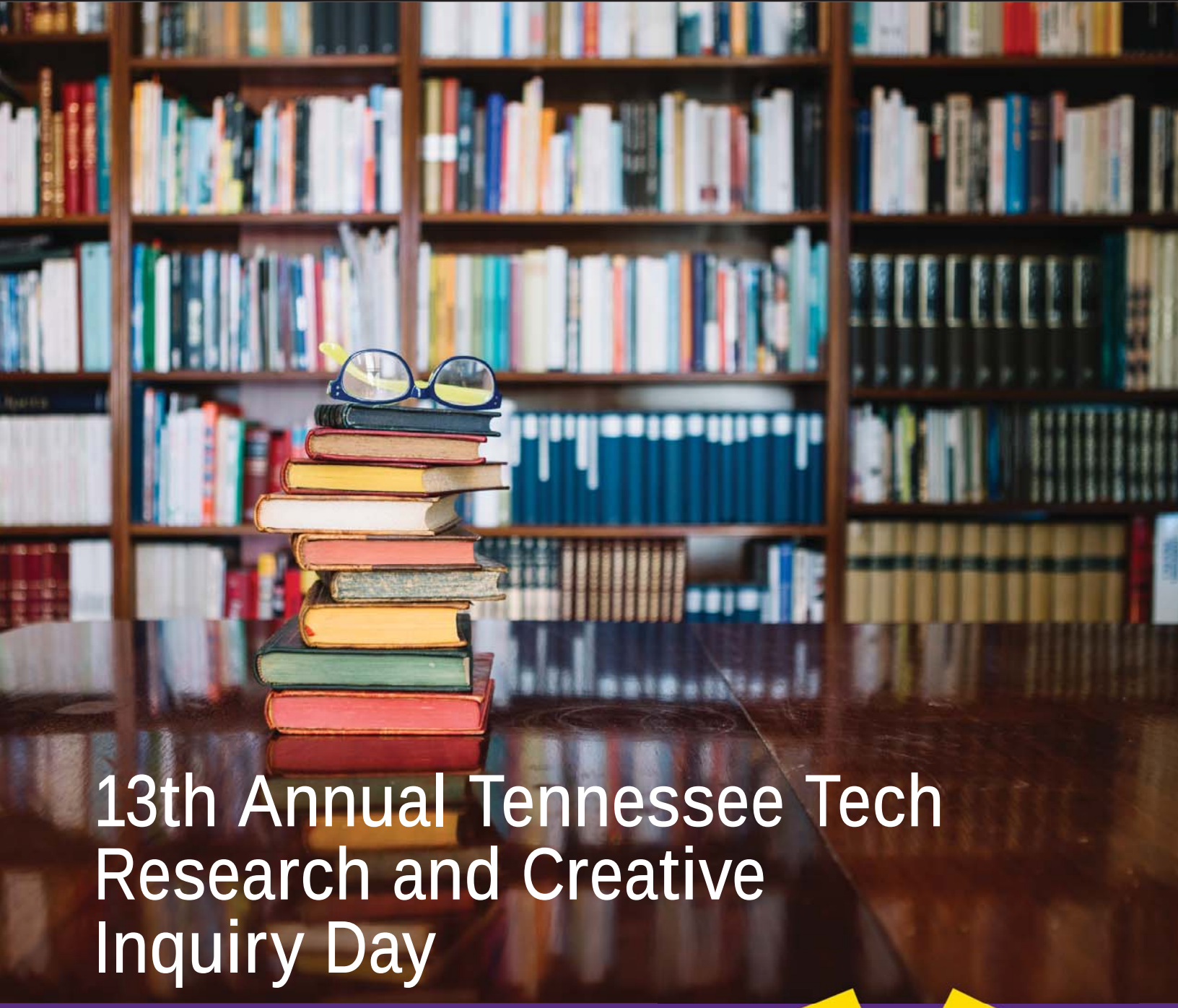
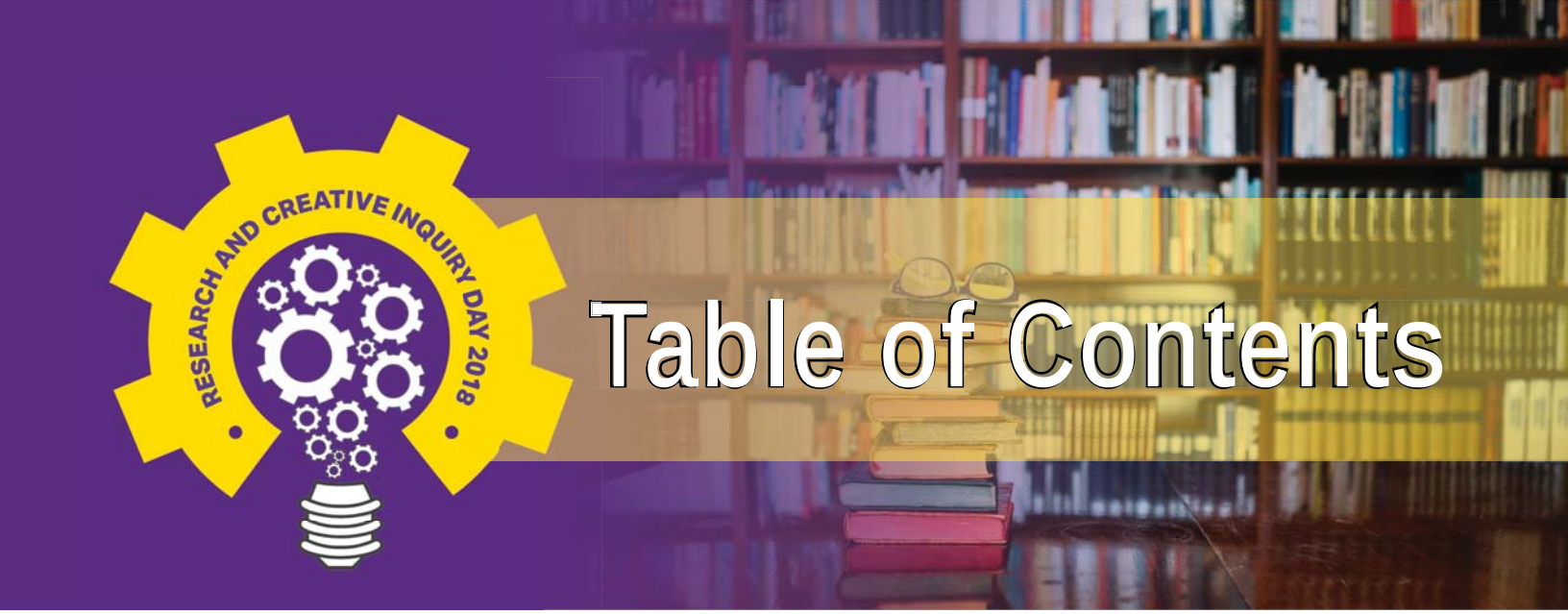


13th Annual Tennessee Tech Research and Creative Inquiry Day

April 9-10, 2018
Hooper Eblen Center

tntech.edu/research/research-day

Book image by freepik.com.



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Preface

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Tennessee TECH

Tennessee Tech University is part of the State University and Community College System of Tennessee. #REDR217-PRNT-18

U.S. House of Representatives Resolution

H. Res. 1654

In the House of Representatives, U. S.,
November 16, 2010.

Whereas close to 600 colleges and universities in the United States and thousands of undergraduate students and faculty pursue undergraduate research every year, providing research opportunities that will shape the trajectory of students' lives and careers and researchers' and institutions' purpose and contributions to academia and the research enterprise;

Whereas students and faculty engaged in undergraduate research contribute to research across many disciplines, including arts and humanities, biology, chemistry, health sciences, geosciences, mathematics, computer science, physics and astronomy, psychology, and social sciences;

Whereas research at the undergraduate level provides both students and faculty members opportunities for improving and assessing the research environment at their institution, develops critical thinking, creativity, problem solving, and intellectual independence, and promotes an innovation-oriented culture;

Whereas undergraduate research is essential to pushing the Nation's innovation agenda forward by increasing the interest and persistence among young people in the crucial science, technology, engineering, and mathematics (STEM) disciplines, and to cultivating the interest of would-be researchers who pursue a new aspiration of graduate education after participating in undergraduate research; and

Whereas the week of April 11, 2011, would be an appropriate week to designate as ' 'Undergraduate Research Week'':

Now, therefore, be it

Resolved, That the House of Representatives—

(1) supports the designation of ''Undergraduate Research Week'';

(2) recognizes the importance of undergraduate research and of providing research opportunities for the Nation's talented youth to cultivate innovative, creative, and enterprising young researchers, in collaboration with dedicated faculty;

(3) encourages institutions of higher education, Federal agencies, businesses, philanthropic entities, and others to support undergraduate research and undergraduate researchers and their faculty mentors;

(4) encourages opportunities, including through existing programs, for females and underrepresented minorities to participate in undergraduate research; and

(5) supports the role undergraduate research can and does play in crucial research that serves the Nation's best economic and security interests.

Attest:

Clerk.

STATE OF TENNESSEE

PROCLAMATION

BY THE GOVERNOR

WHEREAS, graduate education attracts over 45,000 students nationally and internationally to Tennessee universities, awards over 15,000 graduate student degrees from Tennessee public and private institutions annually, and contributes to the economic growth and stability of the state, generating more than 300 million dollars in economic impact; and

WHEREAS, graduate education in Tennessee is enhanced by assistantships and involvement with local organizations and businesses that participate in the advancement of resources to the community and to the public; and

WHEREAS, Tennessee graduate students and graduate education across the state have helped increase the earning power of Tennessee citizens, have attracted new businesses and creative ideas such as artificial intelligence, neuroscience, the arts, biomedical engineering, nanotechnology, information technology, literacy, materials science, and children's health; and

WHEREAS, Tennessee graduate faculty engage in internationally-recognized scholarship, producing a significant body of research that contributes to the broad base of knowledge essential for advancing education in the State; and

WHEREAS, alumni from Tennessee graduate schools occupy leadership roles in school systems, institutions of higher learning, health-related institutions, businesses, government, and politics; and

WHEREAS, Tennessee universities have recognized the strengths and contributions of a culturally diverse student body and as a result attract student scholars from diverse backgrounds interested in pursuing graduate education;

NOW, THEREFORE, I, Bill Haslam, Governor of the State of Tennessee, do hereby proclaim the week of February 26 through March 2, 2018, as

Graduate Education Week

in Tennessee and encourage all citizens to join me in this worthy observance.

