**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:** Gary Snyder

**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:** Gary Snyder

**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**

**Electrochemical Energy Storage**

Through this Research Services Agreement, CIC energiGUNE will provide hard carbon materials for Na-ion batteries to OSU for research that is of mutual interest to the sponsor and the university. The material is suitable for Dr. Çapraz’s ongoing work on alkali-ion battery electrodes. The CIC team will benefit from Dr. Çapraz’s preliminary measurements.

**Sponsor:** CIC Energigune

**PI/PD:** Ömer Özgür Çapraz

**RII Track 1: Socially Sustainable Solutions for Water, Carbon, and Infrastructure Resilience of Oklahoma – Science-Based Clumsy Solutions for Wicked Problems in Oklahoma**

The unifying research question is whether science-based assessment, coupled with systematic and iterative engagement with Oklahoma opinion leaders and input/feedback from members of the Oklahoma public, can result in development of socially sustainable solutions. The project will employ a framework informed by theories of public policy learning to invest in science at the intersections of four key focus areas that are important to Oklahoma: changing subseasonal to seasonal weather patterns, variable and marginal quality water supplies, shifting terrestrial water and carbon dynamics, and sustainable water and energy infrastructure.

**Sponsor:** National Science Foundation

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

Civil and Environmental Engineering: Mark Krzmarzick, Rifat Bulut

Arts & Sciences: Babu Fathepure, Yuting Zhou, Michael Long, Kristin Olofsson

DASNR: Kevin Wagner, Rodney Will, Dayton Lambert, Chris Zou, Gail Wilson

OU: Hank C. Jenkins-Smith, Carol L. Silva

**Reinforced Recycled Polymer Composites**

The technical approach is to mold recycled carpet as a reinforcement with recycled polymer resins from bottling operations to make novel materials. The deliverable materials will include compression and extrusion molded structures for construction applications, reparable pallets as replacements for wood pallets used for automated supply chain management. The pallets will have significant advantages over wood pallets, especially in food and beverage-related facilities.

**Sponsor:** Sustainable Manufacturing Innovation Alliance Corp. dba REMADE Institute

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

Materials Science and Engineering: Ranji Vaidyanathan, Raman Singh

**Flow Control Strategies for Protection of Aircraft Passengers and Workers Against SARS-CoV-2**

The team proposes to develop modular, low-cost active flow control (AFC) devices that can be retrofitted on existing aircraft seats for controlling airborne transmission of virus-containing aerosols. Using synthetic jet actuators that generate pulsed air jets, commercially-available axial fans and passive 3D printed nozzles, the concept relies on suction-based trapping of aerosols and redirection to exhaust slots near the floor. The proposed AFC device is intended to function within a hierarchy of controls, such that it can be used in conjunction with traditional measures and also incorporate emerging solutions for potential inactivation using ultraviolet light units.

**Sponsor:** Centers for Disease Control and Prevention

**PI/PDs:** Yu Feng

Mechanical and Aerospace Engineering: Arvind Santhanakrishnan, Jamey Jacob

**In Situ Characterization of Interfacial Instabilities in All-Solid-State Li-S Batteries**

Solid polymer electrolyte can mitigate undesired polysulfide shuttle effect and improve thermal stability of the batteries. However, solid-solid interactions at the electrode/electrolyte interfaces and large volumetric changes in sulfur and silicon electrodes during battery operations are major factors leading to low capacity retention. These factors also prevent discharging batteries at faster rates. This project proposes utilizing self-healing polymer networks in order to mitigate mechanical instabilities, which will lead to improved lifetime and faster discharge rates required for electrical propellers.

**Sponsor:** Skydweller US Inc. for U.S. Air Force

**PI/PD:** Ömer Özgür Çapraz

**Predicting Health Endpoints of Inhaled Nicotine/THC-Containing Aerosols in Human and Rat Respiratory Tracts to Optimize the Therapeutic Effects using CFPD-PBTK Models**

Mathematical modeling and computational analysis will result in these deliverables: (1) Virtual diffusion denuder and virtual VitroCell® for studying the fundamental condensation/evaporation of multi-component droplets with different compositions; (2) CFPD-PBTK modeling frameworks of human and rat respiratory systems with instruction manuals; (3) Simulation results of the transport, deposition/absorption, and translocation of nicotine/THC-containing aerosols in human and rat respiratory systems associated with different gas/particle partition inlet conditions; (4) Parametric analysis concerning key parameters influencing deposition/absorption/translocation patterns; (5) Pulmonary targeted nicotine/THC delivery plan by modulating nicotine/THC-containing liquid formulation, puffing pattern, and mouthpiece design of the drug delivery device in vaping system shape.

**Sponsor:** Spectrum Dynamics Research

**PI/PD:** Yu Feng

**SECARB Offshore Supplemental Funding**

This is a feasibility study on SECARB project-related geophysical, petrophysical, production, and infrastructure data interpretation and visualization using SAS Viya platform for ranking the reservoirs in terms their suitability for CCS and CO2 EOR.

**Sponsor:** Southern States Energy Board for Department of Energy

**PI/PD:** Prem Bikkina

**Solar-Energy-Combined Desalination Systems**

One graduate student in the Chemical Engineering Program will be the Project Lead. Three graduate students in the Civil & Environmental Engineering Program, the Physics Program, and the Sociology Program will be the Project Members. The student team will construct a solar evaporation and membrane process device. A successful demonstration has the potential to increase water supplies and reduce operational costs, energy consumption, and environmental impacts of wastewater management.

**Sponsor:** United States Environmental Protection Agency

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

Arts & Sciences: David McIlroy

**Mitigating infection risks to airborne SARS-CoV-2 laden aerosols in a patient room**

**via portable air sanitizers and smart ventilation control**

The goal is to numerically determine the optimal mitigation strategies using a portable air sanitizer to reduce the exposure risks for healthcare providers when closely interacting with COVID-19 patients in the patient room. To achieve the research goal, the team will employ an experimental validated computational fluid-particle dynamics (CFPD) model to predict the generation, transport, filtration, suspension, and deposition in a realistic patient virtual room, associated with different ventilation conditions of the room and operational conditions of the sanitizer.

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

**PI/PDs:** Yu Feng, Jianan Zhao

**Collaborative Research: Selective Flow through Membrane Pores with in situ Change of Wettability**

The need for membranes or meshes which can allow certain liquids to flow while others do not is high for biomedical and liquid-liquid separations. This function can be achieved by modifying physical (pore sizes, nanoparticles) or chemical (surface coating) characteristics of the membrane materials. These are usually set when prepared or manufactured, unable to change the functionality in situ. Through this project, the team plans to develop membranes for oil-water separation with the selectivity that can be changed in situ utilizing electrowetting provided by surface molecules on the membrane materials.

**Sponsor:** National Science Foundation

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

**Screening Reservoirs in Oklahoma and Beyond for Enhanced Oil & Gas Recovery Using Novel Nitrogen-Assisted Nanofluid Systems**

From the preliminary study conducted, it has been evident that the crude oil composition which changes from a reservoir to reservoir, composition of connate water which can also vary in a wide range, surface chemistry of the rock, and the rock-oil/gas-brine interactions dictate the percentage of recoverable oil using nanofluids, for which Nitro-Lift Technologies LLC, of Tishomingo, Oklahoma, is the master distributor in lower 48 states of USA. The objective of this proposal is to scientifically screen reservoirs in and beyond Oklahoma for cost-effective enhanced oil and gas recovery using the nanofluids.

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

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

**I-Corps Ceramic Membrane Systems for Produced Water Treatment**

The team developed ceramic membranes that can purify Produced Water (PW) by providing 99.5% salt rejection and total organic carbon (TOC) below 50 ppm, making it suitable for many applications. Through experimental results and industry surveys, the team estimated that cleaning water with the membrane technology would be 60-80% cheaper than what is being spent in industry for the treatment of PW. During the national NSF I-Corps national program, the team plans to perform ~100 customer discovery interviews to understand the requirements of industry better and then use that information to further improve its technology.

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

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

**Collaborative Research: Protein Engineering and Processing of Plant Viral Templates for Controlled Nanoparticle Synthesis**

This project develops Barley stripe mosaic virus (BSMV) as a novel biotemplate for nanoparticle synthesis. This work will elucidate structural details about how BSMV capsid proteins self-assemble and provide insight into the organic-inorganic interactions involved in metal deposition on biotemplates. Design rules will be established that determine BSMV Virus-Like Particle length scales. The role of specific amino acids in metal mineralization will be interrogated to understand mechanisms of nanoparticle-templating. Residues in the Caspar carboxylate cluster will be identified that are critical for viral assembly to strengthen capsid protein interactions and stabilize the template for nanoparticle synthesis under broader processing regimes.

**Sponsor:** National Science Foundation

**PI/PDs:** Shohreh Hemmati

Purdue University: Kevin Solomon, Michael T. Harris, L. Sue Loesch-Fries

**Characterization of Catalytic Materials by Advanced NMR Methods**

The purpose 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 Company

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

**Elucidating the Link Between Alkali Metal Ions and Reaction-Transport Mechanisms in Cathode Electrodes for Alkali-ion Batteries**

The objective is to identify the intrinsic relationship between the role of alkali metal-ions, and electrochemically-driven mechanical stability and kinetic properties of battery materials. The hypothesis is that intercalation of larger alkali metal-ions (Na and K) inevitably alters the coupled transport-reaction processes during battery operation in organic electrolytes, leading to more intensive chemo-mechanical instabilities in cathode electrodes, resulting in rapid capacity fade. To validate the hypothesis, the team will experimentally characterize the reaction-transport processes and governing forces driving the instability of electrode materials in different alkali metal-ion environments. Dr. Capraz will collaborate with Dr. Murugesan at Pacific Northwestern National Laboratory.

**Sponsor:** Department of Energy

**PI/PD:** Ömer Özgür Çapraz

**Evaluation of COVAS Effectiveness on the Clearance of the COVID-19 Aerosols in a Patient Room and a Restaurant (2nd Phase)**

The goal of the 2nd phase of this project is to evaluate the clearance efficiency of the novel COVID air sanitizer (COVAS) of the suspending cough droplets with a much higher mass flow rate than was used in the 1st phase of the project in a COVID-19 patient room, and the effectiveness of the COVAS in a virtual restaurant environment (multiple tables).

