Spring 2016 Undergraduate Research Poster Forum

Friday, April 15, 2016
10:30 a.m. – 12:00 p.m.
Engineering Hall Atrium

Sponsored by:
Office of Engineering Research and Graduate Programs
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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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ELONGATION OF REINFORCED CONCRETE BEAMS IN SPECIAL MOMENT-RESISTING FRAMES
Gabrielle Liuzza, Colten Johnson, Dr. Don Phillippi
Department of Architectural Engineering and Construction Science

In the past, non-ductile frame buildings frequently experienced significant damage or collapse in moderate to severe earthquakes. Earthquake-resistant buildings are intended to protect the structure from earthquake motions through ductile inelastic response of the seismic force resisting system. To reduce the amount of damage, ductile concrete frames were introduced into building codes. At present, these ductile frames are designated as Special Moment-Resisting Frames (SMRF), which have special detailing requirements including location and amount of steel reinforcement. Effects of beam deformations in SMRF are the subject of this research. The SMRF are typically designed with finite element analyses (FEA) using two-dimensional beam elements for the concrete and the steel reinforcement. In the research presented LS-DYNA, a three-dimensional FEA that includes eight node solid elements for the concrete material and two-dimensional beam elements for the steel reinforcement, was used for analysis. The results indicate that when a SMRF frame is monotonically-laterally displaced and the beams crack, the beams “elongate” due to changes in the height of the neutral axis at the adjacent columns. This means that the column farthest from the applied load (leeward) is displaced farther than the column closest to the applied load (wayward). Functionally, all other things being equal, the augmented displacement increases the shear loading that the leeward column must resist. With this new understanding of how SMRF frames act, improvements can be made earthquake-resistant building design.

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ASSAY DEVELOPMENT FOR DETERMINING ENZYMATIC ACTIVITY OF THE AUTOLYTIC ENZYME PRODUCED BY THE MICROALGAE C. REINHARDTII
Ryan Clark, Ms. Laura Soto Sierra, Ms. Chelsea Dixon, and Dr. Lisa Wilken
Department of Biological and Agricultural Engineering

The freshwater microalgae, Chlamydomonas reinardii, has the potential to accumulate bioproducts such as oil, protein, and pharmaceutical compounds. Developing an efficient and cost-effective extraction method can potentially improve the feasibility of using microalgae as a feedstock for food, pharmaceuticals and fuel industries. However, several challenges are associated with bioproduct extraction from C. reinardtii including the energy-intensive chemical/mechanical process of cell wall disruption. Enzymatic cell wall disruption is an energy-efficient alternative extraction method that facilitates release of intracellular bioproducts by specifically targeting the cell wall microstructure. C. reinhardtii has a glycoprotein-rich cell wall that can be disrupted using an autolytic enzyme, providing an inexpensive enzyme source for cell lysis. The application of autolysin as an enzymatic pretreatment prior to protein and lipid extraction from C. reinhardtii has not been explored. Thus, no sufficient efforts have been made to optimize autolysin production that would allow for a scalable and robust enzymatic extraction method. Developing a method to quantify autolysin activity is critical for screening of autolysin production methods. In this research, an autolysin activity assay was developed based on the degree of cell permeability of C. reinhardtii cells. Chlorophyll release was quantified and correlated with cell permeability by measuring changes in absorbance (at 435 nm) over time. Cell density (enzyme substrate concentration) was optimized to find a suitable rate of reaction, and an activity curve was developed. With this assay, the specific activity of autolysin was determined and used to identify optimal autolysin production conditions.
Poster 3
FUNCTIONALIZED BORON NANOPARTICLES: CHARACTERIZATION OF THIOL-ENE CLICK CHEMISTRY
Diane Collard, Dr. John Schlup
Department of Chemical Engineering

Carboranes are a family of cluster compounds comprised of boron, carbon, and hydrogen that are being investigated in a number of applications, including self-assembling monolayers (SAMs), cancer treatment, and non-catalytic synthetic agents. Various functionalities have been attached to carboranes to facilitate their utilization. Thiol-ene “click” chemistry between thiol-functionalized m-carborane and a variety of maleimide derivatives provides a facile path to a wide variety of functionalized boron nanoparticles. The reaction rate shows a strong dependence on the solvent as well as on the position of the thiol group on the carborane. To test the reaction rate dependences, absorbance measurements were taken over time in a temperature controlled spectrophotometer for each selected solvent. Preliminary testing revealed reactivity differences greater than an order of magnitude between m-carborane-1-thiol and m-carborane-9-thiol. In order to better understand observed differences in reactivity, the chemical kinetics are modeled to clarify the reaction mechanisms and to quantify the rate constants and activation energies. Future research entails computational and electron density modelling to further investigate the cause of the reaction kinetic differences.

Poster 4
MOLECULAR UNDERSTANDING OF THE RELATIONSHIP BETWEEN CATALYST STRUCTURES AND REACTION SELECTIVITIES
Jiayi Xu, Mr. Quanxing Zheng, Dr. Keith Hohn, Dr. Bin Liu
Department of Chemical Engineering

Molecular modeling is a powerful tool for understanding the atomic-level catalytic processes. ZSM5 and Y-zeolite used in experimental studies of 2,3-butanediol dehydration showed dramatically different reaction selectivities, where the metal Cu ions, the Al acid site, and the protons all actively participate the dehydration reactions. Our hypothesis is that multi-functional sites are available in different ZSM5 and Y-zeolite frameworks and they function differently. In order to understand this intriguing but rather complex behavior, molecular-level models representative of catalyst active sites were constructed and investigated. Density functional theory-based calculations were performed to gain insights into the molecular structures, and the influences on the eventual selectivities. Many active sites configurations were tested first to verify our hypothesis. We found that Cu show preference to bind at the Al acid site, but secondary locations for Cu ions are also possible when all the acid sites become occupied. The reaction species were then placed in the zeolite framework. The calculations show that dehydration is much favored at or near the acid site even in the presence of Cu, but dehydrogenation may become more favorable at the secondary locations.
With the growing application of contact membrane reactors (CMRS) in organic systems, cross-linking polymeric membranes becomes vital for successful reactions. When water is in the feed of CMR, and passing over the skin side of the membrane, it passes back through the membrane, resulting in no reaction. To reduce the hydrophilicity of aromatic polyimides, such as polyetherimide (PEI), the –imide bonds in the polymer need to be reformed into –amide bonds through the addition of a diamine functional group. By soaking the PEI membranes in solutions of 1wt% cross-linking agent, such as ethylenediamine, and 99wt% acetone, the nonsolvent in which the PEI membranes had been cast. The cross-linking reaction occurs between the diamine and the imide ring, results in an amide bond.