IN WITNESS WHEREOF, I have hereunto set my hand and caused the official seal of the State of Tennessee to be affixed at Nashville on this eighth day of January, 2018.

Governor

Secretary of State

Foreword

The Office of Research and Economic Development welcomes you to the 13th Annual Research and Creative Inquiry Day. This event provides an opportunity for students to display their research and creative inquiry projects from departments across Tennessee Tech's campus. Student research experiences are important because they stimulate active learning, cultivate curiosity, increase critical-thinking skills, and equip students to evaluate situations creatively and pursue solutions to real-world problems. Participation in research and creative works is an important part of the university experience at every level and across all disciplines as these activities serve as the foundation for lifelong learning and prepare students for the workforce of the 21st century. Through research and creative inquiry, new knowledge is created and shared, and new technology is developed for the benefit of society.

The projects displayed at this event underscore our students' creativity, innovative mindsets and investigative spirits. They also highlight the importance of inter-disciplinary collaboration and scholarship to achieve high-quality results, which is critical to the advancement of knowledge. The students' efforts in these areas have helped bring honor and recognition to the university, the region and the nation.

In recognition of the importance of research and creative inquiry to the advancement of knowledge, the U.S. House of Representatives passed a resolution designating a week in April as "Undergraduate Research Week," and the Governor of the State of Tennessee proclaimed Feb. 26 through March 2 as "Graduate Education Week." Through this acknowledgment of undergraduate and graduate student research, we see society focusing increasingly on finding solutions to problems that only research can solve. This trend is playing out in the university setting, especially events like this one.

Throughout the years, Research and Creative Inquiry Day has grown and expanded in many ways, including an increase in posters presented and in departments represented. During the initial years of the event, approximately 65 abstracts from 11 departments were submitted. This year, 221 abstracts were submitted from 21 fields of study.

Congratulations to the students and faculty advisors who have worked very hard to prepare and present these posters and papers that display Tech's dedication to excellence in learning and discovery. The judges who volunteered to evaluate the students' work are also greatly appreciated. This event would not have been possible without the support of the entire campus community.

Special Appreciation & Acknowledgements

TTU Offices, Departments and Staff

Engineering Workstation Lab, Dining Services and Catering, Information Technology Services, Library Services, Office of Communications and Marketing, Office of Creative Inquiry, Student Services

We also wish to acknowledge David and Sherri Nichols for their endowment to support Student Research and Creative Inquiry.

This year's event features graphic developed by TTU design major.

Tori Vann, senior art major in digital design and student of Assistant Professor David Gallop, designed this year's graphic for the Research and Creative Inquiry Day.

New this year is a video showcase by students from the Honors Engineering and Social Justice class.

In conjunction with this year's event, Assistant Professor Tania Datta and STEM Center Director Sally Pardue invite you to visit the **Communicating Research and Creative Works via Video Showcase** to view the outcomes of creative research conducted by students in Honors 4013 Colloquia: Engineering and Social Justice. The students shared their individual case analysis projects with one another using a video format. The showcase will take place on the concourse level of the arena. An abstract for one of the video projects is on page 76 in the abstracts following.

Schedule of Events

The 13th Annual TTU Student Research and Creative Inquiry Day

Monday, April 9, 2018

Hooper Eblen Center

11 a.m. to 3 p.m.: Student Registration and Poster Setup

4 to 6 p.m.: Judge Registration and Judging (Students are invited to be available to discuss posters, and hors d'oeuvres will be served.)

Volpe Library Instruction Room 248

12:20 to 1:15 p.m.: English Department Paper Presentations

Tuesday, April 10, 2018

Hooper Eblen Center

9 to 11 a.m.: Poster Display for Campus and Community (Students are invited to be available to discuss posters, and light snacks will be served.)

*The Communicating Research and Creative Works via Video Showcase will take place on the concourse level of the Hooper Eblen Center arena.

11 a.m. to noon: Awards Ceremony

Noon to 2 p.m.: Poster Pickup/Cleanup

2018 Judges

Michael Adenson, Chemical Engineering
Steve Anton, Mechanical Engineering
Laura Arias-Chavez, Chemical Engineering
Curtis Armstrong, Decision Sciences and Management
Joseph Asante, Earth Sciences
Megan Atkinson, Volpe Library
Indranil Bhattacharya, Electrical and Computer Engineering
Jeremy Blair, Art, Craft and Design
David Brown, Computer Science
Debra Bryant, Volpe Library
Hugh Cameron, Business Synthesis
Stephen Canfield, Mechanical Engineering
Amanda Carroll, Chemistry
Derek Cashman, Chemistry
George Chitiyo, Curriculum and Instruction
Rufaro Chitiyo, Human Ecology
Joshua Cisco, Chemical Engineering
Oana Cojocaru, Chemistry
Janet Coonce, Chemistry
Kristen Deiter, English
Dennis Duncan, Agriculture
Bill Eberle, Computer Science
Ismail Fidan, Manufacturing and Engineering Technology
Jerry Gannod, Computer Science
Sheikh Ghafoor, Computer Science
Melea Gilmore, PMI BioPharma Solutions
James C. Gray MD, Upper Cumberland Medical Society
Steven Hayslette, Biology
Ann Hellman, Nursing
Nicole Henniger, Counseling and Psychology
Adam Holley, Physics
Samantha Hutson, Human Ecology
Stephanie Jorgensen, Chemical Engineering
Alfred Kalyanapu, Civil and Environmental Engineering
Ahmed Kamal, Manufacturing and Engineering Technology
Duckbong Kim, Manufacturing and Engineering Technology
Seth King, Curriculum and Instruction
Charlie Koudelka, Y-12 National Security Complex
Ehsan Languri, Mechanical Engineering
Wayne Leimer, Earth Sciences
Edward Lisic, Chemistry
Satish Mahajan, Electrical and Computer Engineering
Hayden Mattingly, Environmental Studies
Leora Maxwell Loftis, Chemical Engineering
OP McCubbins, Agriculture
Colleen Mestayer, Communication
Christine Miller, Decision Sciences and Management
Allan Mills, Mathematics
Holly Mills, Volpe Library
Gene Mullins, Chemistry
Justin Murdock, Biology
Christopher Murray, Biology
Venkat Padmanabhan, Chemical Engineering
Nikki Panter, Biology
Michael Phillips, Exercise Science, Physical Education and Wellness
Jeff Plant, Human Ecology
Mustafa Rajabali, Physics
Chad Rezsnyak, Chemistry
Cynthia Rice, Chemical Engineering
Sam Schiller, Schiller Law Firm
Julie Shell, Kimberly-Clark
Ambareen Siraj, Computer Science
Doug Talbert, Computer Science
Sandra Terneus, Counseling and Psychology
Hannah Upole, Human Ecology
Daniel VandenBerge, Civil and Environmental Engineering
Ahmad Vaselbehagh, Mechanical Engineering
Lenly Weathers, Civil and Environmental Engineering
Janet Whiteaker, Learning Support Program
Kübra Yeter-Aydeniz, Physics
Liqun Zhang, Chemical Engineering
Ying Zhang, Mechanical Engineering
Jiahong (John) Zhu, Mechanical Engineering

Abstracts

College of Agriculture and Human Ecology

School of Agriculture

Undergraduate

USING SEWAGE AND BROILER LITTER SOIL AMENDMENTS FOR ESTABLISHING GRASS AND LEGUME PASTURES

Primary Author: Lauren Borst, Agriculture

Advisor: Pat Bagley

In much of the world we are concentrating both humans and animals, resulting in manures that need to be recycled to return nutrients back on productive lands where foods are grown. The continual harvesting of foods, sending them to cities and cities placing these human wastes in lagoons and dumps has concentrated much needed nutrients away from production areas. While producers use fertilizers as soil amendments, often these purchased fertilizers lack the array of micro-nutrients required by plants that are present in manures, eventually leading to lowered productivity and higher costs of production. We are using processed human wastes from the City of Livingston to return nutrients back to agricultural production areas to help end the concentration of nutrients in landfills. Further, we are also applying broiler litter, a product comprised of bedding, chicken wastes, feeds, feathers, etc., that have been properly composted to determine impacts of varying levels of these nutrients on establishing grasses and legumes in livestock pastures. Recycled human wastes will be applied to a 22 acre pasture at rates of 0, 4 or 8 tons/acre, with pastures planted to native grasses using for grazing. Further, a small plot within the 22 acre pasture will be planted to seven different cool-season plants, including white clover, Will ladino clover, red clover, crimson clover, KY 31 Tall Fescue, common orchardgrass, and perennial ryegrass. Plots will be evaluated for rates of establishment and growth during the first growing season based upon amendment rates of application.

Undergraduate

CONSUMER RATING OF IMPORTANCE OF "ALL NATURAL" AND "OMEGA 3" IN PORK SAUSAGE PRODUCTS

Primary Author: Bonnie Breland, Agriculture

Advisor: Pat Bagley

Consumers are increasingly more concerned about the how “natural” a product is, and the nutrients they contain. This project was conducted in cooperation with Wampler’s® which produces Wampler All Natural Sausage as well as Wampler’s® sausage in Lenoir City, TN. Product was picked up frozen at “Cash & Carry” in Cookeville. Products were cooked by an experienced chef. During the “Annual Cookeville Rotary Club Pancake Breakfast” a random 23 volunteers of 275 attendees were used in this study. Participants were asked to taste both sausage products, 1) pork sausage and 2) “All Natural” pork sausage. Participants were not told which product was on either platter, they were simply marked as “Sample 1” and “Sample 2.” After consuming both freshly cooked sausage products, participants were asked to rate each sausage product on a 1 – 3 scale, where 1 = poor, 2 = average, and 3 = good. After rating both products, participants were asked to respond to two questions,

based on a 5-point Likert Scale, where 1 = not important, 3 = no opinion, and 5 = very important. Questions were: A) How important is a product that is "All Natural?" B) "How important to you is a product that is high in Omega 3 fatty acid?" Responses to the question regarding All Natural: 1=1, 2=0, 3=3, 4=10, 5=9. For the question on the importance of high Omega 3, 1=0, 2=0, 3=1, 4=13, 5=9. This random sample viewed "All Natural" as important, but high Omega 3 more important.