**Sponsor:** Coveng Limited

**PI/PD:** Yu Feng

**Produced Water Treatment Fueled by High Value Product Extraction**

The purpose of this project is to transform produced water from a waste to a resource by developing an efficient separation strategy for removing hydrocarbons through the synergy of silica nanoparticles and inorganic membranes while also removing valuable resources including rare earth elements. The first aim will focus on the development of microporous, inorganic membranes to increase energy efficiency and cost savings in oil/water separations. The second aim focuses on testing the silica-modified inorganic membranes in a continuous system using produced water provided by D&B Oilfield Services.

**Sponsors:** Oklahoma Center for the Advancement of Science and Technology, D&B Oilfield Services

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

Civil and Environmental Engineering: Mark Krzmarzick

**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

**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

Mechanical and Aerospace Engineering: 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:** Ömer Özgür Çapraz

**Continuous, Large-Scale Manufacturing of Functionalized Silver Nanowire Transparent Conducting Films**

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

**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:** Clint Aichele

New Product Development Center: Robert Taylor

Fire Protection and Safety Technology: Haejun Park

**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:** Ömer Özgür Çapraz

**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, 2) Develop solar evaporation and condensation system, 3) Synthesize ceramic membranes for desalination and organics rejection.

**Sponsor:** United States Geological Survey

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

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

**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

**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

**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

**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

**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

**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

**Joint Industry Project for the Quantification of Fluid Phase Kinetics in Hydrocarbons Phase 4**

Phase 4 will consist of two research aims: 1) Quantify gas evolution in the presence of nucleation, 2) Understand how oil concentration and supersaturation ratio impact gas evolution in emulsions. The gas evolution experiments will be performed over a range of pressures up to 1,500 psia (high pressure experimental setup) and 150 psia (low pressure experimental setup) and temperatures up to 200 °F (90 °C) for both experimental setups. In Phase 4, the team will use ultra high purity methane as the gas phase.

**Sponsors:** Exxon-Mobil Upstream Research Company

**PI/PD:** Clint Aichele

**CIVIL AND ENVIRONMENTAL ENGINEERING**

**Graduate Research Fellowship for Rabecca Wiseman**

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| This Graduate Research Fellowship was awarded to Rabecca Wiseman, a graduate student in Environment Engineering who is researching automated energy optimization of the aeration process within municipal wastewater treatment. The Graduate Research Fellowship Program recognizes and supports outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education. The GRFP provides three years of support for the graduate education of individuals who have demonstrated their potential for significant research achievements in STEM or STEM education.  |

**Sponsor:** National Science Foundation

**PI/PD:** Mark Krzmarzick

**Develop Acceptance Protocol for the use of Fly Ash**

The goal is to develop a protocol for performance evaluation of fly ash to determine critical properties and tests for evaluating fly ash including consideration of alkali‐silica reactivity. The deliverable for this project is a guide to evaluating fly ash performance in concrete, which will provide an overview of the tests to evaluate fly ash and how to interpret the results.

**Sponsor:** Minnesota Department of Transportation

**PI/PD:** Tyler Ley

**Shrinkage Induced Deformations in Steel Bridges Made Composite with Concrete Deck Slabs – Phase 3 – Modification for Structural Monitoring of the SH-11 Chikaskia River Bridge**

This award provides funding to perform Structural Monitoring of the SH 11 Bridge over the Chikaskia River in Kay Co., Oklahoma during FY 2021. The work activities included in this work plan extend and augment the work that has already been performed within SPR 2260.

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

**PI/PD:** Bruce Russell

**Analysis of ODOT’s Traffic Speed Deflection Device Data for Pavement Structural Evaluation**

Traffic Speed Deflection Devices (TSDDs) that measure surface deflection at traffic speeds have recently gained significant popularity among pavement researchers/engineers as well as state highway agencies. TSDDs provide a rapid and continuous picture of the pavement condition, thereby significantly enhancing the amount of information available related to the pavement condition. This project will analyze the TSDD data being collected by ODOT as part of Transportation Pooled Fund Project TPF-5(385) and identify different approaches to integrate the data into ODOT’s pavement management decisions.

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

**PI/PD:** Debakanta Mishra

**On-Demand Support of the ODOT Skid Program**

This project is to perform on-demand services for the ODOT Skid Program, including: 1) the collection of skid resistance, surface texture, and roadway geometry data requested by ODOT, and 2) analysis of the data sets and delivery of the data summary report to ODOT.

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

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

**Long Term Performance and Benefits of Combined Balanced Mix Design and Chemical WMA Technology**

The long-term performance and benefits of a combined approach involving Balanced Mix Design (BMD) and chemical Warm Mix Asphalt (WMA) technology are not clearly defined. Thus, the main objectives of this project are: 1) Quantify the long-term benefits associated with a combined implementation approach involving BMD and chemical WMA technology through laboratory binder and mixture testing as well as observed or simulated field performance, and 2) Develop a special provision/specification to facilitate the implementation of a combined approach involving BMD and chemical WMA technology in the state of Oklahoma.

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

**PI/PD:** Debakanta Mishra

**SPR-4521: Comprehensive Pavement Patching Tools and Web-based Software for Pavement Condition Assessment and Visualization**

The OSU team will develop approaches for the Purdue team to integrate data sets from the 3D data collection van at INDOT so that visual and other pavement condition data are usable by the Purdue team to accomplish the deliverables for part two, a web based cloud information system. The OSU deliverables include methods and software code or Application Programming Interface for the Purdue team to extract datasets collected based on WayLink software at INDOT. The data sets to be included in the deliverables are spatially tagged rutting surveys, longitudinal pavement profiling, roughness measurements, crack severity, and pavement images.

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

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

**One-Voice Stage 2**

After completing Stage 1, the team has moved to Stage 2 grant funding to assist in further developing their technology and plans for commercialization. One-Voice is a cloud-based software that analyzes the quality of the historical sewer systems data and provides quality assurance to the data to yield a unified format. With One Voice, industry stakeholders can be better informed about the condition of sewer assets and become proactive in their asset management and maintenance strategies. The team is working on the prototype based on the developed data quality assurance algorithm and sewer data management and integration tools.

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

**PI/PD:** Yongwei Shan

**Resilient Analysis and Design of Slab-on-Ground Foundations on Expansive Soils**

This project will develop a finite element method based analysis technique that is up-to-date in terms of the current state-of-the-art knowledge and developments for the predictions of stresses and deformations in the structural slab as well as more rational and practical design parameters representing the behavior of the foundation soil in response to applied loads and various climatic conditions. The research work will produce an analytical protocol and a finite element code that can be adopted by various design codes that are in use in the United States.

**Sponsor:** United States Department of Housing and Urban Development

**PI/PD:** Rifat Bulut

**Center for Native American Environmental Health Equity Research**

Dr. Gonzalez Estrella will collaborate with the community to identify sites where open dumping and burning commonly occur and will use his expertise in environmental chemistry, contaminant mobility, exposure to work with the community and his team to determine the risks posed by micro- and nano-scale plastic contaminants resulting from dumping, degradation, and combustion of waste.

**Sponsor:** The Regents of the University of New Mexico Health Sciences Center for the National Institutes of Health

**PI/PD:** Jorge Gonzalez Estrella

**Load Testing and Long-Term Monitoring of SH 4 Bridge in Canadian Co.**

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| Under this work order, the following services will be provided: 1) Perform structural health monitoring for 12 months; 2) Add to the instrumentation package accelerometers to enable the measurement of vibrations, and impact. Assess the Impact Factor, IM that is required in design; 3) Perform static load testing of Spans 9 and 14 on the SH4 Bridge. Stresses, strains, and deformations will be measured and recorded. Data can be used to compare results to current design methods, and for assessing the load rating of PC beams in flexure and shear. The distribution factor for PC girders can also be evaluated.  |

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

**PI/PD:** Bruce Russell

**Variation of Shear Wave Velocity due to Moisture Changes**

This study will assess the potential of shear wave velocity data to simulate the climate-related variations in mechanical properties of subgrade soils using SCPTu field equipment. The basic parameters to be measured with depth are shear wave velocity and moisture content.

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

**PI/PD:** Rifat Bulut

**Reduction and Preliminary Analysis of Instrumentation Data for Advanced Pavement Design and Evaluation**

The goal of this project is to develop a mechanistically validated procedure for the U.S. Army Engineer Research and Development Center (ERDC) to process and analyze the large volume of data available through the Hill Air Force Base pavement instrumentation effort. Development of this mechanistically validated protocol will help ERDC efficiently analyze the large amount of data generated, and extract valuable information from the data to facilitate the design and construction of better-performing airfield pavement systems that can withstand loading from new aircraft types and can include recycled and marginal quality pavement materials.

**Sponsor:** United States Army Corps of Engineers

**PI/PD:** Debakanta Mishra

**Development of an Apple App for GDOT AASHTOWare Project**

The OSU team will assist Georgia DOT (GDOT) to develop and implement a bar code based concrete sample management app for the Apple operating system that is based on AASHTOWare. This project will provide a working version of the app for GDOT that can be used with the CTAG (concrete TAG) developed at OSU. The CTAG is a specialized label that creates a barcode on the inside and outside of a concrete cylinder mold. The CTAG has a low profile and will not impact the performance of the concrete and will stay bonded on the sample until it is tested.

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

**PI/PD:** Tyler Ley

CEAT Academic Affairs: Qinang Hu

**Evaluation of Pavement Rehabilitation Alternatives for I-15 Sections in Idaho**

This collaborative project between OSU and the Idaho Transportation Department (ITD) will involve pavement performance monitoring and structural evaluation of recently rehabilitated sections, as well as identification of suitable rehabilitation methods for pavement sections that have been identified as being problematic. Rather than focusing primarily on commonly used methods, this project will involve extensive review of published literature on different pavement rehabilitation methods. This will result in the development of an extensive rehabilitation selection matrix that can be used by ITD in the future while trying to repair and rehabilitate problematic pavement sections.

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

**PI/PD:** Debakanta Mishra

**RII Track 1: Socially Sustainable Solutions for Water, Carbon, and Infrastructure Resilience of Oklahoma – Science-Based Clumsy Solutions for Wicked Problems in Oklahoma**

The unifying research question is whether science-based assessment, coupled with systematic and iterative engagement with Oklahoma opinion leaders and input/feedback from members of the Oklahoma public, can result in development of socially sustainable solutions. The project will employ a framework informed by theories of public policy learning to invest in science at the intersections of four key focus areas that are important to Oklahoma: changing subseasonal to seasonal weather patterns, variable and marginal quality water supplies, shifting terrestrial water and carbon dynamics, and sustainable water and energy infrastructure.

