Spring 2017
Undergraduate Research Poster Forum

Thursday, April 27, 2017
5:30 p.m. – 7:00 p.m.
Engineering Hall Atrium

Sponsored by:
Office of Engineering Research and Graduate Programs
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ERGP Disclaimer

The ERGP staff has compiled this abstract booklet with information provided by the undergraduate students. We have reprinted it with their permission exactly as they submitted it.
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Poster Abstracts

Poster 1
ANALYSIS OF NITRIDATION OF PURE BORON, NICKEL, CHROMIUM AND NI-B-CR ALLOY
Xiu Wang, Mr. Song Liu, Dr. James Edgar
Department of Chemical Engineering

Hexagonal boron nitride (hBN) crystal has advantageous properties such as high electrical resistivity, high thermal conductivity and thermal stability. It is significant to grow crystals that are free of defects and have low impurity concentrations. Studying how producing such high quality crystals experimentally is valuable. Molten nickel-chromium (Ni-Cr) solution has been used as a solvent for hBN single crystal growth, because boron (B) dissolves well in nickel and chromium is a good solvent for nitrogen. The solubility of nitrogen has a big impact for hBN quality since hBN is from the formation of boron and nitrogen. Hence, the nitridation analysis of B, Ni and Cr is critical for hBN formation. This project studied the reactions of pure nickel, chromium, and boron powder in nitrogen gas from 1350-1550 °C. The mellen furnace was used to process this experiment. The forming gas (hydrogen and argon) was used to remove the impurities, and avoid oxidation. X-ray diffraction was used to analyze the composite of chromium nitride, which includes CrN or Cr2N. From results, the mass change of nickel was almost zero, which indicates nickel doesn’t react with nitrogen at all. From x-ray diffraction detection, chromium nitride (Cr2N) was the main production. Moreover, reaction forming Cr2N is reversible, because it returns to Cr when heated in forming gas at 1500°C. Boron partially reacts with nitrogen to form boron nitride; the conversion increased with temperature. Due to high vapor pressure of chromium, some chromium evaporates, while nickel and boron do not evaporate.

Poster 2
COLD-FORMED STEEL AND OSB SHEATHING SLIP MODULUS
Hunter Wheeler, Ms. Kimberly Kramer, Dr. Bill Zhang
Department of Architectural Engineering and Construction Science

Cold-Formed Steel (CFS) sections covered with OSB (Oriented Strand Board) structural panel sheathing are commonly used in commercial construction. Current design of this type of assembly does not consider the partial composite action that takes place between the two materials. Composite action requires shear force to be transferred between the dissimilar materials. In the case of Cold-Formed Steel Wood Structural Panel (CFSWSP) assemblies, shear force is transferred by the connections, which are typically screws spaced at close intervals. When such assemblies are loaded in bending, the screws will transfer shear, but not until certain amount of slip occurs between the two materials. The amount of slip that will occur can be expressed as a quantity known as the slip modulus. Using the slip modulus, shear flow can be calculated, and in turn the effective composite stiffness of the assembly can be found. The purpose of this research is to investigate the effect of sheet metal thickness and fastener spacing on slip modulus, to verify the slip modulus values from previous studies, and to expand the varied parameters by conducting additional tests.
Poster 3
COMPARING DISTRIBUTION SYSTEM DESIGN FOR EDUCATIONAL SUPPLIES TO SUPPORT HURRICANE RECOVERY IN HAITI
Norma E. Varona Ortiz, Dr. Jessica Heier Stamm
Department of Industrial and Manufacturing Systems Engineering

Hurricane Matthew in October 2016 was the most powerful Caribbean storm in a decade, damaging many communities across Haiti. Numerous organizations are participating in the recuperation of the country. Education is essential for the country recover and thrive, but many schools were damaged or destroyed. Therefore, organizations are helping through the provision services, allotment of education kits and other activities. Although all the organizations want to meet current needs, they often do not coordinate with each other, which impacts their effectiveness. The goal of this research is to quantify the differences in outcomes resulting from different distribution scenarios. The study considers eighteen highly impacted communes (Haiti’s third administrative level) and the organizations working in each commune as published in “Humanitarian Data Exchange.” The data are used as input to optimization models representing different distribution scenarios for education kits. One scenario requires each organization to have its own distribution center at each commune, the second model has a shared distribution center for all organizations serving in the commune and in the third model each organization has a single warehouse. The total distribution cost under each scenario is compared, providing quantitative information about tradeoffs in distribution system design. The insights acquired from this research have the potential to support more effective humanitarian relief efforts. There are thousands of humanitarian organizations operating around the world on a daily basis. Research to better understand and encourage coordination is critical to achieving the greatest impact.

Poster 4
CROSSLINKING AND SOLVENT TREATING POLYETHERIMIDE MEMBRANES
Connor Seacat, Griffin Karr, Dr. Michael Wales
Department of Chemical Engineering

This project investigates the chemical crosslinking of polyetherimide (PEI) membranes for use in gas separations. Membranes are sheets of layered polymer chains that are selectively permeable to different gasses based on traits such as size and geometry. Some molecules, such as CO₂, can be absorbed into the membrane in large quantities and disrupt the packing of the membranes’ polymer chains. This phenomenon, known as plasticization, creates gaps within the membranes which greatly reduces their selectivity. Plasticization can be reduced by binding the polymer chains together through a diamine crosslinking process. Crosslinking is accomplished by immersing membranes in an alcohol and diamine solution. The alcohol swells polymer chains in the membrane, giving the diamine access to the polymer chains where the crosslinking occurs. This project tests the effectiveness of several alcohols, diamines, and crosslinking times to determine the best combination to treat the membranes without damaging them. The gas flux transport properties of the membranes are measured before and after crosslinking with Helium, Oxygen, and Nitrogen gas. The surface chemistry of the membranes will be characterized using powder x-ray diffraction (XRD), x-ray photoelectron spectroscopy (XPS), and attenuated total reflectance- fourier transform infrared spectroscopy (ATR-FTIR).

A second project investigates the use of corrective solvent treatments to improve the selectivity of imperfectly cast membranes. Treatments are conducted with various solvents via liquid and vapor contact. Gas flux of the membranes will be tested after each treatment and will be compared to determine the optimal solvent and number of treatments to improve membranes.
Poster 5  
CURVATURES AND SHEAR-LOAD DISTRIBUTION IN A SPECIAL REINFORCED CONCRETE MOMENT-RESISTING FRAME FOR A SEVEN-STORY BUILDING  
Colten Johnson, Gabrielle Liuzza, Dr. Don Phillippi  
Department of Architectural Engineering and Construction Science  

This research analyzes the behavior of the framing system of a reinforced concrete building which uses moment frames to resist lateral loads. LS-DYNA, a general-purpose three-dimensional finite element analysis (FEA) dynamic software, was used to model and simulate the lateral loading of a seven-story, five-bay building. The behavior examined is over the curvature of the columns and beams throughout the building. The curvature in a member is the amount of rotation in the cross section at a given section in the member. The curvature of the beams and columns were compiled into a general graph which resembles the frame system. The points of interest are where the curvatures are the maximum within the members. At the base of the columns plastic hinges form due to lateral loading and resulting lateral displacements. In the beams plastic hinges form at both ends of each beam and results in beam elongation. LS-DYNA's moments at the base of the columns and at the ends of the beams are compared to the moments obtained from a simplified fiber model that used the same curvatures and axial forces. The comparison shows that the moment values obtained from both LS-DYNA and the fiber models were similar, thus validating the findings. The findings are that the end-column in compression resists a substantially larger portion of the lateral shear-load than previously thought. Future engineers can use this information in the design of special reinforced concrete moment-resisting frames that account for the disparity in column shear-load resistance.

Poster 6  
ELECTROCHEMICAL CORROSION TESTING ON MOLYBDENUM DISULFIDE, BORON NITRATE, AND TUNGSTEN DISULFIDE  
Diana Arreola, Mr. Monsur Abass, Dr. Gurpreet Singh  
Department of Mechanical and Nuclear Engineering  

This report investigates the corrosion resistance properties of a commercial grade stainless steel in 3.5% NaCl(aq) coated with molybdenum disulfide (MoS₂), boron nitrate (BN) and tungsten disulfide (WS₂). The slurry coatings on the tested stainless steel were made via drop casting method. The electrochemical behavior of the coated stainless steels was studied in comparison with bare stainless steel using open circuit potential and Tafel plots. The molybdenum disulfide coated stainless steel displays a superior corrosion resistance than the boron nitrate and tungsten disulfide coated stainless steel. Scanning electron microscopy images confirms the observed the superior corrosion resistance properties of molybdenum disulfide is due its uniform coatings with lesser defect sites for diffusion of corrosive ions. Moreover, bare stainless steel was stable to the corrosive environments it was being tested at. It is believed that reduced corrosion resistance of the coated samples is due to distortion of the stainless surface property during coating.
Poster 7
LIFTED EQUALITY CUTS FOR THE MULTIPLE KNAPSACK EQUALITY PROBLEM
Alonso Talamantes, Dr. Todd Easton
Department of Industrial Manufacturing and Systems Engineering

Integer programming is an important discipline in operation research that has numerous real world applications that positively impact society. Unfortunately, no algorithm currently exists to solve IPs in polynomial time. Researchers are continuously developing new techniques to help solve IPs including cutting planes. For example, Delissa discovered the existence of equality cuts limited to zero and one coefficients for the multiple knapsack equality problem (MKEP). This thesis introduces lifted equality cuts, which can have coefficients greater than or equal to two.