Undergraduate

EXPLORING THE KNOWLEDGE AND PERCEPTIONS OF HONEY BEES WITHIN THE COMMUNITY

Primary Author: Amber Dunnaway, Agronomy and Soils

Advisor: Dennis Duncan

Co-Author(s)/Collaborator(s): Dennis Duncan, Tennessee Tech University

Honey bees are essential to agriculture production in the United States. For example, 80-100 percent of specific agronomic crops are dependent on honey bee pollination – crops include blueberries, cherries, and almonds. However, over the past decades there have been significant losses of honey bee colonies across the U.S. Educating people about this crisis and informing homeowners on methods to improve bee health is a great place to begin making a change that could lead to an increase in honey bee populations in the U.S. This research project analyzes the knowledge and perceptions of community involved adults on the importance of honey bees to society. Using a retrospective survey design, the primary investigator gave a presentation to 50 participates of different organizations within the community followed by a 20-question instrument that was designed to gauge participants knowledge and perceptions of honey bee culture. The presentation covered the basics or beekeeping and the dangers that face honey bees and the usefulness of planting pollinator friendly plants and how to seek out alternatives to synthetic pesticides. Preliminary results indicate that the presentation expanded the knowledge base of the participates and stimulated participate to be more proactive in performing best management practices around honey bees. The researchers concluded that a 20-30-minute presentation can influence community members by increasing their awareness on multiply honey bee issues related to everyday life.

Undergraduate

COMPARISON OF DIFFERENT ESTRUS SYNCHRONIZATION PROTOCOLS

Primary Author: Savannah Greenwood, Biology

Advisor: Pat Bagley

Co-Author(s)/Collaborator(s): Bo Greenwood

Genetic make-up of a cow herd is comprised by 50% of the bull's genetic material, so genetic progress in herd improvement can quickly be made with usage of genetically superior bulls. Generally, commercial beef producers cannot afford to purchase truly "outstanding" bulls because they are expensive and can only breed about 40 cows per year. However, artificial insemination (a.i.) offers relatively inexpensive alternative with semen as cheap as $5 per breeding without the annual maintenance costs of bulls which can be $500 and higher. Further, different a.i. bulls can be used on specific cows to complement their deficiencies, such as lack of milking ability or lack of mature size, etc., and even by selecting sexed semen to select desirable traits for bull or heifer calves. There are several a.i. protocols, and we selected two for this experiment; a) short duration (33 d) and b) long duration (54 d). Longer duration generally results in more heifers exhibiting estrus at appropriate time. Heifers (n= 36) were randomly assigned to protocols, and treatments

administered. Heifers were observed for estrus as per the protocol, and inseminated when appropriate. Those not exhibiting estrus were inseminated on the final day of the trial. Heifers were palpated about 60 days post a.i. treatment with conception rates as follows: short duration pregnant = 89%, and long duration pregnant = 89%. Conception rates were much higher than expected, and no differences due to treatment (16/18 for both treatments palpated pregnant) were observed.

Undergraduate

FIELD EVALUATION OF SOUTHERN APPALACHIAN HEIRLOOM BUSH TYPE GREEN BEANS

Primary Author: Mary Holden, Agriculture

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Brian Leckie

Green beans are an important vegetable that serve as a primary source of protein in diets. The Sustainable Mountain Agriculture Center holds a collection of approximately 900 heirloom green bean lines of various market classes including pole, bush, greasy, and half runner. Due to the recurrent selection of these Appalachian beans, they are expected to be regionally adapted and may hold genetic resistances to biotic constraints. Bush beans from the collection are of interest as candidates for commercialization due to their growth habit and ease of harvest. Currently, the SMAC collection holds bean lines characterized as bush but these lines have not been rigorously phenotyped and these designations are largely based on the description of the seed collector. In May 2017, forty-six putative bush-type green beans from the collection along with commercial controls were sown for evaluation in a high tunnel greenhouse. Six lines germinated poorly and were excluded from the experiment. The remaining lines were grown to maturity. Data was recorded for multiple traits including plant growth habits, flowering date, pod traits, and yield. Stable bush-type growth was observed in eleven SMAC lines and in the four commercial controls. A single bush line (Executive Bush) outperformed all lines with a significantly higher average yield of 253 g. Commercial controls varied with Blue lake 274 (Seedway) yielding the lowest at 14.8 g and Contender (Johnny's Seed) yielding the highest at 129.5 g. All other lines were statistically similar to the Contender control for average harvest weight.

Undergraduate

TRACKING OF LIVESTOCK USING CONNECTIVE TECHNOLOGY

Primary Author: James A Kiger, Engineering Technology

Advisor: Pat Bagley

Co-Author(s)/Collaborator(s): Christopher Bennett, Kurtis Boehms, Jacob Kennedy, Matthew Warner

The main goal this project is to develop a self-sustaining integrated mineral feeder acts as a relay to a central hub for collecting data on the cattle information. In the developed feeder, an RFID is mounted to read the tag located on the left ear of each cow, and will identify if that cow is due for an insecticide spray. The data will be logged into a developed cattle-management system, which has an integrated section of the feeder to automatically detect and spray the cattle with pesticides. A mesh network was created throughout the ranch, and connecting a Raspberry Pi 3 to the central hub to relay vital information such as how often the cattle are visiting feeder, their age, or when they are predicted to give birth. The computer will then tell the sprayer pump to turn on if a cow is due for an insecticide spray. An online data network provides necessary information for each individual cow to allow for quick responses to abnormal behavior signaling potential for highly infectious and contagious diseases that require

containment. The system can also provide alerts via email for potential theft of cattle to protect ranch assets. All of this information will be saved in an online database which can be accessed from anywhere in the world by anyone with the password to login. In the future, with the use of solar-powered GPS ear-tags, we could know the exact locations of any cow at any given time.

Undergraduate

PREPARING STUDENTS TO BECOME "CITIZENS OF THE WORLD" THROUGH STUDY-ABROAD

Primary Author: Rachel Ledbetter, Agriculture

Advisor: Pat Bagley

Co-Author(s)/Collaborator(s): Pat Bagley, Amy Miller

Students were approved for Study-Abroad to Dominican Republic January 1 – 10, 2018. All students were in the School of Agriculture and most were Animal Science/ Pre-Vet majors. Primarily stationed in Santo Domingo, 3 million people in a country of 5 million, group toured many historical sites including Columbus House, first sugar refinery in the Americas constructed in 1504, along with farmer's markets and federal buildings of interest, and National Zoo where we were allowed to tour the hospital and pet two 5-week-old lion cubs. The group visited and took school supplies to four "Alfalit Schools" and one "Rotary School." The Alfalit Schools are for very poor children, 3 – 5 years of age, mostly from illiterate parents and the purpose of these schools is to prepare these children for public school, which begins with first grade. Delivered to these schools, which have no electricity, were over 80 lb of colors (donated by Cookeville Legal Assn.), coloring books, books, paper, pencils and other school supplies donated by the students. Also toured was a small public "Rotary" school, with 850 students in a tiny, 8 classroom building. A "pre-travel/ post-travel" survey was developed by this author and administered during the flight layover in Miami, plus post-travel interviews. More important responses from the post-survey included: "good trip- 100%;" "perception of other country" – 47% responded "they live happy while owning little;" and "how has this modified your career goals?" – 87% responded "want to travel, work, and study internationally."

Undergraduate

IMPROVING CATTLE MANAGEMENT USING CONNECTIVE TECHNOLOGY

Primary Author: Dani Madson, Agriculture

Advisor: Pat Bagley

Co-Author(s)/Collaborator(s): Christopher Bennett, Jacob Kennedy, James Kiger, Matthew Warner

Managing livestock thru geo-positioning would dramatically improve several aspects of livestock production. While there are systems capable of tracking cattle, they are prohibitively expensive, particular when you consider the "profit" of a cow-calf operation is a $150 - $200 per year per head. The company we have received a grant from has determined that $20 per head annually is the maximum beef producers will pay for such technology. Therefore, we are focused on relatively simple systems that use RFID technology as a base, limited to scanning about 30 inches. Other technologies are being tested that reach about 300 ft, and can be used separately from the RFID scanners and antenna.

This study is focused on using different technologies, to determine different things: 1) cattle location; 2) accessing a mineral feeder; and 3) accessing a "creep feeder." Phase 1: cattle will be fitted with RFID tags placed in the left ear, with a "reader" inside the mineral feeder. Cows with also be fitted with a longer-range ear tag (300 ft) to determine their movement related to estrus synchronization. 2: when cows enter the mineral feeder and consume mineral

supplements, a wireless system will relay information, and is connected to a spray pump at the mineral feeder to spray for control "horn fly" populations every 18 – 21 days. 3: a "creep feeder" will monitor calves as they enter, also fitted with RFID tags, with the creep feeder having a load cell so feed intake can be determined.

School of Human Ecology

Undergraduate

DIETARY PATTERN AND TYPE 2 DIABETES IN CHILDREN

Primary Author: Kholoud Bintalib, Human Ecology

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Melinda Anderson

Type 2 diabetes mellitus consists of an array of dysfunctions characterized by hyperglycemia and resulting from the combination of resistance to insulin action, inadequate insulin secretion, and excessive or inappropriate glucagon secretion. It usually occurs in the human body when the body is unable to make the required level of insulin or the body is unable to use the produced insulin in an effective way. One out of three children in the United States is considered to be affected with the diabetes. The chance of diabetes increases with the level of obesity; the more a child is obese the more the chances of his or her being affected with the diabetes. Medical nutrition therapy for children with diabetes should include consideration for the individual's usual food and eating habits, metabolic profile, treatment goals and desired outcomes. This paper will examine the association between major dietary patterns and risk for type 2 diabetes mellitus in children and how dietary habits early in life can affect risk of type 2 diabetes mellitus in children.

