Yongwei Shan

**I-Corps: Data Quality Assurance and Inventory Tool (One Voice) for Sewer Inspection Data**

I-Corps encourages translation of fundamental research to the marketplace, promotes industry and academic collaboration, and trains faculty and students in entrepreneurship. The proposed technology includes: 1) a data quality assurance tool to evaluate and improve the data quality of current sewer pipeline inspections and 2) a comprehensive and uniform sewer data inventory based on the collected sewer pipe inspections across the country. This technology will provide the sewer industry with easily accessible and high-quality data to support wastewater infrastructure asset management. I-Corps funding will allow the team to conduct customer discovery and better target the potential customers of the technology.

**Sponsor:** National Science Foundation

**PI/PD:** Yongwei Shan

**Element Data: HDR: Enabling Data Interoperability for NSF Archives of High-rate Real-time GPS and Seismic Observations of Induced Earthquakes and Structural Damage Detection in OK**

This project addresses challenges that limit the joint exploitation of real-time GPS and seismic data: 1) assuring gap-free archive quality transmission of realtime data streams from remote stations to the final community archive, and 2) producing precise GPS displacement time series that can be incorporated into the community seismology archive. The project builds on existing capabilities by adding modules to the Antelope Environmental Monitoring System and leverages the NSF investment in seismic data feeds to community archives. These new modules will handle data streams in a manner that is independent of the content and formats of the environmental sensor measurements.

**Sponsor:** National Science Foundation

**PI/PD:** Mohamed Soliman

**New Steel Connections for Seismic Retrofit and Strengthening of Bridges and Buildings**

This project investigates the behavior of steel connections that are both bolted and welded, with the bolts and the welds sharing loads. Steel building connections have traditionally relied on either bolts or welds to transfer forces from member to member. However, for many applications in existing structures it becomes apparent that strengthening can only be accomplished by welding pre-existing bolted connections. This research is in partnership with W&W|AFCO Steel and the American Institute of Steel Construction. The goal is to provide design guidance for realistic configurations of connections employing bolts and welds that may exist in steel buildings and bridges.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Mohamed Soliman, Bruce Russell

**Aeration Process Controls to Reduce Energy Costs in Wastewater Treatment Plants**

Wastewater treatment plants (WWTPs) use large quantities of energy for treatment. WWTPs often drastically oversupply oxygen in their aeration processes. The problem of excess energy consumption in these facilities is particularly pervasive in rural areas where operational budgets are limited. The long-term goal of the proposed project is to develop a simple, cost effective approach to decrease energy costs in WWTPs using new process control and design technology. The proposed technology has potential commercial viability through the sales of a monthly licensing agreement to ensure compliance and reduce WWTP energy costs.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** David Lampert, Tyler Ley

Electrical and Computer Engineering: James Stine

**Global Computer Analysis to Include Hinge Crack and Thermal Stresses on the I-235 Bridge in OKC**

The principal investigator will investigate the cause of cracking originating from the hinges within the 1-235 bridge. The assessment will integrate a review of bridge data, computer analysis, and the results of the ongoing structural health monitoring of the bridge. Bridge data (e.g., sectional dimensions, reinforcement details, paste tensioning attributes) will be extracted from as-built drawings and inspection/repair reports.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Mohamed Soliman

**Investigation of Slag-Cement Effects on High Sulfate Soils in Oklahoma**

This project will investigate slag-cement and its effects on high sulfate soils found in Oklahoma. It has been determined that utilizing slag-cement in order to control sulfate induced heave as a stabilizing agent will help the Oklahoma Department of Transportation establish new protocols in this troublesome area.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Rifat Bulut

**Ground Tire Rubber (GTR), (dry process) Experiment Pavement Surface Evaluation**

ODOT will place a GTR test section on a county/state highway in early 2019. This project will gather surface data from both the GTR and control sections of pavement, including but not limited to cracking and surface texture at intervals of pre placement, post placement, 3 months, 6 months and 12 months.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PDs:** Kelvin Wang, Joshua Li

**Transportation Consortium of South-Central States (Tran-SET): Administrative Account**

OSU is a subrecipient in Louisiana State University’s Transportation Consortium of South-Central States (Tran-SET). M. Samir Ahmed is the PI for the project at OSU. Dr. Ahmed is responsible for managing the TranSET UTC projects at OSU, soliciting and getting external reviews for research problem statements, working with the PIs of the selected projects to finalize their projects and budgets, and responding to all inquiries from TranSET.

**Sponsor:** Louisiana State University and A&M College for the United States Department of Transportation

**PI/PD:** M. Samir Ahmed

**Transportation Consortium of South-Central States (Tran-SET): A Comprehensive Framework for Life-Cycle Cost Assessment of Reinforced Concrete Bridge Decks**

The project focuses on introducing an approach that: 1) characterizes the life-cycle maintenance needs and repair intervals associated with bridge decks constructed using various reinforcement alternatives in FHWA Region-6, 2) develops a systematic methodology for quantifying the impact of bridge maintenance on indirect life-cost including the effect of increased travel time, work zone crashes, operating cost, greenhouse gas emissions, and social losses, and 3) compares different steel reinforcement materials (e.g., regular, epoxy coated, galvanized, stainless steel, and MMFX) based on their long term performance and maintenance requirements.

**Sponsor:** Louisiana State University and A&M College for the United States Department of Transportation

**PI/PDs:** Mohamed Soliman, M. Samir Ahmed

**Transportation Consortium of South-Central States (Tran-SET): Vehicle Sensing and Communications Using LED Headlights to Enhance the Performance of Intelligent Transportation Systems: Proof-of-Concept, Implementation, and Applications**

This project aims to improve the accuracy and reliability of traffic data required for developing effective visible-light-based intelligent transportation system technologies and solutions. The objective is to perform a proof-of-concept for the ViLDAR system by conducting the following tasks: 1) implement the ViLDAR system in a real-world setting, 2) perform lab and field tests in various scenarios, 3) optimize the ViLDAR system performance, and 4) test the ViLDAR system in different applications.

**Sponsor:** Louisiana State University and A&M College for the United States Department of Transportation

**PI/PDs:** Sabit Ekin, M. Samir Ahmed

**An Integrated Framework for Prediction of Fatigue Crack Propagation Under Random Sea Loading Through Coupled Experimental and Numerical Analysis**

The research will include 1) small-scale experimental testing to collect data that can reduce uncertainty in crack growth parameters in marine steels, 2) large-scale testing to characterize the crack growth in stiffened box girders subjected to variable amplitude sea loading, and 3) developing an integrated numerical approach using finite element analysis and fracture mechanics approaches to predict crack growth under realistic conditions often encountered in ships.

**Sponsor:** Office of Naval Research

**PI/PD:** Mohamed Soliman

**Transportation Consortium of South-Central States (Tran-SET): Developing Implementable Climatic Input Data and Moisture Boundary Conditions for Pavement Analysis and Design**

This project is to develop realistic climatic input data for identifying surface and subsurface moisture boundary conditions, and to develop a practical numerical model for predicting the moisture regime within the pavement subgrade system.

**Sponsor:** Louisiana State University and A&M College for the United States Department of Transportation

**PI/PD:** Rifat Bulut

**Implementation of Prep-ME for Vermont Agency of Transportation (VTRANS)**

The goal of this work is to develop a customized Prep-ME software with traffic module for the

Pavement ME Design at VTRANS, and provide technical support for the implementation of

Prep-ME in the state.

**Sponsor:** State of Vermont

**PI/PDs:** Joshua Li, Kelvin Wang

**FAST Act Emergency Vehicle (EV-3) Load Rating**

The Fast Act made certain emergency vehicles including fire trucks legal on the Interstate and within reasonable access to the Interstate. These vehicles can generate greater load effects in bridges as compared to other legal vehicles. These EVs now must be considered when load rating and posting bridges on the Interstate and within the range of reasonable access to the Interstate (generally taken to be one mile from an Interstate interchange). The existing bridge in the Cooper Lab at OSU provides a unique opportunity to study the actual stresses and strains on a full scale load from an EV3 loading.

**Sponsor:** Oklahoma Department of Transportation for the United States Federal Highway Administration

**PI/PD:** Bruce Russell

**Protecting Piers of Overhead Structures from Degradation Due to Snow and Ice Chemical and Material Usage, Phase II**

Degradation of piers due to corrosion of reinforcing bar is a major maintenance problem for Ohio DOT districts. This corrosion is largely caused by plows throwing chloride laden ice and snow onto the piers and by chloride laden spray from vehicle traffic. This Phase II project will evaluate the effectiveness of two products in providing a barrier to protect the piers from chloride laden ice, snow and spray. The Poly Salt Armor product and the polyaspartic product will both be evaluated. The cost effectiveness of both products will also be addressed.

**Sponsor:** University of Cincinnati for the Ohio Department of Transportation for the Federal Highway Administration

**PI/PD:** Norb Delatte

**Determining Concrete Patch Locations Other Than Visual**

This project concerns patch locations in concrete and asphalt-on-concrete pavements in Indiana It is difficult from visual inspection alone to determine the health of an existing pavement patch. Concrete pavement patches are frequently overlain with asphalt, effectively concealing the location until failure is well underway. The research goal is to find methods to locate and classify three types of concrete patches and to deliver a corresponding patching table. The approach will use the 3D imaging system to create a 1 mm resolution image of the pavement surface and develop an artificial intelligence based technique to narrow the patch search area.

**Sponsor:** Purdue University for Indiana Department of Transportation

**PI/PDs:** Kelvin Wang, Joshua Li

**P3 Award: Decreasing the Energy Use in Wastewater Treatment**

The technical aims of this P3 student design project are to: (1) construct a lab-scale experiment to analyze the relationships between critical biological process parameters including dissolved oxygen, biochemical oxygen demand, and aeration; (2) build a simple, automated process control to adjust aeration inputs as oxygen and organic levels fluctuate; (3) simulate the lab-scale results using a mathematical model that can be extended to the full-scale facility; and (4) assess the potential energy, greenhouse gas emissions, and cost savings associated with this design using life cycle analysis.

**Sponsor:** United States Environmental Protection Agency

**PI/PDs:** David Lampert

Electrical and Computer Engineering: James Stine

**Concrete Pavement Mixtures with High Supplementary Cementitious Materials (SCM) Content**

The principal objectives of phase I of this project are to first validate/calibrate existing fly ash compositional equations that predict properties of concrete materials for pavements and then extend and/or develop new characterization protocols for high SCM replacement rates of cement (fly ash and slag) available in the State of Illinois. The goal is to have simple characterization and testing protocols that will allow the use of high volume SCMs in concrete pavement without compromising workability, air content, initial setting time, early strength gain, long term mechanical properties, and durability.

**Sponsor:** The Board of Trustees of the University of Illinois for the Illinois Department of Transportation for the United States Department of Transportation

**PI/PD:** Tyler Ley

**Performance Engineered Concrete Paving Mixtures – TPF 5(368)**

Tasks include: 1) Prepare slides for workshops and webinars, 2) Webinars – Prepare overview of the PEM specification and give annual update on new tests and lessons learned, 3) Guide states in the use of specification, 4) Test support – Demo at NC2 – Guidance documents, 5) Shadow Project Support – Project level education with workshop and testing demonstrations, 6) Set up database, 7) Collect, save and publish field data and pavement performance, 7) Update AASHTO – Annual update on system performance and revise specification, 8) Water content – develop/improve test method, 9) Review constructability.

**Sponsor:** Snyder & Associates, Inc. for Iowa State University for Iowa Department of Transportation

**PI/PD:** Tyler Ley

**Behavior of Steel Connections with Bolts and Welds in Combination**

This project investigates the behavior of steel connections that are both bolted and welded, with the bolts and the welds sharing loads. The research is a collaborative effort between OSU and W&W/AFCO Steel Co. which will provide the fabricated samples to be tested at the Bert Cooper Engineering Laboratory at OSU. Additionally, W&W/AFCO Steel Co. will provide technical expertise and technical support to help ensure the overall success of the research program. The goal of the project is to provide design guidance for realistic configurations of connections employing bolts and welds that may exist in steel buildings and bridges.

**Sponsor:** American Institute of Steel Construction

**PI/PDs:** Mohamed Soliman, Bruce Russell

**Complete Biodegration of Insensitive High Explosive Compounds**

The objective is to develop and deploy microbial strategies for the complete biodegradation of Insensitive high explosive (IHE) compounds. The project is being carried out by a partnership of the University of Arizona, University of West Florida, Georgia Tech and Oklahoma State University. The work at Oklahoma State University focuses on the development of molecular tools for genomic and transcriptomic analyses of the isolated bacteria or bacteria in highly enriched IHE-biodegrading cultures. The bioinformatic analyses will elucidate putative genes involved in biodegradation and thus provide testable hypotheses for biodegradation mechanisms and will inform and support all aspects of the project.

**Sponsor:** The University of Arizona for the United States Army Corps of Engineers

**PI/PD:** Mark Krzmarzick

**Performance Based Classification Methods for Reclaimed Fly Ash**

New specifications are needed on the usage of reclaimed fly ash to produce concrete mixtures with long lasting performance. This project will combine advanced material characterization methods, performance based testing, mechanistic modeling, and machine learning to create engineering tools to classify reclaimed fly ash. These tools will then be used to develop specifications and new AASHTO documents to classify and design concrete mixtures to use reclaimed fly ash from a variety of sources to ensure concrete mixtures that are constructible, durable, and with satisfactory engineering properties. A pilot project will be created to showcase the usage of reclaimed fly ash.

**Sponsor:** U.S. Department of Transportation -- Federal Highway Administration

**PI/PDs:** Tyler Ley, Paul Tikalsky

Electrical and Computer Engineering: Guoling Fan

**Developing Standard Definition for Comparable Pavement Cracking Data**

In order to unify data reporting, sharing, and evaluation, standardization of pavement cracking definitions is needed. The objective of this project is to develop standard, discrete definitions for common cracking types in flexible, rigid, and composite pavements. The standard definitions shall be used to facilitate comparable measurement and interpretation of pavement cracking. The definitions shall be of sufficient detail to serve as the basis to meet user and system requirements for developing automated cracking software, and for being compatible with both existing and emerging image-based data collection technologies.

**Sponsor:** National Academy of Sciences for the Federal Highway Administration

**PI/PDs:** Kelvin Wang, Joshua Li

**Continuous Friction Measurement Equipment (CFME) for Highway Safety Management in Oklahoma**

Objectives are: 1) Evaluate Grip Tester capabilities for continuous friction measurements (CFME), and 2) Provide information for Oklahoma Pavement Safety Management. Sub-objectives are: 1) Compare CFME measurements from Grip Tester with data from ODOT locked-wheel trailers. 2) Use Oklahoma pavement surfaces to investigate effect of operational factors on CFME friction measurements. 3) Provide guidance for ODOT to implement CFME for pavement management programs for surface treatment selection. 4) Use CFME data to develop crash rate prediction model and use PaveVision3D technology to collect 1mm 3D data. 5) Develop software that allows users to visualize and analyze continuous pavement friction data.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Joshua Li, Kelvin Wang

**Implement Balanced Asphalt Mix Design in Oklahoma**

The project will result in development of draft specifications and draft supplemental specifications for a balanced mix design procedure for the Oklahoma Department of Transportation, which will move ODOT away from a voids based mix design procedure, allowing more innovative design concepts and producing longer lasting more durable and rut resistant pavements.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Stephen Cross, Joshua Li

**Collaborative Research: WERF: GOALI: Bioaugmentation-Enhanced Anammox for Mainstream Nitrogen Removal**

The project involves collaborative research between the University of Arizona, Oklahoma State University and an industrial partner, Pima County Regional Wastewater Reclamation

Department. The university collaboration will combine engineering expertise on nonconventional biological nutrient-nitrogen removal with expertise on metagenomics/transcriptomics to gain insights and biomarkers to improve the process. The project directly addresses the National Academy of Engineering’s grand challenge of improving the management of the nitrogen cycle by developing technology to control the load of excess nutrient nitrogen into the environment.

**Sponsor:** National Science Foundation

**PI/PD:** Mark Krzmarzick

**Long-Term Performance Monitoring of High Friction Surfacing Treatments (HFST) Sites**

The OSU team will identify the influential factors in HFST service life, select approximately 30 sites for data collection across 11 states based on a comprehensive experimental design considering these factors, and develop an overall data collection method for each site. The OSU team will also develop a software package for collection of field cracking, profiling, texture, geometric data, and use of grip tester for friction. Relevant data sets will also be gathered from state agencies. The OSU team will conduct a comprehensive analysis of the time series performance data collected in the field and also in the laboratory environment.