**Sponsor:** National Science Foundation

**PI/PDs:**  Mark Krzmarzick, Rifat Bulut

Chemical Engineering: Prem Bikkina, Clint Aichele

Arts & Sciences: Babu Fathepure, Yuting Zhou, Michael Long, Kristin Olofsson

DASNR: Kevin Wagner, Rodney Will, Dayton Lambert, Chris Zou, Gail Wilson

OU: Hank C. Jenkins-Smith, Carol L. Silva

**Developing Deflection Acceptance Criteria for Compacted, Open-graded Aggregate Bases for Permeable Pavements Using Lightweight Deflectometers (LWDs)**

The primary objective of this research study is to develop a deflection-based compaction control specification for open-graded base courses for permeable pavements using Lightweight Deflectometers. The research team will adopt an integrated approach involving laboratory testing, numerical modeling, and testing of full-scale pavement sections to achieve the project objectives. The primary outcome will be a specification document that can be used during the construction of open-graded base courses across the world.

**Sponsor:** Interlocking Concrete Pavement Institute Foundation for Education and Research

**PI/PD:** Debakanta Mishra

**Integrating Construction Practices and Weather into Freeze Thaw Specifications**

This research will produce improved specifications and advance existing test methods, while improving the underlying understanding of freeze thaw damage. Low-cost data loggers will be used to measure the moisture and temperature changes in a concrete sent to a number of different environments. This information will be combined with new models that account for the rate that concrete reaches a critical degree of saturation. This work will create specifications tailored for different weather conditions and create a useful forensic tool that could be used to determine the loss in the life of a structure if a substandard concrete is placed.

**Sponsor:** Oklahoma Department of Transportation for FHWA SPR Pooled Funds

**PI/PD:** Tyler Ley

**Tran-SET: Smart Battery Management System for Electric Vehicles: Self-Learning Algorithms for Simultaneous State and Parameter Estimation and Stress Detection**

The goal is development of a smart battery management system (BMS) with human brain-like complex learning for accurate estimation of the health of the Li-ion battery. This involves significant intellectual challenges related to development of state-of-health inclusive models and real-time learning of highly nonlinear and time-varying dynamics. The research directs towards a unified design and will lead to a significant increase in the safety, capabilities, and autonomy of the BMS for Li-ion batteries. The success of this project will provide the necessary tools for smart BMS design leading to efficient and safe operation of the Li-ion battery in electric vehicles.

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

**PI/PDs:** Samir Ahmed

Electrical Engineering Technology: Avimanyu Sahoo

**Tran-SET: Safety of Road Users in Light-Rail Transit Environment**

The goal is to provide transit agencies, state DOTs and local governments with a resource guide of best practices available for improving the safety of vulnerable road users (VRUs) in light-rail transit (LRT) environments. This project objectives are: (1) to survey, review and evaluate the existing body of knowledge and the state of practice regarding VRUs safety in LRT environments; and (2) to synthesize this information and package the results into a Best Practices Resource Guide and companion PowerPoint Training Material that can be incorporated in existing rail safety courses and used in making presentations at schools and public events.

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

**PI/PDs:** Samir Ahmed, Rifat Bulut

**Tran-SET: A Resource Guide for State DOT’s Maintenance Equipment Fleet Management Decisions**

The overarching goal of this research effort is to help ODOT strategically improve its equipment management practices using the data recorded in its equipment fleet management system. The specific objectives of this project are to: 1) Assist ODOT in calculating ownership and operating costs of the selected types of equipment, 2) Develop a model for equipment management decisions, 3) Develop a resource guide to introduce ODOT management to state-of-the-art techniques and practices for equipment management.

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

**PI/PDs:** Yongwei Shan, Samir Ahmed

**One-Voice**

Developed through research supported by the National Associations of Sewer Service Companies, the One-Voice technology includes 1) a data quality assurance tool to evaluate and improve the quality of sewer pipeline inspection databases and 2) a comprehensive data management and analysis tool based on the collected inspection databases across the country. The VentureWell Early-Stage Innovator Training Program brings together student science and tech innovators and entrepreneurs for a three-day workshop to dive into topics like business model development, customer discovery, team dynamics, value chains, and intellectual property. The Stage 1 grant will cover expenses to attend the 3-day Pioneer workshop.

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

**PI/PD:** Yongwei Shan

**Produced Water Treatment Fueled by High Value Product Extraction**

The purpose of this project is to transform produced water from a waste to a resource by developing an efficient separation strategy for removing hydrocarbons through the synergy of silica nanoparticles and inorganic membranes while also removing valuable resources including rare earth elements. The first aim will focus on the development of microporous, inorganic membranes to increase energy efficiency and cost savings in oil/water separations. The second aim focuses on testing the silica-modified inorganic membranes in a continuous system using produced water provided by D&B Oilfield Services.

**Sponsors:** Oklahoma Center for the Advancement of Science and Technology, D&B Oilfield Services

**PI/PDs:** Mark Krzmarzick, David Lampert

Chemical Engineering: Clint Aichele, Seok-Jhin Kim

**Acquisition of a Full Field Non-contact 3D DIC System for Characterizing Crack Propagation Under Variable Amplitude Loading**

This grant award will fund the acquisition of a full field non-contact three-dimensional (3D) digital image correlation (DIC) system in support of DoD-funded research at OSU’s Bert Cooper Engineering Laboratory. The system will be mainly used to support experimental and numerical research focusing on characterizing crack propagation in naval and aerospace structures and designing maintenance and repair procedures for extending the service life of these structures in the presence of fatigue damage. The system will be used for 3D surface profiling, measuring 3D displacements and rotations, and real-time tracking of 3D strains.

**Sponsor:** Office of Naval Research

**PI/PD:** Mohamed Soliman

**Applying Unmanned Systems for Water Quality Monitoring**

The goals are to develop a monitoring system for Grand Lake that provides high-spatial resolution datasets of nutrients, sediments, and HAB levels using unmanned systems and provide improved models of the behavior of these constituents. The development of these tools will assist with decision support for various water management activities at Grand Lake. Unmanned systems have potential to reduce the costs of monitoring in addition to providing extensive quantities of spatial and temporal data. The long-term goal is to develop a system to identify, forecast, and respond to nutrient and sediment resuspension and HAB formation events to preserve water quality.

**Sponsor:** Department of Interior, Bureau of Reclamation

**PI/PDs:** David Lampert

Mechanical and Aerospace Engineering: Jamey Jacob

**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/PDs:** 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 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 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 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:** Mark Krzmarzick, 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 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 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 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 for the Federal Highway Administration

**PI/PD:** Tyler Ley

**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. for the United States Department of Transportation Federal Railroad Administration

**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:** Mark Krzmarzick, 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

**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/PD:** Yongwei Shan

**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:** Robert Emerson, Julie 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

**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

**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:** Mark Krzmarzick, Tyler Ley

Electrical and Computer Engineering: James Stine

**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

**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

**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

**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

**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

**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

**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

**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, Bruce Russell

**Development of Concrete Mixtures 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

**ELECTRICAL AND COMPUTER ENGINEERING**

**High-Level Synthesis and Tools for System-On-Chip Design for Space Exploration**

The goal is to develop techniques, tools, and flows for high-level synthesis of SoC platforms in sub-micron CMOS technologies that: 1) provide ability to efficiently integrate embedded memories, processors, hardware accelerators, and communication structures, 2) utilize synthesis and layout information to accurately estimate area, delay, and power from high-level SoC architecture descriptions, 3) facilitate design-space exploration and component reuse in SoC solutions, 4) are well documented, easy to use, publicly available. This will be accomplished by researching/developing high-level synthesis tools and design flows for complete SoC solutions, and using these open-source tools to explore new techniques for power management.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** James Stine

**Development of an Unmanned Aircraft Capability for Instrument Landing System Calibration**

Jump Aero has partnered with OSU to develop an unmanned aircraft specifically to calibrate airport Instrument Landing Systems (ILS) for the FAA and DoD. In this Phase I project, OSU will demonstrate the utility of a sensor payload capable of calibrating ILS systems on a commercial off the shelf drone platform.

**Sponsor:** Jump Aero Inc. for Air Force Research Laboratory

**PI/PD:** James C. West, Sabit Ekin

Mechanical and Aerospace Engineering: Jamey Jacob

**Soil Monitoring Through UAV-Assisted LoRa Underground Sensors-REU Year 1**

Oklahoma NSF EPSCoR REU awards provide funding that allows undergraduate students to perform research during the summer months. Students benefit from hands-on research experience and guidance from faculty mentors. This award will allow an OSU student to do research around these tasks: 1) develop a UAV-assisted IoT-based wireless underground soil sensing system, including integration of sensors, communication modules, and IoT base station mounted to a UAV; 2) indoor system validation and testing for communications between the IoT sensors and base station mounted on a UAV; 3) perform field testing and performance validation with different soil types, moistures and depths.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** John O’Hara

**Electrical Power Resilience Against Ice-Storms-REU Year 1**

Oklahoma NSF EPSCoR REU awards provide funding that allows undergraduate students to perform research during summer months. Students benefit from hands-on research experience and guidance from faculty mentors. This award will allow an OSU student to do research to identify techniques for improving distribution grid resilience against ice storms. Research thrusts include: 1) Study the physics of ice-forming and ice-melting on power lines; 2) Study the structure and operation of distribution systems; 3) Propose a set of proactive actions in the distribution system for preventing, reducing or mitigating the impact of ice storms, and preventing the disruption of distribution systems.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** Hamidreza Nazaripouya

**0.41-Thz CMOS-based short-range imager for industrial applications**

As part of Texas Instruments Foundational Technology Research Program on millimeter-wave and high-frequency microsystems, Wooyeol Choi at Oklahoma State University will investigate methods to realize affordable high-resolution (8.7cm at 5m) short-range (5cm to 5m) imaging systems that can be applied in material defects inspection, moisture content monitoring, inspection through packaging and others. This is one of the fundamental platform technologies that can provide a wide variety of significant opportunities for the integrated circuits industry.