Undergraduate

STRESS EATING AND EFFECTS ON HEALTH

Primary Author: Kelly Campbell, Human Ecology

Advisor: Melinda Anderson

Stress eating is a behavioral response that is the increase or decrease in food consumption, often used to help cope with difficult situations. Stress eating is present within both genders, a wide variety of age groups, and among multiple ethnicities. The purpose of this paper is to look at the causes and effects, coping strategies, and treatments of stress eating. Research has been conducted on the causes and effects, coping strategies, and treatments of stress eating. However, there are still many unanswered questions of how to reduce this behavior. With chronic life conditions such as obesity, type II diabetes, hypertension, and cardiovascular disease on a steady rise, it is more imperative than ever to change the American lifestyle. These chronic conditions are increasing the mortality rate of those that are affected, but not before being passed down through heredity. Individuals can bypass predisposition to these diseases if diet and lifestyle are monitored carefully. The studies reviewed in this paper share common conclusions and data. Although women are more likely to engage in stress eating, it still occurs among men. Stress eating is a precursor to becoming obese as well as other life-threatening conditions. Future research should focus on examining the diet patterns of a mixed group

of participants with these chronic health conditions and determining when stress eating appears in the life cycle. College (of faculty advisor): Agriculture and Human Ecology

Undergraduate

THE EFFECTS OF GESTATIONAL DIABETES MELLITUS

Primary Author: Anna Cooper, Human Ecology

Advisor: Melinda Anderson

The intent of this thesis is to investigate the effects of gestational diabetes mellitus (GDM) on mothers during and after pregnancy and the postpartum effects on children who are born to mothers with GDM. The RDN has three main goals when helping women manage their GDM: promote optimal development and growth of the baby throughout pregnancy, regulate blood glucose levels and return them to normal, and to prevent excessive weight gain of obese women throughout pregnancy. In relation to GDM, the journal articles chosen focused on education and management, intervention and prevention, effects on early childhood, and long-term effects. Infant birthweight was shown to positively correlate with gestational age and negatively correlate with carbohydrate intake, which shows the macronutrient composition of the diet in women with GDM affects the outcome of the pregnancy. High-intensity breastfeeding showed a protective effect against the development of abnormal glucose tolerance during the first year (up to 14 months) postpartum period, independent of prepregnancy obesity and weight changes both during pregnancy and postpartum. Of particular importance were the long-term effects.

Even when controlled, GDM was shown to have the potential to cause differences in infant cognitive function and development. A particular study found that GDM is an independent risk factor for long-term cardiovascular morbidity and cardiovascular-related hospitalizations. The prevalence of obesity in society, along with the increasing number of women with GDM, allows many opportunities to conduct further studies.

Undergraduate

THE ROLE OF SOCIAL NORMS AND RAPE CULTURE IN REPORTING SEXUAL ASSAULT ON COLLEGE CAMPUSES

Primary Author: Raygn Denton, Human Ecology

Advisor: Melinda Anderson

The prevalence of sexual assault against women is astoundingly high on college campuses, with estimates as high as 1 in 4 females (Hines, Armstrong, & Reed, 2012). Women on college campuses are less likely to make a formal report to the authorities after sexual assault than women off-campus (Orchowski & Gidycz, 2012). Less than 5% of sexual assaults on college campuses are reported to the police (Rubenfeld, 2014, as cited in Schwarz, Gibson, & Lewis-Arévalo, 2017). More often, occurrences of sexual assault on college campuses are informally reported, such as with a peer or family member (Fisher, Daigle, & Cullen, 2003; Foubert, Langhinrichsen-Rohling, Brasfield, & Hill, 2010, as cited in Schwarz et al., 2017). Between one-fourth and three-fourths of women who reported sexual assault were responded to negatively (Campbell et al., 1999; Campbell & Raja, 1999; Campbell, Wasco, Ahrens, Sefl, & Barnes, 200, as cited in Orchowski & Gidycz, 2012). Sexual assault is an intimate violation and can therefore be even more damaging than some other traumas (Allison & Wrightsman, 1993, as cited in Paul, Gray, Elhai, & Davis, 2009). When a victim discloses sexual assault and receives a negative response, it can be considered a second injury to the victim (Symonds, 1980, as cited in Orchowski & Gidycz, 2012). The purpose of this literature review

is to explore the role of social norms and rape culture in the underreporting and the response to sexual assault on college campuses.

Undergraduate

NUTRITION INTERVENTION EFFECTS IN PEDIATRIC ONCOLOGY

Primary Author: Jessica Fentress, Human Ecology

Advisor: Melinda Anderson

Cancer is the most prevalent non-accidental cause of death in children ages one to 14 years old. Within the realm of pediatric oncology, malnutrition is a common side effect that decreases survival rates of patients. Since malnutrition is such a significant cause of patient deaths, it is important to look closer into how it affects their disease state. Cancer has an additional risk of malnutrition because of the patient's increased metabolic rate, anorexia, inflammation, and lack of physical activity. Malnutrition in pediatric oncology is associated with treatment delays, increased risk of infection, impaired wound healing, lower quality of life, and inferior treatment tolerance and response. According to the literature, the malnutrition rate for the pediatric oncology patients ranges from less than 10 percent up to 50 percent. The high rate of malnutrition within pediatric oncology patients is concerning. This paper will aim to explore the outcomes of nutrition intervention within the pediatric oncology patient population, types of nutrition interventions, the effects of malnutrition, nutrition screening, meal satisfaction, groups dedicated to pediatric oncology nutrition, and the future of pediatric oncology. Research is needed in order to explore the different types of nutrition intervention such as the benefits of the use of enteral, parenteral, and total parenteral nutrition. The future of pediatric oncology in relation to nutrition is very broad, including advancements in the use of glutamine, antioxidant supplements, and even use of ketogenic diets. Improvements in these areas would potentially lead to better outcomes within the population.

Undergraduate

THE PREVALENCE, CONSUMPTION, AND OVERALL HEALTH EFFECTS OF NONNUTRITIVE SWEETENERS

Primary Author: Tara Flora, Human Ecology

Advisor: Melinda Anderson

This review of literature aims to examine the prevalence, consumption and overall effects of Non-nutritive sweeteners (NNSs) on human health. There are currently six NNSs approved for use in the United States which include acesulfame potassium (Ace-K), advantame, aspartame, neotame, saccharin, and sucralose. Artificial sweeteners remain a controversial topic despite their prevalence in our foods. The national average consumption in the United States increased from 24% (2001-2002) to 28%. Most observational cohort studies find association between routine intake of NNS and increased risk of obesity, hypertension, metabolic syndrome, and stroke. However, most randomized Controlled Trials (RCTs) find a positive association between NNS intake and weight loss. Short-term RCTs do not show immediate metabolic effects. Long-term health effects are not known, however, due to lack of research. Until recently, NNSs were regarded as a useful tool in decreasing energy intake and supporting a goal of weight management, weight loss, and/or glycemic blood control. However, recent studies have shown that there is not a significant correlation between NNS use and weight loss. Although the prevalence of NNS consumption has increased, the amount of research on long-term health effects of NNS use has not kept pace. More research needs to be done to investigate potential long-term effects of NNS and to evaluate whether the possible weight loss benefits of NNS is maintainable long-term.

Undergraduate

THE INFLUENCES AND EFFECTS OF PEDIATRIC OBESITY THROUGHOUT THE LIFE CYCLE

Primary Author: Callie Groves, Human Ecology

Advisor: Melinda Anderson

Obesity affects about 12.7 million children; a number which continues to increase. Pediatric obesity is defined as a BMI (body mass index) greater than or equal to the age- and sex-specific 95th percentile. Some influences of pediatric obesity include socioeconomic status, physical activity, parental influences, and advertising. The amount of money and resources a family has may dictate the quantity and quality of food that they consume. This leads to disrupted eating patterns and the likelihood of consuming high caloric foods. Also, parents have a large impact on children as an overweight teen with at least one obese parent has greater than an 80 percent chance of being an obese adult. Effects of prolonged pediatric obesity include coronary heart disease, type 2 diabetes, and hypertension. These issues can lay the foundation for other health issues such as metabolic syndrome. Finally, remedies or preventive measures of participation in the WIC program, adherence to the dietary recommendations and guidelines outlined by the Academy of Nutrition and Dietetics, and increased physical activity are reviewed. In the WIC program, low income households are able to receive foods that help them consume a balanced diet and reduce weight and health complications. Further research is needed to see what are the long term effects of children who undergo bariatric surgery and how likely it is that they regain or maintain a healthy weight throughout the life cycle. All in all, it takes individuals, families, and health care professionals working very closely together.

Undergraduate

PROPER NUTRITIONAL SUPPORT FOR REDUCING SIDE EFFECTS DURING LEUKEMIA TREATMENT

Primary Author: Mary Haddock, Human Ecology

Advisor: Melinda Anderson

Leukemia is cancer of the early blood-forming cells; however, the most common form of leukemia is cancer in the white blood cells. The impact of treatment on an oncology patient can truly affect their body in a negative way. Therefore, receiving the proper nutritional support needed for leukemia patients will be a factor that will influence how their treatment progresses and how their body will react to the side effects. The Academy of Nutrition and Dietetics established guidelines (through the Evidence Analysis Library), which outlines the proper nutritional needs specifically in cancer patients. The recommendations were finalized into the EAL and include: validated tools for malnutrition screening and nutrition assessment, evaluation of nutrition status, medical nutrition therapy in patients undergoing chemotherapy and radiation therapy. A randomized controlled study was conducted to see how well the nutrition interventions protocol for radiation therapy affected oncology patients compared to the standard practice protocols. A study conducted in France looked at the patient's quality of life and how that can affect the nutritional statuses of oncology patients. The World Cancer Research Fund estimates that about twenty percent of all cancers diagnosed in the U.S are related to body fatness, physical inactivity, excess alcohol consumption, and/or poor nutrition. When discussing the relationship of nutritional support in leukemia as well as other forms of cancer, nutrition interventions are an important component of reducing the side effects of treatment.