Two main theorems illustrate the conditions in which lifted equalities exist. An equality cut differs from a standard cut because every feasible integer point satisfies the equality. Thus, an equality cut is an improper cut as it defines the entire space. However, an equality cut reduces the dimension of the linear relaxation space by at least one. The Algorithm of Lifted Equality Cuts (ALEC) finds lifted equality cuts in quadratic time.

The computational study verifies the benefit of lifted equality cuts in random MKEP instances. ALEC generated millions of lifted equality cuts and reduced the solution time by a total average of 15%. To the best of the author's knowledge, ALEC is the first algorithm that has found over 30.7 million cuts on a single problem while still reducing the solving time by 18%.

Poster 8
MEASURING DYNAMIC PROPERTIES OF STEEL FRAMING FLOORS
Connor Meeske, Tyler Benschoter, Dr. Bill Zhang
Department of Architectural Engineering and Construction Science

In long span and lightweight floor construction structural vibration can become a serviceability issue that needs to be studied. Several locations within the Engineering Complex were built with long-span steel floor systems, which are prone to floor vibration. In previous studies, field measurements were taken in terms of acceleration at multiple long-span locations. An instrumented force input device (impact hammer) was added to the current study allowing measurement of the force input into long-span systems. Recorded force inputs and corresponding floor responses were analyzed in the frequency domain, and dynamic properties of the floor structures were obtained.
In Phase I of this research project, we determined that High Density Polyethylene (HDPE) can be recycled, and used as an alternative construction material. The recycled HDPE can be formed into Plastic Masonry Units (PMU), similar to a brick or concrete building blocks. Our overarching project goal is to help reduce plastic waste going into landfills. The Phase II objectives involve prototyping PMU shapes/connections, testing compressive strength, testing flexural properties, and experimenting with manufacturing processes. We initially utilized 3D-printer technology to prototype potential PMU shapes at a reduced scale which allowed us to physically examine connectivity methods for PMUs. Next, we began testing the compressive strength of the recycled HDPE. The involved soliciting a donation of recycled HDPE from a regional plastics manufacturer. Testing involved melting recycled HDPE chips and reforming them into plastic cylinders, similar to the ones used in testing concrete compressive strength. We experimented with different production processes to determine the optimal method for layering the plastic into the test cylinders, so that it could be repeated in the future PMU molds. HDPE test cylinders were crushed using the Big Purple machine in the basement of Fiedler Hall. Our “z-fold” method yielded the highest compressive strength. The compressive strength of the recycled HDPE was similar to that of lower grade concrete design mixes. Our last task for this phase is to construct a PMU beam assembly to test flexural properties using a 3-point bending test.

Hexagonal boron nitride (hBN) has many unique properties such as a strong interaction with thermal neutrons. Thus, it is a good candidate for compact, efficient, and low-cost neutron detectors. These detectors can be used to efficiently scan cargo for nuclear weapons and other radioactive materials. hBN’s wide energy bandgap (>6.0 eV) makes it suitable for light emitting diodes capable of emitting deep UV light. This is useful for sterilizing water without the use of chemicals.

Currently, we are producing hBN single crystals (up to 2mm in diameter and tens of microns thick) by precipitation from a molten nickel-chromium solvent. Crystals of this size are uncommon and not yet commercially available. However, these crystals still contain too many impurities for device applications. Therefore, a chemical equilibrium thermodynamic analysis was performed, to determine what reactants could be added to the gas phase to remove carbon and oxygen, the main impurities. Equilibrium constants were calculated from Gibbs energy of formation data and relevant reactions were coupled. This analysis has revealed that hydrogen is unlikely to remove carbon from the solution and that boron oxide (B₂O₃) will be the most prevalent oxide (as compared to the oxides of nickel and chromium). Under normal process conditions, B₂O₃ may be reduced by hydrogen to form water vapor and will also readily evaporate. Both mechanisms remove oxygen from the system, so the system should include hydrogen and be run at high temperature (to promote evaporation). More research is necessary to determine viable methods of removing carbon.
Poster 11
AUTONOMOUS ASSISTANT QUADCOPTER
Alice Lam, Shelby Coen, Yihong Yan, Carlos Aguirre, Fernanda De La Torre, Dr. William Hsu
Department of Computer Science

The project’s goal is to develop an autonomous indoor drone with a robotic arm that can serve as a personal assistant. The current research is focused on autonomous flight, object recognition, and spatial mapping. The drone will receive information from a developed phone application to map and navigate a home space while using machine learning and computer vision to identify common objects through a camera. The drone will be controlled through an application that is programmed specifically to collect sensor data. Users will interact with a point and tap camera view to select and move objects from point A to point B. The main body of the prototype is 2 x 2 inches and is 3D printed to fit an Arduino mini pro, an IMU sensor board, Wi-Fi module, and battery. The software that is currently being modified for the autonomous flight and navigation is MultiWii Firmware, an open-source software package containing libraries for flight control. Py-faster-rcnn is our current experimenting model for object recognition on image data. YOLO is a real-time object detection system that classify images at multiple locations and scales by using a single neural network. OpenCV and OpenSLAM are sources that have useful libraries for computer vision and spatial mapping. Active learning will be implemented to train the drone to query user for feedback to perform iterative supervised learning. Continuous modification to the drone will be done while proceeding to merge all deep learning and navigation and flight control entities into one coherent project.

Poster 12
D* LITE DYNAMIC SEARCH PERFORMANCE VARIATION BY HEAP OPTIMIZATION AND SEARCH SPACE CHARACTERISTICS
Jeffrey Cook, Dr. William Hsu
Department of Computer Science

Dynamic Pathfinding Algorithms are becoming increasingly relevant as self-driving cars, robots, and autonomous drones become mainstays in everyday life. The ability to recalculate a path in a constantly-changing environment has applications ranging from consumer GPS to Mars rovers. Incremental Algorithms such as D* Lite, Dynamic SWSF-FP, and LPA* reuse information from the initial path search to improve recalculation speed when an obstacle is encountered or traversability otherwise changes. These algorithms have been successfully employed in real-world applications and have demonstrated substantial speed increases over non-incremental methods. However, safety-critical accident prediction and avoidance software, including image processing functionality, has proven to be computationally-intensive; consequently, any speed increase in other systems is desirable to leave more resources for safety-critical functions. These optimized algorithms—and especially D* Lite—have been extensively compared to each other and to earlier algorithms. Platform-independent metrics including heap percolates, vertex accesses, and vertex expansions are widely published, establishing the superiority of D* Lite to Breadth-First Search, A*, and others. Additional research has already compared D* Lite using an optimized heap (Fibonacci heap) with the standard algorithm, demonstrating improvement. To determine how other optimized heaps affect performance and heap percolate scaling in spatial applications, standard D* Lite with a Binary heap was compared to versions implemented with Binomial, Fibonacci, Pairing, Brodal, and Rank-Pairing heaps. Scaling with obstacle density and space size was also investigated to establish which optimizations yield the most improvement in different search space topologies.
Poster 13
LEARNING TO FILTER: CLASSIFICATION FOR EXAMPLE SELECTION FROM WEB DOCUMENT CORPORA AND A RAPID ANNOTATION INTERFACE
Carlos Aguirre, Fernanda De La Torre, Alice Lam, Mr. Sneha Gullapalli, Dr. William Hsu
Department of Computer Science

This work addresses the problem of extracting procedural information from published papers: specifically, the task of choosing which documents from among a collection are of specified type, structure and content depending of a query and context. The novel contribution of this project is the development of a fast and usable user interface for annotation of training documents for machine learning.

In prior research, we developed a system aimed at extracting experimental data from scientific publications, with the long-term goal of extracting procedural information from relevant sections on experimental methodology. For this purpose, we use supervised machine learning to learn a classifier that can filter documents crawled from the web with respect to such relevance criteria. This learning task requires a lot of training data, hence the need to make human labeling of data (annotation) more efficient.

We consider subsequent information extraction tasks that depend on the documents passed by the filter: marking up sections (or passages) that contain the desired procedural information; finding the elements, compounds, and relationships that are related to a recipe of interest; and explaining to a domain expert why a document is relevant. These distinct use cases make the annotation task multifaceted, and illustrate the need for a new approach to annotation. Our approach focuses on speeding up annotation in learning to filter, while minimizing loss of precision or recall on the learning task, and aiming towards developing a reconfigurable user interface for text annotation.