**Sponsor:** Texas A&M Transportation Institute for Federal Highway Administration

**PI/PDs:** Kelvin Wang, Joshua Li

**Using Medical X-ray Machines to Determine the Service Life of Concrete**

Medical X-ray machines will be used to image the penetration of fluids containing a tracer into concrete. This information is used to calculate the diffusion coefficient of the concrete. This is an indication of how easy it is for outside fluids to penetrate the concrete and is useful to predict the service life of the concrete structure. A software package developed in this project will take the raw data and use standards to determine the rate of penetration of the fluid. The software then can calculate the service life of the structure by using two different well established models.

**Sponsor:** National Academy of Sciences for the Federal Highway Administration

**PI/PD:** Tyler Ley

**Using In Situ Chemical and Structure Mapping of Calcium Sulfoaluminate Cement to Control Hydration**

The goal is to understand the mechanisms that control formation of the microstructure of concrete that uses calcium sulfoaluminate cement. 3D in-situ structure and chemistry imaging techniques will be used at multiple length scales in combination with microstructural modeling to characterize, quantify, and understand the structure, chemistry, and properties of concrete over the first 12 hours. The focus will be on initial formation of the microstructure over the first hours of reaction with water, including evaluation of the role of crystal defects on dissolution rate, identification of nucleation sites, and characterization of evolving density and composition of phases that precipitate.

**Sponsor:** National Science Foundation

**PI/PD:** Tyler Ley

**The Use of Resistivity Testing for Quality Control of Concrete Mixtures – Phase 2**

The project will investigate the potential of resistivity testing in assessing the performance of typical concrete mixtures used in bridge and pavement infrastructure. The efforts are concentrated towards development of guidelines using resistivity as a means for mixture approval and compliance in addition to ODOT’s current specifications. Strength would no longer be the only value used to accept a concrete mixture; instead, a measurement of permeability could be included. Based on the outcomes of Phase 1 research activities, a systematic approach using resistivity testing for Classes A and AA concrete mixture design compliance control during construction will be developed.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Julie Hartell, Tyler Ley, Mohamed Soliman

**Shrinkage Induced Deformation in Steel Bridges Made Composite with Concrete Deck Slabs – Phase 3**

The project will further investigate the phenomena of concrete shrinkage and other volume changes, and assess their effects on deflections in steel bridges made composite with concrete decks. Tasks include: 1) ongoing review of relevant research, 2) perform forensic investigation of known bridges, 3) build prototype to test bracing systems for formwork and screeds, 4) build, monitor and test full-sized prototype bridge, 5) laboratory testing, 6) field bridge instrumentation and monitoring, 7) computational analysis of shrinkage and other effects, 8) identify likely causes for excessive or unpredicted deflections, 9) develop and refine design and construction methods for ODOT bridges.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PD:** Bruce Russell

**Resource Recovery from Produced Water using Forward Osmosis and Membrane-assisted Regeneration of Draw Solutions**

The objective is to identify and develop novel, feasible, cost effective produced water treatment processes that are comparable in cost to the disposal of produced water by underground injection. Specifically, the research will optimize a newly developed produced water treatment technology based on a Forward Osmosis process to recover valuable materials, purified water and recyclable brine from an integrated operation that can be used as a trailer mounted modular field unit.

**Sponsor:** Frosty Cooling Systems, LLC

**PI/PDs:** Mark Krzmarzick

Chemical Engineering: Seok-Jhin Kim

**I-235 Bridge Repair Monitoring**

Due to national issues with grouting errors, FHWA required state DOTs to inspect their post tensioned grouted tendons. Based on these inspections, ODOT discovered issues with the I-235 bridge. Due to construction errors some ducts were not filled with grout and water filled the ungrouted voids, resulting in corrosion issues with some of the strands. ODOT hired a company (VSL) to inspect the post tensioning ducts, develop a plan, and implement repairs. OSU will help ODOT in the assessment of these repairs by performing an array of nondestructive tests including live load testing, strain monitoring, and acoustic emissions monitoring.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Robert Emerson, Julie Hartell, Bruce Russell

**Load Test Monitoring of I-235 Bridge Repairs**

Based on inspections of grouted post tensioned bridges, ODOT discovered some durability issues with the I-235 bridge. ODOT hired a company to plan and implement repairs. The faculty at OSU have significant experience in structural health monitoring and will help ODOT in the assessment of these repairs by performing an array of nondestructive tests including live load testing, strain monitoring, and acoustic emissions monitoring.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Robert Emerson, Julie Hartell, Bruce Russell

**Design of an Airplane Transporting System**

The goal of this project is to complete the full research, conceptualization and design for a 90 degree curve that is bounded on each end with a 15 meter straight section of the underground airplane conveyance system presented to Oklahoma State University by Airplane Transport Systems. The design process will be completed in 18 months with all documentation necessary to fabricate and install the system for testing with an aircraft.

**Sponsor:** ATC World Wide, LLC

**PI/PDs:** Julie Hartell, Mohamed Soliman

Electrical and Computer Engineering: Nishantha Ekneligoda

Mechanical and Aerospace Engineering: James Kidd

New Product Development Center: Robert Taylor

**Development of Concrete Mixture to Mitigate Bridge Deck Cracking; Validate Using 3D Bridge Deck Surface Evaluations**

In task one, a workshop over bridge deck cracking technologies will be held at ODOT. In task two, the researchers will investigate concrete mixtures with different technologies to minimize cracking with Oklahoma materials. In task three, the researchers will work with ODOT to construct different spans of a bridge deck that use these technologies. The forth task will use 3D crack mapping technology to follow field performance of these mixtures for three years. In task five, a specification will be authored to implement these technologies on ODOT bridges. The sixth task will be the completion of a final project report.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Tyler Ley, Kelvin Wang, Joshua Li, Bruce Russell, Julie Hartell

**Long Term Pavement Performance (LTPP) Monitoring of Six LTPP SPS-10 Sections in Oklahoma with 3D Laser Imaging**

Results of this research will be an evaluation of the long-term field performance of warm mix asphalt (WMA) mixtures through a five-year performance monitoring effort using the OSU 1mm 3D technology and several other instruments. The outcome of this project will assist ODOT and the industry in understanding WMA performance, its suitability for field implementation, and corresponding desired engineering properties.

**Sponsor:** Oklahoma Department of Transportation for the Federal Highway Administration

**PI/PDs:** Kelvin C.P. Wang, Joshua Li

**Highway Construction Materials Technician Training and Certification Program**

The College of Engineering, Architecture, and Technology (CEAT) at OSU is partnering with the Oklahoma Department of Transportation for the administration, management and delivery of the Training and Certification Program (HCMTP) for the Oklahoma Highway Construction Materials Technician Certification Board. This program serves ODOT, the Oklahoma Turnpike Authority, and the transportation construction industry. OSU CEAT assumes responsibility for all aspects of HCMTP training and certification including program training, certification, program administration, record keeping, and equipment upkeep and maintenance.

**Sponsor:** Oklahoma Department of Transportation

**PI/PDs:** Stephen A. Cross

Professional Development: Brandy Mays

**Improving Specification to Resist Frost Damage in Modern Concrete Mixtures**

Objectives include: 1) Determine the necessary properties of the air-void system to provide satisfactory frost durability in laboratory testing of laboratory and field concretes with different combinations of admixtures, cements, and mixing temperatures in salt environments; 2) Determine the accuracy of a field test method that measures air void system quality with field and laboratory concrete; 3) Determine critical combinations of absorption and the critical degree of saturation on the frost durability in accelerated laboratory testing in the presence of deicer salts; 4) Establish test methods and specifications for fresh and hardened concrete to determine frost durability and field performance.

**Sponsors:** Oklahoma Department of Transportation for FHWA SPR Pooled Funds, Ready Mixed Concrete Research & Education Foundation

**PI/PDs:** Tyler Ley

Oregon State University: William Weiss

**Southern Plains Transportation Center**

OSU is a subrecipient of the Southern Plains Transportation Center, a Regional University Transportation Center headquartered at the University of Oklahoma. OSU conducted several research projects funded with the 2013 Regional UTC grant as well as education and workforce development activities within the theme of the 2013 Regional UTC proposal.

**Sponsor:** University of Oklahoma for Southern Plains Transportation Center for U.S. Department of Transportation

**PI/PD:** Kelvin Wang

**ELECTRICAL AND COMPUTER ENGINEERING**

**Non-Pavement-Intrusive Technologies for Vehicle Classification for Toll Collection**

The primary objective of this project is to provide OTA with detailed analysis of the fitness of various non-pavement-intrusive vehicle detection and classification technologies under different roadway, traffic, and environmental conditions to inform decision-makers of the accuracy, performance, and life-cycle-cost of these technologies.

**Sponsor:** Oklahoma Turnpike Authority

**PI/PDs:** Keith Teague

Civil and Environmental Engineering: Samir Ahmed

**Distributed Protection and Restoration Schemes for Integration of Large-Scale Solar PV Installations and Responsive Loads: Design, Testbed, Proof of Work and Impact Studies**

The goal of the project is to prototype SPV integration technologies for distribution systems including microgrids considering demand behavior of associated load or group of loads, such as buildings, campuses or military bases. The integration of the autonomous primary protection and restoration scheme and technology to existing micro-grid and Distributed Energy Resources technologies and Distribution Management Systems includes the validation at the research laboratory, Solar Photovoltaics farms at the participating utility company (OG&E) and the participating National Renewable Research Lab (NREL).

**Sponsor:** University of Oklahoma for Department of Energy

**PI/PDs:** Ramachandra Ramakumar, Nishantha Ekneligoda

**Soil Monitoring through UAV-Assisted Internet of Things Wireless Underground Sensors**

The objective is to develop a proof-of-concept soil monitoring system with wireless underground Internet of Things (IoT) sensors and unmanned aerial vehicles (UAVs). The team will develop and pilot the “Smart Field,” where the smart soil monitoring system can be tested and preliminary data can be collected for future large-scale applications. The study will look at the feasibility of innovative IoT-enabled underground sensors for soil sensing that can improve soil and water management, consequently leading to conservation of water quantity and quality. The project will involve field experiments and software and hardware implementation of UAV and IoT systems.

**Sponsor:** United States Geological Society

**PI/PDs:** Sabit Ekin, John O’Hara

Mechanical and Aerospace Engineering: Jamey Jacob

Biosystems and Agricultural Engineering: Saleh Taghvaeian

**Radiation-Hardened RF Receiver with On-Board Performance Compensation**

The team will develop a performance compensation technique for commercial-off-the-shelf (COTS) electronic components that are exposed to space radiation effects. By implementing main and auxiliary receivers, the system can monitor the TID-induced degradation of COTS parts by measuring the dc bias currents and voltages of the auxiliary receiver. Using this information, the bias conditions of the COTS parts in the main receiver are adjusted to maximize the RF performance.

**Sponsor:** IEEE Microwave Theory & Techniques Society

**PI/PD:** Ickhyun Song

**FAA COE Zone 3 ILS Measurements**

The objective is to record the glideslope depth of modulation in Zone 3 for analysis of manned aircraft flight inspection system (FIS) accuracy and to advance development of Unmanned Aircraft Systems (UAS) for ILS facility preparation. A UAS will be instrumented with a lightweight ILS receiver capable of recording both localizer and glideslope depth of modulation (DDM). The UAS will be equipped with an RTK GPS to more accurately track and record position within 5cm laterally and vertically. The UAS position data will be recorded and synchronized with localizer and glideslope DDM.

**Sponsor:** Federal Aviation Administration Center of Excellence

**PI/PDs:** Jim West

Mechanical and Aerospace Engineering: Jamey Jacob, Gary Ambrose

**Space-bourne Antennas and Circuits for Condensed Radars and STEM (SPACERS)**

The goal is to provide NASA with updated technologies and processing techniques to help with the move towards space-borne application of synthetic aperture radar (SAR) systems. Tasks include: 1) The quality of a waveform used in the SAR algorithms will be analyzed and optimized. 2) NASA’s current requirements will be reviewed to make recommendations about the hardware design. Previously collected terrestrial data from surface, airborne, and current NASA space-borne remote sensing platforms will be studied to provide advice about the radar’s operation for maximum sensitivity. Initial analysis of any experimental data will be provided at the end of the program.

**Sponsor:** University of Oklahoma for the Oklahoma Space Grant Consortium for the Oklahoma Regents of Higher Education

**PI/PD:** Jim West

**Experiments to Characterize Statistics of the Electric Field in a Spacecraft Payload Fairing**

OSU is supporting Robust Physics in performing its NASA STTR project. The work will be performed by OSU’s Robust Electromagnetic Field Testing and Simulation (REFTAS) personnel. The first task is fabrication of the test device, which will consist of a cylindrical insert to be placed in a scale-model rocket fairing. The second task will be electromagnetic measurement of the test structure under various conditions. Testing will be performed in large, on-site electromagnetic reverberation and anechoic chambers. REFTAS will perform secondary roles in design of the test article, review and analysis of test data, and review of the Phase I report.

**Sponsor:** Sonelite, Inc. d/b/a/ Robust Physics for National Aeronautics and Space Administration

**PI/PDs:** James West, Chuck Bunting

**FW-HTF-P: Robotic Health Assistants: A New Human-Machine Partnership in Home Healthcare**

The long-term goal is to empower home healthcare providers to achieve high productivity and quality of work life by developing a robotic health assistant (RoHA)-based smart home healthcare system (SHHS). In a SHHS, AI-powered robotic health assistants interact with homebound older adults and incorporate health monitoring, and if needed, provide proactive interventions. The objectives of this one-year planning project are: 1) building the research team and fostering collaboration with industry partners and stakeholders to develop the research concept of a RoHA-based SHHS, and 2) conducting preliminary study and test of this concept.

**Sponsor:** National Science Foundation

**PI/PDs:** Weihua Sheng

Human Development and Family Science: Alex Bishop

OU Health Sciences Center: Barbara Carlson

**Collaborative Research: SpecEES: Designing A Spectrally Efficient and Energy Efficient Data Aided Demand Driven Elastic Architecture for Future Networks (SpiderNET)**

The goal is to design, characterize, optimize and validate through a state-of-the-art testbed a new architecture that enables additional degrees of freedom in mobile network design and operation to yield substantial gains in spectral efficiency (SE) and energy efficiency (EE) while ensuring customizable Quality of Experience. The idea is to introduce additional degrees of freedom through an intelligent and adaptive operation to relax the rigid SE-EE tradeoff and thus enable simultaneous enhancement of both SE and EE. This is done by shifting the pivot of operation from the rigid always on base station centric cells to user-centric on demand cells.

**Sponsor:** National Science Foundation

**PI/PDs:** Sabit Ekin

University of Oklahoma: Ali Imran

**Horizon II Radio and GPS Research Phase (FOUO)**

OSU will perform a holistic study to determine the best Courses of Action to prevent jamming of the global positioning system and determine which radio frequencies (outside of standard ranges) and ranges provide the best performance and minimize the possibility of jamming when used as a command and control link for the PUMA II. The focus is to provide a complete analysis of the GPS system and the potential of using a software defined radio as a material solution, with the ability to pre-select frequencies to the customer and deliver a final report within 60 days from receipt of task.

**Sponsor:** Cambridge International Systems, Inc. for the General Services Administration

**PI/PDs:** Jim West, Sabit Ekin

Mechanical and Aerospace Engineering: Jamey Jacob, Gary Ambrose

**RI: Small: Enabling Sound-based Human Activity Monitoring for Home Service Robots**

This project aims to solve a fundamental research problem critical to the application of service robots in complex home environments: human activity monitoring. By proposing an innovative concept called visual-acoustic semantic map (VASM), this project is able to create a bridge between environmental understanding and human behavior understanding, which offers a new theory to realize non-visual, sensor fusion-based monitoring of resident behaviors. The theoretical framework will be verified and evaluated through experiments in robot-integrated smart homes.

**Sponsor:** National Science Foundation

**PI/PD:** Weihua Sheng

**Performance Based Classification Methods for Reclaimed Fly Ash**

New specifications are needed on the usage of reclaimed fly ash to produce concrete mixtures with long lasting performance. This project will combine advanced material characterization methods, performance based testing, mechanistic modeling, and machine learning to create engineering tools to classify reclaimed fly ash. These tools will then be used to develop specifications and new AASHTO documents to classify and design concrete mixtures to use reclaimed fly ash from a variety of sources to ensure concrete mixtures that are constructible, durable, and with satisfactory engineering properties. A pilot project will be created to showcase the usage of reclaimed fly ash.

**Sponsor:** U.S. Department of Transportation -- Federal Highway Administration

**PI/PDs:** Guoling Fan

Civil and Environmental Engineering: Tyler Ley, Paul Tikalsky

**CATcare: Cognition Assistive Technology for Dementia Homecare**

The goal is to improve the quality and sustainability of dementia homecare via low-cost wearable, personalized and customizable technology. The two aims are: 1) Identify major environmental cueing functionalities essential for individuals with dementia to accomplish in-home activities of daily living (ADLs) and instrumental activities of daily living (IADLs); 2) Develop and evaluate a wearable tool that can be customized by the caregiver to assist the care recipient with relative independence and quality of living at home. The proposed prototype not only encapsulates hardware innovations (smartglass and smartphone) but also advanced software solutions (image processing, machine learning, computer vision techniques).