**Sponsor:** University of Texas at Dallas for Texas Instruments

**PI/PD:** Wooyeol Choi

**A Low-Cost and Non-contact Respiration Monitoring Method for COVID-19 Screening and Prognosis**

Given the link between human respiration and COVID-19, there is a need for sensing methods that can monitor respiration in a non-contact fashion. This research proposes noncontact measurement of respiration rate using light wave sensing. Simple visible or nearinfrared light sources and photodetectors are used with signal processing to turn slight variations in reflected light power into accurate measurements of respiration rate. Participation in NSF I-Corps Teams will allow the team to 1) better understand the unmet needs by conducting customer discoveries and interviews, 2) develop a business model, and 3) learn the desired features for developing a compelling product.

**Sponsor:** National Science Foundation

**PI/PD:** Sabit Ekin

**CNS Core: Small: Non-contact Monitoring of Respiration and Heart Rates Through Light-Wave Sensing**

Preliminary studies show that light-wave sensing can measure respiration and heart rates with more than 94% accuracy in practically relevant scenarios. This work will bring this technology into a fully functional and practical architecture. The research thrusts include: 1) Establishing the Fundamental Limits of light-wave sensing; 2) Establishing a Comprehensive Theoretical Model to enable purposeful engineering, design, and tradeoff analyses; 3) Quantifying the Approaches and Benefits of Advanced Signal Analysis, where the team investigates the algorithmic approaches that extract respiration and heart rates from non-ideal measured data, improve system performance, and eliminate noise and spurious signals.

**Sponsor:** National Science Foundation

**PI/PDs:** Sabit Ekin, John O’Hara

**Stochastic Cable Harness Coupling to Electric Fields in Spacecraft Cavities**

OSU will support Robust Physics in performing this NASA STTR Phase II continuation project. The work will be performed the OSU Robust Electromagnetic Field Testing and Simulation (REFTAS) experimental and computational facilities. REFTAS tasks will be divided into two major efforts. The first effort is the development of a computational engine to predict the coupling of electromagnetic fields within an enclosed cavity onto cable bundles passing through the cavity and the transfer of those signals into adjacent cavities. The second major effort will be experimental validation of the computational coupling model.

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

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

**Graduate Research Fellowship for Karl Strecker**

This Graduate Research Fellowship was awarded to Karl Strecker, a graduate student in Electrical Engineering whose research focuses on the phenomenon of group velocity dispersion in broadband terahertz signals. The Graduate Research Fellowship Program recognizes and supports outstanding graduate students who are pursuing full-time research-based master's and doctoral degrees in science, technology, engineering, and mathematics (STEM) or in STEM education. The GRFP provides three years of support for the graduate education of individuals who have demonstrated their potential for significant research achievements in STEM or STEM education.

**Sponsor:** National Science Foundation

**PI/PD:** John O’Hara

**MRI: Acquisition of a Wideband Continuous-Wave Characterization Platform**

Research activities in novel material science, wireless communications, imaging, and electronics at OSU and neighboring universities require a high-frequency, wideband, continuous-wave (CW) mm-wave/ terahertz instrument with excellent frequency-resolution, and high dynamic-range. To address this need, this award provides for acquisition of a CW characterization instrument covering the 0.11-0.50 THz frequency range with sub-500 kHz resolution and 120 dB dynamic range. This would be a one-of-a-kind instrument in Oklahoma and nearby regions and would enable new science in advanced sensors with artificial materials, quasiparticle dynamics in magnetic and topological materials, 5G and beyond communications, and mm-wave and terahertz imaging and electronics.

**Sponsor:** National Science Foundation

**PI/PDs:** John O’Hara, Sabit Ekin, Weili Zhang, Wooyeol Choi

Physics: Emrah Turgut

**Robust and High-Data-Rate Hybrid RF/Optical Communications for Lunar Missions**

A space communication network suitable for planned lunar missions requires a new architectural paradigm that is dynamic, scalable, and capable of supporting diverse mission types at unprecedented communication speed with high reliability, continuous coverage, and minimum latency. The team proposes a hybrid approach, incorporating both RF and optical communication elements within a smart networking framework. The theoretical and experimental effort will integrate RF and optical communication systems for small satellites (SmallSats) and will design an encompassing network architecture that leverages this combination among Earth stations, a LEO SmallSat constellation, the Lunar Gateway, and Moon explorers.

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

**PI/PDs:** Sabit Ekin, John O’Hara, Wooyeol Choi, Ickhyun Song

Mechanical and Aerospace Engineering: Andy Arena, Jamey Jacob

University of Oklahoma: Ali Imran

University of Tulsa: Peter LoPresti

**Frontier Electronic Systems Corp. Internships**

An MOU has been established to provide students with Engineering Internships at Frontier Electronic Systems Corp. The student interns will be responsible for providing technical support to assist Frontier Electronic Systems Corp. engineering staff with testing, troubleshooting, and repairing electronic assemblies and test equipment.

**Sponsor:** Frontier Electronic Systems Corp.

**PI/PD:** Chuck Bunting

**Pulsed-Laser-Based Radiation Effects Characterization System for Millimeter-Wave/Terahertz Materials and Devices**

The research team will set up a pulsed-laser single-event effects (SEE) characterization system for high-frequency electronics, which will be combined with OSU’s existing time- and frequency domain terahertz characterization setups. By adding the two-photon absorption system to OSU’s existing instruments, a wide range of research topics in SEE becomes possible. First, SEE in a variety of circuit building blocks can be investigated. The system will also be used to analyze the benefits or potential weaknesses of radiation-hardening techniques.

**Sponsor:** Air Force Office of Scientific Research (AFOSR)

**PI/PDs:** Ickhyun Song, John O’Hara

**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

**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

**Exploration and Design of Low-Power High Performance Secure Computer Architectures**

The goal is to research and develop high-level synthesis tools for SoC platforms in nanometer CMOS technologies that 1) specifically target digital system designs for high-performance and low-energy computer architectures, 2) research and deploy efficient arithmetic and architecture designs for security in current computer architectures, 3) combine synthesis and layout information to accurately estimate area, delay, and power from high-level SoC architecture descriptions, 4) facilitate rapid design-space exploration of secure SoC solutions, and 5) are well documented, easy to use, and publicly available for AFRL personnel.

**Sponsor:** Air Force Research Laboratory

**PI/PD:** James Stine

**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

**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

**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

Center for Veterinary Health Sciences: Ashish Ranjan

**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

**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: Mark Krzmarzick, Tyler Ley

**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 SERVICE TRAINING**

**AFG - COVID-19 Supplemental to Purchase PPE**

This supplemental AFG grant allowed for the purchase of Personal Protective Equipment (PPE) and supplies to respond to the COVID-19 public health emergency. Fire Service Training worked with Oklahoma Emergency Management to deliver items such as Tyvek suits, N-95 masks, gloves, and sanitation machines to fire departments in the state.

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

**PI/PD:** Caroline Reed

**Total Fitness and Wellness Program**

Fire Service Training in cooperation with School of Kinesiology, Nutritional Sciences, and First Responders Support Services is developing a Total Wellness program for Emergency Responders. The goal is to design a program to address the high risk issues within the following topics areas: physical, nutrition, and mental health. This total wellness program will be designed using the train the trainer method allowing local fire departments to stand up internal wellness programs within their own department that will reduce injuries, address nutritional supplement problems and provide guidance on how to prevent and respond to mental health issues of first responders.

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

**PI/PD:** Caroline Reed

**AFG to Purchase a Commercial Fire Pumper/Engine**

This grant is for the purchase of a commercial fire pumper apparatus. The fire apparatus requested with this grant application is a Commercial chassis, two-person cab, 1,250 gallons per minute, 1,000-gallon water capacity pumper. This project will directly support the delivery of firefighter training throughout Oklahoma with driver operator/pumper training and water supply for live fire training. This unit will provide 12,000 volunteer firefighters training opportunities in locations not available in rural areas.

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

**PI/PD:** Caroline Reed

**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

**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**

**Phase VI: An Integrated GIS Application for HazMat Flow Analysis and Risk Assessment to Support Local Emergency Planning and Preparedness in Oklahoma**

In previous phases, the team developed a GIS application to visualize HazMat shipment flow, along with a risk assessment methodology for HazMat incidents on Oklahoma roadways. This next phase will focus on making the computer application fully functional and taking it from a lab environment to a web-based application suitable for the end-users in the field. Additional analytics capability will be added to generate customized reports. User-friendly interfaces will be tailored to the needs of specific communities. Quality control tests will be performed. A user guide will be created, and Version 1 of the application will be rolled-out.

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

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

Biosystems and Agricultural Engineering: R. Scott Frazier

**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

**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

**Creating Resilient Manufacturers: Recovery, Reshoring, and Reimagining Manufacturing in Oklahoma**

The program will provide pandemic recovery and resiliency evaluation and solutions, engineering technical design and assistance, and workforce development activities aimed at small and medium sized manufacturers. The anticipated outcome is long-term economic resiliency as a result of job stability, increased revenues, strengthened innovation capacity, and improved health and safety of manufacturing employees. The engineering assistance and training components will be guided by the Industrial Engineering disaster preparedness faculty team’s evaluation and recommendations. The program is also a collaboration between OSU and the MidAmerica Industrial Park Automation Resource Center, offering workforce development training and technology application evaluation and research.

**Sponsor:** United States Department of Commerce Economic Development Administration

**PI/PDs:** Sunderesh Heragu, Katie Jurewicz

New Product Development Center: Robert Taylor

**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**

**Reinforced Recycled Polymer Composites**

The technical approach is to mold recycled carpet as a reinforcement with recycled polymer resins from bottling operations to make novel materials. The deliverable materials will include compression and extrusion molded structures for construction applications, reparable pallets as replacements for wood pallets used for automated supply chain management. The pallets will have significant advantages over wood pallets, especially in food and beverage-related facilities.

**Sponsor:** Sustainable Manufacturing Innovation Alliance Corp. dba REMADE Institute

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

Chemical Engineering: Jeffrey White

**OLED-based Infrared Sensor**

OSU’s work in this STTR project will be to validate the innovative OLED-based infrared sensor structure for the low-cost, large format, high-resolution, and flexible SWIR focal plane arrays.