Undergraduate

HORMONES IN DAIRY AND THE EFFECT ON HUMAN HEALTH

Primary Author: Lina Hernandez, Human Ecology

Advisor: Melinda Anderson

Is there a connection between an animal-based diet, particularly milk and the prevalence of obesity, early menarche in children and hormone dependent cancer? One-hundred years ago the economy was mainly agrarian, the mass production of milk was in its infancy, and the use of hormones and synthetic hormones did not exist. The use of Synthetic hormones in milk has raised concerns since the major source of estrogen in the diet is from milk derived from pregnant cows when the concentration of estrogen in blood, and hence in milk, increases. This has prompted many studies about safe levels and the long-term health risk of animal-derived food sources. If hormones are a potential culprit in endocrine disruptions and physiological effects, what could be the possible health risks? Studies have suggested that endocrine disruptions could be related to low-dose and long-term exposure of hormones, especially for specific and sensitive populations at their critical stage of development; fetal and prepubertal children. The normal production of estradiol in the body for prepubertal children traditionally were determined using radioimmunoassay (RIA) from the 1970s, the findings presented huge discrepancies in the levels of natural estrogen in the blood of prepubertal children. This discrepancy triggered new studies which reevaluated the established recommendations by the FDA. New studies used the ultrasensitive recombinant yeast bioassay (RCBA) and detected that estradiol concentration levels in prepubertal children was almost 100-fold lower than previously reported. One concern is that even miniscule amounts of estrogen could affect prepubescent girls and boys.

Undergraduate

LEVELS OF BACTERIAL INHIBITION IN ANTI-MICROBIAL FABRICS BEFORE AND AFTER LAUNDERING

Primary Author: Nikki Hickman, Human Ecology

Advisor: Lizabeth Mullens

Co-Author(s)/Collaborator(s): Cainon Fox, AEI

The purpose of this research was to determine if cotton fabrics treated with antimicrobial finishes would keep their antibacterial properties after being washed and dried multiple times. Antibacterial products became increasingly popular to the market of late, therefore leading consumers to believe there was a need for the finish to protect against bacteria. Hanes® FreshIQ™ was one prominent brand marketing this claim. The Hanes® tank tops were washed, dried, and tested at regular intervals to check for bacterial inhibition. A 100% jersey-knit cotton fabric was washed with a Hanes® FreshIQ™ tank to test antimicrobial leaching from one fabric to the other. The hypothesis was that cotton fabrics treated with antimicrobial finishes would lose their antibacterial properties after laundering. The independent variable was the antibacterial finish present in the FreshIQ™ technology. The dependent variable was the change in antimicrobial effectiveness after laundering. The characteristics of 100% cotton were considered. The history and composition of antimicrobial cotton fabrics were evaluated, as well as the influence of washing and drying fabrics. Leaching during washing was also evaluated. AATCC Test Method 147-2004 Antibacterial Activity Assessment of Textile Materials: Parallel Streak Method was used to test for bacterial resistance. The results of the test for antimicrobial activity show that the treatment for this garment is insufficient in terms of effectiveness. The conclusion was that Hanes® only used the antimicrobial label as a marketing campaign

to sell more product. Recommendations were to test other antimicrobial branded items and to check for presence of agent.

Undergraduate

THE EFFECT OF HOME-DELIVERED MEALS ON THE ELDERLY POPULATION'S HEALTH STATUS

Primary Author: Alishia Hill, Human Ecology

Advisor: Melinda Anderson

As the elderly population grows at rate never previously seen in human history, there is a greater need than ever to identify and improve upon programs which decrease risk of hospitalization, increase quality of life, and maintain the health of the nation's seniors. Existing research has shown that malnutrition is the strongest indicator of institutionalization in older adults. A series of functional, psychological, social, and economic issues combined with medical issues may contribute to weight loss and poor nutrition in this population. Chronic disease effects 80% of those 65 and older, and 50% of those have been diagnosed with more than one condition which may affect their ability to procure or prepare nutritious food. This text will review the current literature regarding the benefits and shortcomings of the largest home-delivered meal program in the United States (US), Meals on Wheels (MOW). While fruit and vegetable intake were shown to be higher in those who participated in MOW, they were still lower than the recommended intake of 3 servings or more per day. This implies that the program may be successful in increasing diet quality, yet there is still room for improvement. Currently, very limited outcomes research exists for MOW, unlike similar programs like the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). Registered Dietitians can provide an invaluable source of information for outcomes research related to home-delivered meals.

Undergraduate

OVERALL HEALTH EFFECTS OF BINGE EATING AND FASTING

Primary Author: Haylea Melton, Human Ecology

Advisor: Melinda Anderson

This research paper seeks to raise awareness regarding the physical, psychological, social, and life-threatening effects of fasting and binge eating. The Academy of Nutrition and Dietetics emphasizes eating patterns instead of specific foods as a more effective approach to lessening the risk of eating disorders. Research from Montreal Neurological Institute, McGill University, the University of Tartu, and Dalhousie University determined that consistent eating patterns can be influenced by the individual's personality traits, self-control, outside influence, environment, and state of mind. Some individuals skip meals and even go without eating for extended periods of time to lose weight, for religious beliefs, or medical necessity. According to Fuhrman, fasting can be quite dangerous; and medical experts agree fasting is not a healthy or effective way to lose weight. Unlike fasting, individuals with binge eating disorder (BED), eat unusually large amounts of food in a short period of time. Results published in Biological Psychiatry, found that 3.5% of women and 2.0% of men had binge eating disorder during their life. All foods can be within healthy eating patterns when they are appropriately portioned, eaten in moderation, and combined with physical activity. Raising awareness about prevention, encouraging early detection and treatment is crucial and possible.

Undergraduate

INTERNAL AND EXTERNAL COMPONENTS INFLUENCING THE PREVALENCE OF OBESITY

Primary Author: Andrew Seiber, Human Ecology

Advisor: Melinda Anderson

The United States is enduring a battle against an epidemic of detrimental weight gain engendered by abnormal eating behaviors and distorted mindsets about food. Waist lines continue to enlarge, while efforts to counteract excessive weight gain and maintain weight lost continue to remain unsuccessful. Recent field work has revealed that both male and female adolescents who proclaim they diet strongly predict future binge eating episodes and weight gain. Eating behaviors learned during adolescence continue through adulthood alongside misinformed knowledge about weight loss and appropriate diets. The struggle Americans face in regards to their diet is evident by the high instances of morbidity and failure rates of weight loss. Research continues to unveil new field work about internal mechanisms involved in food intake and appetite regulation that facilitates new intervening actions against the obesogenic environment plaguing the United States. The purpose of this paper is to reveal the internal and external components influencing the prevalence of obesity.

Undergraduate

EFFECTS OF FAT INTAKE ON CARDIOVASCULAR DISEASE RISK AND IMPLICATIONS FOR PREVENTION

Primary Author: Meghan Server, Human Ecology

Advisor: Melinda Anderson

The purpose of this research paper was to review current research on how the different fats affect cardiovascular disease and provide an overall summary and conclusion based on the findings. In order to know what health effects are to be expected from dietary fat, individuals have to be able to distinguish the difference between types of fat with varying fatty acid composition. Fatty acids are often categorized by their saturation status, but understanding the different roles of each individual fatty acid and how they affect ones health is crucial. Monitoring the types of fatty acids being consumed is important because each type has a different effect in the body. Cutting back on saturated and trans fat can be good for health if it is being replaced with good fats, like polyunsaturated or monounsaturated fats. Eating polyunsaturated and monounsaturated fats lower low-density lipoprotein cholesterol and improves the ratio of total cholesterol to high density lipoprotein cholesterol, which lowers the risk of cardiovascular disease. Consumer education is extremely important when it comes to the different types of fats and how they affect cardiovascular health. Consumers should also be educated on how to accurately estimate their portion size of fat relative to standardized values on the Nutrition Facts Panel.

Undergraduate

HOW COMPLEMENTARY AND ALTERNATIVE MEDICINE AFFECTS DEPRESSION

Primary Author: Kaitlyn Shults, Human Ecology

Advisor: Melinda Anderson

With the prevalence of depression in modern day society, it is no surprise that people are turning to several kinds of treatment. Many people have experienced unpleasant side effects with traditional antidepressants and their disenchantment has led them to explore other methods, specifically alternative and complementary medicine. Interestingly, many depressed individuals have been found to have nutritional deficiencies. This research paper examines three supplements specifically, omega-3 fatty acids, s-adenosylmethionine, and St. John's Wort. Examination of omega-3 fatty acid found little efficacy for the treatment of depression, but pointed towards a need for more extensive and unbiased research. However, side effects are generally mild. On the other hand s-adenosylmethionine showed positive outcomes in the

treatment of depression, but more long-term trials are needed. Side effects for this drug also proved to be fairly mild. Lastly, the efficacy of St. John's Wort in the treatment of depression also proved to be debatable. Though the trials ran were fairly successful and showed promising outcomes, there was also a large potential of bias due to cultural beliefs. Overall, these three supplements proved to have somewhat positive results and mild side effects, but unveiled a need for more extensive research. The purpose of this research paper is to bring awareness to the different CAM supplements people seek in pursuit of treating depression, including evidence-based outcomes related to efficacy and potential side effects.

Undergraduate

EXPLORING OPTIMAL MACRONUTRIENT COMPOSITION IN NUTRITION THERAPY FOR TYPE 2 DIABETES

Primary Author: Daniel Sukowski, Human Ecology

Advisor: Melinda Anderson

According to the National Diabetes Statistics Report (2017) published by the CDC (Centers for Disease Control), it was estimated that 30.3 million people (9.4% of the total American population) have diabetes. Type 1 diabetes accounts for approximately 5% of all cases of diabetes reported, while Type 2 diabetes accounts for 90 – 95% of all cases reported. In order to see if specific macronutrient compositions in the diet are superior in Type 2 diabetes nutrition therapy, this paper analyzed six studies that focused on the effects of different macronutrient compositions in diet interventions of overweight/obese patients with Type 2 diabetes. Due to the emphasis placed on glycemic control, the articles utilized in this paper follow a carbohydrate to fat or protein comparison structure. Parameters in the six selected studies included weight, A1C (%), HDL-cholesterol, blood pressure, fasting glucose, and insulin. All parameters were measured at baseline and in periods leading up to endpoint.