**Sponsor:** National Institutes of Health

**PI/PDs:** Guoliang Fan

Human Sciences: Emily Roberts

**Nested Cavity Reciprocal Field Study**

NASA Launch Service Program has worked with AI Solutions and Oklahoma State University to statistically characterize a cavity by using an outer reverberation chamber capability. This study will examine the reciprocal nature of the nested cavity radiated and incident fields. Characterizing the external environment using reciprocity theory will significantly reduce the computation time required to validate an internal electromagnetic environment in launch vehicle fairings. Currently only spot checks of this external environment can be performed. In this project, a series of test cases will be performed to support an analysis of the reciprocity concept in the reverberant nested cavity condition.

**Sponsor:** AI Solutions for National Aeronautics and Space Administration

**PI/PDs:** Jim West, Chuck Bunting

**A Mobile Platform for Clinical Gait Analysis**

There is a need to have an affordable and easy-to-use clinical solution for comprehensive gait analysis that can be operated in a free and natural setting by clinicians and medical professionals without special training. Toward this end, specific aims of the project are: 1) to develop a vision-based real-time navigation system to allow the robot to track a walking subject from behind, side or front; 2) to estimate gait kinematics from depth sequences captured from a walking subject; 3) to evaluate the performance of the proposed mobile platform for gait imbalance assessment by comparing with the gold-standard motion capture system.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Guoliang Fan

**Structured Low-Energy High Performance Application-Specific Computer Architectures**

The research emphasis is on designing a complex VLSI processor architecture and signal systems using an elaborate design flow or sequence of steps while optimizing constraints for energy, power, and speed given a complex set of OCV issues. Design flows and tools will be created to assist designers in specific computer architectures that are robust, have high amounts of performance, and are considered mobile in that they consume small amounts of power and energy. The objective for these design flows is to create an implementation that outperforms similar architectures in terms of propagation delay, yet produces savings in power consumed.

**Sponsor:** United States Air Force

**PI/PD:** James Stine

**Investigation of Focused Ultrasound Mediated Enhancement of Chronic Non-healing Wound Antimicrobial Therapy in Client-owned Dogs**

Acute and chronic wounds typically require treatment with a combination of antibiotics administered systemically and locally. They often require extensive surgical debridement, including amputation in patients. The team’s previous studies have shown that focused ultrasound-induced local warming decreases resistance within vascular beds to elevate local intravascular concentration of systemically-administered drugs within the solid tumor. This method has not heretofore been adapted to wound therapy in client-owned dogs. Unlike murine models, canine models replicate the infection profile in humans, and thus a demonstration of focused ultrasound efficacy in a veterinary clinical trial would provide an easier path for human clinical trials.

**Sponsor:** Focused Ultrasound Foundation

**PI/PDs:** Daqing Piao

Center for Veterinary Health Sciences: Ashish Ranjan

**Optimization and Exploration of Trusted Low-Power High Performance Computer Architectures**

This project’s goal is to design, develop, and evaluate hardware support for secure computer architectures at the nanometer level. This will be accomplished by designing complete design flow integration with commercial and open-source Electronic Design Automation tools. The design flow will take a high-level system-level architecture description as inputs along with area, critical path delay, and power dissipation constraints. Based on the SoC architecture description and design constraints, the tools will automatically generate synthesizable HDL models, embedded memories, and custom components to implement the specified VLSI architecture.

**Sponsor:** United States Air Force

**PI/PD:** James Stine

**Magnetic Hyperthermia Combined Antimicrobial Targeting of Bone Pathogens**

The goal is to achieve on-demand rapid, thermally-targeted antimicrobial agent release within infected bone tissue, using a novel dual-platform technology that combines Low Temperature-Sensitive Liposomes (sLTSL) with Alternating Magnetic Field (AMF)-induced mild local hyperthermia, generated using sLTSL loaded with superparamagnetic iron oxide. Such sLTSL permit induced release of liposome-borne antimicrobial agent using mild local elevations in tissue temperature. Therefore, the hypothesis is that localized AMF-induced mild tissue warming combined with microbicide-loaded sLTSL, administered either systemically or locally, can elicit targeted antimicrobial release in a millisecond time scale, permitting synergistic bacterial killing of poorly-accessible biofilm bacteria within bone.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Daqing Piao

**Aeration Process Controls to Reduce Energy Costs in Wastewater Treatment Plants**

Wastewater treatment plants (WWTPs) use large quantities of energy for treatment. WWTPs often drastically oversupply oxygen in their aeration processes. The problem of excess energy consumption in these facilities is particularly pervasive in rural areas where operational budgets are limited. The long-term goal of the proposed project is to develop a simple, cost effective approach to decrease energy costs in WWTPs using new process control and design technology. The proposed technology has potential commercial viability through the sales of a monthly licensing agreement to ensure compliance and reduce WWTP energy costs.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** James Stine

Civil and Environmental Engineering: David Lampert, Tyler Ley

**Design of an Airplane Transporting System**

The goal of this project is to complete the full research, conceptualization and design for a 90 degree curve that is bounded on each end with a 15 meter straight section of the underground airplane conveyance system presented to Oklahoma State University by Airplane Transport Systems. The design process will be completed in 18 months with all documentation necessary to fabricate and install the system for testing with an aircraft.

**Sponsor:** ATC World Wide, LLC

**PI/PDs:** Nishantha Ekneligoda

Civil and Environmental Engineering: Julie Hartell, Mohamed Soliman

Mechanical and Aerospace Engineering: James Kidd

New Product Development Center: Robert Taylor

**FIRE PROTECTION PUBLICATIONS**

**Study of Emergency Services Funding Alternatives**

This cooperative agreement provides funding to study required information updates and revisions to the April 2012 edition of Funding Alternatives for Fire and Emergency Service and incorporate such changes into the document to provide the most up to date information regarding sources of funding for local-level Emergency Medical Services (EMS) and fire departments. The project will allow for development of a comprehensive and informative document that provides information on funding programs and initiatives for local-level EMS and fire departments with the intent of FEMA distributing this information to the appropriate audiences.

**Sponsor:** Department of Homeland Security Federal Emergency Management Agency

**PI/PD:** Mike Wieder

**Fire Safety Solutions for Oklahomans With Disabilities**

The goal of this program is to improve the safety of Oklahomans who are deaf, have a hearing loss, are blind, or use a mobility device. Fire Protection Publications is collaborating with ABLE Tech and Fire Service Training to provide technical support, train, implement and evaluate a smoke alarm installation program for Oklahomans statewide who have a disability.

**Sponsor:** Oklahoma Assistive Technology Foundation for the United States Department of Homeland Security – FEMA

**PI/PD:** Nancy J. Trench

**FIRE SERVICE TRAINING**

**Firefighter Training for the Gyeonggi-do Fire and Disaster Headquarters, South Korea**

Fire Service Training instructors provided both lectures and skill training for South Korean firefighters from September 3, 2019 through October 22, 2019. Twelve members of the firefighting force from the Gyeonggi province of South Korea participated in several different training courses including Firefighter 1, HazMat Awareness, HazMat Operations, Vehicle Extrication and Flammable Liquid and Gas Training.

**Sponsor:** Gyeonggi-do Fire and Disaster Headquarters

**PI/PD:** Erick Reynolds

**Homeland Security Grant Program – Mobile Pump Station**

This grant provides funding for the purchase of a mobile pump station.

**Sponsor:** Oklahoma Office of Homeland Security for the Department of Homeland Security

**PI/PD:** Caroline Reed

**AFG to Purchase Over the Road Tow Vehicle**

The grant is for the purchase of an over-the-road tow vehicle. The tow vehicle requested is a Class A conventional cab commercial highway truck tractor with tandem axle and 44 inch low roof sleeper for storage, with a gross combined weight rating capable of 80,000 pounds. Providing the firefighters of Oklahoma with more localized training is always the goal of Fire Service Training. With this tow vehicle, FST will better serve the firefighters of this state with specialized training at the local level.

**Sponsor:** Department of Homeland Security Federal Emergency Management Agency

**PI/PD:** Caroline Reed

**Susan Harwood Training Grant: OSU Chemical Hazards/Hazardous Communications Project**

OSU proposes to build new training capacity by providing Awareness level training and Operations level training on the topic of chemical hazards/hazard communication in agricultural industries. Examples of the training topics include: OSHA regulations for hazardous communications, chemicals used in agricultural settings and their health hazards, what personal protective equipment (PPE) to use and proper use of PPE, what type of monitors to use to monitor for chemical hazards, how to use the monitoring equipment, and how to make decisions based on the information obtained from monitoring equipment.

**Sponsor:** United States Department of Labor – Occupational Safety and Health Administration

**PI/PD:** Caroline Reed

Biosystems and Agricultural Engineering: Carol Jones

**AFG to Purchase Mobile Live Fire Liquefied Petroleum Gas Simulator**

The grant is for the purchase of a multipurpose Mobile Live Fire, Liquefied Petroleum Gas Simulator. This multipurpose simulator will allow OSU-FST to provide live fire training that meets NFPA 1001 certification requirements for both Firefighter I and II in rural areas where training facilities are not available to fire departments. With this unit OSU-FST will be able to provide specialized training in the areas of controlling propane tank impingement fires, flammable liquid spill fires, pipeline valve flange fires, vehicle fires and trash dumpster fires all from one trailer.

**Sponsor:** Department of Homeland Security Federal Emergency Management Agency

**PI/PD:** Caroline Reed

**National Fire Academy State Fire Training Grant**

OSU’s 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. Courses for Emergency Responders will be provided throughout the state in both conference settings as well as single course deliveries. The trainings will be provided in rural and metropolitan settings in an effort to bring the training to the responder locally.

**Sponsor:** Department of Homeland Security Federal Emergency Management Agency

**PI/PD:** Caroline Reed

**Public Safety Small Unmanned Aerial Systems Operations Training Baseline Materials & Usage Assessment**

The objective of this effort is to develop a curriculum that will address sUAS utilization across all operational settings including structural and wildland firefighting, search & rescue, hazardous material responses, natural disasters, and any other events in which public safety operations would benefit from use of drones.

**Sponsor:** Fire Protection Research Foundation, Inc. for the Federal Emergency Management Agency

**PI/PDs:** Dean McFadden

Mechanical and Aerospace Engineering: Jamey Jacob, James Kidd

Engineering Outreach and Extension: Ed Kirtley

Fire Protection & Safety Engineering Technology: Rob Agnew

Fire & Emergency Management Administration: Haley Murphy

**INDUSTRIAL ENGINEERING AND MANAGEMENT**

**CAREER: Advancing Mathematical Models and Algorithms for Decentralized Optimization in Complex Multi-agent Networks**

This research is expected to advance the area of distributed optimization over networks, including networks associated with time-varying directed graphs, by innovations in three aspects: 1) Development of an enhanced mathematical modeling framework by utilizing the theory of variational inequalities for the first time, 2) Design and analysis of new classes of iteratively regularized consensus-based algorithms with explicit performance bounds to address the proposed modeling framework, and 3) Explore novel ways to address nonsmoothness in the proposed modeling framework.

**Sponsor:** National Science Foundation

**PI/PD:** Farzad Yousefian

**CAREER: Parsimonious Models for Redistricting**

Previous models for redistricting do not scale well. Even the best of them begin to struggle on county level instances of redistricting. This is due, in part, to the large number of variables defining these models. In order to satisfy the rigid population-equality constraints, one must redistrict at a finer level of granularity, resulting in an even larger problem. This research will consider new models for redistricting that have the potential to handle significantly larger instances. This is enabled, in part, by the newly proposed Arborescence Models, which exploit planar graph duality to simultaneously achieve small size and remarkable strength.

**Sponsor:** National Science Foundation

**PI/PD:** Austin Buchanan

**Phase 5: Using HazMat Flow Analyzer and Risk Assessment Tools to Support Emergency Response Planning and HazMat Training Activities in Oklahoma**

A working prototype of a GIS application has been developed, which shows (reported) flows of extremely hazardous substances (EHS) on Oklahoma roadways. Ongoing research includes development of risk assessment models that use EHS flow data, HazMat incident data, and accident data for Oklahoma roadways to estimate HazMat incident risk levels for roadway segments. This next phase will enhance the GIS application and risk assessment tool to provide useful planning and training functionality for end-users. Tasks include: 1) Integrating results of the risk assessment models into the GIS application, 2) End-user requirements, feedback, and training, 3) Testing software functionality and output.

**Sponsor:** Oklahoma Emergency Management for the USDOT-Pipeline and Hazardous Materials and Safety Administration

**PI/PDs:** Manjunath Kamath, Farzad Yousefian

Biosystems and Agricultural Engineering: R. Scott Frazier

**Modeling Worst-case Defender-Attacker Problems as Robust Linear Programs with Mixed-integer Uncertainty Sets**

Project objectives include: 1) Study models and algorithms for a base case in which the uncertainty is limited to the cost coefficients and the outer problem contains only continuous variables while the uncertainty set contains continuous and integer variables; 2) Similar to the first objective, explore models and algorithms for a pure integer case in which the uncertainty is not limited to the cost coefficients and both the outer problem and the uncertainty set are represented using only discrete variables; 3) Identify classes of relevant problems that can be solved by the algorithms that are developed.

**Sponsor:** Office of Naval Research

**PI/PD:** Juan Borrero

**Phase 4: Development of a GIS Application for Analyzing HazMat Flows in Oklahoma**

In previous phases of this project, the research team developed The Hazardous Material Movement Model (HazM3) Framework that includes a database of Oklahoma commercial facilities, which store materials considered as being extremely hazardous substances (EHS). Following this, a web-based survey application was designed and built on top of this database of facilities storing EHS materials. In the current phase, this survey is being distributed to these Oklahoma commercial facilities to collect shipment data for the EHS materials they store. This approach of collecting HazMat movement data using a targeted survey of facilities is a novel idea of this research effort.

**Sponsor:** Oklahoma Emergency Management for the USDOT-Pipeline and Hazardous Materials and Safety Administration

**PI/PDs:** Manjunath Kamath, Farzad Yousefian

Biosystems and Agricultural Engineering: R. Scott Frazier

**Validating a Clinical Decision Support Algorithm Developed with Big Data to Diagnose, State, Prevent, and Monitor a Patient’s Diabetic Retinopathy**

With a growing diabetic population, it is imperative to develop a tool for preventing, diagnosing, screening, and managing diabetic retinopathy to cater to patients living with diabetes. This project lays the foundation for this kind of tool. The research team will finalize and test a clinical decision support algorithm based on a patient’s current lab results to decipher whether a patient has diabetic retinopathy. The algorithm will lead to a new standard of care for diabetic patients. Ideally, primary care physicians will be empowered to assess patient diabetic retinopathy as part of a standard in-office primary care visit.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Tieming Liu

Center for Health Systems Innovation: William Palva

Statistics: Ye Liang

**Optimization-based Aggregate Master Planning Tools for Bay Valley Foods, LLC**

The project focuses on the master planning/scheduling activity, which is a key driver of current operations as it guides production by setting monthly production targets. The goal is to develop analytical approaches for guiding master planning decisions. The objectives are: 1) design and formulate mathematical optimization models that recommend aggregate-level master production schedules; and 2) develop computer implementations of the mathematical models that can be solved using a commercial optimization solver. This integrated approach using costs and revenues to drive the plan while simultaneously considering the various resource constraints can lead to better master planning decisions that result in savings.

**Sponsor:** Big Valley Foods, LLC

**PI/PDs:** Baski Balasundaram, Austin Buchanan, Sunderesh Heragu

**Collaborative Research: Enhancing Power System Resilience Via Data-Driven Optimization**

A new class of data-driven optimization methodologies is proposed to assist power system operations under contingency. This project studies probabilistic modeling of power grid contingency based on meteorological and historical transmission availability data. The data analytics is incorporated in distributionally robust optimization models to (a) conduct risk assessment analysis, (b) harden pre-disaster power grid, (c) take corrective actions during disasters, and (d) conduct post-disaster self-healing and system restoration. Successful implementations of the research can provide data-driven approaches to address critical resilience issues facing the nation’s power system infrastructure.

**Sponsor:** National Science Foundation

**PI/PD:** Chaoyue Zhao

**Imposing Connectivity Constraints in Large-Scale Network Problems**

Previous approaches to solve vertex-centric connectivity problems use additional edge (and possibly flow) variables, which overburden IP solvers, or rely on simple, weak inequalities, leading to the exploration of a large number of branch-and-bound nodes. This research is expected to overcome these limitations and lead to a rich body of knowledge regarding connectivity problems, and, in particular, to faster approaches for solving vertex-centric connectivity problems. The work will likely generalize existing results about edge-centric connectivity and will have consequences for hop-constrained and survivable network design problems. An REU supplement has been received for student support for this project.