Successful cross-linking increasing the density of polymeric branching. Increased selectivity of the H₂/N₂ gas pair and an increased hydrophilicity are qualities of a cross-linked membrane. Gas flux testing and X-ray diffraction (XRD) are used to characterize the branching of the membrane. A decrease in d-spacing of the membrane is indicative of successful cross-linking. With the improved membranes, catalytic reactions for systems such as the valorization of lignin model compounds can be performed successfully to further the width of CMR application and technology.

The growth of high-quality, highly dense carbon nanotube (CNT) carpets via chemical vapor deposition (CVD) has been largely limited to catalysts supported on insulators such as silicon dioxide or amorphous aluminum dioxide. However, CNTs supported on insulators have limited applications in energy storage and thermal management, where high electron transport properties are required. Thin layers of amorphous aluminum dioxide have been deposited on metal surfaces prior to the catalyst deposition to create a basic, low-energy surface and promote CNT growth, but this method greatly reduces the conductivity of the CNT carpet. To overcome this challenge, surface modification of metallic substrates using ion beam bombardment has been explored to create surface porosity. This method has demonstrated the ability to reduce the amorphous aluminum oxide film thickness required to grow CNT carpets on metallic surfaces. These modifications will be analyzed to determine their effects on substrate-catalyst interactions and CNT growth.
Boiling has many applications in our world, one important application is generating electricity. Boiling is an efficient method of heat transfer. The bubbles generated from boiling take away heat from the surface through the latent heat of vaporization. The performance of boiling is measured by the heat transfer coefficient and critical heat flux. Previous research has shown that at atmospheric pressures micro/nano structured surfaces and coated surfaces will increase the heat transfer coefficient. However, boiling applications in the power industry are done at high pressures. The purpose of this research is to examine the heat transfer enhancement at elevated pressures on modified surfaces. During our research, we used a plain copper substrate for our surface. Experiments were done on the copper substrate in a boiling vessel that can reach pressures up to 300 psi. From our findings, we concluded that the heat transfer coefficient of plain copper increases by 100 percent at a pressure of 45 psi. As we continue our work we will experiment with graphene-coated surfaces and micro/nano structures where we expect to find a higher increase in the heat transfer coefficient. In our research, we hope to find a modified surface that enhances the performance of boiling under high pressures.

Thermal ablation has emerged as an effective modality for targeted destruction of tumors and localized benign disease. Within the gastroesophageal space, ablation targets include mucosal tissue for treatment of Barrett’s esophagus, distended blood vessels, and esophageal tumors. The gastroesophageal space provides a challenge for ablation therapies because of the sharp transition between targeted tissue (e.g. vessels within the esophageal wall) and surrounding healthy tissue and other critical structures (e.g. mucosa). Our research involves the evaluation and response of thermal ablation with catheter-based microwave antennas on tissue samples resembling Barrett’s esophagus, and esophageal adenocarcinoma. Barrett’s esophagus is a condition where the esophageal wall changes, which can lead to the development of esophageal cancer. We hypothesize that microwave radiation patterns can be tuned to cause selective thermal damage to gastroesophageal targets, while sparing the outer mucosa layer. Experimental ablations have been performed to examine the thermal damage pattern in ex vivo tissue models, mimicking a target structure (simulated with porcine muscle) enclosed by the mucosa layer of the esophageal wall. We considered a directional microwave antenna with a modified tip to radiate energy in a preferred direction. The mucosa layer was stripped from horse blood vessels, wrapped around pork cuts, inserted into the catheter, and ablated for varying time periods. The extent of thermal damage to the outer mucosa layer as a function of time was examined histologically. Further response to thermal injury will be evaluated by haemotoxylin and eosin (H&E) staining, and viability stains following in vivo tissue experiments (in progress).
Poster 9
ANALYSIS OF COAXIAL FEEDLINE HEATING IN MICROWAVE ABLATION DEVICES
Kaley Brungardt¹, Mr. Jan Sebek², Dr. Punit Prakash²
Department of Biological and Agricultural Engineering¹, Department of Electrical and Computer Engineering²

Image-guided thermal therapy is a minimally-invasive modality that is being increasingly used for treatment of tumors in the liver, kidney, lungs, and other organs. In current practice, devices are typically inserted percutaneously into the target tissue under image guidance. Our group is investigating the feasibility of employing flexible, catheter-based microwave antennas for targeting tumors via an endoscopic approach. A challenge with using thin coaxial cables to feed ablation antennas is the heating along the cable due to losses in the coaxial transmission line. To mitigate the undesired heating of tissues in contact with the cable, cooling agents (e.g. chilled water) are widely used, at the expense of increasing applicator diameter. In this study, we measured temperature profiles along the length of a UT-85 and UT-47 coaxial cables at varying powers and frequencies to characterize heating of the coaxial cable during microwave ablation. Alternative approaches for mitigating detrimental effects of cable heating were also investigated.