Poster 14
COMPARATIVE ASSESSMENT OF 2.45 GHZ VS 5.8 GHZ FOR SPHERICAL ABLATION ZONES
Daniel Clausing, Dr. Prakash Punit
Department of Electrical and Computer Engineering

Primary aldosteronism, also known as Conn’s syndrome, is a benign tumor in the adrenal gland that causes excess aldosterone in the blood and subsequently high blood pressure in otherwise healthy individuals. The negative effects of chronic hypertension are widely known and currently a patient with Conn’s must undergo adrenalectomy or intensive medical management. Recently, however, we have become interested in exploring microwave ablation as another alternative. Microwave ablation (MWA) is a thermal treatment modality that has long been used to treat both benign and malignant tumors. Most of the research into microwave ablation, however, has been focused on treating malignant disease and thus concentrated on achieving large ablation zones and a definitive margin between cancerous and healthy tissue. However, in Conn’s syndrome the advantage of using microwave ablation is the possibility of salvaging healthy adrenal tissue and preserving tissue function. Preliminary experiments at 2.45 GHz have indicated that the frequency may not be conducive to creating small spherical ablation zones which are more predictable for clinicians and which would reduce excessive ablation. The clear higher frequency alternative was 5.8 GHz because of its approval as an Industrial Scientific and Medical (ISM) band. The purpose of this paper is to compare the axial ratio (length of the ablation zone along the cable divided by the width of the ablation zone perpendicular to the cable) at two different frequencies, 2.45 and 5.8 GHz, to determine if one frequency produces an axial ratio closer to 1 (a perfectly spherical ablation zone).
Poster 15
ENURESIS DETECTION BY WAY OF THERMOCOUPLE AND DIGITAL SENSOR DATA ANALYSIS
Shangxian Wang, Mr. Charles Carlson, Dr. Steve Warren
Department of Electrical and Computer Engineering

Sleep quality for children with severe disabilities is correlated to their daytime wellness and ability to learn. Enuresis, or bedwetting, can significantly affect sleep quality. Kansas State University researchers are currently working with Heartspring clinicians to develop a bed-based toolset to monitor a disabled child’s well-being and activity during the night. A portion of the bed sensor suite will consist of a collection of thermocouples or digital temperature sensors placed near the top of the mattress and covered by soft foam, where these temperature data will be used to track various parameters, including enuresis. Such an automated system would eliminate the need for Heartspring staff to conduct manual bed checks several times during the night for each child in a residential apartment. In this study, training and test data are collected from temperature sensors using previously determined configurations, and enuresis-detection algorithms are assessed in terms of their probability for successful event detection as well as their false alarm rate.

Poster 16
EVALUATION OF DIRECTIONAL MICROWAVE ABLATION ANTENNAS
Whitney Cox, Dr. Punit Prakash
Department of Electrical and Computer Engineering

Thermal ablation uses extreme temperatures for minimally invasive treatment of malignant tumors. During this procedure, a tumor is treated with low temperatures (Cryoablation) or high temperatures (Radio Frequency, Microwave, or Laser Ablation) to induce cellular death through coagulative necrosis. Ablation has been used to treat tumors in the liver, kidney, lung, and bone. Microwave ablation has been identified to have larger ablation zones, higher tissue temperatures, and travel through charred tissue more efficiently when compared to other ablation methods [1, 2]. Current Microwave Ablation devices radiate in a cylindrical pattern and must be inserted directly into the middle of the tumor. This study focuses on the build and performance evaluation of Microwave Ablation devices designed to create a directional ablation pattern. Devices with a directional radiation pattern eliminates the need for inserting the device directly into the center of the tumor. This can eliminate the risk of reseeding, allow for safer treatments near critical structures, and allows for the use of multiple devices to provide optimal ablation coverage. Currently, the performance of these devices has been evaluated through an iterative design process and ex vivo testing. This information will be used to characterize and conduct an in vivo test.
Poster 17
INVESTIGATING VARIATIONS IN ORGAN MORPHOMETRY IN ADULT COMPUTED TOMOGRAPHY EXAMINATIONS
Emily Stallbaumer, Dr. Amir Bahadori
Department of Mechanical and Nuclear Engineering

Radiation is a factor in everyday life. The Sun and many objects on Earth are sources of naturally-occurring radiation. One can be exposed to radiation occupationally, through medical examinations or treatments, or in a single, large dose in the case of a nuclear accident like Chernobyl, or the bombings of Hiroshima and Nagasaki. Computational phantoms are used to represent the human in radiation transport codes to predict the radiation dose to organs within the body. While the flexibility of phantoms has increased to represent people of different genders, ages, and body types, there are still fundamental limitations in representing the internal organs of a single person, since organ shape, size, and position in phantoms are typically determined from a population of individuals. In this pilot study, inter-individual differences affecting the size, shape, and position of the thyroid are being examined. De-identified computed tomography data are being segmented to create a three-dimensional representation of the thyroid for each patient. These representations are then analyzed to determine how size, shape, and position of the thyroid varies from person to person. This presentation includes information on the thyroid, radiation and segmentation, as well as 3D renderings of thyroid segmentation done in 3D Slicer.

Poster 18
MICROFLUIDIC DEVICES: INSPIRING A NEW ERA OF CANCER DIAGNOSIS
Megan Richards, Kaley Brungardt, Kendra Schuette, Mr. Edwin Brokesh, Dr. Mei He
Department of Biological and Agricultural Engineering

‘Lab on a chip’ devices are currently being studied to aid in blood based diagnostic assay tests for personalized medicine applications. These biosensors are appealing due to their low cost, simplicity of use, and quick feedback of results. The goal of team One Drop was to design a chip that simplifies the diagnosis of breast and ovarian cancer by searching for certain antigens in the bloodstream. The main objective for this semester has been to design a microfluidic ‘lab on a chip’ device that will mix blood and reagent streams to generate turbulent flows within a fluidic chamber using no external forces. The resulting fluid mixture will settle within the device for further analysis. One Drop was able to prototype four different microfluidic flow designs in SolidWorks for further simulation testing in COMSOL Multiphysics modeling with the aid of a theoretical analysis for analyzing fluid flow properties. One design was selected due to its high diffusive capability for efficient mixing of blood and reagent streams. Each design was compared through qualitative analysis, a simple COMSOL simulation, and 3D printing capabilities.
Poster 19
ANDROID MALWARE DETECTION WITH WEAK GROUND TRUTH DATA
Jordan DeLoach¹, Dr. Doina Caragea¹, Dr. Xinming Ou²
Department of Computer Science¹, University of Florida Department of Computer Science²

For Android malware detection, precise ground truth is a rare commodity. As security knowledge evolves, what may be considered ground truth at one moment in time may change, and apps once considered benign may turn out to be malicious. The inevitable noise in data labels poses a challenge to inferring effective machine learning classifiers. Our work is focused on approaches for learning classifiers for Android malware detection in a manner that is methodologically sound with regard to the uncertain and ever-changing ground truth in the problem space. We leverage the fact that although data labels are unavoidably noisy, a malware label is much more precise than a benign label. While you can be confident that an app is malicious, you can never be certain that a benign app is really benign, or just undetected malware. Based on this insight, we leverage a modified Logistic Regression classifier that allows us to learn from only positive and unlabeled data, without making any assumptions about benign labels. We find Label Regularized Logistic Regression to perform well for noisy app datasets, as well as datasets where there is a limited amount of positive labeled data, both of which are representative of real-world situations.

Poster 20
1-D CONDUCTION IN A LINEAR MATERIAL UNDER STEADY STATE, TRANSIENT AND HARMONIC CONDITIONS
Austin Schuberth, Dr. Zayd Leseman
Department of Mechanical and Nuclear Engineering

Conduction heat transfer is studied in a cantilever beam configuration. When a beam’s length is considerably longer than its other dimensions it can be modeled as a 1-D system. Analytical solutions to the heat diffusion equation demonstrate that a linear temperature gradient will develop for conduction in the cantilever beam if it has homogenous material properties. Analytical solutions were determined under three conditions: steady state, transient, and harmonic variation. To demonstrate these phenomenon, an experiment using a tip-heated copper cantilever beam was designed. The beam has a high-aspect ratio of 9 to allow it to be modeled as a 1-D system. A heater was attached to apply a heat flux, while the bottom end was attached to a copper heat sink placed in ice water. Fine gauge thermocouples were used to measure the temperature of the system without interference. Temperature was measured at five locations along the length of the beam with equal distance. In addition, 1-D heat transfer was verified by measuring the temperature along the width of the beam at three evenly spaced locations. To reduce the effects of convective and radiative heat loss, the beam’s surfaces were insulated. Experiments were performed under steady state, transient, and harmonic conditions and compared to theoretical predictions. Thermal conductivity and capacity were extracted from the experimental results. The average thermal conductivity and heat capacity were measured to be around 390 W m⁻¹ K⁻¹ and 385 J kg⁻¹ K⁻¹, respectively. The calculated values are within ~3% of the known properties of copper.
Poster 21
A NEW SUSTAINABILITY INITIATIVE: ASSESSING THE WIND RESOURCE OF SOUTHWEST KANSAS
Abdullateef Shodunke¹, Parker LaMascus² Dr. Ruth Miller¹,
Department of Electrical and Computer Engineering¹, Oklahoma Christian University²

Western Kansas farmers often depend on water from the Ogallala Aquifer to irrigate their crops; however, this water is a limited resource and will become depleted without intervention. A policy solution was proposed to incentivize reduced usage of aquifer water, called wind-for-water: farmers would have the opportunity to generate energy from wind on their land to offset the costs of reduced irrigation. We have investigated the feasibility of such a program, and conclude that Southwest Kansas is an ideal location for the institution of a wind-for-water program. The team further concluded concludes that larger wind turbines are more cost-effective over time, generating more annual revenue and boasting cheaper install costs per capacity, despite the fact that upfront costs for the larger turbines are much greater.