Abstracts

College of Arts and Sciences

Department of Biology

Graduate

BENTHIC MACROINVERTEBRATE AND PERIPHYTON RESPONSE TO ANTIMYCIN DURING BROOK TROUT RESTORATION IN A SMALL HEADWATER STREAM

Primary Author: Aden Blackburn, Biology (M.S.)

Advisor: Justin Murdock

Co-Author(s)/Collaborator(s): Keith Gibbs, Justin Murdock

The piscicide antimycin has been used as an alternative to rotenone to eradicate nuisance fish in small streams. In many cases, antimycin is a better piscicide than rotenone because it is not as detectable by fish and is highly effective in eradicating coldwater fishes such as trout. The objective of this study is to identify potential negative effects of both the antimycin and potassium permanganate detoxifier treatments on non-target organisms. The study was done during a brook trout (Salvelinus fontinalis) restoration project in the Great Smoky Mountains National Park in Fall 2017. Nine sites within adjacent treated and untreated streams were sampled five times bracketing an antimycin treatment to remove nonnative rainbow trout (Oncorhynchus mykiss). At each site, periphyton chlorophyll and ash-free dry mass, macroinvertebrate composition, and water quality were collected. Preliminary results suggest small effects on macroinvertebrates. While this study is ongoing, it is predicted that the antimycin treatment will have no large effect on periphyton and water quality in the stream, but the effect of the detoxifying agent is unclear. If minimal effects are found, this study would reinforce the idea that antimycin is a preferred piscicide to use in coldwater streams.

Graduate

EFFECTS OF A MILO DIET, MINERAL SUPPLEMENTATION, AND NATIVE SEED USE IN PEN-RAISED NORTHERN BOBWHITES

Primary Author: Sarah Brown, Biology (M.S.)

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Steven Hayslette

Stocking of pen-raised northern bobwhites (Colinus virginianus) into natural habitat for hunting or other purposes is a common management strategy for the species, as is supplemental feeding of milo or other grains to wild bobwhites. Milo may be deficient in minerals compared to native seeds, however, leading to negative effects on bobwhites eating a milo-only diet. Pen-raised bobwhites may be reluctant to eat native seeds, which could have implications for the survival of pen-raised bobwhites stocked into the wild. We studied the effects of a milo diet on pen-raised northern bobwhites during the non-breeding season, and we tested the hypothesis of mineral deficiency in such a diet. We also studied use and selection of native seeds by pen-raised bobwhites, and we tested the hypothesis that exposure to a cultivated seed (milo) diet improves the willingness of pen-raised bobwhites to eat native seeds. Bobwhites maintained

body mass on a milo-only diet. A milo-only diet may be deficient in minerals, however, as the break-even point (milo consumption point at which body mass is stable) was lower on a milo diet supplemented with powdered mineral supplement, and mass gain at a given milo intake was higher for mineral-supplemented birds. Pen-raised bobwhites with no experience with a seed diet ate only small amounts of native seeds over a 48-hr period, even when no other foods were available; bobwhites with experience eating a milo diet ate twice as much. Unwillingness to eat native seeds may limit survival of pen-raised bobwhites stocked into the wild.

Graduate

LINKING WATER DEPTH TO DENITRIFICATION IN SHALLOW AGRICULTURAL LAKES

Primary Author: Jordan Evans, Biology

Advisor: Justin Murdock

Co-Author(s)/Collaborator(s): Justin Murdock, Tennessee Technological University

Many shallow oxbow lakes in northwest Mississippi are hypereutrophic due to nitrogen (N) loading from agricultural fertilizer application. However, high turbidity often limits the depth of photosynthesis to the upper water column and lake edges and reduces overall photosynthesis rates. High water temperature from shallower depth, along with low oxygen, and high nitrogen conditions create increased potential for nitrogen removal through denitrification. The objective of this study is to determine spatial and temporal variations of denitrification rates in the sediment and water column of Roundaway Lake, Mississippi, focusing on the relationship between water depth, temperature, and N removal. Denitrification and nutrient retention rates were measured in lake water and sediment cores collected across a depth gradient during three occasions in spring 2017 using a flow-through core system in the laboratory. In fall 2017, sediment denitrification rates were measured across a 20°C temperature gradient for five days. Initial results suggest that shallower lakes have higher N removal rates. As these lakes are frequently manipulated for agricultural irrigation and experience substantial depth fluctuations independent of seasonal rainfall, there is potential to manage lake depth to optimize nitrogen removal through denitrification.

Graduate

COMPUTATIONAL PREDICTIONS OF THE BINDING SITES OF RAF KINASES WITH HRAS

Primary Author: Shanrya Foster, Biology (M.S.)

Advisor: S. K. Ballal

Co-Author(s)/Collaborator(s): Derek Cashman, Tennessee Technological University

A, B, and C Rapidly Accelerated Fibrosarcoma (RAF) kinases are a family of three protein serine/ threonine kinases that are related to retroviral oncogenes. It has been shown that RAF family kinases play a role in organism development, cell cycle regulation, proliferation and differentiation, survival and apoptosis, as well as other cellular and physiological processes. These proteins are part of the Ras-Raf-MEK-ERK signal transduction pathway that activates genes involved in cell growth and is implicated in cancer. In this study, protein-protein interaction and active sites of three RAF kinase family proteins were predicted using computational methods. First, the three-dimensional crystal structures were downloaded from the RCSB Protein Data Bank. Prediction was done using an energy landscape based method called the Protein Frustratometer, and a multi-sequence alignment method called Evolutionary Trace to identify amino acid residues with exhibiting high energetic frustration as well as high sequence conservation across different species in the phylogenetic tree. These results indicate that there are

multiple highly-frustrated and highly-conserved residues in A-RAF, B-RAF, C-RAF and hRAS, respectively. The predictions of these residues can then be used for protein-protein docking calculations using ClusPro, which performs a high-throughput docking calculation to obtain the most probably docked complexes of each protein complex. Successful completion of this study can lead to a mechanism for the inactivation of the RAF kinase family proteins and hRAS, which could lead to a potential form of targeted therapy for cancer treatment.

Graduate

SHORT-TERM RESPONSE OF FISH ASSEMBLAGE TO A LOW-HEAD DAM REMOVAL

Primary Author: Valerie Jones, Biology (M.S.)

Advisor: Keith Gibbs

Co-Author(s)/Collaborator(s): Aden Blackburn, Jordan Evans, Savannah Fernholz, Jordan Holtswarth

Over the last two decades, over 1,200 dams have been removed in the United States due to concerns about safety and ecological integrity. We wanted to investigate the possible changes in fish community structure following the removal of a low-head dam on Roaring River in north-central Tennessee. We hypothesized that there would be significant differences in species assemblage in perennial upstream riffles and newly established downstream riffles and that tolerant, more mobile species would be the first fishes to colonize downstream riffles. Fish assemblages were assessed using backpack electrofishing units at six sample sites at and above the site of the removed dam. There were significant differences between communities in riffle habitats vs communities in pool habitats across all sites. Since few studies have been done to explore the effects of dam removal on ecosystem recovery processes, our study will contribute to our expanding knowledge of the ecological effects of dam removal.

Undergraduate

IDENTIFYING PATTERNS IN THE CULTURABLE SKIN MICROBIOME OF APPALACHIAN SALAMANDERS

Primary Author: Bailey Burns, Biology

Advisor: Donald Walker

Co-Author(s)/Collaborator(s): Fantasia Erdman; John Griffith; Aubree Hill, Tennessee Technological University, Department of Biology; Gabrielle Russell; Donald Walker, Tennessee Technological University, Department of Biology; Megan Wharton

Batrachochytrium dendrobatidis (Bd) is a fungal pathogen that has devastated amphibian populations worldwide. However, in the eastern United States, salamander populations persist in the presence of this fungus with relatively low rates of infection. We hypothesize that probiotic species within the salamander cutaneous microbiome protect their host by inhibiting growth of Bd. During previous work, we identified cutaneous defenses of salamanders by isolating bacteria from skin swabs and challenging them against Bd. The objectives of our current work are to (1) characterize the microbiome through 16S sequencing techniques, and (2) determine whether the culturable microbiome differs based on host species and/or habitat. Salamanders belonging to the genera Desmognathus (n = 8), Eurycea (n = 7), and Plethodon (n = 7) were sampled in the Great Smoky Mountains National Park. From their skin swabs, we obtained and sequenced a total of 110 bacterial isolates. Bioinformatics analyses were conducted using the software mothur, and a two-way permutated multivariate analysis of variance was conducted in Primer7. Preliminary results indicate that differentiation exists between the microbiome of terrestrial and aquatic salamanders. In addition, 81% of inhibitory isolates occurred on Plethodon glutinosus salamanders, and Gram-positive bacilli accounted for 38% of inhibitory

isolates. During future work, we will compare our findings to the high-throughput sequencing dataset to confirm if these patterns hold true. We hope our work will pinpoint the best candidate probiotics and help establish a procedure for treating amphibians infected with Bd.

Undergraduate

ANTAGONISTIC AND SYNERGISTIC CO-CULTURE ACTIVITY OF THE BAT MICROBIOME

Primary Author: Kelly Dunham, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Donald Walker

Co-Author(s)/Collaborator(s): Olivia Bowers; Matthew Grisnik; John Munafo, University of Tennessee Knoxville; GeunSeup Shin; Donald Walker

Throughout North America, the emerging disease White-nose Syndrome (WNS) has decimated bat species (Cheng et al. 2016). The causative agent of WNS is the pathogenic fungus Pseudogymnoascus destructans. This fungus invades epidermal tissue and disrupts the physiological processes of hibernation, which leads to dehydration and starvation. Treatment options for WNS include antifungal volatiles, UV light, and antifungal bacteria from the bat microbiome. The bat microbiome is a complex mixture of different bacteria that can be assigned into two categories, the core (resident) and non-core (transient). To determine potential antagonistic or synergistic interactions with members of the microbiome we performed co-culture assays using the bacteria Staphylococcus aureus and Pseudomonas aeruginosa. An isolate was considered bioactive if it produced a zone of inhibition when singularly challenged against S. aureus or P. aeruginosa. In co-culture, if only one isolate was bioactive we assumed antagonism or synergism depending on previous single challenge activity, while if both isolates were active we assumed synergism. For S. aureus, 7/10 core and 7/10 non-core isolates produced activity in single culture, while one co-culture produced synergistic activity and 2/10 core and 3/10 non-core combinations were antagonistic. For P. aeruginosa, 3/10 core and 1/10 non-core isolates produced activity in single culture, while six co-culture combinations produced synergistic activity and 4/10 core and 5/10 non-core combinations were synergistic. The differences in assay activity between the non-core and core isolates with S. aureus and P. aeruginosa indicate probable antagonistic and synergistic activity in the bat microbiome that is likely species specific.