Poster 10
PROCESS DEVELOPMENT FOR PURIFICATION OF RECOMBINANT HUMAN SERUM ALBUMIN FROM TRANSGENIC RICE
Kseniya Sheshukova, Dr. Lisa Wilken
Department of Biological and Agricultural Engineering

Transgenic plant systems have successfully been used to express a variety of recombinant proteins without risk of pathogenic or viral contamination, including rice seed-expressed recombinant human serum albumin (rHSA), an acidic protein. The development of an efficient and integrated rHSA extraction and purification process would allow rHSA to be used for various medical applications. Extraction is a critical step that determines recombinant protein concentration and purity and the type and quantity of impurities that must be removed during purification. Previous studies indicated that pH 3.5 extraction resulted in high protein purity (78%) but solubility of rHSA was 8- to 10-fold lower than at pH 4.5 and 6. Extraction at pH 4.5 and 6 maximized rHSA recovery but also resulted in higher native rice protein concentrations, which would increase purification requirements. To develop an integrated process, the effect of extraction conditions on subsequent purification using anion exchange chromatography (AEX) must be evaluated. Small-scale batch binding experiments were performed to identify suitable adsorption conditions (pH, ionic strength, time) for rHSA. Then, the impact of rice impurities on purification efficiency through absorption studies using Q Sepharose FastFlow® resin was evaluated. Binding results of purified rHSA and extracts were analyzed and compared for further development of an integrated, cost efficient process.
Poster 11
EFFECTS OF TEMPERATURE SENSITIVITY OF HHELA AND HFB CELLS ON PROLIFERATION AND VIABILITY RATES
Noe Nunez¹, Dr. Xiuxhi Sun²
Department of Chemical Engineering¹, Department of Grain Science and Industry²

The objective of this project is to study the temperature sensitivity of growth performance of selected cell lines. Human Hela (hHela) and human fiberblast (hFB) cells were cultured in a 3D environment using PepGel matrix at two temperatures: regular cell incubation condition and room temperature. Cells were grown for various hours, and cell proliferation and viability were analyzed. hHela were recovered from cryogenic conditions and the cell viability determined. Six wells were seeded with 1*10^5 cells on six separate 48-well plates. The gel matrix, in which the cells were suspended in, was composed of 65% cell solution + DMEM medium, 30% PG Matrix © and 5% PG Works © by volume. Of the six plates cultured, plates 2, 4, and 6 were maintained in an environment at 20°Celsius, plates 1, 3, and 5 were maintained in an environment of 37°Celsius with 95% O2 and 5% CO2. Plates 1, 2 were harvested after 48 hours, plates 3, 4 were harvested after 96 hours, and plates 5, 6 were harvested after 144 hours. At harvest, cell proliferation and viability for each culture was determined. A second sample set was replicated on Day 2, in which cultures were seeded. An average of the cell proliferation and viability for each time set was taken from the samples.

Poster 12
ENURESIS DETECTION USING THERMAL SENSING METHODS
Taishan Li, Shangxian Wang, Mr. Charles Carlson, Dr. Steve Warren, Dr. Punit Prakash
Department of Electrical and Computer Engineering

Sleep quality in children with severe disabilities correlates to their daytime wellness and learning. Enuresis, or bedwetting, can affect sleep quality. A Kansas State University team is working with HeartSpring (Wichita, KS) to develop bed-based tools to monitor a disabled child’s health/activity during the night. One element of this work involves the use of thermal measurements to detect bedwetting incidents automatically. Such a system will lessen the need for HeartSpring staff to conduct manual bed checks during the night for each child in their residential apartments. Two thermal detection approaches are being investigated to this end. The first approach utilizes thermocouples placed near the top of a mattress and covered by soft foam. Here, warm-water-filled balloons and thermal blankets are phantoms that emulate a child, and water funnels connected to tubing deliver warm water at normal body temperature (37°C) to simulate the bedwetting process. Thermocouple data, acquired with a LabVIEW interface, enable analyses of time-changing signals/images that will lead to automated enuresis detection. The second approach involves the migration to solid-state, digital temperature sensors whose data can be collated and sent wirelessly to a nearby hub, which can then forward these data to a LabVIEW acquisition system, a smartphone, or a database. This digital, wireless approach will allow the removal of the wiring harness between the mattress and the bed, creating a fully-enclosed sensing mattress that, if moved by the child, will not pose a safety risk or disable the data-gathering ability of the bedwetting system.
Poster 13
FEASIBILITY OF DRY CONTACT ELECTRODES FOR ELECTRODERMAL ACTIVITY MONITORING
Austin White, Mr. Charles Carlson, Dr. Steve Warren
Department of Electrical and Computer Engineering

A Kansas State University team is working with Heartspring (Wichita, KS) to develop a wrist-worn device capable of monitoring daytime health/activity parameters for children that are severely disabled. One element of this work targets electrodermal activity (EDA) measurements to monitor emotional status and predict seizure onset. This type of system would provide Heartspring staff with insight into the emotional well-being of these children and allow them to proactively address seizures in this vulnerable population. Two EDA monitoring approaches are being compared in this investigation. The first approach, a standard industry adoption, utilizes conventional gel-based electrodes. The second approach utilizes dry contact electrodes, which are reusable and less problematic to deploy. For both approaches, two circuit implementations are used, where the electrodes are placed on the ventral side of the wrist. Signal quality, repeatability, robustness (e.g., in the presence of movement), and other factors are compared to assess dry electrodes as a viable alternative to conventional electrodes.