**Sponsor:** Ghost Display Technologies for United States Air Force Research Laboratory

**PI/PD:** Do Young Kim

**PETAL, A Sustainable Product to Reuse Aluminum Cans and PET Bottles and Keep Them Out of Landfills**

Single use PET plastic bottles and aluminum cans are used extensively but recycled at very low rates (29% for plastic and 50% for aluminum). PETAL will be the market's first reusable bottle made of at least 90% recycled materials. It will take dozens of aluminum cans and PET bottles out of landfills. The recycling methods are already feasible. PETAL bottles will create a market of upcycling the single use bottle and replace it with a reusable, sustainable alternative. This grant will provide funding to further validate the team’s hypothesis and to demonstrate commercial viability.

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

**PI/PD:** Ranji Vaidyanathan

**EAGER: Manufacturing of Diamond Nanocrystals for Quantum Applications**

The objective is to study manufacturing of diamond crystal arrays by Microwave Plasma Enhanced Chemical Vapor Deposition toward a broader applicability in quantum devices for Quantum Computing, Spintronics, Magnetic Field Sensing, Encryption, and Biolabeling/Transduction. Some applications require small size (nano-meter/nm or micro-meter/μm) diamond crystals containing preferably only one type of N-V defects that are arranged into isolated diamond crystal arrays for greatest sensitivity, individual addressability and applicability. This project will address this challenge of developing manufacturing approaches to synthesize diamond single crystal arrays containing only one type of N-V defect centers that are preferentially oriented along one crystallographic direction.

**Sponsor:** National Science Foundation

**PI/PD:** Raj Singh

**NASA Oklahoma EPSCoR Research Infrastructure Development Qualification and Certification of Additively Manufactured Metallic Components in Space and Other Industry Applications**

This travel grant will enable strategic partnerships that support the activities funded by the Space Mission Directorate at NASA Marshall. Specifically, the team seeks to pursue

collaborative research in lightweight structures and additive manufacturing. They also seek

collaboration in developing capabilities related to real-time property prediction during the AM process. This grant will allow interaction with the additive manufacturing group at NASA Marshall Space Flight Center and thus enable identification of primary areas of mutual interest.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** Ranji Vaidyanathan

Engineering Technology: Hitesh Vora

**I-Corps: Infrared-driven Organic Light-Emitting Diode (OLED) Projection Display**

This I-Corps project aims to evaluate the commercialization potential of the new cost-effective, highly-flexible, extremely-large display screen technology and to accelerate the translation of this technology into emerging products. Direct conversations with prospective customers will allow for a greater understanding of the team’s customer sub-segmentation and further narrowing of the team’s value proposition. Participation will also help the I-Corp team clarify the direction the business and technology can take going forward such as refining the product development process to target and meet identified specific market needs.

**Sponsor:** National Science Foundation

**PI/PD:** Do Young Kim

**Structural Supercapacitors for Onboard Energy Storage and Delivery in Manned or Unmanned Surface Vessels**

This research effort will investigate the simultaneous enhancement of mechanical and electrical characteristics in polymer matrix composites with the objective of developing structural supercapacitors. These structural supercapacitors are multifunctional materials that provide both load-bearing and electrical-energy-storage capabilities in a synergistic manner. The research focus is on hierarchical modifications of various components of the proposed supercapacitor architectures supported by a fundamental multi-scale and multi-physics investigation of the chemo-mechanics of these materials. Material behavior will be studied across multiple length scales. These materials are expected to lead to energy storage structures that find application in various surface and underwater vessels and vehicles.

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

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

Brown University: Pradeep R. Guduru

**Analysis of Corrosion Scales in Iron/Steel Drinking Water Distribution Pipes from OKC**

In this research services agreement, the composition and microstructure of iron tubercles/scales from six pipe specimens provided by Carollo, will be analyzed. The pipes will be harvested from the distribution system network in Oklahoma City (OKC), OK.

**Sponsor:** Carollo Engineers, Inc.

**PI/PD:** Pankaj Sarin

**OLED-Based Infrared Image Sensor**

Being able to sense light over a broad spectrum of light can increase the quality of images and our ability for night vision. For highly specialized applications like military and space missions, there are extremely expensive Indium Gallium Arsenide (InGaAs) image sensors with shortwave infrared (SWIR) wavelength sensitivity. Until now, the applications of these InGaAs SWIR image sensors have been severely limited due to the formidable price. The proposed innovative infrared image sensors, using an inexpensive IR sensitive OLED and a low-cost silicon-based visible image sensor, will be low-cost and have comparable performance to InGaAs sensors.

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

**PI/PD:** Do Young Kim

**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 Manufacturing of Functionalized Silver Nanowire Transparent Conducting Films**

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

**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/PDs:** Raman P. Singh, Pankaj Sarin

**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

**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

**MECHANICAL AND AEROSPACE ENGINEERING**

**I-Corps: Device to Deliver Cold Plasma Therapeutic to Wound Sites to Promote Wound Healing**

The technology that has been developed delivers cold plasma through a device to promote wound healing while maintaining a level of sterilization to prevent reinfections. The device can be widely manipulated allowing for the treatment of a large variety of wound sizes, although the team is specifically focusing on small animals at first. This I-Corps project will allow the team to conduct customer research to determine whether the veterinary market is receptive to the implementation of this type of technology,

**Sponsor:** National Science Foundation

**PI/PD:** Jamey Jacob

**New Sounding Rocket Tech**

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

**Black Sage Flight Test Event**

OSU’s Unmanned Systems Research Institute (USRI) will provide pilots and aircraft for field flight demos at the Black Sage Flight Test Event.

**Sponsor:** Berry Aviation

**PI/PD:** Jamey Jacob

**KPN Hole Cleaning Monitoring in drilling with distributed sensors and hybrid methods**

OSU and SINTEF will collaborate and develop joint research to improve the understanding of how hybrid methods can improve interpretation of drilling data. The aim is to increase knowledge on how to best use a combination of physics-based modelling and machine learning for real-time interpretation of drilling data with along-string measurements.

**Sponsor:** SINTEF for Research Council of Norway

**PI/PD:** Omer San

**Development Tasks for Veroplane Manned and Unmanned Vertical Take-Off and Landing Aircraft**

This risk reduction task includes design, fabrication, test and analysis of a ducted rotor component test stand. The scope of work includes the Ducted Rotor Test Rig structure, electrical power, instrumentation, and data acquisition and control system. Testing will include evaluation of the ducted and unducted rotor to determine the lift contribution of the wing section duct.

**Sponsor:** Veroplane Limited

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

**Simulation of a Tankless Water Heater**

An open source platform, OpenFOAM, will be used to create a simulation tool that can be used in designing tankless water heaters. Premixed burners are of interest for Rheem in order to meet strict emission targets (e.g. California 1111 rule for NOx). Expensive premixed flames allow better control of the flame temperature but unfortunately may cause excessive noise. To solve the acoustic problem and reduce the manufacturing cost, the industry needs to have fast design cycles of furnaces using cheap computational tools. The value proposition of this project is to reduce the cost of furnace simulation by harnessing the capability of open-source OpenFOAM solver to simulate Ultra Low-NOX residential furnaces.

**Sponsor:** Rheem Manufacturing Company

**PI/PD:** Khaled Sallam

**Balloon Infrasound Observations of Terrestrial Earthquakes with Applications to Venus**

The team will observe the infrasound generated by terrestrial earthquakes from balloon platforms in the Earth's troposphere and stratosphere to demonstrate the feasibility of detecting and geolocating quakes from one or more balloons at Venus. At present, there is no feasible technique available for investigating seismic activity on Venus and probing its interior. The interiors of Earth and the Moon have been studied in great detail using terrestrial seismology. Surface seismology experiments are being performed on Mars as part of the InSight mission. However, such a study has been denied to Earth’s sister planet because of its high surface temperatures.

**Sponsor:** Jet Propulsion Laboratory for National Aeronautics and Space Administration

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

**Structural Investigation of Carbon Aerogels Synthesized by Pyrolysis**

Under supervision of Dr. Kalkan, the Functional Nanomaterials Laboratory will conduct a structural investigation of carbon aerogel samples developed by Aspen Aerogels. The investigation will employ X-Ray diffraction and transmission electron microscopy to reveal and characterize different phases and domains in these aerogel materials, such as: graphene platelets of different number of atomic layers and sizes; graphite nanocrystals of different sizes; graphene oxide and amorphous carbon domains; silicon nanocrystals of varying size; silicon carbide nanoparticles of varying size and phase. The goal is to elucidate nucleation and growth of these different domains and phases as a function of pyrolysis temperature.

**Sponsor:** Aspen Aerogels, Inc.

**PI/PD:** Kaan Kalkan

**Value of Blending Heat-pumps and Chillers on Multiuse Property**

The objective of this study is to investigate the impact of blending heat pumps and chillers in two multiuse buildings (Office building 1 and Office building 3) in Utica Place, Tulsa, Oklahoma. The monthly kWh and natural gas consumption of an existing blend of hydronics heat pumps, chillers, and air handling units will be analyzed to determine the energy savings impact on each building in the current blended configuration.

**Sponsor:** Utica Place, LLC

**PI/PD:** Khaled Sallam

**Model Validation and Valve Modeling for the Development of a Rotating Spool Compressor**

Spoolcomp is a comprehensive model of a novel rotating spool compressor. Spoolcomp has been validated and extensively used to develop increasingly optimal designs of R410A compressors. However, regulatory trends in the HVAC&R industry and the intrinsic attributes of the spool compressor have suggested that lower pressure refrigerants 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. Therefore, it is necessary to improve this tool. This project aims to improve the predictive capability of Spoolcomp through additional code development and/or re-tuning.

**Sponsor:** Torad Engineering LLC

**PI/PD:** Craig Bradshaw

**RII Track-4: Exploiting Thermoacoustic Assonance to Enrich Multifunctional Meta-Structures**

The goal is to educe new insights into scaling laws and structure-performance relationships for thermoacoustic meta-structures (TAMS) aiding design, analysis and evaluation advances that enable development of impactful solutions for multifunctional applications. The project will lead to development of a new, computationally-efficient, multiphysical model combining thermoacoustic and vibroacoustic elements within the ZKTL framework capable of rapid design optimization iterations for TAMS-based acoustic liners. Correlation with experiments on prototypical TAMS-based acoustic liners will yield new insights into scaling laws and structure-performance relationships emanating from assonant mechanisms. Intellectual property related to structural material configurations for core liners is expected to be generated.