Poster 22
ANALYSIS OF THE AMA PUBLICATION, HUMAN AND ENVIRONMENTAL EFFECTS OF LIGHT EMITTING DIODE (LED) COMMUNITY LIGHTING
Aoife Callanan, Katherine Clark, Mr. Fred Hasler
Department of Architectural Engineering and Construction Science

In June 2016, the American Medical Association (AMA) released a report entitled Human and Environmental Effects of Light Emitting Diode (LED) Community Lighting. The AMA released this report without consulting many of the leading organizations within the lighting and electrical community, such as Illuminating Engineering Society (IES) and National Electrical Manufacturers Association (NEMA). Concerns of the report included the potential health and physiological effects of the blue LED light. The report has had mixed reactions and has brought about many responses and discussions while also publicizing this controversial topic. The research poster presented will dive deeper into the background of the topic, through an analysis of the report and the responses by IES and NEMA.
Poster 23

CARBIDE MANOMETER FOR DETERMINING WATER CONTENT IN FEEDSTOCK OIL FOR BIODIESEL PRODUCTION

Allison Crowther1, Mark Neal1, Dr. Edwin Brokesh2

Department of Chemical Engineering1, Department of Biological and Agricultural Engineering2

Analytical techniques are used to assess the quality of the oil to be used, namely for Free Fatty Acid and water content. High water content can contribute to problems such as low conversion, emulsions, and soap formation. Accurate water testing allows us to utilize resources better in terms of the energy used to remove water and the reagents used in converting the oil to biodiesel. It allows us to determine when oil is of a low enough water content that excess reagent or additional heating is unnecessary or of a high enough water content that significant quantities of additional reagent may be required. Most simple quantitative tests rely on a reaction producing gas, and therefore additional pressure, from which water content can be calculated. Thus far the Biodiesel Initiative has used Sandy Brae kits, which include reaction chambers with pressure gauges attached, but these have had short enough life spans to warrant looking into other methods, prompting us to build and test our own carbide manometer as an alternative to the current method. This method utilizes the same analytical concepts as the method previously used to a degree of accuracy adequate for its purpose and still allows for relatively quick testing compared to other quantitative methods as well as direct observation and manual calibration.

Poster 24

INVESTIGATING AND IDENTIFYING FUEL CONTAMINATION IN KSU RECYCLING TRUCK FUEL SYSTEMS

Logan Joos1, Allison Clark1, Dr. Edwin Brokesh2

Department of Chemical Engineering1, Department of Biological and Agricultural Engineering2

As part of Kansas State University’s sustainability movement, the Biodiesel Initiative collects used vegetable oil (UVO) from the dining centers on campus and reacts the oil into biodiesel through transesterification. The fuel is checked for reaction completion, water content, and free fatty acid (FFA) concentration before being passed to the KSU Recycling Center for use in facility vehicles. Recently, the fuel filters of one of the recycling trucks has become clogged with a viscous syrup, requiring replacement several times in a week. To investigate the problem, fuel samples have been collected from storage tanks and samples of recently reacted batches of biodiesel. FTIR was completed on all samples collected. It was found that over time the ester peak on the FTIR graph broadens, representing the formation of carboxylic acid. When the plots of the past batches, the unknown syrup, and the contents of the storage tanks were overlaid, the plots matched with acid troughs and broadened ester peaks. It was determined that the stored fuel had autoxidized during storage, as a result of the poly unsaturated methyl esters reacting with the free radicals in the air to form oligomers and peroxides. Oligomers are insoluble in non-polar substances, such as petroleum diesel, resulting in highly viscous emulsions. Utilizing this information, recommendations have been made and are being implemented to improve the storage and handling of biodiesel post production, to insure the stability of the fuel is maintained.
Poster 25
KINETICS OF DEHYDRATION OF 3-HYDROXYPROPIONIC ACID TO ACRYLIC ACID

Esther Radaha, Dr. Keith Hohn, Dr. Michael Wales
Department of Chemical Engineering

Acrylic acid is a chemical that is currently being used as raw material to produce superabsorbent polymers (SAP) and detergent polymers. The global market for acrylic acid is expected to increase to 22.55 billion dollars by 2022, making it high in demand. Traditionally, acrylic acid is made from propylene, a byproduct of petrochemical production. This process is considered non-sustainable due to its petrochemical origin. Recent efforts have been made to produce acrylic acid through bio-based routes to make the process sustainable and fossil-free. Several of these routes include dehydration of lactic acid and dehydration of 3-hydroxypropionic (3-HP), with both lactic acid and 3-HP derived from fermentation of sugar. Due to low selectivity as well as production of unwanted side products such as acetaldehyde and acetic acid for the lactic acid route, the 3-HP route is considered the more promising route; however, little has been reported on the catalytic dehydration of 3-HP to acrylic acid. This project measures the reaction kinetics of 3-HP dehydration to acrylic acid over solid acid catalysts, γ-alumina and ZSM-5. Reaction was run in a Parr batch reactor. Concentrations of 3-HP and acrylic acid were measured over time at different temperatures and a kinetic expression was developed.

Poster 26
MATERIAL WETTABILITY EFFECTS ON TWO-PHASE OIL-WATER FLOWS

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Department of Mechanical and Nuclear Engineering

The separation of oil and water is a time and energy consuming process required since corrosive salt water must be separated from oil. In oil-water flows through a mini-channel, surface tension forces dominate and can produce flow regimes that separate the oil and water (i.e., annular flow). This research studies surface tension effects for oil-water separation. Because surface tension forces are important, the effects of material wettability must be considered. Two-phase oil-water flows are investigated by measuring the pressure drops across a test section and visualizing the flow patterns through borosilicate glass, Inconel, stainless steel, and fluorinated ethylene propylene (FEP). Of these, glass, Inconel, and stainless steel are hydrophilic and FEP is hydrophobic. Stratified, intermittent, annular, and dispersed flow regimes are observed in the hydrophilic channels; however, stratified, inverted intermittent, inverted annular, intermittent intermittent, annular intermittent, annular annular, intermittent, annular, and dispersed flow was observed in the hydrophobic FEP channels.
Poster 27
MODELING UNCERTAINTIES IN SOLAR THERMAL RECOVER USING THERMAL-HYDRAULICS CODE RELAP-5
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Energy from the Sun can be harnessed for many different applications such as electrical power generation, steam production, or energy storage for later use; however, power output from solar energy systems is difficult to predict. There are many uncertainties in the day-to-day solar flux due to cloud transients which may impede or completely obstruct the Sun’s solar radiation over the course of a day. The impact of these cloud transients on solar power generation, is not yet well understood. Thus the main objective of this study is to use the Reactor Excursion and Leak Analysis Program 5 (RELAP-5) to model the uncertainties in the daily temperature, pressure, and void fraction oscillations along the length of a typical Linear Fresnel Reflector over the course of a year. Solar flux data from the National Renewable Energy Lab (NREL) will be used to estimate daily uncertainties over the course of a year. RELAP 5 has been selected as the primary tool of analysis because of its ability to simulate multiphase flow through piping networks. RELAP 5 allows the user to control many different initial conditions and fluid properties to tune models to accommodate very specific scenarios, which make it ideal for modeling this process. The goal of this research is to provide data on the effect of uncertainties of solar incidence, which can be used to optimize the design of future generations of solar facilities.

Poster 28
SMART HOME CONTROLS II
Caroline Kabus, Mr. Chris Ahern
Department of Architectural Engineering and Construction Science

Smart controls are a booming industry in the home improvement market today. These tools are great for the energy conscious and technology savvy home owner. Product lines are expanding from smart lighting controlled with your phone, to smart locks that sense when you arrive. Smart thermostats know when you are home and only condition the occupied space. Smart speakers can now decipher voice instructions for all these products making the user interface even easier.