Poster 14
A GAIT ANALYSIS STUDY USING THE MICROSOFT KINECT
Lucas Verschelden, Dr. Shing Chang, Dr. Margaret Rys
Department of Industrial and Manufacturing Systems Engineering

Gait analysis can be used to study and analyze people's walking patterns. The Microsoft Kinect is proposed to record the coordinates of joints of human skeleton. This study aims to convert coordinates into gait parameters for various applications, such as elderly people fall prediction, physical therapy, and biometric identification. Our research was performed by analyzing small populations and focuses on the ability to draw conclusions from the data. This can be achieved by using sample entropy to detect pattern changes. Once Kinect coordinates are converted into gait parameters, such as hip tilt, knee angle, or shoulder tilt, it allows for tracking problems in the person's gait. Our current research has shown that it is simple to convert data from Kinect into gait parameters. We are working on detecting changes of the same person over time due to aging or progress in physical therapy. We are also working to more accurately identifying people based solely on gait parameters. The proposed study aims to discover meaningful statistics and detect methods that would allow for the possibility of gait recognition for various applications. Expected research results may lead to the distinction between injured and healthy subjects allowing for improved treatments and early diagnoses.
Poster 15
HUMAN HEAT STRESS ANALYSIS OF PERSONAL PROTECTIVE EQUIPMENT FOR EBOLA APPLICATIONS
Michael Omana, Mr. Garrett Mann, Dr. Steven Eckels
Department of Mechanical and Nuclear Engineering

Ebola has heavily impacted West Africa, a region plagued by weak health systems. Ebola patients often times are treated by healthcare workers in Ebola Treatment Units which expose everyone involved to the high temperatures found year round in the region. Health care workers must use high grade personal protective equipment (PPE) in order to prevent exposure to Ebola. The combination of climate, work rates of the workers, and PPE required increases the risk of heat stress in the workers and leads to the need for frequent breaks. This results in frequent doffing and donning of the PPE worn which increases the likelihood of the worker being exposed to Ebola. While guidelines for PPE types and safety rating requirements have been provided by WHO and the CDC, no specific brand or model recommendations are available for the PPE which meets the current guidelines. One particular PPE item, the coveralls, plays a major factor in the rate at which heat can be dissipated by the workers as it covers the entirety of the body from the ankles up to the neck. Various coverall brands were analyzed using ASTM standards for hot plate and sweating thermal manikin tests. From these test results, recommendable working time durations for each overall can be calculated and a particular coverall can be recommended based on its ability to extend the time a healthcare worker can perform their tasks safely, which would also reduce the number of times they must doff and don the PPE.

Poster 16
DISTILLATION OF BIODIESEL CO-PRODUCT REDUCES WASTE AND COULD GENERATE REVENUE
Adam Lappe1, Jack Gerhold2, Mr. Edwin Brokesh1
Department of Biological and Agricultural Engineering1, Department of Chemical Engineering2

Production of biodiesel by the Kansas State Biodiesel Initiative is a “green” way for K-State to power their Recycling Facilities vehicles. A co-product of biodiesel production is glycerin. This glycerin contains methanol, an important component of the biodiesel reaction that if separated, can be recycled. Distilling the glycerin separates the methanol, allowing it to be used in the production of another batch of biodiesel. The clean glycerin can be used to make other products, such as soap.
Poster 17
PROCESS SUSTAINABILITY AND CARBON FOOTPRINT ANALYSIS OF EXTRUSION IN FOOD PRODUCTION
Nathaniel Brown1, Nayan Mallick2, Peterson Pacheco3, Dr. Sajid Alavi4
Department of Biological and Agricultural Engineering1, Indian Institute of Technology, Kharagpur2, São Paulo State University3, Department of Grain Science and Industry4

The objective of this research was to develop qualitative and quantitative methodology for studying process sustainability in the manufacture of dry pet food. Objectives included data collection and analyses to compare and quantify sustainability of extrusion and baking. The current study focused on development of a model to quantify carbon footprint using life cycle analysis, and also evaluate water usage and energy efficiency in the extrusion and baking processes.

A pilot-scale single screw extrusion system was used for production of dry expanded dog food with varying degrees of preconditioning. Thorough thermodynamic analysis a mass and energy balance was conducted to determine water usage, and energy usage and efficiency. Results were compared with batch baking process using the same standard pet food recipe. Lastly a model was developed based on life cycle analysis to link process with carbon dioxide footprint and sustainability.

CO2 footprint was calculated based on constants currently used by the Environmental Protection Agency using 2007 data. Results indicated that extrusion had a CO2 print lower than the baking process (0.2 versus 4 lb CO2 per kg product). Results also indicated that extrusion had lower water usage, and higher energy efficiency (lower loss) as compared to baking.

This research is significant due to the methods used to determine sustainability and CO2 footprint, which lay the foundation for future development of a composite index for sustainability based on life cycle analysis, and can be used to compare a multitude of food manufacturing processes.

Poster 18
WASTE VEGETABLE OIL DRYER UNIT FOR REDUCTION OF WATER CONTENT IN FEEDSTOCK OIL
Devon Ronsse1, Mark Neal1, Mr. Ed Brokesh2
Department of Chemical Engineering1, Department of Biological and Agricultural Engineering2

The Kansas State University Biodiesel Initiative synthesizes biodiesel from waste vegetable oil collected from on campus dining centers. The produced biodiesel is supplied to the Kansas State Recycling Center as a fuel additive. A major problem in biodiesel production is emulsification caused by a high water content in incoming feedstock waste vegetable oil. To reduce the potential for emulsification, a batch waste vegetable oil dryer unit with a capacity of fifty gallons has been constructed. The dryer has demonstrated an ability to effectively heat and circulate waste vegetable oil. Further testing is ongoing to determine the specifics of the waste vegetable oil dryer’s ability to reduce the water content in incoming waste vegetable oil. The results of these tests will be included in the data presented at the Spring 2016 Undergraduate Research Poster Form. The conclusions drawn from the generated results will be used to create operating procedures for the waste vegetable oil dryer unit with the goal of reducing biodiesel production time.
Poster 19
HYDRAULIC ENGINEERING: LOW-HEAD MICRO HYDRO TURBINE FOR ELECTRICAL POWER GENERATION
Petra Jureckova, Dr. David Steward
Department of Civil Engineering

The Civil Engineering class for CE552: Hydraulic Engineering addressed the problem of how to generate electricity from hydro power. This is an emergent technology to capture excess water energy to develop energy to power society needs into the future. The class assignment was to design and physically test the micro hydro turbine to estimate power generation from a water source. The class was divided into groups of three students and each group designed how to install the equipment into the laboratory and subsequently compute the power and efficiency. Group discussion was held after students designed individual team projects, all ideas were discussed and synthesized and one final design was formed and built. The apparatus will allow for measurements to determine the turbine properties and compare results with team calculations and evaluate the equipment’s capacity. A simple set of calculations are provided to illustrate this simple low-head micro hydropower concept and implement into real world application. This concept has the potential to be a cost-effective and smart solution in electricity production.