**Sponsor:** National Science Foundation

**PI/PD:** James Manimala

**Enhanced Design Tools for Ground-Source Heat Pump Systems**

Ground heat exchanger design programs have been focused on sizing of regular configurations for building systems, after the building heating and cooling loads are determined. However, there is significant room for improved designs in two areas: borefields that take advantage of irregular geometries, and simultaneous optimization of the building envelope, system, and ground heat exchanger. Existing methods for computing g-functions don’t adequately support these types of designs. This project will further improve the methodology used to calculate g-functions, by speeding up the underlying calculation and utilizing regression or machine learning to come up with equation fits to the reference calculation.

**Sponsor:** Various Private Sponsors

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

**Development of a Semi-Empirical Compressor Model Accounting for Modulation and Extrapolation to Expedite System Development**

Traditional development of modulating compressor systems requires large experimental datasets and heuristic design iterations that are slow and expensive. With the critical addition of fast, accurate, compressor models that can extrapolate beyond trained bounds, Oklahoma-based AC and HP manufacturers have an opportunity to create a competitive advantage during the development of their next generation products. This project will accomplish this by developing a predictive modeling platform specifically for expediting compressor selection. The development will focus on enhancing the speed and flexibility to expedite the addition of new features and modulation in future products.

**Sponsor:** Various Private Sponsors

**PI/PD:** Craig Bradshaw

**Low GWP Refrigerant Evaluation for Fin-tube Coils: Differences in Coil and Simulation Model Performance**

Fin-tube evaporators are a staple in unitary equipment. Regulatory changes will require utilizing new refrigerants in the short-term, resulting in unknown changes in thermal performance. This project will address these issues by determining the effect of a member-selection of low GWP A2L drop-in refrigerants onto fin-tube evaporators’ performance relative to a R410A (GWP: 2088) baseline. The team tentatively plans to evaluate both A2L R32 (GWP: 675) and A2L R454B (GWP: 466) in the first year of the project. The objective is generating an improved understanding of the implication of low GWP fluid changes onto fin-tube heat exchanger performance.

**Sponsor:** Various Private Sponsors

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

**Development of an Unmanned Aircraft Capability for Instrument Landing System Calibration**

Jump Aero has partnered with OSU to develop an unmanned aircraft specifically to calibrate airport Instrument Landing Systems (ILS) for the FAA and DoD. In this Phase I project, OSU will demonstrate the utility of a sensor payload capable of calibrating ILS systems on a commercial off the shelf drone platform.

**Sponsor:** Jump Aero Inc. for Air Force Research Laboratory

**PI/PDs:** Jamey Jacob

Electrical and Computer Engineering: James C. West, Sabit Ekin

**NASA Oklahoma EPSCoR Research Infrastructure Development: Ionization Radiation Studies in SiC Based Components for Lunar Missions**

The goal is to evaluate the performance of 4H-SiC based metaloxide-semiconductor field-effect transistor (MOSFET) devices in heavy-ion radiation environment. with high electrical performance in single-ion events. This travel grant will facilitate the visit to the NASA Space Radiation Laboratory (NSRL), Brookhaven National Laboratory, where the single ion radiation studies will be conducted. The device fabrication will be conducted at OSU. The focus of the device design will be to modify gate dielectrics in the MOSFET devices to enhance ionization radiation resistance. The travel will facilitate the interaction of the PI and graduate student with the experienced scientists at NSRL.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** Ritesh Sachan

**NASA Oklahoma EPSCoR Research Infrastructure Development: Numerical Simulation and Flight Test Validation of Prandtl-D Lift Distribution**

Improved aerodynamic performance and more efficient air vehicle structure are achievable using the bell span-load compared to a purely elliptical load distribution. The research will investigate these benefits with the following: 1) Design a flying wing configuration unmanned vehicle with a twist distribution set to match the bell span-load using design tools based on low-order aerodynamics, 2) Analyze the resulting configuration using a commercially available computational fluid dynamics (CFD) software package, 3) Compare the results from the low-order aerodynamics model and CFD, 4) Construct the designed vehicle, and 5) test fly the vehicle to verify the predicted proverse yaw characteristics.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** Ryan C. Paul

**2020/2021 Aerospace Propulsion Outreach Program (APOP): Low Loss Ducted Inlet - Phase 1**

The 2020-2021 Aerospace Propulsion Outreach Program (APOP) research activity requires undergraduate students, working as a team, to research and develop a compact, S-Duct inlet for the JetCat P100-RX. This inlet will better allow the engine to be integrated with a future airframe, as most platforms mount the engine of the airframe centerline but have a ducted inlet on the sides or bottom. The goal with this project is to design a new inlet that ducts the flow from a single inlet that is 6 inches from the centerline of the JetCat engine.

**Sponsor:** ARCTOS Technology Solutions, LLC for Air Force Research Laboratory

**PI/PD:** Kurt Rouser

**Raman spectral characterization of carbon aerogels obtained by pyrolysis at different temperatures**

Aspen Aerogels will provide Professor Kalkan’s laboratory with samples of carbon aerogels for conducting Raman spectroscopy. The samples will belong in three groups: 1) fragments from carbon aerogel monoliths; 2) micron-sized carbon aerogel beads; and 3) micron-sized carbon aerogel beads with additional elemental silicon dispersed in their bulk. The samples will share a common polymeric precursor, but they will have been obtained by pyrolysis at different temperatures, therefore the type of carbon is expected to range from amorphous to graphitic. Raman spectroscopy is ideally suited for the characterization of those carbons in terms of their crystallinity, ordering and overall quality.

**Sponsor:** Aspen Aerogels, Inc

**PI/PD:** Kaan Kalkan

**Center for Integrated Building Systems**

The Center for Integrated Building Systems (CIBS) is an industry/university cooperative research center at OSU. CIBS’ membership includes several Oklahoma-based companies and manufacturers. CIBS has a mission to serve its membership by providing tangible outcomes and manpower to improve the integration of components, systems, and the built environment through an exploration of the fundamental mechanisms of interaction from component to building scales. The Center develops research projects based on the recommendations of its advisory board, composed of representatives of the member companies.

**Sponsors:** AAON, Inc., Harrison-Orr Air Conditioning, LLC., Torad Engineering, LLC., Alliance for Sustainable Energy, LLC for National Renewable Energy Laboratory, International Ground Source Heat Pump Association, Johnson Controls, Inc., Rheem Sales Company, Inc., Koura, Various Private Sponsors

**PI/PDs:** Craig Bradshaw, Dan Fisher

**Toward Optimal Secondary Furnace Heat Exchanger: Modeling of Furnace Combustion Gas Condensation**

This project will create a computational fluid dynamics (CFD) using Siemens’ STAR-CCM+ software to simulate condensation and heat exchange in a secondary heat exchanger (SHX). In year one, the model will be used to generate a dataset of results for a range of inlet temperatures, inlet water concentrations, tube diameters, tube lengths, and tube internal wall enhancements. In parallel, a simple test apparatus will be created that will generate a validation data set for the CFD simulation. Validated CFD results will provide confidence for extension of the model to different tube diameters and shapes along with variation in inlet conditions.

**Sponsor:** Various Private Sponsors

**PI/PD:** Christian Bach

Engineering Technology: Aaron Alexander

**A Smart Skin to Treat and Prevent Pressure Ulcers**

In this study, the researchers will develop a smart skin to treat and prevent pressure ulcers. The smart skin will act as an adaptive pressure off-loading device by continuously and autonomously redistributing the skin contact pressure. This goal will be achieved by harvesting the unique mechanical properties of liquid crystal elastomers. Pressure triggers a reorientation of their microstructure, which, in turn, leads to a change in shape and in mechanical properties.

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

**PI/PDs:** Aurelie Azoug, Jerome Hausselle

**UAS Combat Flight Inspection Project Plan**

Oklahoma State University will leverage unique UAS programmatic past performance and experience with emerging UAS capabilities to develop a market survey of current and anticipated UAS that are capable of performing the OCONUS flight inspection mission. This will be generally contained within group 2 and group 3 systems deployable by air shipment and operated with minimal manned footprint.

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

**PI/PDs:** Rick Gaeta

**Real-time Weather Awareness for Enhanced Safety Assurance in UTM**

This project addresses emerging needs in real-time weather forecasting to improve the safety of low altitude aircraft operations through the integration of real-time observations from autonomous systems with numerical weather prediction and flight management and safety systems. By including diverse disciplines, this project will provide manned- and unmanned aircraft improved situational awareness to enhance safety and efficiency, particularly for unmanned traffic management, urban air mobility, and airport operations.

**Sponsor:** National Aeronautics and Space Administration

**PI/PDs:** Jamey Jacob, Brian Elbing, Imraan Faruque, Nicoletta Fala

**DARPA CRANE AFC Design & Integration**

Oklahoma State University (OSU) will serve as a subcontractor to the Georgia Institute of Technology (GT) in support of the Defense Advanced Research Program Agency (DARPA) and the Control of Revolutionary Aircraft with Novel Effectors (CRANE) Program. OSU will lead an Integrated Product Team (IPT) to accomplish a full scale Hardware-in-the-Loop (HiL) experiment. The HiL experiment will consist of using a robust subsonic fixed wing UAS as a test bed for aerodynamic effectors to demonstrate flight control authority.

**Sponsor:** Georgia Institute of Technology for Defense Advanced Research Projects Agency

**PI/PDs:** Rick Gaeta, Imraan Faruque

**Support for an Online Ground-Source Heat Pump Design and Techno-economic Evaluation Tool**

The scope of work builds on the design tool and g-function calculation methodology developed in 2019-2020. The automated design tool takes loads calculated by EnergyPlus along with some additional information provided by OpenStudio to select a ground heat exchanger configuration, size it, and return the details, including the g-functions to OpenStudio, so that a detailed analysis can be done with EnergyPlus. The current version of the design tool can size square and near-square borehole configurations. This project is intended to improve the capabilities of the automated design tool to size ground heat exchangers that better fit the available land area.

**Sponsor:** U.T.-Battelle, LLC for Oak Ridge National Laboratory

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

**Robust and High-Data-Rate Hybrid RF/Optical Communications for Lunar Missions**

A space communication network suitable for planned lunar missions requires a new architectural paradigm that is dynamic, scalable, and capable of supporting diverse mission types at unprecedented communication speed with high reliability, continuous coverage, and minimum latency. The team proposes a hybrid approach, incorporating both RF and optical communication elements within a smart networking framework. The theoretical and experimental effort will integrate RF and optical communication systems for small satellites (SmallSats) and will design an encompassing network architecture that leverages this combination among Earth stations, a LEO SmallSat constellation, the Lunar Gateway, and Moon explorers.