Undergraduate

USE OF BLOOD MEAL DETECTION TO DETERMINE THE RESERVOIR HOST OF AMBLYOMMA MIXTUM LARVAE

Primary Author: Cody Ellis, Chemistry

Advisor: David Beck

Co-Author(s)/Collaborator(s): Mekenzie Weems, TTU; Rosa Vasquez, TTU

Amblyomma mixtum is a known vector of Rickettsia rickettsii, the causative agent of Rocky Mountain spotted fever. This tick is known to feed very aggressively on humans and a large variety of mammals. The tick's distribution extends from Central America to South Texas. The primary reservoir for its wild population in South Texas has not been yet determined. Nymph and A. mixtum ticks were collected from multiple sites within Webb County, Texas and their DNA was purified. The polymerase chain reaction (PCR) was used to amplify the blood meal DNA. Every tick was UV treated and washed in a 10% bleach solution. PPE and strict decontamination protocols were used at all times to minimize human contamination and to limit false positive results. Nested

PCR of the mitochondrial Cytb gene was used to detect mammal DNA. The Cytb gene was detected in 21% (17 out of 81) of the samples. This gene segment can provide substantial information on mammal's species identification. Sequencing has identified the presence of sheep, bovine, peccary, mule deer and European roe deer DNA in A. mixtum ticks. We are working to determine what other mammal species are present. The research continues with the hope that the results can potentially contribute to a better understanding of the natural ecology of A. mixtum ticks.

Undergraduate

INHIBITING THE CAUSATIVE AGENT OF SNAKE FUNGAL DISEASE, OPHIDIOMYCES OPHIODIICOLA, WITH COMMON CUTANEOUS BACTERIA ISOLATED FROM SNAKE SKIN

Primary Author: Fantasia Erdman, Biology

Advisor: Donald Walker

Co-Author(s)/Collaborator(s): Aubree Hill, Gabrielle Russell

Recent declines of North American snake populations have increased conservation concerns. These declines have been attributed in part to snake fungal disease (SFD) caused by mycotic infection of Ophidiomyces ophiodiicola (Oo). Multicellular organisms, including reptiles, have a beneficial microbial assemblage on their skin that defend the host from disease. We hypothesized that the snake skin microbiome may protect its host against SFD by production of antifungal metabolites, outcompeting Oo for space, and/or stabilizing the microbial community possibly increasing innate defensive immunity. The objectives of this project were to 1) obtain culturable resident bacterial isolates from snake skin, 2) genotype culturable isolates, and 3) challenge all isolates against Oo to determine if antifungal activity is present in the host microbiome which may translate to an innate protective response against SFD. From the twelve captured snakes, four black racers (Coluber constrictor) and eight timber rattlesnakes (Crotalus horridus), microbial samples were collected using a standardized swabbing technique. Those swabs from the 12 host snakes yielded a total of 58 bacterial colonies that were isolated, genotyped, and challenged against Oo. Sixteen of these bacterial isolates inhibited the growth of Oo in vitro. Species of antifungal bacteria occurred in the genera Aeromonas, Erwinia, Myroides, Morganella, and Stenotrophomonas, along with in the families Bacillaceae and Enterobacteriaceae. This study sheds light on the innate immune function of the culturable snake cutaneous microbiome and the resident probiotic members which may play a vital part in the fight against this emergent disease for both infected and uninfected hosts.

Undergraduate

GENETIC DIVERSITY AT THE MAJOR HISTOCOMPATIBILITY COMPLEX

Primary Author: Alexis Harman, Biology (M.S.)

Advisor: Carla Hurt

Co-Author(s)/Collaborator(s): Natalie Ellis

Genetic diversity at the Major Histocompatibility Complex (MHC) is particularly important for species viability as it allows populations to respond to emerging pathogens and infectious disease. Patterns of variation at this gene complex serve as a useful complement to information obtained from neutral loci for planning management and conservation strategies that seek to ensure the adaptive potential of at-risk species. In this study, we investigate patterns of genetic variation at exon 2 of the MHC class II gene in the critically endangered Barrens Topminnow (BTM). This species has undergone dramatic declines over the last thirty years, leading to its recent proposal for federal protection under the Endangered Species

Act. Patterns of nucleotide substitution and phylogenetic analyses revealing trans-species polymorphisms suggest that this locus has been of adaptive importance in the history of this species. Despite recent population declines and documented population bottlenecks, measures of genetic diversity were high in comparison to patterns observed at putatively neutral microsatellite and mitochondrial markers. Results from this study are discussed in the context of recovery plans for the BTM and lend support to the previous designation of evolutionary significant units and management units based on neutral markers.

Undergraduate

CLIMATE CHANGE-MEDIATED EXPANSION OF UTAH JUNIPER ACROSS THE BIGHORN CANYON NATIONAL RECREATION AREA: IMPLICATIONS FOR BIGHORN SHEEP

Primary Author: Luke Melancon, Wildlife and Fisheries Science

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Robert Kissell

Co-Author(s)/Collaborator(s): Sydney Wieczorek

Plant distribution is changing with a warming climate, with some species expanding into adjacent areas that were formerly unsuitable. Since the late 1990s, curl-leaf mountain mahogany (Cercocarpus ledifolius; CLMM) has shown an increased mortality rate concurrent with an expansion of Utah juniper (Juniperus osteosperma) within Bighorn Canyon NRA, which caused concern about impacts for the resident bighorn sheep (Ovis canadensis) population. To understand some of the mechanisms responsible for the progression of the change to a new climax community, the following objective was addressed: estimate the density, percent mortality, and recruitment density of curl-leaf mountain mahogany and Utah juniper on the Bighorn Canyon National Recreation Area across a precipitation gradient. The density of CLMM (34.4-1744.4 plants/ha) and juniper (30.0-454.4 plants/ha) varied by stand type and area. The percent mortality of CLMM differed by stand type ($F = 18.06$, $P < 0.0001$) and area ($F = 4.11$, $P = 0.0189$), whereas there was an interaction ($F = 3.33$, $P = 0.0122$) between stand type and area in the percent mortality of juniper. Recruitment of CLMM ranged from 0 to 86.6 plants/ha and juniper recruitment ranged from 0 to 14.6 plants/ha. There was an interaction between area and stand type ($F = 6.91$, $P < 0.0001$) in density of juvenile CLMM. Our results did not definitively show an effect of juniper upon CLMM mortality or recruitment. Relationships varied dependent on stand type, area, and location.

Undergraduate

DETECTION OF SMALL COLONY VARIANT STAPHYLOCOCCUS IN THE NORMAL FLORA OF COLLEGE STUDENTS

Primary Author: Shelby Milsaps, Biology

Advisor: David Beck

Co-Author(s)/Collaborator(s): Fahad Alharbi, TTU

Purpose: The goal was to isolate small colony variant (SCV) Staphylococcus from the public and determine its frequency on body sites and how this relates to known risk factors.

Background: S. aureus and S. epidermis commonly cause nosocomial infections. SCVs are often found in patients with osteomyelitis and cystic fibrosis. SCVs often have increased resistance to antimicrobials due to slow growth.

Methods: We screened participants for SCV Staphylococcus by swabbing at four sites; nose, ear, armpit, and bellybutton. Participants completed an anonymous survey relating to risk factors for colonization. Gram positive cocci were screened by multiplex PCR for Staphylococcus genus, S. aureus, S. epidermidis, and S. haemolyticus.

Results: We are in the process of characterizing the 2,407 isolated bacteria from 250 test subjects. We have identified 1,040 isolates as Staphylococcus, of which 742 have been identified to species [35 S. aureus [3.4%], 690 S. epidermidis [66.3%], 16 S. haemolyticus [1.5%], 1 S. saprophyticus [0.001%], 298 other [28.7%]]. We detected 16 SCV S. epidermidis [2.3%] on 14 test subjects, 5.6%. Conclusion: At least 5% of human subjects have SCV Staphylococcus as part of their normal flora. This is of concern because these isolates are rarely identified in the clinical lab.

Future directions: We will finish characterizing the other 1,367 isolates and use multiplex PCR to determine antimicrobial resistance profiles of the SCV isolates. We will then use statistical analysis to determine if there are risk factors that correlate with SCV colonization.

Department of Chemistry

Graduate

CONVERGENT APPROACH TO MODULAR DIPOLAROPHILES TOWARDS ASYMMETRIC SOFT LEWIS BASE DONATING N-HETEROCYCLIC COMPLEXANTS FOR SELECTIVE SEPARATION OF MINOR ACTINIDES

Primary Author: Sauradip Chaudhuri, Chemistry

Advisor: Jesse Carrick

Extraction and recovery of selective minor actinides [An(III)] from lanthanides [Ln(III)] in a spent nuclear fuel (SNF) waste remains a major challenge in the field of separation science. To this end, soft lewis base donating N-heterocyclic scaffolds like bis-triazinyl pyridines (BTPs) and bis-triazinyl bipyridines (BTBPs) have been investigated as potential solutions to this challenge. Described herein is the convergent approach to modular dipolarophile synthons for the synthesis of a novel class of asymmetric frustrated complexants. Palladium catalyzed alkynyl coupling of 6-bromo-mono-triazinyl pyridines (6-Br MTP) is employed to generate 2-triazinyl-6-alkynyl pyridines, which undergoes dipolar 1,3-cycloaddition with functionalized diazo compounds to generate asymmetric 2-[1,2,4-triazine-3-yl]-6-[1,2-pyrazole-5-yl] pyridines. Optimization of reaction conditions, as well as an extended scope of functionalized alkynes have been investigated. Lastly, scale up reactions of selected examples have been carried out for separation studies to better understand complexation and solubility as a structure/activity relationship in process-relevant solvents.