Poster 20
ENERGY PRODUCTION AND USAGE MODELS FOR THE FLINT HILLS RENEWABLE ENERGY AND EFFICIENCY COOPERATIVE
Mark Ronning, Dr. Ruth Miller
Department of Electrical and Computer Engineering

The Flint Hills Renewable Energy and Efficiency Cooperative (FHREEC) is a community organization that is focused on reducing the carbon footprint of Manhattan residents through the application of renewable energy resources and the installation of efficient technology. The effect of energy-saving efforts can be predicted utilizing math and computer modeling for these installations. Through the right combination of batteries and solar panels, the electric load of residences can be reduced to lower the economic and environmental cost of producing energy during peak hours of energy usage. We simulated this energy production model using data from the Department of Energy and the Brattle Group, giving accurate estimates for energy consumption in the state of Kansas. Energy production information from K-State’s solar panels allowed us to estimate the energy production for various arrays of panels. Additionally, we modeled the energy efficiency of air conditioners and water heaters and demonstrated how to reduce the carbon footprint of these devices. This was simulated using different combinations of available technologies over the period of a day. Math modeling allows FHREEC beneficiaries to make informed decisions as consumers, lowering the environmental impact of their homes.
Poster 21
ASSESSING SOUTHWEST KANSAS PLOTS TO DETERMINE POTENTIAL WIND TURBINE PROFIT
Alan T. Caro, Dr. Ruth Miller
Department of Electrical and Computer Engineering

The purpose of this research is to assess plots in Southwest Kansas to determine if said plots would be viable to sell wind energy. Currently there are financial/regulatory restraints throughout Kansas with the selling of energy. This research would help determine if the selling of wind energy in exchange for pumping less water would make economic sense for all parties associated. I will be analyzing data from met towers located at several locations to calculate the total annual energy expected from wind turbines at 80, 100, and 120 meters at pre-selected potential regions. I will be using the mean wind speed from already existing wind map data combined with shape factor from a Tall Tower wind data analysis already conducted using KDOT antenna towers in six Kansas counties to come up with a wind frequency curve for a given site on the map. Multiplying the wind frequency curve by the power curve for a selected wind turbine we calculate the total annual energy. Total annual energy would help me calculate the amount of profit a person might make by selling wind energy on their plot of land.

Poster 22
WIND FOR SCHOOLS PROJECT: K-12 RENEWABLE ENERGY EDUCATION AND RESEARCH
Elkana Nyambegeta, Cameron Kennedy, Alan T. Caro, Shangxian Wang, Dr. Ruth Miller
Department of Electrical and Computer Engineering

The purpose of this research is to help install wind turbines for the purpose of education and to incorporate renewable energy concepts into K-12 science curriculum through the Wind for Schools project, which has been working since 2008. This entails installing 2.4-kilowatt wind turbines on 70-foot guyed or 60- or 45-foot monopole towers at schools throughout the United States. We are currently working on getting wind energy data, collected from turbines at all our designated schools, on our OpenEI and Wind for Schools websites and developing teaching materials for K-12 students. The way we are streaming data onto these websites is configuring small micro-computers called Raspberry Pis to acquire data from a receiver radio called a Zigbee, which would usually be connected into a computer. The Raspberry Pi serves as a connection for the data to the website. We have been sending and installing Raspberry Pis to all schools to establish data streaming to our websites.
Wildcat Wind Power is one of the twelve university teams participating in the biennial Collegiate Wind Competition sponsored by the Department of Energy. The competition is designed to provide an opportunity for students to explore the wind industry. Our team is required to design, build, and test a small-scale wind turbine used for off-grid energy production. An addition to this year’s competition, we are required to develop a creative load that demonstrates the usefulness of our turbine, as well as a business plan around our turbine’s real-world application. Our model turbine is being designed to power an LED display for the competition. This model will prove our scaled up turbine will provide sufficient power for tailgate, as proposed in our business plan. Participation in the Collegiate Wind Competition prepares members of the team to enter the workforce by providing real-world experiences while obtaining a greater understanding of the wind industry.

Energy consumption for buildings account for 41% of the primary energy consumption in the US. About 37% of the energy consumed by those buildings is used in space heating and cooling applications. The introduction of a Thermal Energy Storage (TES) applied to thermal load of building could reduce the energy consumption during peak hours. This thermal energy loads can be supplied from renewable energy sources which usually have a peak supply during off-peak demand hours. By storing the energy supplied during higher production of renewable energy or during off-peak hours and then utilizing later to meet the demand, the peak to off-peak cost variation of energy can be reduced. Thus deployment of TES systems when integrated with building thermal loads will have the capacity to improve the market penetration of renewable energy and reduce the peak to off-peak ratio of electricity loads on the grid.
**Poster 25**

**IMPROVING FILTRATION SYSTEMS FOR PARTICLE REDUCTION IN THE PRODUCTION OF SOY BEAN BASED BIODIESEL AND GLYCERIN BYPRODUCT**

**Allison Clark¹, Nathan Henderson², Logan Joos¹, Mr. Ed Brokesh², Dr. Daniel Higgins³**

*Department of Chemical Engineering¹, Department of Biological and Agricultural Engineering², Department of Chemistry³*

The production of biodiesel reduces the waste footprint of Kansas State and provides a useable fuel to campus vehicles. To recycle the maximum amount of waste vegetable oil (WVO) the K-State Biodiesel Initiative focuses on filtration to improve efficiencies and quality of fuel and meet ASTM standards. Sieve filtration of WVO and crude glycerin removes impurities and increases quality of product. Higher quality feedstock and byproducts allows the Initiative to increase profits from distilling glycerin into goods.