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

**PI/PDs:** Andy Arena, Jamey Jacob

Electrical and Computer Engineering: Sabit Ekin, John O’Hara, Wooyeol Choi, Ickhyun Song

University of Oklahoma: Ali Imran

University of Tulsa: Peter LoPresti

**Speedfest XI**

Speedfest is an exciting, high-speed aircraft design/build/fly curriculum and final 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 from across the state of Oklahoma.

**Sponsor:** Oklahoma Aeronautics Commission

**PI/PDs:** Andy Arena

**Apollyon**

OSU will provide support for the Apollyon research event.

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

**PI/PD:** Jamey Jacob

**Development and Testing of Small Capacity Positive Displacement Refrigerant Pumps for Heat Exchanger Tests**

This project will develop refrigerant pumps to be used for various HVAC&R small scale heat transfer experimental setups. For this, several capstone design project teams will design, build, test positive displacement pumps. These pumps will be used in a follow-up senior design project that will develop a small capacity refrigerant calorimeter for testing of heat exchanger samples.

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

**PI/PDs:** Christian Bach,

Engineering Technology: Ilchung Park

**Low-Cost Rocket-Assisted Take-Off (RATO) System of Unmanned Aircraft: Phase 2**

During Phase 1, a quad RATO system was developed for Kratos. During Phase 2, final testing with an actual Firejet and development of an in-house, low-cost solid rocket motor will proceed with a capstone design project to RATO launch a 1/6th scale turbojet powered F-18 to reduce technical risk. Students have been recently mixing and casting sorbitol-based solid rocket motors, using a 500-lb thrust capable mobile test stand to measure performance. This project will entail a similar development for solid rocket motors with a peak thrust around 600 lbs, and average thrust around 550 lbs using a 2000-lb thrust stand.

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

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

**INTERN Support for the Center for Integrated Building Systems at Oklahoma State University**

The Center for Integrated Building Systems (CIBS) will place 5 high-talent undergraduate students per year onto project teams within the center. The interns will be placed onto funded CIBS projects, aligning them with both a faculty and graduate student mentor. This will maximize the students’ experience, add value to the projects, and introduce our industrial members to high-talent students to recruit. The CIBS projects and interns will also support the commercialization of the next generation building systems products for the industrial partners.

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

**PI/PDs:** Craig Bradshaw, Dan Fisher

**Aircraft Engine Design System Analysis Software Development – NOZZLE, COMPR & TURB**

The overall goal is to develop, validate and document conversion of AEDsys Aircraft Engine Design System Analysis Software from VB6 to VB.net with ComponentOne graphic support software. The goal of this specific project is to finish development of three AEDsys component executable programs (NOZZLE, COMPR and TURB) in VB.net, using existing VB6 versions of the programs.

**Sponsor:** Practical Aeronautics, Inc.

**PI/PD:** Kurt Rouser

**Collaborative Research: Operator Theoretic Methods for Identification and Verification of Dynamical Systems**

This work aims to establish a framework for learning problems in nonlinear dynamical systems theory. This work will interface mathematicians, computer scientists, and engineers for the development of new tools that can harness data obtained from unknown black-box and partially known gray box dynamical systems in a manner that is robust to both noise and uncertainties. The developed tools will be validated by solving verification and control problems in unmanned ground, air, and underwater systems.

**Sponsor:** National Science Foundation

**PI/PD:** Rushikesh L. Kamalapurkar

**Flow Control Strategies for Protection of Aircraft Passengers and Workers Against SARS-CoV-2**

The team proposes to develop modular, low-cost active flow control (AFC) devices that can be retrofitted on existing aircraft seats for controlling airborne transmission of virus-containing aerosols. Using synthetic jet actuators that generate pulsed air jets, commercially-available axial fans and passive 3D printed nozzles, the concept relies on suction-based trapping of aerosols and redirection to exhaust slots near the floor. The proposed AFC device is intended to function within a hierarchy of controls, such that it can be used in conjunction with traditional measures and also incorporate emerging solutions for potential inactivation using ultraviolet light units.

**Sponsor:** Centers for Disease Control and Prevention

**PI/PDs:** Arvind Santhanakrishnan, Jamey Jacob

Chemical Engineering: Yu Feng

**NASA Oklahoma Space Grant Consortium**

Oklahoma Space Grant Consortium (OKSG) consists of ten academic affiliates and five business, government and museum organizations. Each affiliate has been strategically chosen so that overall, the consortium has the diversity necessary to address and adapt to both state and NASA challenges. OKSG’s structure and approach to funding supports each institution in developing NASA mission-based programs utilizing affiliate strengths, expertise, and resources on their own campus to inspire, engage, and educate students. Fellowship, Internship, and Scholarship opportunities are open to all students majoring in a STEM discipline at an OKSG affiliate.

**Sponsor:** National Aeronautics & Space Administration

**PI/PD:**  Andy Arena

**Collaborative Research: Joint Space Muscle Fatigue Model and Integration into Full Body Motion Prediction for Repetitive Dynamic Tasks**

Objectives are to develop: (1) a new joint space muscle fatigue model for repetitive dynamic tasks; (2) a new joint space predictive simulation method considering fatigue; and (3) the fatigued joint torques are decomposed into fatigued muscle forces. The project will deliver novel and feasible advanced tools toward solving large-scale optimization problems for dynamic motion prediction considering muscle fatigue. The outcome will be the first full body biomechanics human model considering muscle fatigue for repetitive dynamic tasks. The methods and associated numerical tools will be applicable for broad occupational health and safety design.

**Sponsor:** National Science Foundation

**PI/PD:**  Yujiang Xiang

**FLIR IBAC SkyRaider Wind Tunnel Testing**

FLIR is using testing services from Oklahoma State University to provide access to a wind tunnel due to the unique capabilities of that facility for simulating atmospheric conditions, angle of attack, and horizontal motion of the aircraft.

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

**PI/PD:** Jamey Jacob

**Analysis of Residential Refrigerators**

This ASHRAE Undergraduate Program Equipment Grant will support capstone design project teams as they evaluate various performance parameters of refrigerators, including the energy consumption as well as component level analysis for the compressor, condenser, and evaporators. To support the project, Whirlpool Corporation will contribute two French-door refrigerators as well as technical expertise for the students to complete the project successfully.

**Sponsor:** American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE); Whirlpool Corporation

**PI/PDs:** Christian Bach

Mechanical Engineering Technology: Ilchung Park

**Applying Unmanned Systems for Water Quality Monitoring**

The goals are to develop a monitoring system for Grand Lake that provides high-spatial resolution datasets of nutrients, sediments, and HAB levels using unmanned systems and provide improved models of the behavior of these constituents. The development of these tools will assist with decision support for various water management activities at Grand Lake. Unmanned systems have potential to reduce the costs of monitoring in addition to providing extensive quantities of spatial and temporal data. The long-term goal is to develop a system to identify, forecast, and respond to nutrient and sediment resuspension and HAB formation events to preserve water quality.

**Sponsor:** Department of Interior, Bureau of Reclamation

**PI/PDs:** Jamey Jacob

Civil and Environmental Engineering: David Lampert

**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 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

**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

**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

**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

**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, Rushikesh Kamalapurkar, Kursat Kara

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

**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

**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

**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

**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

**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 development of *Spoolcomp,* a model of a novel rotating spool compressor, it has been validated and used to develop 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

**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

**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

**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

**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

**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

**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 Paddling**

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

**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

**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

**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

**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

**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

**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

**Certification, Validation and Safe Integration of Turboelectric Aircraft Distributed Power and Propulsion Systems**

Over the past decade, hybrid electric aircraft concepts with distributed power and propulsion have emerged to improve aircraft efficiency, reliability and maintainability with reduced need for hydraulic, mechanical and pneumatic systems. Previous studies in aircraft hybrid electric propulsion have addressed conceptual design and analytical modeling; however, there is a critical need to address practical considerations for integration of electrical generation, distribution, control and storage. This study will develop practical recommendations for certification, validation and safe integration of turboelectric aircraft distributed power and propulsion systems, providing data to address safety implications of electrical system components associated with MEA and FEA concepts.

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

**PI/PDs:** Kurt Rouser, Rick Gaeta

**sUAS Radio Solutions**

The Unmanned Systems Research Institute shall research and propose a solution for a sUAS ground control station and sUAS airborne radio in accordance with the sponsor requirements.

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

**PI/PD:** Jamey Jacob

**Low-Cost Rocket-Assisted Take-Off (RATO) System of Unmanned Aircraft: Phase 1**

Kratos is interested in low cost Rocket-Assisted Take-Off (RATO) for use with unmanned aerial vehicles for domestic and international military customers. The OSU team will design and build a Firejet (MQM-178) RATO Bracket and a Firejet Launch Rail Trailer. The OSU team will also design and build a Firejet RATO Launch Test Simulated Mass.

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

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

**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

**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

**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:** Khaled Sallam

Civil and Environmental Engineering: Prem Bikkina

**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**

**ATS Worldwide Regents Business Partnership Excellence Award**

The New Product Development Center faculty and staff will guide a student intern as he/she performs engineering analysis and component selection for a pushback only version of the Airplane Transporting Systems aircraft movement platform. The design process for the pushback only version of the ATS system has just started. The student will be expected to perform stress analysis on the subsurface components of the cart and cart support hardware. The analysis will be used to inform the selection of hardware components to be used for fabricating a prototype system.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PD:** Robert Taylor

**Creating Resilient Manufacturers: Recovery, Reshoring, and Reimagining Manufacturing in Oklahoma**

The program will provide pandemic recovery and resiliency evaluation and solutions, engineering technical design and assistance, and workforce development activities aimed at small and medium sized manufacturers. The anticipated outcome is long-term economic resiliency as a result of job stability, increased revenues, strengthened innovation capacity, and improved health and safety of manufacturing employees. The engineering assistance and training components will be guided by the Industrial Engineering disaster preparedness faculty team’s evaluation and recommendations. The program is also a collaboration between OSU and the MidAmerica Industrial Park Automation Resource Center, offering workforce development training and technology application evaluation and research.