For architectural engineers, this is an exciting time in our industry. Commercial building codes often drive development for energy conscious and innovative products. Smart controls can reduce energy waste by recognizing when to incorporate daylight harvesting, occupancy sensing, and timeclock shut-off mechanisms for lighting and other systems. These home products are like smaller beta test versions of the products that we specify in our commercial building designs. The new smart home wireless products are a great way for us to see what is coming in the near future of the commercial building control industry and forecast potential engineering problems we will need to solve with these new technologies.

This study investigated several wireless smart home products currently on the market. The products were tested in a real-home environment. Personal home control systems can potentially serve as excellent beta tests for the broader commercial market, thereby driving the industry to discover the exciting possibilities and potential hurdles of wireless building controls.
As renewable energy technologies advance it is becoming increasingly imperative that a creative solution is found to effectively integrate renewable energy sources into the electrical grid. Currently, one issue with renewable energy sources is that they only supply a load to the grid whenever the source is powered i.e. when the sun is shining, or when the wind is blowing. Grid instability can lead to higher costs for renewable energy sources to enter market and cause higher costs for consumers. One proposed solution to this problem is to use Thermal Energy Storage (TES). A TES system would be used much in the same way an electrical battery is used and would allow for much less unreliability and more economic utility. Another proposed idea for a TES system is to use it as a building heating and cooling load. Heat generate from renewable energy sources could be stored inside a TES during the day while it is warm outside and the heat could be recovered at night when the temperature drops. The same can be said about power demand. During the day the demand is high, and drops down at night while everyone is asleep. As nuclear energy is producing power around the clock, a TES system could store the excess of energy produced over night, and allow it to be recovered when demand spikes. Another useful possibility is making it portable. TES systems could be set up in vehicles and transported to a location in need of power.

Drivetrains are an essential part to converting power from the engine to the drive wheels, specifically for tractors. An effective drivetrain should be able to maximize power and fuel efficiency with different input to output ratios while losing as little power to friction as possible. In this study, we focused on identifying mechanical inefficiencies in different drivetrains that would hinder performance in a tractor. Using a system of sensors, a prony brake dynamometer, and a hydraulic brake dynamometer, different types of drivetrains from Powercat Tractors were tested. The prony brake dyno was used to measure whole drivetrain efficiency and the hydraulic dyno was used to measure actual engine output. Engine speed, CVT driven speed, axle speed, torque, and horsepower were all measured, over the course of 30 tests. All of the sensors were monitored, calibrated, and controlled by a National Instruments (NI) myRIO using LABView for all programming. Using these results, we were able to conclude that a gear drive transmission with hardened gears produced the best efficiency results.
Poster 31

CNT/TiO₂ PHOTOCATALYSTS FOR POLLUTION DEGRADATION
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Department of Chemical Engineering

Titanium dioxide (TiO₂) photocatalysts utilize ultraviolet light to effectively degrade both organic and inorganic environmental pollutants. Ultraviolet light (λ < 388 eV) excites electrons from the valence band to the conduction band which react with pollutant molecules adsorbed on the surface of the photocatalyst in a degradation reaction. Because ultraviolet light represents approximately 5% the solar spectrum, TiO₂ photocatalysts cannot effectively utilize sunlight to degrade atmospheric pollutants.

Carbon nanotubes, best described as graphene sheets rolled into a tube, have a very high conductivity. Carbon nanotubes (CNTs), when paired with TiO₂ can increase the charge recombination time of the photocatalyst, improving the quantum efficiency. This creates a greater probability that excited electrons will react with adsorbed pollution molecules which therefore increases the effectiveness of the photocatalyst. CNT’s also have the potential to act as “photosensitizers,” increasing the wavelength of light the photocatalyst can utilize. If longer wavelengths can excite electrons in the photocatalyst, a greater percentage of the solar spectrum can degrade pollutants.

The effectiveness of different CNT/TiO₂ photocatalysts has been studied by degrading acetaldehyde, a volatile organic solvent representative of organic atmospheric pollutants. Different loading percentages of CNT’s have been tested and compared to pure TiO₂ photocatalysts in order to determine the effect of CNT’s in photocatalysis.

Poster 32

EVALUATING THE EFFECT OF INITIAL INFILTRATION ON SOIL ERODIBILITY PARAMETERS USING THE JET METHOD
Aaron Akin, Dr. Aleksey Sheshukov
Department of Biological and Agricultural Engineering

Due to the fact that soil erosion accounts for a large portion of land degradation in agricultural communities, it becomes vital to understand how a soil’s erodibility parameters - the erodibility coefficient and critical shear stress value - change across varying soil texture classes and initial infiltration depths. These parameters will be evaluated using the jet erosion test (JET). The JET uses an apparatus that creates an impinging jet of water into a soil sample and one can record the scour depth over time caused by this jet of water. Using this data the erodibility coefficient and critical shear stress values can be determined.

The impact of initial infiltration on the erodibility parameters of differing soil texture classes have been evaluated for both silty clay loam and sandy loam soils. However, further studies are necessary to classify the effects of initial infiltration on soil erodibility for soils closer to the center of the soil texture triangle such as clay loam or loam. This study evaluates these soil texture classes, creating a more complete understanding on how soil erodibility parameters vary across initial infiltration depths and between texture classes.
**Poster 33**

**MICROFLUIDIC DEVICES FOR USE IN BACTERIA CAPTURE**

**Audrey Anderson, Dr. Ryan Hansen**

*Department of Chemical Engineering*

Microfluidic devices are small, often multicomponent chips that can be designed and adapted for a wide variety of laboratory uses. These devices require small sample sizes, are relatively inexpensive to produce, and can be manufactured using common laboratory equipment. In this study, microfluidic devices have been designed for use in capturing and isolating bacteria in liquid samples. These devices, composed of a material called polydimethylsiloxane (PDMS), contain microscopic channels fitted with pillars that liquid samples can flow over and around. These pillars can be functionalized with antibodies, lectins, and other agents that attract and capture bacteria cells. The focus of this research thus far has been creating a procedure that can be used to effectively and reproducibly manufacture these devices. The devices have been used in various simulations to model fluid velocity profiles within the device and study how fluid eddies and turbulence can be minimized. This has been done to study how to increase bacteria adhesion to PDMS microposts. In future studies these devices will be used to examine how different flow conditions, surface topographies, and surface chemistries affect bacteria capture.

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**Poster 34**

**RESIDUAL METAL ANALYSIS IN BIODIESEL FUEL USING FLAME ATOMIC ABSORPTION SPECTROSCOPY**

**Rachel DeMyers¹, Katherine Wurm¹, Dr. Daniel Higgins²,**

*Department of Chemical Engineering¹, Department of Chemistry²*

The Kansas State Biodiesel Initiative is a relatively new club on campus. This club works to make K-State more sustainable by collecting used cooking oil from the dining facilities on campus, and from various locations off campus, and converting it into a source of fuel for Facilities trucks. The purpose behind our research is to ensure that biodiesel produced by the club meets the standards set by the American Society for Testing and Materials (ASTM) and to optimize the production process. We test the waste vegetable oil before and after each wash as well as the final biodiesel product. Metals such as sodium may be found in both the waste oil and in the final product. The original oil may be contaminated with sodium from its use in cooking. Sodium is also added in the form of the catalyst used to convert the oil to biodiesel. Monitoring of the sodium content of the fuel has allowed for recommendations to be made on the number of washes needed to meet ASTM standards. Ensuring that the biodiesel produced meets standards is critical to ensuring that the vehicles in which it is burned are not damaged by corrosion and precipitation of salts. Our goal is to demonstrate that the biodiesel produced by the KSU Biodiesel Initiative is safe and meets standards set by the ASTM.
Poster 35
STANDARDIZING THE PROCEDURE FOR KINECT DATA COLLECTION APPLIED TO HEALTHCARE
Brendon Hutley, Dylan Darter, Jacob Phillips, Mr. Behnam Malmir, Dr. Shing Chang, Dr. Margaret Rys
Department of Industrial and Manufacturing Systems Engineering

Human gait has proven to be a significant indicator of overall health. In this study, gait analysis is used to study, analyze and check for abnormalities in walking patterns of people. Microsoft Kinect software is used to capture 24 joints, construct a human skeleton and walking pattern profile of people. A standardized procedure for data collection protocol for Microsoft Kinect was developed. This included the calibration of the equipment, standardizing the distance walked and clothing requirements for the participants in the study. A pilot test was run on three participants. Raw data gathered from Microsoft Kinect software was analyzed using Minitab. So far 12 joints were analyzed: neck, shoulders, spine shoulder, spine middle, spine base, hips, knees, and ankles. A two phase ANOVA for gauge capability analysis determined which joints carry the most significance and can accurately portray the differences between individual participants’ walking patterns.