**Sponsor:** National Science Foundation

**PI/PD:** Austin Buchanan

**Collaborative Research: Data-Driven Risk-Averse Models and Algorithms for Power Generation Scheduling with Renewable Energy Integration**

The objective is to derive data-driven risk-averse stochastic optimization models and discover strong formulations with efficient decomposition algorithms for the power generation scheduling problems with renewable energy integration, so as to ensure cost effectiveness and system robustness. In this project, an innovative approach will be explored that integrates statistics and optimization methods to derive a reliable and cost-effective power generation scheduling decision. Starting from the historical data, the project team will develop data-driven risk-averse stochastic optimization models and explore efficient algorithms for both system operators and market participants.

**Sponsor:** National Science Foundation

**PI/PD:** Chaoyue Zhao

**MATERIALS SCIENCE AND ENGINEERING**

**Design of Novel Electrocoagulation Systems for Produced Water Treatment**

The project promises a technological breakthrough for electrocoagulation (EC) technology by development of novel, high efficiency but low cost electrodes for produced water treatment. The first project objective is to develop novel electrodes for EC that will have high surface area and will allow for easy removal and/or prevention of the oxide layer formed on the cathode by embedding an electromagnet in the electrodes. The second objective is to identify optimal conditions for electrocoagulation. In particular, conditions to form hyrdroxychloride Green Rusts (GR(Cl-) to decrease the Cl- ion concentrations (and total dissolved solids), will be explored.

**Sponsor:** United States Geological Survey

**PI/PD:** Pankaj Sarin

**CerFoil-High Efficiency Ceramic Propellers for UxS**

The purpose of this research program is to develop a radically new lightweight ceramic composite propeller for use in small unmanned air systems (SUAS) such as commonly known quad-copter drones. The design is constructed of very lightweight high modulus ceramic composites to provide a 10-12 db average reduction in radiated noise compared to the state-of-the-art commercially available hobby enthusiast propellers.

**Sponsor:** Hydronalix, Inc. for the Department of Defense

**PI/PDs:** Ranji Vaidyanathan, Jim Smay

**Continuous Large-scale Functionalized Silver Nanowire (AgNW)-Based Transparent Conductive Films (TCFs) Manufacturing**

The objective is the discovery of reaction conditions in a millifluidic reactor to produce high-quality, low-cost AgNW inks that can be continuously printed onto flexible substrates to create low-cost transparent conductive films (TCFs) for Internet of Nano Things (IoNT) application. To accomplish this, the research aims are: 1) AgNW millifluidic reaction mechanism investigation and synthesis optimization to find the optimum reaction conditions; 2) Large-scale millifluidic synthesis of functionalized AgNW; and 3) Continuous preparation and writing of AgNW inks onto flexible substrates to create TCFs for IoNT.

**Sponsor:** National Science Foundation

**PI/PDs:** James Smay

Chemical Engineering: Shohreh Hemmati

**Demonstration of TFT-less Infrared-driven OLED Projection Display**

OSU is collaborating with Ghost Display Technologies, LLC on this Department of Defense STTR project. OSU’s tasks include: 1) Optimize monochrome IR-driven OLED screens, 2) Optimize solution coating processes of solution-based organic materials for inkjet-printed full-color IR-driven OLEDs, 3) Fabricate solution-processed OLEDs for phase II full-color prototypes.

**Sponsor:** Ghost Display Technologies, LLC for Department of Defense

**PI/PD:** Do Young Kim

**SBIR Phase I: Z4.01-3283 Misse Experiments for Evaluation of Reliability of Cryogenic Composite Systems and Materials**

During the Phase I program, the OSU-Infinite Composites Technologies (ICT) team will leverage the OSU expertise on preparing samples for Materials International Space Station Experiments (MISSE) to evaluate and demonstrate the reliability of composite systems and materials for cryogenic fluid handling in space. ICT will prepare samples for MISSE experiments with the assistance of OSU researchers and also evaluate its reliability under space conditions, especially related to the interfacial characteristics of the fiber-matrix systems after exposure to combined conditions of cryogenic temperature exposure and mechanical stresses or other conditions such as radiation and cryogenic temperatures.

**Sponsor:** Infinite Composites Technologies for National Aeronautics and Space Administration

**PI/PDs:** Ranji Vaidyanathan, Feng Lu

**Engineering Thin Film Solar Cells for Radiation Hardness, Lifetime and Efficiency**

The project will use a combined experimental and theoretical approach for characterization and in depth study of radiation hard multinary halide and chalcogenide solar cells for space applications. The two proposed materials technologies in this project are based on Cu(In,Ga)Se2 (CIGS) and emerging lead halide perovskites that demonstrate a combination of remarkable radiation resistance, high efficiency, light weight, thin, and flexible solar cell arrays for NASA’s CubeSat and SmallSat applications in which high power, light, low payload systems are highly desirable.

**Sponsors:** National Aeronautics and Space Administration, Oklahoma State Regents for Higher Education, University of Oklahoma

**PI/PDs:** Do Young Kim

Mechanical and Aerospace Engineering: Andy Arena

Physics: Mario Borunda

**Marine Composites with Improved Toughness and Thermal Stability**

In this OARS project, MITO Material Solutions, LLC will do research to develop additives that mix easily with polyester and vinyl ester resins. Polyester and vinyl ester resins are commonly used to make marine composites. Marine composites are used to make various types of boats and boat parts. The MITO additives will improve the mechanical properties of these resins and make marine composites tougher. MITO mixed resins will be applied in-between the layers of fiberglass or other fabrics. In this project, the MITO Team will develop new inexpensive formulations as well as scale up the amount of existing MITO products.

**Sponsor:** MITO Materials Solutions for Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Ranji Vaidyanathan

Chemistry: Frank Blum

**Materials Recycling – Promoting Sustainability and a Circular Economy**

Faculty from materials science and engineering, civil and environmental engineering and Spears school of business will set up an experiential graduate level course for graduate students to: 1) understand sustainable practices, 2) develop and evaluate ideas for innovative sustainable practices, 3) generate prototypes and term-papers based on those ideas, 4) test if the idea has commercial potential, 5) apply for scholars programs, 6) generate business plans and elevator pitches, 7) present the pitch to business plan competitions, 8) apply for Venturewell and I-Corps grants, and, 9) create a business based on the idea and bring the product to the market.

**Sponsor:** National Collegiate Inventors & Innovators Alliance d/b/a/ VentureWell

**PI/PDs:** Ranji Vaidyanathan

Civil and Environmental Engineering: Julie Hartell

**SBIR Phase II: Tough Polymer Composite Materials Through iLAMB, or Interlaminar Modifications Through Master Batching**

During Phase I, the OSU/MITO Material Solutions team demonstrated a toughening additive that can be blended directly into an epoxy resin at concentrated levels to create a “Master Batch,” exhibiting excellent dispersion of the hybrid nanofillers combining graphene oxide and polyhedral oligomeric silsequioxanes in an epoxy matrix. This master batch can be incorporated into the current composite manufacturing process without any process changes to result in significantly enhanced interlaminar fracture in carbon fiber/epoxy composites. In Phase II, new nanofillers/toughening additives will be developed, manufactured and scaled up that can be added to epoxy/vinyl ester/polyester resin systems in Master Batch form.

**Sponsor:** MITO Material Solutions

**PI/PDs:** Ranji Vaidyanathan, Raman Singh

Chemistry: Frank Blum

**Large-Volume Stimulation of Rock for Greatly Enhanced Fluids Recovery Using Targeted Seismic-Assisted Hydraulic Fracturing**

This project will develop and demonstrate a new technology for large-volume and targeted comminution of rock in low permeability formations to enhance recovery from unconventional oil and gas resources. This greatly increased rock stimulation, through bulk comminution, is expected to cause significant increase in permeability leading to enhancement of recovery factors for sub-surface fluids. The effort integrates fundamental scientific understanding of dynamic material response under constraint, damage-induced permeability and porosity enhancements at multiple length scales, along with models of comminution due to the local release of kinetic energy associated with high shear strain rate of dynamic deformation.

**Sponsor:** Department of Energy

**PI/PD:** Raman P. Singh, Pankaj Sarin

**Lightweight Large Composite Tanks for Launch Vehicles and In-Space Depots**

This Research Initiation Grant (RIG) will enable the PI to collaborate with Nathanael Greene/Ian Juby and his group in the Propulsion (EP) and Materials and Processes (ES4) branches at NASA Johnson Space Center to develop composite materials that can store and transport cryogenic fuels such as liquid oxygen and liquid methane for long duration space flights. The RIG will allow further development of materials for composite tanks and evaluate the use of highly weight efficient designs for other platforms as well as many space companies. If successful, these materials could be evaluated by NASA for insertion into commercial space activities.

**Sponsor:** Oklahoma NASA EPSCoR for NASA

**PI/PD:** Ranji Vaidyanathan

**Smart Sensor Development Using Infrared Sensible OLEDs**

OSU is collaborating with the Korea Institute of Technology for smart sensor development using infrared sensible OLEDs. OSU’s part of the work will include: 1) fabrication of organic infrared photodetectors, 2) characterization of photodetectors, 3) fabrication of all-organic IR-to-visible up-conversion OLEDs, 4) characterization of up-conversion OLEDs.

**Sponsor:** Korea Institute of Industrial Technology

**PI/PD:** DoYoung Kim

**Assessment of Radiation Shielding Properties of Novel and Baseline Materials External to ISS**

The project will test and measure the radiation shielding and other properties of the multifunctional materials developed in previous awards. In this project, the materials will be tested in the actual space environment external to the International Space Station.

**Sponsor:** National Aeronautics and Space Administration

**PI/PDs:** Ranji Vaidyanathan

Mechanical & Aerospace Engineering: Andy Arena

Department of Physics: Eric Benton

**Nanostructured Materials for Li-Ion Batteries with High Capacity and Performance**

The purpose is to develop state-of-the-art Li-ion battery materials with enhanced capacity and performance. It is anticipated that the research will result in new anode and cathode materials with at least 2X enhancement in capacity and performance. The research relies on quick and easy to implement experimental techniques to develop the battery materials. The end users of this technology include Li-ion battery materials manufacturers, alternative energy, portable electronics, and automobile industries. Three local OK commercial partners have been identified who are interested in commercializing the technology upon demonstration of the proof-of-concept.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Raj N. Singh, Nirmal Govindaraju

**Loading-rate and Constraint Dependent Hydraulic Fracturing of Shale: Optimizing Resource Extraction**

The long-term objective is to build real-time predictive models of shale fracture as a function of mineral constituent, prevailing confinement pressure, and rate of loading employed during fracking. These models could then be calibrated using historical data collected during hydraulic fracturing and subsequently used for maximizing resource extraction efficiencies. In this project, the researchers will quantify the fracture response of shale as a function of loading rate and constraint to formulate a predictive model for failure mechanisms. It is speculated that the interplay of loading rate and constraint can affect a ductile-to-brittle transition in the failure process of shale.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Raman Singh

Geology: James Puckette

**Innovation Corps Site Program**

The vision for the Oklahoma State University I-Corp Site is to increase the number of STEM-related startups and licensing opportunities emerging from the OSU campus. The OSU I-Corp Site will accelerate startup activity on campus not only by providing funding and training to startup teams, but by helping create a faculty and student population that is familiar with the business startup process. It will also provide a pathway for underrepresented students to participate in STEM-related business startups. The grant will provide 90 teams (over a three year period) $3,000 in funding per team along with training in the startup process.

**Sponsor:** National Science Foundation

**PI/PDs:** Ranji Vaidyanathan

Spears School of Business: Bruce Barringer

**Modification of the Coefficient of Thermal Expansion Analysis Suite (CTEAS)**

Support from GE Global Research will be used to improve the existing Coefficient of Thermal Expansion Analysis Suite (CTEAS) software developed as a freeware by the principal investigator Dr. Sarin. Some areas for improvement of CTEAS software include: 1) Matlab based GUI interface for the CTEAS software, 2) Ability to install and run the CTEAS without the requirement for a Matlab license, 3) Corrected and updated user manual.

**Sponsor:** GE Global Research

**PI/PD:** Pankaj Sarin

**Radiation Smart Structures with H-rich Nanostructured Multifunctional Materials**

Through this NASA EPSCoR award, radiation smart structures and materials with H-rich nanostructured multifunctional materials will be developed and built for shielding astronauts from ionizing radiation during human missions beyond low-Earth orbit. The approach is interdisciplinary and involves research groups in Materials Science and Engineering at OSU Tulsa, the Dept. of Physics and Mechanical and Aerospace Engineering at OSU Stillwater. The research will find applications in a number of radiation based industries including medical physics and nuclear power generation in which high-strength, lightweight radiation shielding materials and appliances are needed.

**Sponsors:** University of Oklahoma for NASA EPSCoR, University of Oklahoma for Oklahoma State Regents for Higher Education

**PI/PDs:** Ranji Vaidyanathan

Mechanical and Aerospace Engineering: Raman Singh

Physics: Eric Benton

**MECHANICAL AND AEROSPACE ENGINEERING**

**Collaborative Research: Data-Driven Variational Multiscale Reduced Order Models for Biomedical and Engineering Applications**

To develop reduced order models (ROMs) that are accurate in realistic, under-resolved regimes, the ROM closure problem needs to be solved, i.e., the effect of the discarded ROM modes on the ROM dynamics needs to be modeled. This project puts forth a new data-driven ROM paradigm that centers around the hierarchical structure of variational multiscale (VMS) methodology and uses machine learning and numerical and observational data to dramatically increase the ROM accuracy at a modest computational cost. The novel data-driven VMS-ROM framework aims at transforming ROMs into general and robust computational tools for applications across engineering, science, and medicine.

**Sponsor:** National Science Foundation

**PI/PDs:** Omer San

Virginia Polytechnic Institute and State University: Traian Iliescu

Emory University: Alessandro Veneziani

**Operator Theoretic Methods for Data-Driven Control Synthesis**

The goal is to develop novel operator theoretic techniques for data and model-driven synthesis of control policies through synthesis of control Lyapunov functions (CLFs) and solution of optimal control problems. The technical tasks focus on the use of trajectories (i.e., time-series) as the fundamental unit of data for the resolution of control synthesis and certification problems in dynamical systems. If successful, the efforts in this project will lead to mathematically rigorous methods that admit efficient linear and/or quadratic programming based numerical approximations for construction of CLFs and solution of optimal control problems using data-driven black-box and gray-box models.

**Sponsor:** Air Force Office of Scientific Research

**PI/PD:** Rushikesh Kamalapurkar

**Public Safety Small Unmanned Aerial Systems Operations Training Baseline Materials & Usage Assessment**

The objective of this effort is to develop a curriculum that will address sUAS utilization across all operational settings including structural and wildland firefighting, search & rescue, hazardous material responses, natural disasters, and any other events in which public safety operations would benefit from use of drones.

**Sponsor:** Fire Protection Research Foundation, Inc. for the Federal Emergency Management Agency

**PI/PDs:** Jamey Jacob, James Kidd

Engineering Outreach and Extension: Ed Kirtley

Fire Protection & Safety Engineering Technology: Rob Agnew

Fire & Emergency Management Administration: Haley Murphy

Fire Service Training: Dean McFadden

**Speedfest X**

Speedfest will be celebrating its 10th anniversary in 2020, and is an exciting, high-speed aircraft design/build/fly competition that is intended to foster enthusiasm for aviation and STEM in general. There are two flight competition classes: Alpha Class is the advanced class for collegiate-level teams. India Class is the invitational class that consists of high school teams, and teams of K-12 teachers formed from across the state of Oklahoma.

**Sponsor:** Oklahoma Aeronautics Commission

**PI/PD:** Andy Arena

**FLIR IBAC SkyRaider Wind Tunnel Testing**

OSU’s wind tunnel will be used to conduct experiments to characterize the response of an instantaneous biological aerosol counter payload attached to a drone.

**Sponsor:** FLIR Detection, Inc. for Advanced Technology International for Department of the Army

**PI/PD:** Jamey Jacob

**Group 3 Unmanned Airborne Systems UAS Design (Project 117)**

The OSU investigator will provide an acoustic assessment of a baseline fixed-wing VTOL UAS platform and then proceed to design and integrate a sound attenuation plan for a new Group III fixed-wing VTOL USA platform. OSU’s team will design and fabricate a ground based mock-up test rig for the motor/propeller/fuselage section of the platform in order to test design choices. OSU’s team will assess and provide input to the VTOL rotors in an effort to reduce their noise signature. The results of the test rig measurements and assessment will feed into the final design of a prototype aircraft.