A typical batch of biodiesel requires 50 gallons of filtered WVO. The current filtering procedure can take students up to three hours to perform. With improved technique, the filtering time will be decreased while quality of fuel increases. These improvements include implementing intermediate settling tanks, increasing the amount of filtering stages with varying pore sizes, and requiring regular sieve filter maintenance. With these improvements a greater amount of impurities are removed from the biodiesel, resulting in a more viable byproduct for producing alternate goods. The byproduct, glycerin, can be refined into soap or fire-starters as opposed to disposal with hazardous waste. As a raw product, impurities in glycerin react with air and create a soap-mix dense film (confirmed through pH testing) if not distilled immediately. When glycerin is separated from the biodiesel, particles, like excess glycerol and carbon, will be removed through a similar settling and sieve filtration process, as well the use of diatomaceous earth.

**Poster 26**

**SOLAR POWERED CHARGING INFRASTRUCTURE FOR ELECTRIC VEHICLES: A SUSTAINABLE DEVELOPMENT**

**Matthew Reynolds, Blake Ronnebaum, Rachel Walker, Dr. Larry Erickson**

*Department of Chemical Engineering*

Last year, the Paris Agreement on Climate change was adopted as an active effort to reduce greenhouse gas emissions across the globe. One of the most important ways to achieve this goal is by finding a way to generate clean electricity, such as solar power. The next goal will be to electrify transportation to eliminate another of the leading sources of carbon emissions. Our research discusses how Solar Powered Charging Stations (SPCSs) will help to meet these goals. With 30% of the United States now generating power from solar energy and one million electric vehicles in use, these charging stations will make a large difference in the United States power market. These infrastructures can be highly adaptable due to their ability to supply energy to the grid or the vehicle when it is plugged in. They will increase the ease of use for consumers as they no longer require trips to the gas station, but can plug in at home and at work. Due to these changes in lifestyle, the nation’s carbon emissions will drop significantly, improving air quality and the effects of climate change. All of these factors contribute to the SPCS’s sustainable impact on our society. The information shared here is also to be published as a book under the same title with our research professor Dr. Larry Erickson as the leading editor.
Poster 27
GLOBAL SENSITIVITY ANALYSIS OF DAM EROSION MODELS
Geordy Williams, Dr. Mitchell L. Neilsen
Department of Computing and Information Sciences

WindowsTM Dam Analysis Modules (WinDAM) is a set of modular software components that can be used to analyze overtopped earthen embankments and internal erosion of embankment dams. These software components are being developed in stages. The initial computational modules address routing of floods through the reservoir with dam overtopping and evaluation of the potential for vegetation or riprap to delay or prevent failure of the embankment. Subsequent modules incorporate dam breach analysis. Current work is underway to include analysis of internal erosion, non-homogeneous, zoned embankments, and the analysis of various other forms of embankment protection. The focus of this project is on the overall software architecture and its integration with Sandia National Laboratories’ DAKOTA software suite to perform global sensitivity analysis on a wide range of input parameters.

Poster 28
MCNP BASED CRITICALITY CALCULATIONS FOR HYPOTHETICAL COLLOIDAL REACTORS
Diego Laramore, Jordan Lindstrom, Mike Pfeifer, Dr. Hitesh Bindra
Department of Mechanical and Nuclear Engineering

Nearly all currently operating nuclear power reactors are considered “heterogeneous reactors,” i.e. the reactor core consists of lumped regions of fissile fuel with moderator between the individual fuel elements. Such an arrangement optimizes the thermal utilization factor and resonance escape probability of the reactor by changing the neutron flux levels in the fuel and moderator region to achieve better overall multiplication factors than a completely homogeneous system. The configuration of these fuel elements within the reactor core is, in general, fixed and non-transient, therefore the critical condition of the reactor must be controlled by some other means, normally by introducing neutron absorbing control rods into the core, i.e. adding or removing neutron absorbing materials into the system.

In this paper a hypothetical reactor consisting of a colloid suspension of uranium dioxide particles in water is considered. Such a reactor would theoretically be able to adjust the pitch distance between its fuel elements (uranium dioxide particles) during operation, eliminating the need for an absorbing control medium. The effective neutron multiplication factor (k_eff) of the colloid suspension can be adjusted by changing the spacing between fuel particles using physic-chemical changes. For a particular range of particle separation distances the fuel arrangement has a k_eff >1, and outside this range k_eff <1.
Poster 29
ADVANCED DRY CASK STORAGE FOR SPENT NUCLEAR FUEL
Casey Weiser, Duc Nguyen, Andrew Wolford, Diego Laramore, Jordan Lindstrom,
Dr. Hitesh Bindra
Department of Mechanical and Nuclear Engineering

Current methods for spent nuclear fuel rely heavily on dry cask storage containers that are intended to withstand the test of time and any natural disaster they may encounter. Many existing dry cask designs seal the spent nuclear fuel in a stainless steel canister and enclose the canister in a concrete overpack. However, these dry casks are intended to last as long as possible; improvements can be introduced to further ensure the spent nuclear fuel will be stored safely without affecting the ambient environment. These dry cask designs are intended to dissipate heat in an efficient manner while maintaining adequate shielding from the radiation emitted by the spent fuel.

An enhanced design was proposed by researching existing designs and introducing additional features that will allow the dry cask to perform optimally. Fins were added to the canister to allow the heat to distribute uniformly. Additional air channels were strategically integrated into the overpack to promote airflow past the canister without compromising the necessary shielding. Buoyant plugs were also introduced inside the overpack to protect the dry cask from flooding and prevent erosion of the interior. Models were created using MCNP and COMSOL Multiphysics to ensure that the design met shielding requirements while managing decay heat efficiently.

Using these methods, improvements were observed in heat management without compromising shielding requirements. Models created for Finite Element Analysis (FEA) in Solidworks verified the design’s structural resilience up to a 80 mm drop. Simulations are still pending for the final design modifications.