Progress made so far indicates that the system will be able to identify those participants who deviate from the usual walking pattern and thus notice the abnormalities and provide assistance before the accident may happen (i.e., fall). The findings of our research will help move healthcare focus from rehabilitative treatment to preventative treatment. Radically improving patient health, reducing hospital visits and dramatically driving down health care costs.

Poster 36
AUTONOMOUS SEARCH CAPABILITIES FOR RADIOLOGICAL/NUCLEAR MATERIALS-RDT
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Department of Mechanical and Nuclear Engineering

Remotely-controlled systems have a proven record of entering dangerous environments in support of search-and-rescue or similar operations. These environments may contain sources of radiation, but yet few attempts have been made to imbue such systems with radiation detection capability. Modularity permits a single system to adapt to these unique situations. Radiation Detection Technologies, Inc. (RDT), a Manhattan, Kansas-based company, wishes to develop such an autonomous radiation detection system for potential customers. Our team is working on a solution to address the needs of these customers in the form an aerial drone and companion software. Employing neutron and gamma radiation detectors from RDT, an aerial drone was constructed for the purpose of finding a radiation source. The system reports the information back to a companion mobile application for the user. The complete system will allow a user to select an area of interest to be surveyed and monitor the results from the drone. Integration of the detectors with the drone has been the major focus of our project. This started with extensive research of the current market offerings and then selecting which products would work best for the objective. Construction of the drone, cases for the detectors and microprocessor board, and fixtures for attaching these accessories followed. Alongside all of this was the mobile application development and additional flight control algorithms. A proof of concept prototype is the final result of this design project.
In wake of the accident at the Fukushima Daiichi Nuclear Power Plant, it is clear that passive safety design features are imperative for the next generation of nuclear power plants. Current liquid metal fast reactor, and in particular, sodium-cooled fast reactor (SFR), designs incorporate passive safety elements such as negative reactivity feedbacks and natural circulation heat removal systems. Despite these merits, liquid metals are more susceptible to thermal stratification and associated challenges as compared to other coolants. Thermal stratification can cause thermal fatigue, which can lead to material or structural failure, and can also cause thermal contraction in the Upper Instrumentation Structure (UIS), which can lead to positive reactivity insertion after core shutdown. The situations of greatest concern are when thermal stratification is most pronounced: post-scram, and during low flow and natural convection scenarios. The purpose of this work is to utilize computational fluid dynamics (CFD) simulations to verify scaling analysis and improve the design of a scaled-down experimental facility that will be used to study thermal stratification in SFRs under the stated transient conditions. After design refinement and a grid convergence study with 3-dimensional numerical thermal hydraulics models in ANSYS CFX, a commercial CFD program, a final scaled design was developed that clearly displayed thermal stratification behavior similar to full-scale SFRs under off-normal scenarios.

Linear Stirling cycle cryocoolers are used in everyday application ranging from infrared sensors to airborne and ground based military applications. With innovational devices becoming smaller and more versatile, linear Stirling cycle cryocoolers are becoming more advantageous to use considering its small size and high performance. The only issue with these is that there is no specific and easy way to keep these devices cool while operating. The goal with the Stirling Cycle Cryocooler is to create a heat sink for these devices that optimizes convection and conduction in a minimal given volume. Due to the geometry of this specific cryocooler, a rectangular heat sink was made and tested in Solid Works with various fin thicknesses and number of fins to find the best heat sink design for the optimal amount of heat transfer. When deciding the material to use to create the heat sink, aluminum was chosen for its high conductivity, light weight and cost efficiency. Simulations through Solid Works shows the heat distribution throughout the heat sink and air flow throughout the heat sink to find the best results.
Poster 39
IN-CORE TEMPERATURE MEASUREMENTS OF THE TRIGA MARK II NUCLEAR REACTOR
Dustin Woolsey, Dr. Jeremy Roberts
Department of Mechanical and Nuclear Engineering

Modeling a reactor core primarily consists of neutronics (neutron flow) and thermal hydraulics (heat and fluid flow). The temperature within the core is a critical characterizing parameter for modeling efforts. Current modeling efforts at Kansas State University (KSU) are validated against the Triga Mark II nuclear reactor present at KSU. This study seeks to better understand the temperature profile within the core of the KSU reactor using three resistance temperature detector (RTD) probes and fiber optic temperature sensors. Each probe contains 9 RTDs to measure the axial temperature profile at various radial locations. A calibration system was developed to establish the relationship between the RTD output and the temperature. In a preliminary test, a single RTD probe was inserted near the center of the core to measure the local, axial temperature distribution at various power levels. In a joint effort with University of Wisconsin researchers, a fiber-optic sensor was attached to the RTD probe for simultaneous measurements with both sensors. Although further analysis is needed, the results from these two sensors are similar and suggest a temperature distribution consistent with both theory and the fuel temperature, which was read from the core-monitor instruments. Further research will focus on the comparison between these measurements, a deployment of all three probes, and the use of measured temperatures to refine existing neutron models.

Poster 40
MODELING THE KSU TRIGA REACTOR IN OPENMC
Prerona Kundu, Dr. Jeremy Roberts
Department of Mechanical and Nuclear Engineering

The purpose of this project was to create a model of the KSU TRIGA reactor core using OpenMC. OpenMC is a Monte Carlo simulation code for reactor physics calculations. The first step was to create a two-dimensional model of a single fuel cell. This was done by defining the materials for a zirconium filler, the uranium fuel, the stainless-steel cladding surrounding the fuel element, and the water that would eventually surround all the fuel cells. The radii for the cells in each fuel element were then defined to plot the model of the fuel cell. A short Python program was written and used to produce the origins of all the fuel elements in the reactor core. These coordinates were used to extend the model of the single fuel cell into a model of the full core. Materials and radii for the graphite and aluminum reflectors surrounding the core were then defined, and the resulting geometry was plotted. Once the entire core model was verified, the OpenMC script was run to compute a fission rate mesh tally output file. These tally results were then plotted to visualize the distribution of the fission rates throughout the reactor core. The fission rates were higher towards the center of the core and lower towards the outer ring, which was consistent with our expectations. Future work includes producing element-averaged fission rates and creating a three-dimensional model of the reactor core.
Poster 41
PRISM
Brad Schoonover¹, Mr. Richard Reed², Dr. Jeremy Roberts²
Department of Computer Science¹, Department of Mechanical and Nuclear Engineering²

A need was identified in the 1980s for a better-than-real-time simulation of a nuclear reactor, which would incorporate all reactor systems including both primary and secondary sides as well as the ability to run within tripped or startup conditions. In 1984, the PRISM simulation was created at MIT to address that need. PRISM was written in FORTRAN 77 with several libraries that no longer work on modern operating systems without an emulator (e.g., DOSBOX). The present work seeks to update that original work to Python which is a modern and cross-platform programming language resulting in a modernized user experience with a more interactive and sharper looking GUI. To this end, PyQt5, based on Qt, was chosen to develop the GUI, in order to leverage the flexibility of C++ and Python. The simulation is based on three main physics models including the pressurizer, core, and steam generator. The backend physics models are a straightforward translation of the original program, whereas the GUI has been developed from scratch. Upon completion, this simulation can be used to teach students or reactor operators the capabilities and controls for a standard pressurized water reactor. Furthermore, future uses of the simulation include use as a sandbox environment in which to test how new reactor physics models or new components could affect the reactor operation.

Poster 42
SUBMERSIBLE CSI SPECTROSCOPIC GAMMA-RAY RADIATION DETECTION SYSTEM
Aaron Mason, Nill Patel, Brandon Haggerty, Dr. Walter McNeil
Department of Mechanical and Nuclear Engineering

Acquisition of gamma radiation spectrum in underwater environments can be useful in industries where vessels or equipment give off signature spectra that would be used to identify events in operation. For instance, in the oil industry, operators will often release radioactive solution into their flow stream to track mixture movement in wells and pipelines. It is conceivable that these kinds of industrial applications could be extended to underwater operations. Measuring foreground spectra requires an understanding of what typical background radiation looks like for that given environment. To acquire sufficient background for a given location in a matter of minutes or hours, a large Cesium Iodide spectroscopic scintillator detector will be used to acquire gamma-ray background spectra at varying depths in bodies of water. This detector and supporting equipment must be made waterproof so that it will survive the high pressures seen at great depths. A system was constructed that is capable of efficiently measuring gamma-ray spectra up to 4500ft underwater using a Cesium Iodide gamma-ray spectrometer along with a single-board data acquisition computer. Work was done to machine a vessel from aluminum, set up a battery powered, remote system capable of logging data while underwater, and design test experiments that are safe for the detector and provide good data. A test of the complete system will be run in Tuttle Creek Lake to ensure the system works as planned and provide background radiation data at various depths in the water.
Solar proton events (SPEs) are important phenomena requiring appropriate modeling for astronaut radiation protection and space electronics design. A predictive model for the worst case single event, for both time-integrated particle fluence and maximum particle flux, can be developed using the Maximum Entropy Principle, first applied to SPEs by Xapsos et al. This method is preferred because it produces the least biased form of a probability distribution under known constraints with incomplete data. For SPE modeling, the probability distribution results in a cutoff power law. The source of the SPE data for this work is the SEPEM database, developed by the European Space Agency. This dataset has 250 events that exhibit behavior that is not well-described by models; namely, the high-energy tail of the derivative of the energy spectrum for these distributions is non-monotonically decreasing. A procedure is implemented whereby the high-energy tail for these events is corrected by extrapolating using data from a more well-behaved region of the energy spectrum. The original dataset and the “corrected” dataset are compared using the Kolmogorov-Smirnov statistical test to determine whether these changes result in significant differences in the cumulative distribution functions for time-integrated particle fluence and maximum particle flux in the high-energy bins. The findings will indicate whether corrections to high-energy bins should be considered within the SEPEM database. The high-energy bins are particularly important for evaluating astronaut risks from radiation exposure and the effects of space radiation on electronics, since high energy particles are more capable of penetrating radiation shielding.