**Sponsor:** Cambridge International Systems, Inc. for the General Services Administration

**PI/PD:** Rick Gaeta

**Atmospheric Gravity Wave Radiosonde Field Campaign for Eclipse 2020**

OSU will collaborate with the University of Montana on the planning, design, implementation and demonstration of scientific research investigating the atmospheric responses to a total solar eclipse. This will include development and testing of observation and data acquisition systems, including balloons, sensors, radiosondes, telemetry, tracking and ground station systems. The project includes international travel to the eclipse site to conduct research including 24+ hours hourly balloon launching, ground station control, data collection and site monitoring.

**Sponsor:** Montana State University for National Science Foundation

**PI/PD:** Jamey Jacob

**Pistol Pete’s Propulsion Posse**

Pistol Pete’s Propulsion Posse is competing in the C3 Challenge to further develop the concept of turboelectric propulsion and power for unmanned aerial vehicles (UAVs). The turboelectric system will power small UAV (<55lb) platforms in demonstration flight tests, which will show the versatility and scalability of the system. In addition, electrical systems and subsystems will be designed and developed to address integration/vehicle level considerations. Deliverables include 5 kW, 7 kW and 9 kW turboelectric systems in the Proof of Concept phase and UAVs integrated with turboelectric system in the subsequent System Integration phase, including fixed-wing and multi-rotor platforms.

**Sponsor:** Wichita State University for Department of Defense

**PI/PD:** Kurt Rouser

**Tools and Methods for Fatigue Behavior in Surface-Modified Metallic Structures**

This research is aimed at developing tools and methods to support aircraft gas turbine engine repair activities. The project focuses on fatigue behavior in metallic structures, including a study on the effect of surface treatments and coatings on fatigue and life-limiting mechanics. The goal is to develop an understanding of fatigue behavior to improve structural analysis associated with the repair of metallic structures. The project will enable advancements in gas turbine engine repair development and predictive engine life management for maintenance, repair and overhaul activities. The results will lead to reduced engine life cycle costs and increased engine readiness levels.

**Sponsor:** United Technologies Corporation – Pratt & Whitney Division

**PI/PDs:** Kurt Rouser, Sandip Harimkar, Shuodao Wang

**Soil Monitoring through UAV-Assisted Internet of Things Wireless Underground Sensors**

The objective is to develop a proof-of-concept soil monitoring system with wireless underground Internet of Things (IoT) sensors and unmanned aerial vehicles (UAVs). The team will develop and pilot the “Smart Field,” where the smart soil monitoring system can be tested and preliminary data can be collected for future large-scale applications. The study will look at the feasibility of innovative IoT-enabled underground sensors for soil sensing that can improve soil and water management, consequently leading to conservation of water quantity and quality. The project will involve field experiments and software and hardware implementation of UAV and IoT systems.

**Sponsor:** United States Geological Society

**PI/PDs:** Jamey Jacob

Electrical and Computer Engineering: Sabit Ekin, John O’Hara

Biosystems and Agricultural Engineering: Saleh Taghvaeian

**Investigate and Implement Flexible and Fast g-function Calculation Methods to Support Automated Design and Optimization of Ground Heat Exchangers**

To enable wider adoption of the geothermal heat pump (GHP) technology, which can more efficiently provide space conditioning to a built environment than conventional HVAC technologies, it is highly desirable to have a software tool that can reliably predict the performance and analyze the economics of a GHP system. This project will investigate and implement g-function calculation methods that are fast enough, accurate enough, and flexible enough to support automated design of ground heat exchangers. The project will also investigate and implement ground heat exchanger simulation algorithm improvements that allow the model to go down to very short time steps.

**Sponsor:** UT-Battelle, LLC for Oak Ridge National Laboratory

**PI/PD:** J.D. Spitler

**Research and Sounding Rockets**

The objective is to support the establishment and execution of a high-tempo cost effective process to rapidly drive technology maturation from conceptual to application to reduce overall lifecycle time by providing impactful data for performance evaluation and model validation. This involves providing a capability to evaluate new technology performance utilizing low-cost research rocket flights, which then can progress to higher fidelity tests on sounding rocket and strategic asset flights.

**Sponsor:** Honeywell Federal Manufacturing & Technologies, LLC for Department of Energy

**PI/PD:** Jamey Jacob

**Failure Analysis and 3D Scan of Bolts**

OSU will obtain three 3 bolts from Boeing-OKC and will perform a 3D scan of each bolt using machine Zeiss Xradia 410 X-ray Computed Tomography. OSU will deliver the 3D image file and submit a final presentation describing the results of the effort.

**Sponsor:** The Boeing Company for the United States Air Force

**PI/PD:** James Kidd

**Low Cost Engine Performance Baseline Evaluation**

A team of students and faculty at OSU will construct a test stand for JetCat and AMT Netherlands turbojet engines to evaluate thrust and specific fuel consumption. Performance measures will be corrected for atmospheric effects and evaluated over a range of throttle settings across multiple test runs. Other measurements will include exhaust gas temperature, pressure and swirl. Engine start reliability will be evaluated under different conditions.

**Sponsor:** Kratos Unmanned Aerial Systems, Inc.

**PI/PD:** Kurt Rouser

**Deice/Anti-icing for Unmanned Aerial Systems**

In this capstone project, the icing team will develop initial icing predictions for the Scan Eagle under UAS conditions, using both modeling data and flight information. From these estimations, the team will be able to ascertain the anti-icing mechanisms best suited for the Scan Eagle and develop a design for the prototype. The prototype will be built and tested in simulated icing conditions on either a scan eagle wing or replica.

**Sponsor:** Systems Engineering Research Center (SERC) for Department of Defense

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Online Policy Synthesis for Unmanned Air Vehicles: A Model-aware Reinforcement Learning Approach**

The goal is to develop online model-aware reinforcement learning (RL) algorithms for nonlinear systems in continuous time and space that can tolerate large modeling errors and maintain closed-loop stability during the learning phase. Model-based RL can

be realized in continuous time and space through simulation of experience, however,

simulation of experience requires a predictive model that is accurate over the entire domain of operation. Methods for online real-time learning that are robust to modeling errors and abrupt changes in the dynamic models will be developed via integration of model validation, model-free RL, and MBRL techniques in a model-aware RL framework.

**Sponsor:** Air Force Research Laboratory

**PI/PD:** Rushikesh Kamalapurkar

**Stratosurfer UAS**

OSU’s Unmanned Systems Research Institute (USRI) will acquire materials, build, test and document performance data to submit the airworthiness documentation for the COTS Stratosurfer UAS.

**Sponsor:** Torch Technologies, Inc. for the United States Army

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Hole Drilling Using Electrical Discharge Machining (EDM) for Removal of Rivets and Key-Locking Studs/Inserts – Phase 2A**

This collaborative research between OSU and Pratt and Whitney (P&W) is aimed at developing an electrical discharge machining (EDM) drill for aerospace engine fastener removal. Objectives include: 1) Perform material characterization study to evaluate and quantify damange to flat-plate workpiece material caused by fastener removal using Perfect Point E-DrillTM small hole EDM machine from previous Phase-I repeatability and sensitivity study, 2) Evaluate and quantify damage to the workpiece material caused by fastener removal under geometrically constrained conditions using Perfect Point E-DrillTM small hole EDM machine, 3) Draft subsequent related research proposal to P&W with scope for 2020 calendar year.

**Sponsor:** United Technologies Corporation – Pratt & Whitney Division

**PI/PDs:** Kurt Rouser, Sandip Harimkar

**Model-based Ergonomic Design for Collaborative Lifting**

The key research components include 1) a musculoskeletal lumbar spine model, 2) an efficient dynamic optimization approach, 3) a novel force coupling method for collaborative lifting, and 4) the experimental validation. The innovative aspects of the study include multisubject modeling and a modern simulation approach that allow quantitative characterization of the collaborative lifting process. The expected deliverable is a robust and validated simulation model that can predict the safe lifting strategy and back injury risk for each individual for collaborative lifting. The study will advance the current understanding of lifting biomechanics and back injury mechanisms.

**Sponsor:** Southwest Center for Occupational and Environmental Health

**PI/PD:** Yujiang Xiang

**NRI: INT: Safe Wind-Aware Navigation for Collaborative Autonomous Aircraft in Low Altitude Airspace**

The objective of this project is to validate the hypothesis that knowledge of 'in-time' or 'real-time' wind field, communicated effectively to a pilot, can enhance safety, efficiency and robustness of future autonomous aircraft operations in low altitude airspace. Towards this objective, the team will develop a framework that integrates turbulence modeling, navigation, control, and pilot-aircraft interface to enable autonomous and remotely piloted aircraft to navigate through the Atmospheric Boundary Layer with improved predictability and increased endurance.

**Sponsor:** National Science Foundation

**PI/PDs:** He Bai, Jamey Jacob, Balaji Jayaraman, Rushikesh Kamalapurkar

Aviation Science: Matt Vance

**FAA COE Zone 3 ILS Measurements**

The objective is to record the glideslope depth of modulation in Zone 3 for analysis of manned aircraft flight inspection system (FIS) accuracy and to advance development of Unmanned Aircraft Systems (UAS) for ILS facility preparation. A UAS will be instrumented with a lightweight ILS receiver capable of recording both localizer and glideslope depth of modulation (DDM). The UAS will be equipped with an RTK GPS to more accurately track and record position within 5cm laterally and vertically. The UAS position data will be recorded and synchronized with localizer and glideslope DDM.

**Sponsor:** Federal Aviation Administration Center of Excellence

**PI/PDs:** Jamey Jacob, Gary Ambrose

Electrical and Computer Engineering: Jim West

**Fatigue Analysis of Turbofix™ Ni Superalloy Repaired Components – Phase 1**

The team will use analysis and simulation methods to determine and describe mechanisms causing thermal mechanical fatigue (TMF) cracking and Turbofix™ structural integrity by: 1) Develop a simplified analytical TMF model for a cracked nickel superalloy component that includes applied temperatures, forces and vectors as provided by Pratt & Whitney (PW), 2) Develop a simplified numerical TMF model in ANSYS for a cracked nickel superalloy component sample geometry to describe static stresses and crack growth at the most extreme point of the cycle, comparing analytical and numerical results with each other and with PW experimental data, 3) Follow-on research proposals.

**Sponsor:** United Technologies Corporation , Pratt & Whitney

**PI/PDs:** Kurt Rouser, Shuodao Wang

**Advanced Techno-Economic Modeling for Geothermal Heat Pump Application in Residential, Commercial and Industrial Buildings**

The team has proposed an analogous g-function called “cross-g-function” that gives the response of one ground heat exchanger to imposed loads on a nearby ground heat exchanger. The ground heat exchangers may begin operation at different dates. The cross-g-functions are needed for larger-scale implementations in urban environments where interference between ground heat exchangers is likely to occur. The objectives are (1) to thoroughly review recent developments in g-function calculation in order to identify the best way forward and (2) to implement a fast, flexible, and accurate g-function calculation method in a standalone tool that can support automated design.

**Sponsor:** UT-Battelle, LLC for Oak Ridge National Laboratory

**PI/PD:** J. Spitler

**Integration of Efficient Small Scale Propulsion (ESSP) into USSOCOM MQ-27B and RQ-23 Platforms**

OSU shall serve as a subcontractor to Baker Engineering, LLC. For an Air Force Research Laboratory Phase II program, Improved Turbo/Superchargers for UAS/UGS Application. OSU shall provide technical management for an AFRL engine integration program onto USSOCOM Group 1 and 3 Small UAS platforms.

**Sponsor:** Baker Engineering LLC for the United States Air Force Research Laboratory

**PI/PD:** Rick Gaeta

**OSU Support**

This is a follow-on award to provide sUAS pilot/engineering support for MFIX June/July 2021.

**Sponsor:** Torch Technologies, Inc.

**PI/PD:** Jamey Jacob

**MFIX 2020**

This project will support the Army’s Fires Center of Excellence with the annual Maneuver Fires Integration Experiment (MFIX). MFIX is DOD’s premier Air Defense Artillery Exercise. OSU USRI will support the experiment with manufactured equipment of assembled, integrated and tested UAS, as well as an experienced engineering based flight team familiar as subject matter experts in SUAS and real time target generation. OSU will budget and plan for 1 experienced flight test team to be at Ft. Sill for 6 weeks. OSU will begin manufactured equipment phase and support immediately upon award (estimated 25 April) through 30 December 2019.

**Sponsor:** Torch Technologies, Inc.

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Torch MFIX 2020 Plus Up – Additional Equipment**

This project will support Ft. Sill Fires Battle Laboratory, Fires Center of Excellence with additional equipment and 1 flight team for the MFIX experiment. OSU USRI will support Torch Technologies with additional equipment and 1 UAS flight team on or about mid‐October for 14 days. Additionally, OSU USRI will demonstrate a VTOL flight of Locust aircraft.

**Sponsor:** Torch Technologies, Inc.

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Torch 5th Army at Fort Bliss, Texas**

The purpose was to provide four experienced sUAS pilots to Fort Bliss, Texas from June 23 – July 4, 2019.

**Sponsor:** Torch Technologies, Inc.

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Taper-Lok Fastener Behavioral Analysis**

OSU shall excise an aircraft structural specimen from a provided larger aircraft structural element, conduct computed tomography scans on selected fastener locations, report on activities and findings, and ship the excised specimen to another Boeing vendor. Activities include a technical interchange meeting, planning and conduct of excision and scanning, crating and shipping of structural specimen. Deliverables include minutes from the technical interchange meeting, excised and shipped specimen and a report of activities and scan findings.

**Sponsor:** The Boeing Company for the United States Air Force

**PI/PD:** James Kidd

**Torch Dugway Proving Ground**

The project involves providing remote pilot support for Dugway Proving Ground, July 7-13, 2019. Tasks include: 1) Provide two experienced sUAS pilots to Dugway Proving Grounds, UT from 7 July – 13 July, 2019; 2) Assume travel days 7 July and 13 July, 2019; 3) Support training event 8-12 July 2019; 4) Assume 10 hour workdays during operational support days; 5) Develop and provide training materials (electronic and hard copy) for AGATCS-based SUAS training, to include Mission Planner and Pixhawk-based drones; 6) Mission aircraft are anticipated to be EMRC Intense Eye V2 and E900 multicopters.

**Sponsor:** Torch Technologies, Inc.

**PI/PDs:** Jamey Jacob, Gary Ambrose

**Project 117**

The OSU researcher will participate in an IPT providing acoustic assessment and design input into a new Group III fixed-wing VTOL UAS platform.

**Sponsor:** Cambridge International Systems, Inc. for the National Institutes of Health

**PI/PDs:** Rick Gaeta

**Infrasound Observations and Demonstration of Real-Time Tools**

The project aims to demonstrate the potential value of infrasound technology by co-locating an infrasound array with a Weather Surveillance Radar—1988 Doppler (WSR-88D) site, decreasing uncertainty due to sound propagation by deploying mobile infrasound sensors during severe storms, correlating flow-field metrics with infrasound measurements, and demonstrating processing algorithms to enable real-time analysis. At the completion of this project, the team expects to have demonstrated how infrasound data can enhance tornado threat predication via correlations between the radar and infrasound metrics and demonstrate improved algorithms for real-time processing and analysis to operational meteorologists.

**Sponsor:** National Oceanic and Atmospheric Administration

**PI/PDs:** Brian Elbing, Imraan Faruque

University of Nebraska-Lincoln: Matthew Van Den Broeke

**Validation of Radar-Based Detect-and-Avoid System**

This project is a research, development and testing partnership between OSU and Vigilant Aerospace Systems, Inc. to develop a radar-based detect-and-avoid unmanned aircraft system vehicle collision avoidance system, which will be commercialized into a product to enable safe and efficient access to the US National Airspace by unmanned aircraft. The project will build on existing aircraft and radar technologies and research while pioneering new innovations in integrated systems, radar integration, aircraft and systems autonomy, airspace safety, ground and air-based systems management, vehicle avoidance algorithms and other technologies.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Jamey Jacob

**Horizon II Radio and GPS Research Phase (FOUO)**

OSU will perform a holistic study to determine the best Courses of Action to prevent jamming of the global positioning system and determine which radio frequencies (outside of standard ranges) and ranges provide the best performance and minimize the possibility of jamming when used as a command and control link for the PUMA II. The focus is to provide a complete analysis of the GPS system and the potential of using a software defined radio as a material solution, with the ability to pre-select frequencies to the customer and deliver a final report within 60 days from receipt of task.