Poster 30
SMART HOME CONTROLS
Caroline Kabus, Mr. Chris Ahern
Department of Architectural Engineering and Construction Science

Intuitive lighting controls is hot topic in the commercial building design industry today. Commercial building codes for lighting controls have become significantly stricter in recent years. Now many spaces in new buildings are required to incorporate daylight harvesting, occupancy sensing and timeclock shut off mechanisms for lighting and other systems. The increased awareness of energy efficiency and new energy code requirements have prompted the industry to respond by developing building control products that cater to efficacy and customizable control. This is an exciting time for lighting controls in the commercial industry, but these commercial systems are almost always hardwired via line voltage to the lights and data (CAT-5) cable to the controls. The shear amount of wires needed can be restricting. However, the personal home lighting controls market has taken an exciting leap into the wireless age. There are obvious benefits to a wireless system, like fewer wires and easy installation, but there are also significant downsides to going wireless, like a bogged down network system and spotty connection. This study has taken a look at several different wireless smart home products currently on the market. The projects were tested in a real home environment and a list of pros and cons made for each device. Personal home systems have the potential to serve as an excellent beta test or the wider commercial market. These home projects can drive the industry to discover the exciting possibilities and the potential hurdles of going wireless.
Poster 31

FUMC HARRIS ACTIVITY CENTER SYSTEMS ANALYSIS ABSTRACT
Kyle Rieger, Kaitlin Beeman, Emily Garrison, Jenna Shaw,
Mr. Fred Hasler, Mr. Chuck Burton

Department of Architectural Engineering and Construction Science

The Harris Activity Center is an auxiliary building of the First United Methodist Church on Poyntz Ave. in Manhattan, KS. The Harris Activity Center was originally built as a Masonic Temple and currently serves as a space for youth group, cub scouts, and some church related meetings. Most of the equipment, fixtures, and systems within the building are from the original construction and in some cases in much need of upgrade. It is important for any building, especially one of this age, to occasionally observe, analyze, and upgrade critical building systems so as to keep the systems both relatively modern and safe for occupants. These major systems include structural, mechanical, electrical, and plumbing. This team of undergraduate researchers was each assigned a specific system within the building to take note of existing conditions; to analyze the functionality, life cycle, and use of each of the systems; and to offer a recommendation for improvement and upgrade to the First United Methodist Church Harris Activity Center. The team worked for several months to develop a detailed report on these criteria and plans to present our findings and recommendation to the church’s board of directors so that they may take action for renovation and/or building safety improvement. Research included taking photographs of points of interest and condition of each system, building a Revit model identifying key locations, and periodically submitting updates of our work to our research advisor, Fred Hasler.

Poster 32

FLOOR VIBRATION MEASUREMENT IN ENGINEERING COMPLEX PHASE 4
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. Floor vibrations are typically caused by rhythmic loading from occupants (walking, running, or jumping) as well as the mechanical equipment of a building (HVAC). Traditional serviceability requirements for lightweight, long span floor systems such as deflection limits typically do not guarantee satisfactory vibration performance. For these reasons it is important to measure and study the vibrations to determine if steps should be taken to mitigate the vibrations. Vibrations criteria also depend on the occupancy of the space. Several locations within the Phase 4 construction were built with long-span steel floor systems, which are prone to floor vibration. In this study, field measurements were taken in terms of acceleration at multiple long-span locations. Measured acceleration data is then analyzed and compared to American Institute of Steel Construction (AISC) Design Guide 11 – Floor Vibration Due To Human Activity in order to assess the vibration performance.
**Poster 33**

**MODELING OF HYDROGEN PRODUCTION AND DIFFUSION IN A MICROFLUIDIC DEVICE**

Martha Floy\(^1\), Dr. Christopher Culbertson\(^2\)

*Department of Chemical Engineering\(^1\), Department of Chemistry\(^2\)*

Microfluidic devices consist of a manifold of small fluid-filled channels. These devices have many advantages over conventional chemical analysis instrumentation especially in the area of cellular analysis. Specifically, microfluidic devices have the ability to precisely transport, count, stimulate, incubate and lyse cells followed by chemical analysis. A variety of detection modalities can be integrated into microfluidic fluidics devices including absorbance, electrochemical, fluorescence and mass spectrometry methods. Electrochemical detection, in particular, has advantages for the detection of reactive oxygen (ROS) and nitrogen species (RNS) that are thought to be indicators of several types of neurodegenerative diseases. Electrochemical detection, however, is difficult to carry out in microfluidic devices, because the electrophoretic separation current used to separate the different RNS and ROS analytes prior to detection needs to be grounded in the small microfluidic channels. Due to the high electric field, electrolysis of water occurs at the electrode and causes hydrogen bubble formation, therefore insulating the separation field. We hypothesize that hydrogen gas can be mitigated by diffusion across a thin polydimethylsiloxane (PDMS) membrane. We developed a simulation to model the effects of electric field strength, channel geometry, and fluid flow on the production and diffusion of hydrogen gas. A potentially feasible design for the microfluidic device has been identified and will be tested experimentally.