**Sponsor:** United States Department of Commerce Economic Development Administration

**PI/PDs:** Robert Taylor

Industrial Engineering and Management: Sunderesh Heragu, Katie Jurewicz

**Improving Food Security in the Face of Pandemics / COVID-19: Diversifying Protein via Mechanized High Density Mealworm Farming**

The NPDC will test materials, parts and system components and concepts to refine the Insect Production System (IPS) design. The NPDC will evaluate materials and components to determine their best use in the proposed IPS. The team will test various materials to determine the appropriate media for mealworm husbandry. The NPDC will design a fully functional final Phase I Drop model IPS that employs an innovative high density growth area with mechanized harvesting. The NPDC team will fabricate a complete prototype of the IPS, provide testing of the prototype, and provide any design recommendations based on test results.

**Sponsor:** All Things Bugs LLC for United States Department of Agriculture National Institute of Food and Agriculture

**PI/PD:** Robert Taylor

**Accelerating the development and commercialization of a novel helical sign post**

The New Product Development Center will be responsible for performing the design analysis for several sizes of helical sign posts using the Finite Element Analysis process in the SolidWorks design package. The design process will include the development of helical sign post models, completing finite element analysis using the required loading conditions for each helical sign post size, design and development of the load sensitive connection between the sign and the helical sign post anchor and the development of manufacturing drawing for delivery to the RamJack manufacturing group. The NPDC will also assist as needed during the in-house testing phase for the helical sign post models and provide comparisons of the test data with the finite element modeling results.

**Sponsor:** Ram Jack Systems Distribution, LLC for Oklahoma Center for the Advancement of Science and Technology

**PI/PD:** Robert Taylor

**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/PDs:** Robert Taylor

College of Veterinary Medicine: Ashish Ranjan

**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

**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

**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/PD:** 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 provides clients with one or more of the following: 1) an assessment of the technical viability of the proposed product or process; 2) an evaluation of competing products; 3) a review of relevant patents and intellectual property; and 4) a defined scope of work that outlines additional engineering product and process design assistance. A complete manufacturing drawing package will be provided to each client who successfully enters the engineering design stage.

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

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

**PROFESSIONAL DEVELOPMENT**

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

The Scope of Work is for CEAT Professional Development to 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 for the MSA Testing Services Firefighters.

**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

**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)**

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

In this subaward, Dr. Murphy will help develop the experimental design with regard to residents in Texas and Washington. This will include developing the Qualitative Methods Guide, which will help observers consistently code interaction between household members during the experiment, as well as developing the evolving tornado scenario using DynaSearch. She will also assist in participant recruitment, data collection, data analysis, and final analysis.

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

**PI/PD:** Haley Murphy

**Micro Computer Integrated Rifle w/UAS Control Capabilities STTR Phase II**

OSU will support Casey Corp Defense, LLC in performing its Phase 2 STTR project. Dr. Vora will fabricate the prototype using 3D printing in the ENDEAVOR lab. Tensile and impact tests will be conducted for the prototype using ENDEAVOR material testing equipment.

**Sponsor:** Casey Corp Defense LLC for Department of Defense

**PI/PD:** Hitesh Vora

**Performance of Flame Mitigation Device**

The 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 (FMD) installed. Only one size of PGCs (5 gal) is subject to the experiments.

**Sponsor:** Midwest Can Company

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

**Oklahoma Shared Clinical and Translational Resources: Assessment of Residual Polycyclic Aromatic Hydrocarbons (PAHs) Exposure on Turnout Gear and Biomarkers between Volunteer and Career Firefighters in Oklahoma**

Co-PI Agnew will be responsible for: Recruiting local career and volunteer fire departments into the study; Recruiting members within those departments to participate in the Study; Co-developing the informed consent documentation and receiving IRB approval for human subject research; Co-developing the questionnaire used to collect data from subjects; Attending regular calls and meetings related to the project; Reviewing the results of the data collection and the manuscript(s) for publication/presentation.

**Sponsor:** Board of Regents of the University of Oklahoma Health Sciences Center for National Institutes of Health

**PI/PD:** Rob Agnew

**Flammable Gas Detector Testing**

OSU will perform a testing scheme for the soon to be introduced KANARY Scout, following the sensor manufacturer’s specifications as described in the NevadaNano “Molecular Property Spectrometer™ (MPS™) Flammable Gas Sensor User Manual, as modified to accommodate the geometry of the KANARY Scout (calibration jar).

**Sponsor:** KANARY Alert

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

**Rural Energy Assessment Center (REAC) at Oklahoma State University**

The mission of REAC is to provide energy assessment/audit (at no cost to the client) to small rural businesses and agriculture producers of the state of Oklahoma that will help reduce energy and waste and increase productivity, while educating and training the next generation of energy, waste, and productivity professionals.

**Sponsor:** United States Department of Agriculture

**PI/PD:** Hitesh Vora

**Toward Optimal Secondary Furnace Heat Exchanger: Modeling of Furnace Combustion Gas Condensation**

This project will create a computational fluid dynamics (CFD) model using Siemens’ STAR-CCM+ software to simulate condensation and heat exchange in a secondary heat exchanger (SHX). In year one, the model will be used to generate a dataset of results for a range of inlet temperatures, inlet water concentrations, tube diameters, tube lengths, and tube internal wall enhancements. In parallel, a simple test apparatus will be created that will generate a validation data set for the CFD simulation. Validated CFD results will provide confidence for extension of the model to different tube diameters and shapes along with variation in inlet conditions.

**Sponsor:** Various Private Sponsors

**PI/PD:** Aaron Alexander

Mechanical and Aerospace Engineering: Christian Bach

**Cotton Bale Fire Retardant Testing**

OSU FPST will perform an initial (small scale) assessment as to the efficacy of PeteFireX (agent) for use in the prevention of cotton bale fires. The obtained information will be used to design full-scale field tests.

**Sponsor:** Triangle Insurance Company Inc.

**PI/PD:** Haejun Park

**RAPID: Understanding Evacuation, Sheltering, and Reentry Decisions During the Dual Threat of Hurricane and the COVID-19 Pandemic**

In this subaward, the OSU investigator will help develop the Interview Protocols and Surveys with regard to emergency managers and residents in Texas and Louisiana. This will include participant recruitment, data collection, data analysis, and final analysis.

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

**PI/PD:** Haley Murphy

**NASA Oklahoma EPSCoR Research Infrastructure Development Qualification and Certification of Additively Manufactured Metallic Components in Space and Other Industry Applications**

This travel grant will enable strategic partnerships that support the activities funded by the Space Mission Directorate at NASA Marshall. Specifically, the team seeks to pursue

collaborative research in lightweight structures and additive manufacturing. They also seek

collaboration in developing capabilities related to real-time property prediction during the AM process. This grant will allow interaction with the additive manufacturing group at NASA Marshall Space Flight Center and thus enable identification of primary areas of mutual interest.

**Sponsor:** Oklahoma State Regents for Higher Education

**PI/PDs:** Hitesh Vora

Materials Science and Engineering: Ranji Vaidyanathan

**Development and Testing of Small Capacity Positive Displacement Refrigerant Pumps for Heat Exchanger Tests**

This project will develop refrigerant pumps to be used for various HVAC&R small scale heat transfer experimental setups. For this, several capstone design project teams will design, build, test positive displacement pumps. These pumps will be used in a follow-up senior design project that will develop a small capacity refrigerant calorimeter for testing of heat exchanger samples.

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

**PI/PDs:** Ilchung Park

Mechanical and Aerospace Engineering: Christian Bach

**RAPID: A Multinational Analysis of Factors that Determine the Effectiveness of COVID-19 Warning Messages**

Local governments that issued an order of lockdown could face a dilemma of exhausting its limited resources to contain the toxic virus with an increasing demand for essential public services. The official information sources also suffered from an adverse situation balancing timeliness and accuracy due to understaffing. In the meantime, the public can develop unexpectable stakeholder perceptions due to the conflicting social cues and official information sources. This study explores the roles of emergent norms as a moderator of the relationship between the information conflicts and public perceptions of government stakeholders.

**Sponsor:** National Science Foundation

**PI/PDs:** Xiangyu (Dale) Li, Tony McAleavy, Haejun Park

**Tran-SET: Smart Battery Management System for Electric Vehicles: Self-Learning Algorithms for Simultaneous State and Parameter Estimation and Stress Detection**

Efficient and safe operation of Li-ion batteries in electric vehicles requires an intelligent and smart battery management system (BMS) capable of learning the health degradation for accurately estimating the state-of-charge (SOC) and the state-of-health (SOH). This will add autonomy to the BMS in health-conscious decision making such as fast charging, discharging, cell balancing, and optimal power and energy management. The design of smart BMS will require the development of 1) an enhanced SOC and SOH dependent parameter-varying dynamical model of Li-ion battery and 2) real-time learning algorithms to learn the parameter-varying model.

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

**PI/PDs:** Avimanyu Sahoo

Civil and Environmental Engineering: Samir Ahmed

**Next Generation Smart Heatsinks**

Heatsinks are a ubiquitous requirement for electrical components to dissipate the heat created. These products are oftentimes limited by the available space and allowable weight. The partnering firm, Moog Inc., is a defense and aerospace supplier that must frequently supply components that are space and weight limited while maintaining performance and proper heat dissipation. Providing components that meet the performance requirement while reducing the weight and occupied space will strengthen Oklahoma’s manufacturing and aerospace industry. This OARS project links innovative design, highly efficient additive manufacturing, and suitable material systems to create the tailored performance needed in next generation smart heatsinks.

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

**PI/PDs:** Hitesh Vora, Aaron Alexander, Ilchung Park

**Analysis of Residential Refrigerators**

This ASHRAE Undergraduate Program Equipment Grant will support capstone design project teams as they evaluate various performance parameters of refrigerators, including the energy consumption as well as component level analysis for the compressor, condenser, and evaporators. To support the project, Whirlpool Corporation will contribute two French-door refrigerators as well as technical expertise for the students to complete the project successfully.

**Sponsor:** American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE); Whirlpool Corporation

**PI/PDs:** Ilchung Park

Mechanical and Aerospace Engineering: Christian Bach

**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

**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/PD:** Hitesh Vora

**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

**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:** Haejun Park

New Product Development Center: Robert Taylor

Chemical Engineering: Clint Aichele