**Sponsor:** Cambridge International Systems, Inc. for the General Services Administration

**PI/PDs:** Jamey Jacob, Gary Ambrose

Electrical and Computer Engineering: Jim West, Sabit Ekin

**Raven Phase VI**

Methane (CH4) sensing on an aerial platform (UAV) is a relatively new concept to assist upstream oil and gas operators to find fugitive methane emissions (FME). GE’s Project Raven is a UAV modified with visual reconnaissance and CH4 laser sensing. GE will provide the UAV and sensor to OSU. OSU will provide the assembly of this UAV with the sensor, the testing facility of this prototype, and the CH4 source leak at the ground level.

**Sponsor:** Baker Hughes Oilfield Operations, LLC

**PI/PD:** Jamey Jacob

**Space-bourne Antennas and Circuits for Condensed Radars and STEM (SPACERS)**

The goal of the SPACERS effort is to provide NASA with updated technologies and processing techniques to help with the move towards space-borne application of synthetic aperture radar (SAR) systems. Tasks will include: Radar Fairing Design, Flight Experiments, and Data Collection. A fairing is needed to mount the radar on an aircraft in Oklahoma. The production fairing will be constructed using a multilayer composite fiberglass skin, with Kevlar ribs and spars for support and reinforcements near the fuselage interface as needed. A detailed finite element analysis of the structural loads will be performed.

**Sponsor:** University of Oklahoma for the Oklahoma Space Grant Consortium for the Oklahoma Regents of Higher Education

**PI/PD:** Jamey Jacob

**Collaborative Research: The Leaky Rake to Solid Plate Transition on Flow Through Biological Filtering Structures**

Numerous small organisms that swim, fly, smell, or feed in flows at the intermediate scale (mesoscale), where inertial and viscous forces are balanced, rely on using branched, bristled and hairy structures. Such mesoscale structures (e.g., filtering appendages) can augment underlying biological function (e.g., particle capture) by moving in a manner to transition from acting as solid surfaces to leaky/porous rakes at Reynolds number close to one. This research will elucidate the fundamental fluid dynamics of biological and bioinspired filtering arrays at Reynolds number and Peclet number close to unity.

**Sponsor:** National Science Foundation

**PI/PD:** Arvind Santhanakrishnan

**Research Rockets**

The goal of the project is to determine how parts will perform when subjected to real world environments. A secondary goal is to determine how well simulations match real world data. Tasks include: 1) Design of rocket and payload bay, 2) Fabrication of rocket, 3) Development of data acquisitions system, 4) Launch of rocket, 5) Recovery and presentation of data.

**Sponsor:** Honeywell Federal Manufacturing & Technologies, LLC

**PI/PD:** Jamey Jacob

**Engineering Thin Film Solar Cells for Radiation Hardness, Lifetime and Efficiency**

The project will use a combined experimental and theoretical approach for characterization and in depth study of radiation hard multinary halide and chalcogenide solar cells for space applications. The two proposed materials technologies in this project are based on Cu(In,Ga)Se2 (CIGS) and emerging lead halide perovskites that demonstrate a combination of remarkable radiation resistance, high efficiency, light weight, thin, and flexible solar cell arrays for NASA’s CubeSat and SmallSat applications in which high power, light, low payload systems are highly desirable.

**Sponsors:** National Aeronautics and Space Administration, Oklahoma State Regents for Higher Education, University of Oklahoma

**PI/PDs:** Andy Arena,

Materials Science and Engineering: Do Young Kim

Physics: Mario Borunda

**Iron Mustang Project**

This project will document the feasibility of terrorist groups using hydrogen fuel cells for UAS operations. This testing will demonstrate for National Counter Terrorism Center audiences how the hydrogen fuel cell terrorist threat could develop.

**Sponsor:** ATF Alcohol Tobacco Firearms National Center for Explosives Training and Research

**PI/PDs:** Andy Arena, Jamie Jacob, Gary Ambrose, Rick Gaeta

OSU Center for Health Sciences: John Frucci, Matt Green

**NASA Oklahoma EPSCoR Research Infrastructure Development**

This NASA award will provide Oklahoma EPSCoR with three years of funding to be able to award up to four Travel Grants a year and up to three Research Initiation Grants (RIGs) per year. Each travel grant will average $3,000 to support travel for Oklahoma researchers and their undergraduate/graduate students to spend up to three days visiting with researchers at NASA Centers to explore projects of mutual interest. Each RIG will average $36,000 and are intended to develop experience and research capability to help awardees be competitive for follow-on research with NASA Centers and NASA EPSCoR Implementation and ISS awards.

**Sponsors:** National Aeronautics and Space Administration, Oklahoma State Regents for Higher Education

**PI/PD:** Andy Arena

**OK NASA EPSCoR: Space-borne Antennas & Circuits for Condensed Radars and STEM (SPACERS)**

The goal is to combine recently developed digital radar techniques with new and innovative, adaptive radar hardware to help NASA move towards space-borne applications of new radar systems. A key component of the work will serve to bridge the critical design elements and engineering requirements of the hardware design with the encompassing needs of the scientific community focused on ecosystem dynamics in relation to critical drivers including weather, climate, and available water resources. By training students in the classroom and lab, the students will learn about new technologies and go on internships at the NASA Goddard Space Flight Center.

**Sponsors:** National Aeronautics and Space Administration, Oklahoma State Regents for Higher Education

**PI/PD:** Andy Arena

**Collaborative Research: Transfer Printed, Single-Crystalline Si Nanomesh Thin Films**

The project aims to establish a new unique electronic materials paradigm – Si nanomeshes – for next-generation stretchable electronics. On the basis of strong preliminary results from the PIs’ team, the PIs hypothesize that with tailored nanomesh geometries and engineered sidewall surface states, Si nanomeshes can achieve simultaneously large stretchability, high mobility and high reliability that are needed for high-density stretchable electronics. Through both theoretical and experimental investigations, this project aims to investigate and establish the interrelationship of structure-processing-properties of Si nanomeshes for stretchable devices.

**Sponsor:** National Science Foundation

**PI/PDs:** Shuodao Wang

Northeastern University: Hui Fang

**Comprehensive Model Development for a Rotating Spool Compressor**

Since initial development of *Spoolcomp,* a novel rotating spool compressor, it has been validated and used to develop increasingly optimal designs of R410A compressors. However, regulatory trends in the HVAC&R industry and intrinsic attributes of the spool compressor have suggested that lower pressure refrigerants such as R134a, R1234ze(E), R1234yf, and blends of these are better suited for the application of the spool compressor. *Spoolcomp* does not adequately capture the performance of this novel compressor using these refrigerants when compared against experimental data. This project will improve the predictive capability of *Spoolcomp* by addressing deficiencies in the model platform’s current version.

**Sponsor:** Torad Engineering, LLC

**PI/PD:** Craig Bradshaw

**BH OGTC – Improved Dispersion Modeling for Aerial Sensing of Plumes**

Tasks will include: 1) Develop a plume inversion model for near-field applications in the presence of infrastructure, 2) Develop an improved plume model formulation with manageable computational costs, 3) Combine the improved plume model with a data-driven Bayesian nonlinear inversion framework for source localization, 4) Extend the methods/tools to handle data from the mobile sensor RAVEN, 5) Extend the framework to include a second leak source.

**Sponsor:** Baker Hughes Oilfield Operations, LLC

**PI/PD:** Balaji Jayaraman, Jamey Jacob

**CAREER: Determine the Roles of Material Heterogeneity and Thickness Variability on the Stability of Thin Membranes**

The objective of this CAREER project is to test the hypothesis that a higher degree of heterogeneity in thin membranes reduces the critical buckling loads. The research approach is to experimentally measure and compare the buckling loads of a set of thin membranes of various degrees of heterogeneity ranging from highly heterogeneous to homogeneous. Fluorescence stereo microscopy and inverse finite element analysis will be combined to extract the material property distributions and thickness variability, and then a theory-guided numerical model will be developed to identify a quantitative degree of heterogeneity and elucidate how it is related to reduced buckling loads.

**Sponsor:** National Science Foundation

**PI/PD:** Shuodao Wang

**Insect Group/Swarm Behaviors and their Relation to Individual Feedback Models**

New insect kinematics analysis techniques will be applied to extract the strategies insects use in aerial maneuvering in dense, high traffic environments, including swarm behaviors. By applying new tools from control theory, dynamics modeling and system identification, and leveraging significant recent improvements in aerial multi-insect tracking capabilities, the PI will simultaneously quantify the instantaneous feedback control targets and time histories of individual organisms’ neural function during group and swarm behaviors. The outcome will be an understanding of the foundational mechanisms by which insects provide computationally lightweight swarm behaviors, which will be a strong foundation for design of computationally-limited autonomous swarms.

**Sponsor:** Office of Naval Research

**PI/PD:** Imraan Faruque

**Electrical Discharge Machining (EDM) Drilling: Phase I**

The objectives are: 1) Develop proficiency with the Perfect Point E-DrillTM using common materials and fasteners, 2) Use the Perfect Point E-DrillTM to demonstrate fastener removal for Pratt & Whitney applications using flat-plate specimens, 3) Perform a sensitivity study to understand and quantify Perfect Point E-DrillTM process and equipment parameters for Pratt & Whitney applications, 4) Submit a grant proposal to the Oklahoma Center for the Advancement of Science and Technology (OCAST) for a follow-on project for a more detailed material characterization, development of potential process improvements, and establishment of a predictive, physics-based model for small hole EDM applications.

**Sponsor:** United Technologies Corporation – Pratt & Whitney Division

**PI/PDs:** Kurt Rouser, Sandip Harimkar, James Kidd

**Acoustic Metastructures for Next Generation Aircraft Liners**

In light of recent proof-of-concept achieved at OSU for a metastructural approach to significantly enhance acoustic performance in liners especially for lightweight, compact, broadband, low-frequency applications, for which there are currently no practical solutions, OSU and Spirit AeroSystems, Inc. propose to conduct a joint R&D project to commercialize this technology for developing new acoustic liners for the next-generation of commercial aircraft. Based on prior research, an acoustic metastructural solution combining innovative core geometries such as 3D folded and phased cores with potentially incorporating acoustically nonrigid elements with advanced aerospace materials and fabrication processes is proposed to be developed.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** James Manimala, Rick Gaeta

**Planning IUCRC at Oklahoma State University: Center for Sustainably Integrated Buildings and Sites (SIBS)**

OSU is a new SIBS site, joining the site at University of North Carolina, Charlotte. SIBS-OSU will generate transformative research that addresses lack of integration between building and environmental thermal systems components, equipment, and buildings. The site will address the lack of physical/cyber-physical models for integrated building systems as well as reduced-order models and datasets for building and environmental thermal systems equipment and components, and disseminate the outcomes to the building design process. OSU's research in thermal systems as well as sensing, model-predictive control and physics-reinforced machine learning positions the site to address the integration of building equipment and systems.

**Sponsor:** National Science Foundation

**PI/PDs:** Craig Bradshaw, Christian Bach, Dan Fisher, Jeffrey D. Spitler

**A Hierarchical, Timescale Separation-Based Approach to Wind-Aware Guidance and Control**

As a step towards incorporation of Atmospheric Boundary Layer (ABL) wind field prediction to improve accuracy and predictability of sUAS guidance and control, OSU’s team is combining expertise in optimal control and wind modeling to develop a hierarchical control architecture to exploit the spatiotemporal scale separation in the ABL wind flow dynamics. The architecture will be comprised of a trajectory generator and a trajectory tracker integrated in a hierarchical framework via a formal assume-guarantee approach. The project will lead to a scalable technique that paves the way for incorporation of ABL wind field models into sUAS guidance and control algorithms.

**Sponsor:** University of Oklahoma, Oklahoma Space Grant Consortium for the Oklahoma State Regents for Higher Education

**PI/PDs:** Rushi Kamalapurkar, Balaji Jayaraman

**Collaborative Research: Musculoskeletal Model for Dynamic Manual Material Handling to Prevent Injury**

Objectives are to: 1) derive a general dynamic strength model and validate the model parameters from experiments; 2) introduce and experimentally validate a lumbar spine muscle model; and 3) implement these models with a nonlinear programming algorithm to optimize the dynamic lifting motion during manual material handling for minimum injury and experimentally demonstrate proof-of-concept. Muscle intra/inter-joint coupling will be modeled and the lumbar spine area will be added, thereby generating a musculoskeletal model to measure lumbar stresses for back pain in the dynamic lifting process.

**Sponsor:** National Science Foundation

**PI/PD:** Yujiang Xiang

**Development of a Novel Peristaltic Compressor for Air-Conditioning and Refrigeration Applications**

This project addresses the limitations of the previous work on peristaltic compressors by independently developing expertise on the thermodynamic advantages and the electromechanical actuation mechanisms and combining that expertise to inform appropriate compressor applications. This development will be split into two major thrusts. The first thrust, will quantify the thermodynamic advantage by developing a model of the volumetric flow characteristics of the peristaltic compressor using data from a prototype peristaltic compressor. The second thrust will develop models for various electromechanical actuation technologies and inform the most appropriate HVAC&R applications for the peristaltic compressor.

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

**PI/PD:** Craig Bradshaw

**Efficient Prediction of Low Reynolds Number Propellers for Quiet UAS Aerial Platforms**

OSU will develop a semi-empirical method of predicting low Reynold’s Number propeller operation. The goal is to develop an approach that will help engineers rapidly incorporate quiet propeller design philosophy into a larger quiet aircraft design methodology. OSU will incorporate high fidelity CFD methods and empirical scaling trends as acquired through experimentation. The NASA Langley Research Center will collaborate with OSU and provide test data from their aeroacoustic wind tunnels for analysis development and validation. Data from NASA will be from propellers loaded with freestream flow from their Low Speed Aeroacoustic Wind Tunnel.

**Sponsor:** University of Oklahoma, Oklahoma NASA EPSCoR

**PI/PD:** Rick Gaeta

**Support for Navy SBIR Phase II – Human Computer Interfacing (HCI) for Autonomous Detect and Avoid (DAA) Systems on Unmanned Aircraft (UAS)**

Dr. He Bai at Oklahoma State University (OSU) shall provide research and development support for the SBIR Phase-II program to UtopiaCompression Corporation (UC). Dr. Bai will hire a student at OSU to provide support in the R&D for a period of two years. The deliverables are: 1) DAA Manager formulation, 2) Module to solve DAA Manager formulation, 3) Command blending model and module implementation, 4) Experiment results to show utility and performance of DAA Manager and command blending.

**Sponsor:** UtopiaCompression Corporation for United States Navy

**PI/PD:** He Bai

**2019/2020 Aerospace Propulsion Outreach Program (APOP) – Windmill Prevention and Thrust Vectoring**

Senior undergraduate students will work as a team for program planning, budgeting, designing, fabricating, assembling, and testing a modified JetCat P100. In fall 2019, undergraduate students will design, build and test an altitude engine test stand to determine the windmill prevention load force with an unmodified engine. Students will also begin conceptual and preliminary design for modified engine components for windmill prevention and thrust vectoring. In spring 2020, students enrolled in the OSU Aerospace Engineering capstone design course (MAE 4374) will complete design, build and test of a modified engine, demonstrating windmill prevention and thrust vectoring capabilities.

**Sponsor:** Universal Technology Corporation for Air Force Research Laboratory

**PI/PD:** Kurt Rouser

**Doctoral Dissertation Research: Spatial Structure of Turbulent Flows in the Atmospheric Boundary Layer**

The Co-PI will make 21 two-day trips to collect data across the various ecoregions of Oklahoma that contain Oklahoma Mesonet sites. Data collection near a Mesonet site is important to allow for simultaneous collection of accurate surface conditions.

**Sponsor:** National Science Foundation

**PI/PD:** Brian Elbing

**Turboelectric Unmanned Aircraft Sensor System for Oil and Gas Pipeline Inspection**

The overall goal of this two-year project is to develop and evaluate a turboelectric unmanned aircraft sensor system to determine its feasibility as an economical means for inspecting and monitoring oil and gas pipelines for safety and integrity. A system-level approach will be taken to determine feasibility of both fixed-wing and rotary-wing applications, developed in series with a focus on versatility using interchangeable components. The hypothesis is that a turboelectric unmanned aircraft sensor system will have significantly greater range and endurance than current battery-powered systems, thereby reducing the operating cost of inspecting and monitoring oil and gas pipelines.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Kurt Rouser, Jamey Jacob

**Develop Design Criteria for Psychrometric Air Sampler and Mixer Apparatus for Use in ASHRAE Test Standards**

The objective is to provide: 1) Design recommendations for measuring bulk air conditions (a) “samplerless” RTD grids, (b) Sampling trees, and (c) Air mixers to provide uniform air conditions for the above; 2) Methods for validating performance of a sampler and mixer combination that would provide the most accurate bulk temperature and humidity measurement at indoor air inlet and indoor air outlet. The project covers developing the testing methods for the mixers, developing new mixers and air samplers, developing their performance, and evaluating overall in-situ performance of the newly developed devices with coil tests.