An add-on board has been designed for the Raspberry Pi Zero to expand the UART capabilities, buffer incoming data from power supply control/monitoring and GPS tracking, and to precisely measure up to six 4-wire RTDs for monitoring system temperatures. Design focus was to minimize the interference of digital subsystems in analog measurements to keep temperature data accurate. The board was also designed to allow for low-power operation, offering shutdown modes for all systems either through a GPIO pin or SPI. A Linear Technology LTC2983 ADC is used to measure RTDs. RTDs are excited through the LTC2983’s internal precision current sources. RTD curve data is stored in the LTC2983’s internal memory, and voltage to temperature conversions are done on-chip. The LTC2983 also detects faults in the temperature sensors, such as shorts, broken wires, and disconnected sensors. Access to the MAX14830, Bluetooth communications, and the LTC2983 is done through an SPI bus.
Poster 45
FABRICATION OF MICROWELL ARRAYS FOR HIGH THROUGHPUT SCREENING AND DISCOVERY OF BACTERIAL INTERACTION
Logan McGinley, Dr. Ryan Hansen
Department of Chemical Engineering

Understanding how different types of rhizobacteria interact with each other will allow for the development of synthetic blends of bacteria that can be used as sustainable biofertilizers and biocontrol agents. These bio-based strategies have the potential for lower environmental impact, are less expensive, and are more sustainable over the long-term than current methods. However, our current capability to implement these bio-based strategies is highly limited, largely because most bacterial interactions are unknown. The overall goal of this work is to develop a novel, lab-on-a-chip device that will help the microbiologist discover unknown bacterial interactions that occur within these systems. Current microbiology tools are limited in that they are low throughput and can only observe interactions between large colonies. With this tool, interactions between thousands of unique bacterial species can be studied simultaneously.

This poster outlines our recent efforts to expand the number of organisms that can be monitored in this device. The tool was originally only compatible with anaerobic organisms, as it used silicon microwells and a glass coverslip to trap cells together. In these studies, we found that this limited the oxygen supply to bacteria, inhibiting the growth and interaction between aerobic organisms. Using PDMS coverslips, we were able to promote the diffusion of oxygen to bacteria, allowing for device compatibility with aerobic organisms. This advancement greatly expands the number of organisms this tool can screen for. These studies and the newly developed tool will have major impacts on the ways that microbiologists study bacterial interactions in any microbiome.

Poster 46
LEARNING TO DETECT RELEVANT ITEMS: DEEP LEARNING FOR OBJECT TAGGING IN AERIAL IMAGES AND SEMI-SUPERVISED LEARNING FOR TEXT DOCUMENT CATEGORIZATION
Maria F. De La Torre, Dr. William Hsu
Department of Computer Science

The research presented involves two different projects whose shared goal is to extract relevant items from an annotated data collection: spectral features from tagged bounding areas in images, and documents and subsections from web corpora. Deep convolutional neural networks have improved object recognition on image data, producing models that can be used to classify aerial images. With the purpose of systematically identifying luminous objects in images, this research uses Caffe, a deep learning framework, along with an object detection system that combines bottom-up region proposals with rich features computed by a convolutional neural network. The training input for Caffe models are nighttime aerial photos of ground-level objects superposed on maps showing the expected locations of individual objects. The output are images with bounding boxes and a classification label around each recognized object.

The primary goal of the second project is to train a classifier that can filter documents crawled from the web with respect to our relevance criteria: nanomaterials manufacturing. This requires section extraction, relevance determination, and deduplication. Selective learning was used to decide whether a document scraped from the web was relevant. Features used to train the classifier to identify relevancy came from a gazetteer of key terms and phrases. Training examples were generated by converting documents into a bag of words representation (vectors of normalized term frequencies, or TF-IDF). To improve the classifier’s learning, active learning will be used to query users for feedback when a document is close to the current relevance boundary.
Poster 47
MODELING DAILY FANTASY SPORTS: THE NFL MILLIONAIRE MAKER TOURNAMENT
Sarah Newell, Dr. Todd Easton
Department of Industrial and Manufacturing Systems Engineering

Daily Fantasy Sports, or DFS, is a billion dollar industry where participants select professional athletes to create a fantasy team. Each athlete earns fantasy points based upon his or her on-field performance and each fantasy team is ranked according to the number of fantasy points earned. The participants with the highest ranking teams earn a cash prize. Draft Kings hosts a contest each Sunday, titled the NFL Millionaire Maker Tournament, where the highest-ranking fantasy team earns a prize of one-million dollars. Teams who rank in the top 15-20% also earn a cash prize of lesser value, with the prize amount decreasing as team rank worsens.

This research optimizes the expected payout of a DFS NFL Millionaire Maker Tournament participant through a stochastic integer program. A fantasy team’s distribution of points is created by assuming each NFL athlete’s fantasy points are independently and normally distributed according to their mean and standard deviation. The team’s fantasy point distribution is then discretized to determine the probability of earning a given point threshold. Each possible point threshold that provides a payout to a participant is considered by this stochastic integer program, producing an optimal solution of a fantasy team which maximizes the expected payout.

Poster 48
IMPROVING RECRUITMENT AND RETENTION NUMBERS IN ARE/CNS
Katherine Benton, Dr. Julia Keen, Ms. Katie Loughmiller
Department of Architectural Engineering and Construction Science

Retention rates for those majoring in engineering are typically lower than other non-technical majors. Several factors play a role in the student retention rates within respective engineering majors: class load, internship experience, technical content, etc. To examine interest levels of Architectural Engineering and Construction Science & Management several semesters of students were surveyed at the beginning and end of their orientation class, ARE 100 ARE Orientation and CNS 100 CNS Orientation. The survey consisted of questions regarding demographics and interests, as well as the student’s confidence in their choice of major. Data collected identified commonalities in hobbies and interests of students who were retained versus students who have left the program. This information is important as the department determines the more effective ways to improve retention, as well as better targeted recruitment efforts in Architectural Engineering Construction Science and Management. With this information the department can emphasize specific aspects of the program in the literature and advertising used when recruiting prospective students. These preferences can be used when planning course content modules and social or technical events for current students to increase interest and participation. This data allows the department to help provide more opportunity for current and future students to form relationships with other students based on shared interests outside of the curriculum and engineering groups. The anticipated result will be students of the department of Architectural Engineering and Construction Science and Management who are more excited and engaged in their major during their career at Kansas State University.
PROFESSIONAL ENGINEERING EXAM PASS RATES BY GENDER
Anna Salvatorelli, Dr. Julia Keen
Department of Architectural Engineering and Construction Science

Past research has found undergraduate female architectural engineering (ARE) students at Kansas State University recognize the importance of earning their professional engineering (P.E.) license, and that a majority of those surveyed anticipated earning their license after graduating. A 2010 survey of women with ARE degrees found that less than half of the women surveyed actually earned their P.E. license. While national pass rate information for the exam is available to the public, the pass rates based on gender is not collected, as most states do not track this demographic. This topic is important as it may play a significant role in the retention of women in the engineering workforce, although there is no published literature focusing on this issue. The purpose of this study is to determine the pass rates based on gender of the engineering professional license exam. The data used for this study was collected from different state agencies as this is the level in which the exam is administered and assessed. The intent of this research is to determine if there is a significant P.E. exam pass rate difference for men and women.

AN EVALUATION OF WRONG-WAY CRASHES ON DIVIDED HIGHWAY AT-GRADE INTERSECTIONS IN KANSAS
Rachel A. Eisenbarth, Dr. Eric Fitzsimmons
Department of Civil Engineering

Wrong-way crashes on divided highways originating from at-grade intersections continue to be a safety concern for state transportation agencies since the conception of the interstate system. The objective of this research project was to investigate wrong-way crashes on divided highways near at-grade intersections in Kansas using crash data from the Kansas Department of Transportation. A crash analysis including a statistical model was developed to understand significant variables that contributed to these crashes and common geometric traits of these at-grade intersections.