**Poster 34**

**EFFECT OF INTERMITTENT INTERVAL SAMPLING ON SOFTWARE DEFINED DMZS**

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Software-defined dynamic DMZ configurations typically trust traffic based on a whitelist or fuzzy logic; however, not all traffic in dynamic DMZs is guaranteed to be benign. Intermittent sampling of intervals of flows could potentially increase security confidence. Dividing or splitting a flow contradicts the design of OpenFlow, an industry standard for SDN, but redirecting a flow for a short interval could be an effective way to sample packets. This study looks at the effect of random time-based flow sampling on bandwidth and packet loss for a 10G-capable software-defined DMZ. A series of experiments were conducted on elephant TCP flows in a OpenFlow controlled DMZ. The bandwidths, packet retransmissions, and sample ratios were measured for ten different configurations of interval sampling. These measurements are compared to a control group without interval sampling. We found that by varying the sample ratio of packets we were able to control the bandwidth of a flow without incurring significant packet loss.
Poster 35
ARE DAILY FANTASY SPORTS A GAME OF CHANCE?
Sarah Newell, Dr. Todd Easton
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In October 2015, the State of Nevada ruled that daily fantasy sports are predominantly a game of chance. This research provides mathematical and statistical evidence invalidating their claim. Daily Fantasy Sports is a billion dollar industry where participants select professional athletes to create a fantasy team. Each professional 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 money. If daily fantasy sports are games of chance, teams selected randomly should perform as well as teams that are chosen by skilled players. A skilled player seeks to optimize his or her team’s fantasy points, which can be modeled as an integer program. An unskilled player can be modeled using the acceptance rejection simulation technique. These models are compared throughout ten weeks of the 2015 National Football League season. Statistical tests determine that the skilled players are statistically superior to the unskilled players and thus, daily fantasy sports are not predominantly a game of chance. Besides answering this important question, this research creates the first integer program to optimally solve the NFL daily fantasy sports problem, as well as the first model of unskilled team selection using simulation.

Poster 36
PROFESSIONAL ENGINEERING EXAM PASS RATES BY GENDER
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Past research has found undergraduate female architectural engineering (ARE) students at Kansas State University recognize the importance of earning their professional engineering license (P.E.), 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. 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.
For our undergraduate research project, we looked into the ever increasing pool of technology that is geared towards construction and its day-to-day processes. We used technologies such as Bluebeam, Revit and are beginning look into Navisworks. Our research is intended to help develop curriculum for a new class on BIM technology for the Construction Science and Management and Architectural Engineering Department. This newly developing class will help our department take the necessary steps to incorporate technology to assist the students in being more equipped with the knowledge of the technology the industry is already using. BlueBeam in its simplest form is a PDF reader. Once past that function though it can be used for many different things including finding measurement on drawing put into the program, marking up those drawings when changes occur and also turning those drawings into simple 3D models for viewing to show to owners and clients on a given construction project. Revit is one of the most complex and highly used 3D modeling software in the construction industry. Lastly NavisWorks is meant to present the models made in Revit. Another useful tool you can use NavisWorks for is making time-lapse videos to show the process of the structure or building being built. Incorporating these technologies into the curriculum will not only make our department more attractive to prospective students, but it will also allow our current students to be more marketable to future employers.

Societies’ need for engineers and engineering related fields is constantly growing. Therefore, pointing K-12 grade students to science, technology, engineering, and math education (STEM), is something that must be done. A previous senior design group of electrical and computer engineering students built an inverted pendulum, as part of the outreach materials geared to middle and high school students, with a focus on STEM. By reading various scholarly materials, a set of documents have been created to help students explore some simple physics, control theory, and various engineering disciplines that go into processes performed in today’s high-tech industry. The initial outreach materials were piloted with a high school student, to identify areas of confusion and revise the materials. The pilot also provided a base reference of vocabulary level for our intended audience. Our goal is to have an easy-to-comprehend set of experiments that Kansas State University is able to send to middle and high schools to help promote Kansas State University pride, as well as generating interest in engineering and engineering related topics for higher education. This research project has produced an outreach packet aimed to teach engineering science concepts, as well as generate excitement in engineering as a potential career. Future work includes further testing of these materials, along with assessment of their impact on student learning and perceptions of engineering.
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ANAEROBIC MEMBRANE BIOREACTORS (ANMBRS) FOR ENERGY POSITIVE WASTEWATER TREATMENT AND RESOURCE CAPTURE: CURRENT STATE OF THE ART AND RESEARCH CHALLENGES

Barrett Schmidt, Mr. Tyler Penfield, Dr. Prathap Parameswaran
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The concept of Wastewater treatment has begun to undergo a paradigm shift in recent years, with a greater emphasis towards sustainable energy and resource recovery from the waste streams along with the simultaneous production of treated reusable water. Anaerobic Membrane Bioreactors (AnMBRs) are an emerging technology within this context that does not require aeration to oxidize the organic content in wastewater and has a lower energy footprint than aerobic processes, while producing energy rich biogas (methane + carbon dioxide) that can be used to generate electricity, heat, or transportation. Two additional benefits include the ability to recover valuable Nitrogen and Phosphorus in industrially valuable forms, along with treated water that meets reuse standards. Despite the huge promise of AnMBRs, there are central research challenges to be addressed for success at full scale, namely, minimization of membrane fouling, recovery of dissolved methane from the effluent streams, and the need for deeper understanding of anaerobic psychrophilic microbial physiology for successful ambient temperature AnMBR operation. There is also a significant need for long term pilot studies that demonstrate successful operation under ambient conditions. A research project funded by the Environmental Security Technology Certification Program (ESTCP) that aims to operate a pilot scale AnMBR at Ft. Riley, Kansas provides me a unique opportunity to verify its performance under realistic conditions. I will monitor the performance of the pilot scale AnMBR through an array of chemical and biological assays, performed both on-site and in the laboratories at K-State, to ensure and further improve AnMBR operation.

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OPTIMAL NUCLEAR DESALINATION CONFIGURATION COMPUTATION

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Water demand has sharply increased with the increase in human populations around the world, necessitating the review of water production and purification technologies. In particular, coupled designs wherein a desalination plant draws steam from the main steam supply of a nuclear power plant have demonstrated reliability as sources of potable or industrial water. Nuclear power plants also always operate at the same base load, independent of peak power demands, resulting in dumped energy during low power demand periods. Our preliminary research was to determine the optimal desalination type for nuclear power plant coupling systems, which involved identifying desalination system candidates, reviewing nuclear desalination operation experience, and comparing the different desalination types based on criteria related to costs and thermodynamic efficiencies. With the aforementioned completed, we could move on to our primary goal of the creation of a spreadsheet-based tool that takes known reactor and desalination inputs, and allows for the output of the water production of the desalination plant and effect on thermodynamic efficiency for the nuclear plant.