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

**PI/PDs:** Christian Bach, Omer San

**Identification of the Physical Mechanism Responsible for Tornado Infrasound**

The objective is to identify and test physically-reasoned correlations between infrasound and tornado flow-field properties, which will suggest potential fluid mechanisms for the infrasound production. The central hypothesis is that infrasonic emissions from tornadoes are unique and directly related to core pressure, wind speed, forward speed, and overall size. Three specific goals to test this hypothesis are: 1) Identify infrasonic events associated with severe storms, 2) Characterize flow-fields of identified infrasonic events, and 3) Develop a physically-reasoned empirical model. At the project’s completion, we expect to have identified correlations between tornadic infrasonic signatures and the tornado circulation and size.

**Sponsors:** United States Department of Commerce National Oceanic and Atmospheric Administration

**PI/PD:** Brian Elbing

**Physics-reinforced Machine Learning Algorithms for Multiscale Closure Model Discovery**

At the conclusion of the project period, we will have a computational toolbox that generates and takes large turbulence data sets as input and extracts functional and structural closure models without assuming any phenomenological assumptions on turbulence physics. Development of such physics-reinforced learning algorithms and architectures, which are a core strength of the research, will provide a basis to generate predictive technologies for a broad spectrum of engineering and science applications including pattern classification and scale bridging of hierarchical climate simulations.

**Sponsors:** Department of Energy

**PI/PD:** Omer San

**Non-contact, in vivo Measurement of Hyper-Elastic Response of Bio-Membranes for Predicting Traumatic Injuries**

The objective of this work is to develop a novel non-contact, in vivo testing framework for measuring the hyper-elastic mechanical properties of soft bio-membranes. The PI proposes to use full-field three-dimensional (3D) fluorescent technique in connection with high-speed microscopic photography to detect the deformation of bio-membranes under bulge pressure loading. An inverse problem methodology will be adopted by combining finite element method (FEM) simulation and numerical iterations to obtain the bio-membrane’s full-field response so that a full ‘map’ of localized biomembrane properties can be obtained.

**Sponsors:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Shuodao Wang

**Joint Industry Project for the Quantification of Fluid Phase Kinetics in Hydrocarbons Phase 2**

Phase 2 will consist of two research aims: 1) Quantify the impact of inlet conditioning on gas evolution rates, 2) Quantify the effect of production chemicals on gas evolution rates. For both research aims, the impact of temperature on gas evolution rates will also be evaluated. These research aims build on the Phase 1 work that showed the importance of both shear and crude oil heterogeneity on gas evolution rates.

**Sponsors:** Exxon-Mobil Upstream Research Company, Anadarko Petroleum Company, Chevron U.S.A. Inc., Equinor AS

**PI/PDs:** J.P. Conner

Chemical Engineering: Clint Aichele, Sayeed Mohammad

**Research on Inflatable Kite Technology**

This visiting research scholar program will include: 1) inflatable technology development, 2) kite dynamics modeling, 3) designing and building up the flight system, 4) validation of the system.

**Sponsor:** Toyota Motor Corporation

**PI/PD:** Jamey Jacob

**Assessment of Radiation Shielding Properties of Novel and Baseline Materials External to ISS**

The project will test and measure the radiation shielding and other properties of the multifunctional materials developed in previous awards. In this project, the materials will be tested in the actual space environment external to the International Space Station.

**Sponsor:** National Aeronautics and Space Administration

**PI/PDs:** Andy Arena

School of Materials Science & Engineering: Ranji Vaidyanathan

Department of Physics: Eric Benton

**Application of Raman and Infrared Microscopy for the Forensic Examination of Automotive Clear Coats and Paint Smears**

Current approaches by PDQ, the largest forensic automotive paint database, to identify clear coats have been unsuccessful because the FTIR spectra of clear coats are too similar to generate accurate hit lists by searching clear coat FTIR spectra alone. Recent studies of pattern recognition methods applied to FTIR spectra of clear coats show that information about the line and model of the vehicle can be obtained from these spectra. To enhance the discrimination power of clear coats, Raman spectroscopy and pattern recognition techniques will be investigated as a solution to the problem of extracting investigative lead information from clear coats.

**Sponsor:** U.S. Department of Justice

**PI/PDs:** Kaan Kalkan

Arts & Sciences: Barry K. Lavine

**Reducing Time to Market for Commercial AC Equipment through Development of a Simulation Platform for Multi-Circuit Evaporator Coil Performance**

The research focuses on the development of a new heat exchanger simulation model for multi-circuited heat exchangers. This model will include consideration of cross-fin conduction for multi-circuited coils. The new model will be implemented into Johnson Controls International’s (JCI’s) simulation platform to allow usage for coil design with graphical user interfaces. The model will allow JCI a more competitive product development process.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Christian Bach, Craig Bradshaw

**Collaborative Research: The Roles of Inter-limb Jets and Body Angles in Metachronal Swimming of Crustaceans**

This project examines how small-scale interactions between adjacent limbs of crustaceans coalesce with large-scale flow past the body. Recent robotic models show the formation of suction and expulsion jets between adjacent paddles due to their time-varying geometry that is dictated by the phase difference in motion. Self-propelling metachronal swimming robots will be developed to examine swimming of individuals and aggregates. The findings will provide insight into crustacean foraging, and how schooling behavior in krill is influenced by hydrodynamic cues. Understanding functional roles of pleopod kinematics and body shape on swimming performance will identify biomimetic design principles for autonomous underwater vehicles.

**Sponsor:** National Science Foundation

**PI/PD:** Arvind Santhanakrishnan

**Fundamental Study of the Ultra Precision Machining and Near Surface Damage Evolution in Single Crystal Fluorides for Advanced Optics**

The objective is to test the hypothesis that degradation in optical performance of single crystal calcium fluoride that has been finished by ultra-precision machining is directly related to the nature and extent of the near surface damage introduced. The research will utilize specially designed cutting experiments on single crystal calcium fluoride to investigate the crystal response to machining with single crystal diamond tools. Three cutting geometries will be considered. After surface generation, the resulting subsurface damage will be investigated with Rutherford backscattering spectrometry and cross sectional transmission electron microscopy. Changes caused by machining to transmissivity and birefringence will be quantified.

**Sponsor:** National Science Foundation

**PI/PD:** Don A. Lucca

**Photolytic Nanoconjugate Fuel Generators**

The long-term goal is to develop a novel fuel-generating (H2 and CO from water and CO2) photoelectrochemical (PEC) device, which consists of a metal oxide semiconductor nanowire decorated with metal nanoparticles. The investigator hypothesizes electronic, electrostatic and plasmonic mechanisms, which are unique to the nanoconjugate device structure and materials. These hypothetical attributes will be verified and elucidated by designed experiments. Based on encouraging preliminary results using sol-gel prepared vanadium oxyhydrate nanowires coated with nanogold (5.6% light-to-hydrogen efficiency with H2 to O2 ratio of 2.0 under 445 nm radiation), the project aims at high conversion energy and stability.

**Sponsor:** National Science Foundation

**PI/PD:** Kaan Kalkan

**The Efficacy and Safety of Silicone O-ring Intrauterine Devices as a Horse Contraceptive Through a Captive Breeding Trial**

The purpose is to complete research on the safety and efficacy of an IUD device that has high potential value in feral horse population management and control. Earlier research has shown near 100% contraception when the devices are retained in mares. We are testing a modified IUD, designed for higher retention in the mare. Two years of research have been completed (FY16‐17) on the work described in the supporting CESU agreement (G16AC00050) and project study plan, and this agreement will enable two additional years of direct evaluation of IUD retention rates and biophysical reaction of female horses to IUDs.

**Sponsor:** U.S. Geological Survey

**PI/PDs:** Shuodao Wang

Center for Veterinary Health Sciences: G. Reed Holyoak, Candace Lyman

**Effect of Inlet Duct and Damper Design on ASHRAE 37/116 Fan Performance and Static Pressure Measurements**

The objective of this project is to develop an inlet duct design guideline for inclusion into the AHRI and ASHRAE testing standards. This guideline will reduce the risk of false testing failures and lead to a higher integrity of the testing results across different laboratories. The guideline will reduce the design space towards a set of configurations and report the resulting performance differences relative to reference configuration.

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

**PI/PDs:** Christian Bach, Omer San

**Experimental Validation of Refrigerant Charge Models in Coils for Residential Split Systems**

The goal of the project is to provide high quality data for oil retention and refrigerant charge in fin-tube heat exchangers. The objectives are: 1) Develop a test methodology for measuring both oil retention and refrigerant charge of round tube, plate fin (RTPF) heat exchangers, 2) Obtain oil retention and refrigerant charge data for several sets of 3-ton indoor/outdoor heat exchangers and reduce the results such that it can be used for validation of simulation models, 3) Determine local vapor-liquid fractions in subsections of the heat exchanger.

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

**PI/PDs:** Christian Bach, Craig Bradshaw

**SNM: Roll-to-Roll Nanoimprint Manufacturing of Metasurfaces for Photonic and Optoelectronic Applications**

Roll-to-Roll Nanoimprint Lithography is expected to overcome many limitations of current batch imprint techniques, including large area and high throughput patterning, easy demolding and lower cost. The potential for creating engineered surfaces leading to new products is significant, such as wire-grid polarizers, anti-reflective surfaces, and nanogratings for novel color filters for use in displays. This potential will be demonstrated in this project by manufacturing metasurfaces known to be useful in optical communication, information processing, laser systems and to improve the efficiency of LCD displays.

**Sponsor:** National Science Foundation

**PI/PDs:** James K. Good, Don Lucca

**Modification of Near-Wall, High-Reynolds Number Velocity Profiles with Polymer Solution**

This project experimentally examines how drag-reducing polymer solutions modify the near-wall region of a high-Reynolds number turbulent boundary layer. While this has been thought to be well understood for decades, recent numerical and experimental data show significant deviation from the classical view. Available data shows a non-universal behavior when the drag reduction is above 40%, which can only be partially explained by a Reynolds number effect. Consequently, the behavior must be dependent on polymer properties. Thus this project measures the near-wall region at various values of drag reduction, Reynolds number and polymer properties (Weissenberg number, viscosity ratio, and length ratio).

**Sponsor:** National Science Foundation

**PI/PD:** Brian Elbing

**Metamaterials Inspired Nonlinear and Inertant MEMS Devices**

This project will investigate development of MEMS devices that incorporate metamaterial concepts. Further research on the mechanisms involved as well as interactive synergies between combinations of nonlinear and inertant microstructures along with a focus on practical strategies to scale and fabricate such designs could provide a promising first step in the direction of developing a new class of MEMS devices. Potential applications include vibration and shock isolation of sensitive electronics, broadband transduction and energy harvesting, frequency manipulation, wave steering and focusing, and amplitude-triggered mechanical encryption, all of which are significantly aligned with defense-related interests.

**Sponsor:** Defense Advanced Research Projects Agency

**PI/PD:** James Manimala

**Inflatable Structures Feasibility Studies**

OSU shall perform tasks in support of the development of inflatable structures on a scale model to evaluate and develop design, deployment, and control methods.

**Sponsor:** Toyota Motor Engineering & Manufacturing North America (TEMA)

**PI/PD:** Jamey Jacob

**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, Inc. for National Institute of Standards and Technology

**PI/PDs:** Daniel E. Fisher,

Division of Agricultural Sciences & Natural Resources: Daniel Thomas

**Design of an Airplane Transporting System**

The goal of this project is to complete the full research, conceptualization and design for a 90 degree curve that is bounded on each end with a 15 meter straight section of the underground airplane conveyance system presented to Oklahoma State University by Airplane Transport Systems. The design process will be completed in 18 months with all documentation necessary to fabricate and install the system for testing with an aircraft.

**Sponsor:** ATC World Wide, LLC

**PI/PDs:** James Kidd

Civil and Environmental Engineering: Julie Hartell, Mohamed Soliman

Electrical and Computer Engineering: Nishantha Ekneligoda

New Product Development Center: Robert Taylor

**Electromagnetic Strategies for Locatable Plastic Pipe**

Oklahoma State University will provide access and expertise for the operation of the labscale

extrusion system located in the Helmerich Advanced Technology Research Center.

The partially supported graduate student will run extrusion experiments and help the

University of Tulsa researchers optimize extrusion parameters to meet the technical needs

of the proposed research project.

**Sponsor:** The University of Tulsa for the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration

**PI/PD:** Raman P. Singh

**Sensor and Information Research Center for Understanding Systems**

The objective is to investigate properties of statistical observability and its interaction with controllability. When designing a statistical estimator, the goal is generally to minimize uncertainty of the output below some threshold amount. In linear systems, this is simplified by the fact that performance of the estimator is solely a function of the system itself and the inputs. In real-world systems, however, the control inputs can have a significant impact on performance of the estimator. This project will investigate tools to help estimate what the impact of different control inputs will be on statistical observability of a nonlinear system.

**Sponsor**: Wright State University for Air Force Research Laboratory

**PI/PD:** He Bai

**UNS: Collaborative Research: Role of Bristled Wings for Flying and Swimming at Low Reynolds Numbers**

Although the aerodynamic principles of insect flight at the scale of fruit flies and above are reasonably well understood, the fluid dynamic mechanisms that enable very tiny insects to generate lift or thrust remain unclear. This research will elucidate the fluid dynamic principles used by tiny insects for lift and thrust production under substantial viscous resistance at low Reynolds numbers (Re) from 1-100. Two types of insects will be examined, including: 1) thrips, which are capable of migration between orchards in air, and 2) parasitoid wasps with a focus on fairyflies capable of flying in air and swimming in water.

**Sponsor:** National Science Foundation

**PI/PD:** Arvind Santhanakrishnan

**RII Track-2 FEC: Unmanned Aircraft System for Atmospheric Physics**

Small Unmanned Aircraft Systems (SUAS) have the potential to become an invaluable diagnostic tool for atmospheric science and operational meteorology. However, many scientific, technical, societal, and regulatory challenges must be solved before this can happen. The team of four universities across three EPSCoR jurisdictions, including atmospheric scientists, meteorologists, engineers, computer scientists, geographers, and chemists, will develop integrated smart unmanned aircraft technologies including advanced sensing and imaging, robust autonomous navigation, enhanced data communication capabilities, and data management tools. The team will also address public policy challenges related to adoption of UAS technology and integration of unmanned aircraft into the NAS.

**Sponsor:** National Science Foundation

**PI/PDs:** Jamey Jacob, Brian Elbing

College of Arts & Sciences: A. Frazier, C. Crick

**Fundamental Studies on Sintering of Amorphous Alloys, Composites and Coatings**

This work investigates basic phenomena associated with spark plasma sintering (SPS) of Fe-based amorphous alloys. The theme of the work is that the unique mechanisms of SPS sintering, including Joule heating at the particle contacts under the simultaneous influence of pulsed direct current and uniaxial pressure, will help retain amorphous structure in the sintered compacts without undesirable crystallization. A plan is proposed to overcome the challenges associated with conventional solidification processing through innovative approaches: 1) SPS of bulk amorphous alloys, 2) SPS of in-situ (crystallization induced) and ex-situ (particulate reinforced and laminated) composites, and 3) SPS of amorphous composite coatings.

**Sponsor:** National Science Foundation

**PI/PD:** Sandip P. Harimkar

**Robust Adaptive Autonomy in Contested Environments**

Unmanned Aircraft (UA) have seen deployment and success in diverse battle arenas, however, the current heavily-supervised UA operation paradigm is not well matched with emerging needs of conflict. This work includes development of novel adaptive learning and decision-making algorithms that can provide robust mission performance in dynamically changing contested environments. The approach departs from the emerging theory of Bayesian Nonparametric modeling, leading to: 1) New scalable nonparametric predictive models and inference techniques for stochastic nonstationary processes with both long-term and abrupt changes; 2) Adaptive decision making algorithms that utilize these models for collaborative decision-making in uncertain, nonstationary, and contested environments.

**Sponsor:** Air Force Office of Scientific Research

**PI/PDs:** Girish Chowdhary, Dan Fisher

**NASA Oklahoma Space Grant 2015-2019**

The NASA Oklahoma Space Grant Consortium includes numerous affiliates in the state including eight universities, two community colleges, two industrial affiliates, two informal science education affiliates, research center affiliate, and city government affiliate. The affiliates use NASA funding to develop programs for students to meet NASA goals. Some of the programs at OSU that receive this funding include Speedfest, Mission to Planet Earth, X-Hab, and OSU American Institute of Aeronautics and Astronautics High-Power Rocketry Team.

**Sponsor:** University of Oklahoma for NASA

**PI/PD:** Andy Arena

**EnergyPlus Whole-Building Modeling and Simulation Software Development**

EnergyPlus is a key part of DOE’s building energy-efficiency strategy. In its ongoing program implementation and technical management efforts, the National Renewable Energy Laboratory (NREL) requires the assistance of OSU to provide technical support for new features development and for software defects resolutions.