Wrong-way crash data were obtained from KDOT between the years 2005 to 2015 for Kansas and U.S. Highways. Additionally, 93 wrong-way crashes were reported which resulting in 13 fatalities and 95 serious injuries. Temporal trends indicated that wrong-way crashes were found to be the highest in 2010 and from 2014 to 2015. Wrong-way crashes in Kansas account for 7% of the total number of fatalities and 0.19% of the total number of crashes. The location of each crash site was analyzed using Google Street View and besides the variables in the police crash report, physical features of the intersections including median width, signage, and signalization were recorded.

A logistic regression model was developed to determine what variables contributed to wrong-way fatal / serious injury crashes and PDO crashes based on the KDOT crash dataset variables and observed variables. It was found that the only significant variable was the presence of a traffic signal; where the odds ratio predicted crashes would increase by 3.148 if a traffic signal was not present.
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DURABLE HIGH EARLY STRENGTH CONCRETE
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Department of Civil Engineering

Repair of concrete pavements and bridge decks is a major activity in sustaining Kansas highway infrastructure. This maintenance activity often requires high early strength concrete to limit interruption of traffic flow. However, recent evaluation of repair slabs show premature deterioration in the form of map cracking that later morphed into freeze-thaw damage. Currently, repair slabs do not last more than 5 to 10 years. This experimental study will develop an alternative high early strength concrete mixture design and criteria that can provide a durable 20-year pavement service life yet satisfying current minimum strength requirements for opening to traffic. A concrete pavement mix design used for full-depth patching that deteriorated rapidly will be used as the base point of failure. Another concrete pavement patching mix design that has not deteriorated yet will be used as the control mix. Mixes from both mix designs will be subjected to isothermal calorimetry, compressive and tensile strength, dry shrinkage (ASTM C 157), freeze-thaw (ASTM C666 procedure B) (KDOT Modified), scaling resistance (ASTM C672), and surface resistivity (KT-79) tests. By running the tests on these two mix designs and interpreting the data collected, alternative mix designs that contain supplementary cementitious materials such as sulfoaluminate cement, metakaolin, and alternative non-chloride accelerators can be developed. These alternative mix designs should also provide the minimum strength required for opening to traffic and the 20-year pavement patch durability.

Poster 52
FINITE ELEMENT ANALYSIS OF MCPHERSON COUNTY BRIDGE UNDERGOING SLOW SETTLEMENT
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Depleting oil wells in Kansas were not properly plugged back in the 1940’s, and this has caused different areas of the state that are in close proximity to highways to have sink holes deep down in soil strata. This phenomenon has led to slow settlements on some parts of I-70 and I-135. To tackle this problem fundamentally, by trying to fill these cavities in the soil, requires millions of dollars of grout pumped into them. Alternatively, the bridges impacted by this phenomenon may be analyzed under the effect of these slow settlements and monitored until the amount of settlement incurred triggers a safety hazard, in which case the bridges must be closed to traffic and demolished. A box girder concrete bridge, crossing Highway I-135 near McPherson County, KS, has been experiencing this slow settlement for the past 15 years, and it has become necessary to determine its structural integrity. In this study, a 3D finite element analysis is performed for the full bridge, including the superstructure and supporting piles, using the structural analysis software RISA 3D. The FE model is subjected to the actual measured settlements under gravity loads, by providing linear springs adjusting their values to allow the recorded settlements. Furthermore, future projected settlements are induced in a number of extrapolated schemes to examine the limits on this bridge’s performance. The results will be presented in terms of the projected amount of settlement required to render the bridge on the verge of being unsafe.
**Poster 53**

**IMPROVING REFUELING SYSTEM CONFIGURATIONS TO INCREASE RAILYARD THROUGHPUT**

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This paper introduces the locomotive refueling system configuration problem, which arises when railroad companies face decisions about how to transition from current refueling systems to new technology that can refuel a locomotive more efficiently. Refueling efficiency is important to the overall efficiency of freight railroad operations; faster refueling can increase rail network capacity without the infrastructure cost associated with new terminals or track. Railroad companies must determine how to configure fuel platforms and locomotives with the new equipment to maximize the associated benefits. We propose a method that integrates integer programming and discrete event simulation to inform these decisions, and we demonstrate the method on data derived from industry. Specifically, the models determine the best location to spot trains at the refueling platform and measure the impact on railyard throughput associated with adopting the optimal spotting location in combination with the new refueling technology.

**Poster 54**

**THE EFFECT OF CENTERLINE RUMBLE STRIPS ON KANSAS ROADS**

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Centerline Rumble Strips are a traffic safety device designed to physically and audibly aware drivers when they are drifting over the centerline of a roadway, specifically rural two-lane undivided highways. They are most commonly constructed by grinding out part of the pavement along the centerline of the road in a standardized shape, depth, and interval.

Specific Question: Do Centerline Rumble Strips reduce crash rates enough to be a cost effective traffic safety measure?

Method: Using Google Earth, the CANSYS crash database (provided by KDOT), and the Kansas T-WORKS website, I created a list of projects that included the installation of centerline rumble strips. Each project was then analyzed, and the crash numbers, causes, and severity were quantified. The crash rates were found as the number of crashes per year per mile and the Equivalent Property Damage Only crash rate (EPDO).

Results: Overall, the data shows a reduced number of both total crashes and severe crashes due to the implementation of Centerline Rumble Strips. It is important to note that while some of the individual sections did not see the reduction, the study as a whole did.

Conclusion: Preliminary results suggest that the implementation of Centerline Rumble Strips into Kansas rural two-lane undivided highways can save motorist’s money and lives, all for a very low cost compared to the price of the rest of the project.
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ANAEROBIC MEMBRANE BIOREACTOR FOR SUSTAINABLE WASTEWATER TREATMENT
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The United States Department of Defense (DoD) maintains more than 100 domestic wastewater treatment facilities, as well as many more abroad, all of which use aerobic bio-digestion as their primary treatment process. This process is known to have a very high energy demand which in turn leads to large resource expenditures to keep them running in the form of electricity costs. To find a more cost effective and sustainable alternative the DoD’s Environmental Security Technology Certification Program (ESTCP) is researching a promising new treatment process which uses what is called Anaerobic Membrane Bioreactor (AnMBR) technology. This process is much less energy intensive because it does not require aeration to oxidize organic material. It also produces methane as a byproduct which can be captured and then used to offset the power demands of the plant.

The project is currently in the pilot scale phase in order to optimize the process. One of the two facilities is located on Fort Riley Army Base where regular testing and process manipulation is being conducted to minimize net energy use while still meeting water quality standards for potential water reuse applications.

Poster 56
HYDRAULIC ENGINEERING: HYDRO PUMP AND LOW-HEAD MICRO TURBINE TO ENGINEER WATER POWER
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Hydropower, the crosscutting intersection of water and energy, is an important topic for K-State students to understand and become prepared to design. Last year’s design project was to develop a power generating turbine system; the goal of this year’s Hydraulic Engineering class was to add a pump to the system to understand waterpower in production and in generation. The tasks for this project included computing the required data to estimate discharge and velocity, along with evaluating pumps to find the appropriate input. The pipe system was designed to transport recycled water from a single pump to parallel nozzles while comparing flexible vs. hardline piping. When designing the apparatus, the overall goal was to extrapolate understanding to real life scenarios such as dams and reservoirs to become more efficient in producing energy. Developing engineering and design experience in the coupling of water with energy production is crucial for sustainable development; hydropower is clean power and can help address the energy deficit for a growing world population.
Poster 57
WATER COLLECTION VIA DROPLET COALESCENCE, SWEEPING, AND EJECTION ON VIBRATING SURFACES
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Power plant cooling towers are responsible for significant amounts of evaporated water loss, providing an excellent opportunity for water collection. Previous research has shown that cooling tower moisture can be condensed onto flat metal surfaces and flexible meshes. Water droplets on a stationary film must coalesce until they are large enough to be accelerated down the film by gravity. The current research adds a flapping motion to the flexible film with the aim of collecting more water from a moist air stream. The flapping motion decreases the critical departure size, allowing droplets to be cleared from the film while much smaller, therefore leaving more blank spaces on the film for water to condense. For this research, water droplets were sprayed onto stationary and flapping perflouroalkoxy (PFA) films treated with Rain-X® and droplet departures were visualized and measured. The film was flapped by the rotation of an off-center mass which provided a displacement of about ± 9 mm and a flapping frequency of 11 Hz. High-speed videos were taken of the film from both the front and side in order to capture the motion of the water droplets. From the data collected, it was shown that the flapping motion cleared the film faster than a stationary film. The departure size was also 44 percent smaller on the flapping film. These preliminary results provide a foundation for further work including investigating different surfaces and flapping mechanisms.