**Sponsor:** Alliance for Sustainable Energy, LLC for National Renewable Energy Laboratory

**PI/PDs:** Matt Mitchell, Dan Fisher, Jeff Spitler

**Collaborative Research: Manufacturing of Complex Lenses for Thermal Imaging, Night Vision and Surveillance Systems**

The objective is to test the hypothesis that when diamond milling brittle materials, the material response and character of the resulting surface and subsurface depends not only on the geometry of the tool-workpiece interaction, but also on the non-steady state nature of the process. Because of the effect on material response, some materials that are not practically diamond turnable can be machined by diamond milling. Research tasks include: 1) Design and construction of a simplified milling configuration, 2) Generation of machined specimens, 3) Surface and subsurface characterization. The outcome will identify conditions for more productive diamond milling of materials.

**Sponsor:** National Science Foundation

**PI/PD:** Don A. Lucca

**Radiation Smart Structures with H-rich Nanostructured Multifunctional Materials**

Through this NASA EPSCoR award, radiation smart structures and materials with H-rich nanostructured multifunctional materials will be developed and built for shielding astronauts from ionizing radiation during human missions beyond low-Earth orbit. The approach is interdisciplinary and involves research groups in Materials Science and Engineering at OSU Tulsa, the Dept. of Physics and Mechanical and Aerospace Engineering at OSU Stillwater. The research will find applications in a number of radiation based industries including medical physics and nuclear power generation in which high-strength, lightweight radiation shielding materials and appliances are needed.

**Sponsor:** University of Oklahoma for NASA EPSCoR

**PI/PDs:** Raman Singh

Materials Science and Engineering: Ranji Vaidyanathan

Physics: Eric Benton

**NUE: Nanotechnology Education for Roll-to-Roll Manufacturing**

Roll-to-Roll (R2R) manufacturing of flexible materials offers advantages over batch processing, including better yields, high speed automation, and potential to mass produce finished materials at lower costs. Since R2R manufacturing and the broader paradigm of additive manufacturing are seen as essential parts of advanced manufacturing, it is essential that these topics are introduced to undergraduate students. The goal is to educate undergraduate students in core nanotechnology topics for high precision R2R manufacturing.The investigators will develop curriculum material in nanotechnology and high precision R2R manufacturing in six undergraduate courses: Introduction to Engineering, Measurements, Manufacturing Processes, Mechatronics, Automatic Control, and Vibrations.

**Sponsor:** National Science Foundation

**PI/PDs:** Matthew Klopfstein, Don A. Lucca

**Determining the Environmental Flows Needed to Support the Federally-threatened Arkansas River Shiner Notropis Griadi and Associated Assemblage**

Objectives include: 1) Develop relationships between flow regime and fish diversity and abundance using existing assemblage data across the Southern Great Plains, 2) Identify the discharge(s) that maintains channel complexity under current channel morphology, 3) Determine the relationship among habitat connectivity and flow and identify refuge habitats that persist during low-flow periods.

**Sponsor:** U.S. Fish and Wildlife Service

**PI/PDs:** Jamey Jacob

Natural Resource Ecology and Management: Shannon Brewer

Biosystems and Agricultural Engineering: Garey Fox

**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 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:** Leibniz Institute for Materials Engineering IWT

**PI/PD:** Don A. Lucca

**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/PDs:** Keith Good, Karl Reid

**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 Center

**PI/PD:** Keith Good

**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 Center

**PI/PD:** Keith Good

**NEW PRODUCT DEVELOPMENT CENTER**

**Minimally Invasive Animal Sterilization**

The NPDC engineering team will improve on the basic dual needle/dual syringe configuration that was developed for the initial testing reported.  The goals are: 1) investigate syringe/needle materials that do not degrade under the influence of the chemical compounds in use, 2) improve the dual syringe holder to make it easier for the user to handle, 3) develop a method for producing well bonded dual needle sets.  The NPDC engineering team will investigate improved methods for bonding the two needles being used in the injector configuration. The team will also produce needle sets and syringe holders for all test trials.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Robert Taylor

College of Veterinary Medicine: Ashish Ranjan

**Development of a Fluid Turbulator for Use in Hydrocarbon Burner Tubes to Reduce Coking**

XRG Technologies, in collaboration with OSU’s New Product Development Center (NPDC), will develop a fluid turbulator for use in hydrocarbon burner tubes to reduce coking. The NPDC will be responsible for fabrication and testing of the turbulators.

**Sponsor:** XRG Technologies, LLC for the Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Robert Taylor

**Optimization of Flow and Disbursement for Green Fire Suppression Agent**

SpectrumFX, in collaboration with the OSU New Product Development Center, will plan, design, test and optimize a new green fire suppressant system that may possibly replace existing systems in a variety of fields. The first effort will model the system, defining optimum operating parameters and physical nozzle configuration. The model results will be used to design a fire suppression system with nozzles matching the model, all of which will then be tested and verified by a Phase Doppler Interferometer. The project will also include the fabrication and field testing of the first prototype system.

**Sponsor:** Spectrum FX for the Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Robert Taylor

Chemical Engineering: Clint Aichele

Fire Protection and Safety Technology: Haejun Park

**Commercialization of a novel single-use bioreactor**

Specific aims include: 1) Design and fabricate a 2 to 200 L, two-chamber bioreactor from flexible, pharmaceutical grade plastic film, 2) Perform a ‘design for manufacturing’ analysis of the bioreactor and incorporate design changes necessary to accommodate large scale manufacturing, 3) Develop an operating procedure and evaluate the performance of the 2 to 200 L bioreactor by growing a Chinese hamster ovary cell line that produces the recombinant protein IgG, 4) Build a manufacturing process to produce multi-chamber bioreactors.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Robert Taylor

Chemical Engineering: Josh Ramsey

**Design of an Airplane Transporting System**

The goal of this project is to complete the full research, conceptualization and design for a 90 degree curve that is bounded on each end with a 15 meter straight section of the underground airplane conveyance system presented to Oklahoma State University by Airplane Transport Systems. The design process will be completed in 18 months with all documentation necessary to fabricate and install the system for testing with an aircraft.

**Sponsor:** ATC World Wide, LLC

**PI/PDs:** Robert Taylor

Civil and Environmental Engineering: Julie Hartell, Mohamed Soliman

Electrical and Computer Engineering: Nishantha Ekneligoda

Mechanical and Aerospace Engineering: James Kidd

**Establishing a Working Prototype Development Program**

OSU’s New Product Development Center (NPDC) assists Oklahoma’s industry, inventors, and entrepreneurs with their product and process development, technology commercialization, and technical needs. NPDC clients often lack the resources to develop working prototypes. With this Economic Development Administration grant, NPDC will launch a working prototype development center at the OSU Institute of Technology, allowing NPDC clients to have all the necessary resources for a successful path from concept to commercialization.

**Sponsor:** U.S. Department of Commerce Economic Development Administration

**PI/PDs:** Robert Taylor

**Oklahoma Inventors Assistance Service**

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.

**Sponsor:** Oklahoma Center for the Advancement of Science and Technology

**PI/PDs:** Robert Taylor, Jessica Stewart

**PROFESSIONAL DEVELOPMENT**

**MSA RFP 326668 Customized Fire Suppression Systems Inspection, Testing, and Maintenance Training**

CEAT Professional Development will deliver a 2-day - 20 hour Customized Fire Suppression Systems, Inspection, Testing & Maintenance training course, and a 2-day - 20 hour Customized Fire Alarm Systems Inspection, Testing & Maintenance training course. The training courses will meet all the requirements of the Statement of Work (SOW) provided by the Mission Support Alliance (MSA).

**Sponsor:** Mission Support Alliance, LLC for the Department of Energy

**PI/PD:** Brandy Mays

**MSA RFP 312060 Customized Fire Suppression Systems Inspection, Testing, and Maintenance Training**

CEAT Professional Development will deliver a 4-day - 32 hour Customized Fire Suppression Systems, Inspection, Testing & Maintenance training course, and a 4-day - 32 hour Customized Fire Alarm Systems Inspection, Testing & Maintenance training course. The training courses will meet all the requirements of the Statement of Work (SOW) provided by the Mission Support Alliance (MSA).

**Sponsor:** Mission Support Alliance, LLC for the Department of Energy

**PI/PD:** Brandy Mays

**Highway Construction Materials Technician Training & Certification Program**

The College of Engineering, Architecture, and Technology (CEAT) at OSU is partnering with the Oklahoma Department of Transportation for the administration, management and delivery of the Training and Certification Program (HCMTP) for the Oklahoma Highway Construction Materials Technician Certification Board. This program serves ODOT, the Oklahoma Turnpike Authority, and the transportation construction industry. OSU CEAT assumes responsibility for all aspects of HCMTP training and certification including program training, certification, program administration, record keeping, and equipment upkeep and maintenance.

**Sponsor:** Oklahoma Department of Transportation

**PI/PDs:** Brandy Mays

Civil Engineering: Stephen A. Cross

**OSU as an Authorized OSHA Training Institute Education Center**

OTI Education Centers are a national network of non-profit organizations authorized by OSHA to deliver occupational safety and health training to private and public sector workers, supervisors, and employers on behalf of OSHA. The OTI Education Centers Program supports OSHA’s training and education mission through a variety of safety and health programs.

OTI Education Center courses include OSHA standards and Outreach Training Program trainer and update courses. The OTI Education Centers offer more than 50 courses on various safety and health topics including recordkeeping, machine guarding, confined space, electrical standards, ergonomics, safety and health management, and fall protection.

**Sponsor:** United States Department of Labor – Occupational Safety and Health Administration

**PI/PD:** Clayton Moorman

**DIVISION OF ENGINEERING TECHNOLOGY (TECH)**

**Performance of Flame Mitigation Device**

This research is in the area of flame jetting phenomena from portable gas cans. Multiple fire experiments will be conducted at the OSU Fire Safety Laboratory.

**Sponsor:** Midwest Can Company

**PI/PDs:** Haejun Park, Rob Agnew

**Micro Computer Integrated Rifle**

OSU will support Casey Corp Defense LLC under STTR phase 1 and phase 2 awards. Dr. Vora will represent OSU in this project and will use OSU licensed for CAD software and FEA software as well as OSU CEAT Endeavor, SMART Manufacturing Lab, and other OSU facilities and equipment to manufacture/fabricate a functional hard proof prototype (only housing) that houses the MCIR Controls and other electronics devices.

**Sponsor**: Casey Corps Defense, LLC

**PI/PD:** Hitesh Vora

**State Space Modeling and Parameter Identification of Induction Motors for Fault Diagnostics and Prognostics**

The objective is to develop a model-based fault diagnostics and prognostics scheme for induction motors, with linear/nonlinear state space model(s) and parameter identification algorithms, for online condition monitoring. The scheme can be utilized for detection and isolation of various internal and external faults. The variation in the model states and parameters, when compared to the actual states and parameters, will be used as condition indicators for the predictive models to determine the remaining useful life of the motor. **Sponsor**: The DEI Group

**PI/PD:** Avimanyu Sahoo

**IAFC Climate Culture Survey**

Tasks include: 1) Explore the literature for validated measures related to organizational culture and organizational diversity; 2) Construct questionnaire; 3) Pilot test the questionnaire; 4) Conduct preliminary analysis on the data, discuss results with IAFC partners, and develop customized, department-level reports; 5) Finalize and submit final report on the survey and instructional guide to IAFC.

**Sponsor**: International Association of Fire Chiefs

**PI/PD:** Haley Murphy

**Flame Mitigation**

Multiple fire experiments will be conducted at the OSU Fire Safety Lab to study jetting fire from portable gas containers. For each portable gas container size that contains the prescribed fuel amount, two variables will be tested: 1) Flame Mitigation Device (with and without) and 2) gasoline type (weathered and fresh). Each test will be repeated three times to confirm the test results. If jetting occurs in a portable gas container with a flame mitigation device installed, the test will be repeated for further confirmation.

**Sponsor**: TPG Plastics, LLC

**PI/PDs:** Haejun Park, Rob Agnew

**Safe Quantity of Open Medical Gas Storage in a Smoke Compartment**

Although NFPA 99 allows medical gas up to 300 ft3 to be stored outside of dedicated storage, it is not clear how to determine the volume of gas remaining in the gas cylinder or the cylinder size itself. To provide a requirement as low as reasonably practicable, fire risk assessment associated with the medical gas amount is necessary. The research aims to identify risk associated with the medical gas (normally pure oxygen) and its stored amount based on thorough literature review. Based on this, a guidance to enhance understanding on the fire hazards of the medical gas is proposed.

**Sponsor**: Fire Protection Research Foundation

**PI/PD:** Haejun Park

**Household Risk Perceptions and Hazard Adjustments to Earthquakes in Oklahoma**

The project will result in a significant progression in fundamental understanding of risk, providing emergency managers with key information they can use in the development of emergency management plans and campaigns to encourage the adoption of hazard adjustment measures. Objectives include: 1) to understand Oklahoma household’s view of recent earthquakes, their earthquake risk perceptions, and their levels of adjustment to the seismic hazard, 2) to investigate the ways in which emergency management researchers can increase their mail survey response rate, and 3) to gain insight on minority groups’ earthquake risk perception and adjustment levels in Oklahoma.

**Sponsor**: National Science Foundation

**PI/PD:** Tristan Wu

**An Examination of Household Risk Assessment Judgments and Protective Action Decisions During Tornado Threats**

The project will advance knowledge about households’ dynamic decision making process in response to tornado threats. Objectives include: 1) Understand the extent of each household member’s tornado risk information preference and how that is related to their risk perceptions and expected protective actions, 2) Identify the difference between each individual’s protective action decisions and household’s joint protective action decisions, 3) Examine ways household members see agreement on protective action decisions, 4) Examine household decision making processes when individuals face an unfamiliar disaster, 5) Provide empirical research findings on household risk information preferences and decision-making processes to meteorologists and emergency managers.

**Sponsor:** University of North Texas for National Science Foundation

**PI/PD:** Haley Murphy

**Kangwon National Education Services Agreement**

This agreement is for the delivery of the Master of Science in Fire and Emergency Management Administration degree program offered by OSU to Kangwon National University and the National Fire Service Academy, Republic of Korea. Under the agreement, Kangwon National University will also offer a master’s degree enabling qualified students to receive a master’s degree from both OSU and Kangwon National University after completion of all degree requirements from the respective universities.

**Sponsor:** Kangwon National University

**PI/PD:** Haley Murphy

**RAPID/Collaborative Research: Households Immediate Response During a Night Time Earthquake**

The purpose of this RAPID proposal is to examine households’ earthquake risk perceptions and their night time immediate response following the 2018 Eastern Taiwan Earthquake, a magnitude 6.1 earthquake which stuck Taiwan at 11:50 p.m. on February 6, 2018.

**Sponsor:** National Science Foundation

**PI/PD:** Tristan Wu

**Flame Mitigation**

The main objective of this project is to check if a jet fire occurs when portable gas containers (PGCs) are tilted while being exposed to an external ignition source with and without a specifically designed Flame Mitigation Device installed. Three different sizes of PGCs (1.25 gal, 2.5 gal and 5 gal) are subject to the experiments.

**Sponsor:** Midwest Can Company

**PI/PDs:** Haejun Park, Qingsheng Wang

**Industrial Assessment Center Program**

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 continue to serve clients throughout Oklahoma, Arkansas, Kansas, and north and northwest Texas, including the Texas Panhandle. The latest technology will be employed to perform assessments that focus on energy, waste, and productivity issues in the clients’ facilities.

**Sponsor:** Department of Energy

**PI/PDs:** Hitesh Vora

**Understanding the Significance of Standards in Fire Protection and Related Fields**

The project involves creating seven 30-minute videos as a learning resource to be integrated into existing undergraduate, graduate, and professional development courses to educate students about the role of standards in the field of fire protection. The objective of the videos is to help students understand the standard development process and the applications of codes and standards. The standards to be addressed are product standards, installation and maintenance standards, and model codes.

**Sponsor:** National Institute of Standards and Technology

**PI/PDs:** Bryan Hoskins, Virginia Charter

**Public Safety Small Unmanned Aerial Systems Operations Training Baseline Materials & Usage Assessment**

The objective of this effort is to develop a curriculum that will address sUAS utilization across all operational settings including structural and wildland firefighting, search & rescue, hazardous material responses, natural disasters, and any other events in which public safety operations would benefit from use of drones.

**Sponsor:** Fire Protection Research Foundation, Inc. for the Federal Emergency Management Agency

**PI/PDs:** Rob Agnew, Haley Murphy

Mechanical & Aerospace Engineering: Jamey Jacob, James Kidd

Engineering Outreach and Extension: Ed Kirtley

Fire Service Training: Dean McFadden