Graduate

TRACE DETECTION OF NITROUS OXIDE (N2O) IN SOILS USING SEPARATION AND INFRARED SPECTROSCOPY METHODS

Primary Author: Lahiru Gamage, Environmental Sciences Chemistry (Ph.D.)

Advisor: Wilson Gichuhi

According to NOAA's Global Greenhouse Gas Reference Network, the atmospheric concentrations of nitrous oxide (N2O) increased from 270 ppb to 328 ppb between 1750

to 2015. Whereas soil and manure management practices are regarded as major contributors to N2O emissions, emissions from natural agricultural soils plays a major role in the total N2O emission budget. Emissions of N2O from agricultural lands can vary depending on the soil type. According to the 2012 census data, Putnam County has a total of 31,445 acres of agricultural land. As the most common type of soil in these agricultural lands, loam soils can contain N2O mole fractions ranging from 0.04 to 0.78, depending on whether the land is already cultivated with growing crops or is just manured. In this poster, the viability of Gas Chromatography and Fourier Transform infrared (FTIR) spectroscopic techniques in detecting and quantifying trace concentrations of N2O from Putnam County agricultural soils is being investigated.

Graduate

THE EXPLORATION AND ANALYSIS OF ALTERNATIVE ORIENTING MEDIA FOR USE IN RESIDUAL DIPOLAR COUPLING NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

Primary Author: Dylan Gardner, Chemistry (M.S.)

Advisor: William Carroll

Residual dipolar couplings are a distance and angle dependent coupling observed by NMR spectroscopy when a molecule is in an anisotropic environment. The magnitude of these residual dipolar couplings can be used to determine 3-dimensional structural information about the molecule in solution. Liquid crystals or polymers are often used as orienting media, but these compounds are often difficult to prepare, incompatible with solvents, and reactive with some compounds. The solution would be a chemically inert substance that has channels running vertically with a diameter in the micrometer scale. In this research several substances were tested, and the orienting effect was measured from the dipolar couplings observed in the solvent, CDCl3, as determined using 2H-Observe NMR experiments.

Graduate

IDENTIFICATION OF THE SUBSTITUTES ON A-(N)-HETEROCYCLIC THIOSEMICARBAZONES THAT INTERACT WITH HUMAN TOPOISOMERASE-II-A WITH NUCLEAR MAGNETIC RESONANCE

Primary Author: Jessica Hill, Chemistry (M.S.)

Advisor: Xiaohua Jiang

Co-Author(s)/Collaborator(s): Sarah Bowman; William Carroll, Tennessee Technological University; Nathan Combs; Jennifer Conner, Tennessee Technological University; Edward Lisic, Tennessee Technological University

Topoisomerase IIα (TopoIIα) is an essential enzyme for cell proliferation. Cancer cells are rapidly dividing cells. Thus, TopoIIα is a primary target for many anticancer drugs. Thiosemicarbazones (TSCs) have been known to possess anticancer activity by inhibiting topoisomerase-II. Recent studies of our lab found the structure-activity relationship of TSCs and their inhibition on TopoIIα. Our results suggest that the metal ion of TSC metal complexes, and the terminal nitrogen side chain play important roles in increasing TopoIIα-mediated cleavage complexes. The direct interaction between TSCs and TopoIIα remains unknown. It is hypothesized by our lab that the metal ions and the terminal nitrogen side chains interact with TopoIIα directly. This hypothesis is being tested by studying the interaction of 2-acetylthiazole (ATZ) TSC, 2-acetyl-4-methylthiazole (AMT) TSC, and benzoylpyridine (BZP) TSC palladium metal complexes with TopoIIα by saturation transfer difference nuclear magnetic resonance (STD-NMR). Recent STD-NMR experiments suggest that the aliphatic and aromatic region of 2-acetylthiazole (ATZ)

TSC, 2-acetyl-4-methylthiazole TSC and benzoylpyridine (BZP) TSC palladium metal complexes interact with TopoIIα.

Graduate

DETERMINATION OF PAHS IN WATER BY DLLME WITH GC-MS

Primary Author: Emmanuel Ogunkunle, Chemistry (M.S.)

Advisor: Andrew Callender

Dispersive liquid-liquid microextraction (DLLME) combined with gas chromatography–mass spectrometry (GC–MS) was used for the extraction and determination of four selected polycyclic aromatic hydrocarbons (PAHs) in water samples. In this procedure, several factors such as the type and volume of extraction and dispersive solvents were investigated and the optimized extraction conditions were established. Overall, recoveries were best when using acetone as the dispersive solvent, although the differences were not very large. Replicates of each condition gave consistent results (typically 3 to 7% RSD). The developed method was validated for the analysis of PAHs in samples from surface waters in Tennessee.

Graduate

ANALYSIS OF APOPTOSIS SIGNAL-REGULATING KINASE I (ASK1) OLIGOMERIZATION

Primary Author: Adua Rahman, Chemistry (M.S.)

Advisor: Xuanzhi Zhan

Co-Author(s)/Collaborator(s): Xuanzhi Zhan, Tennessee Tech University

Apoptosis Signal-Regulating Kinase I (ASK1) is a member of the Mitogen Activated Protein Kinase (MAPK) pathway. Responding to various stimulations, ASK1 activates four MAPK kinase (MKK) substrates including MKK4/7 and MKK3/7, which phosphorylate the c – Jun N terminal Kinase (JNK) and p38, respectively. The dysfunction and misregulation of ASK1 lead to various diseases such as cancers, cardiovascular diseases, neurodegenerative disorders, inflammatory diseases and diabetes. The activation of ASK1 is highly regulated by many regulatory factors. However, the molecular mechanism of ASK1 activation largely remains unclear. We recently found out that the purified ASK1 is capable of auto-activating itself and it exists as a huge oligomer instead of a homodimer as previous studies suggested. To explore the mechanism of ASK1 oligomerization and auto-activation, we have generated a series of ASK1 truncates and hoping to identify the responsible domains/motifs for its oligomerization and auto-activation. We have purified two ASK1 truncates - ASK1-NK (N terminal and Kinase domains) and ASK1-K (Kinase domain). After performing gel filtration, it was found out that, ASK1-NK remains as monomer and ASK1-K forms dimer in their native state. In conclusion, this study will help us to understand the detailed mechanism of ASK1 oligomerization which will surely enrich our knowledge in understanding the activation process of ASK1.

Graduate

HEAVY METAL REMEDIATION FROM AQUEOUS SOLUTIONS BY NEW SIT MATERIALS

Primary Author: Emily Rush, Chemistry (M.S.)

Advisor: Edward Lisic

Heavy metals enter the water supply through both natural and industrial processes. While some of these metals are necessary for human metabolism, many are toxic even in small concentrations. Various methods such as ion-exchange chromatography, reverse osmosis, and chemical precipitation are currently employed to remove heavy

metals from water, however the high costs and large waste generation associated with these have led to research in new methods of heavy metal remediation. This work will focus on the metal ion extracting capabilities of new silica-immobilized-thiosemicarbazone (SIT) materials. These materials were synthesized by introducing a covalent linkage between various thiosemicarbazide compounds and a functionalized silica particle, resulting in five new immobilized thiosemicarbazone ligands. Preliminary experiments show that all five materials are capable of extracting Cu2+ from an aqueous solution, but further work will be reported focusing on the Pb2+ and Cd2+ ions in aqueous solution with varying pH levels. The radioactive isotope 109Cd will be used to track the extraction by the new SIT materials, and competition studies will be performed using ICP-MS. Successful extraction of heavy metals by these newly produced SIT materials could lead to more efficient remediation of toxic substances in water.

Graduate

SITE-SPECIFIC INCORPORATION OF 19F INTO ARRESTIN-3 AS AN NMR PROBE FOR CHARACTERIZING ITS CONFORMATIONAL CHANGES

Primary Author: Rebecca Stout, Chemistry (M.S.)

Advisor: Xuanzhi Zhan

Co-Author(s)/Collaborator(s): William Carroll, Tennessee Technological University

Signal specificity is achieved through highly-regulated molecular recognition. Arrestins, a small family of multi-functional adaptor proteins, mediate surprisingly complex cellular signaling events. To elicit the appropriate cellular response, arrestins have to ensure correct components are linked together to prevent the formation of mismatched protein complexes. It is now clear that arrestins undergo significant conformational movements in many regulating processes; however, previous studies of arrestin conformational changes are almost completely focused on receptor-induced conformational changes, and little is known about binding-induced conformations that allow arrestins to accomplish their diverse signaling functions. We hypothesize that binding-induced conformational changes play decisive roles in regulating the recruitment of binding partners.

19F NMR has proven to be a powerful technique in the study of protein structure and dynamics because the 19F nucleus is easily incorporated into protein through specific labeling. The chemical shift of 19F is extremely sensitive to changes in the local microenvironment caused by the conformational movements of protein, making it possible to analyze minor movements within a protein molecule. 19F NMR is performed by incorporating a fluorine label into the protein structure Fluorine labeling can be accomplished in a variety of ways. Here, we developed a 19F NMR-based method to detect conformational movements of arrestins by employing a thiol-based method to incorporate 19F to specific arrestin residues. We have observed the release of the C-tail in arrestin-3 upon binding of inositol hexaphosphate (IP6). The methods developed here can be employed to detect the conformational changes of arrestin with many other binding partners.

Undergraduate

ISATIN THIOSEMICARBAZONE LIGANDS AND THEIR CHARACTERIZATION BY NMR SPECTROSCOPY: FORMATION OF THEIR CU(II) METAL COMPLEXES

Primary Author: Arielle Buckner, Pre-Professional

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Sarah Bowman, Julia Little

A new series of Isatin Thiosemicarbazone (I-TSC) ligands

were synthesized. The ligands were synthesized with the following substituent groups: methyl thiosemicarbazone, ethyl thiosemicarbazone, tert-butyl thiosemicarbazone, phenyl thiosemicarbazone, and benzyl thiosemicarbazone. These ligands were then characterized by NMR spectroscopy in order to verify their structures. The following test were ran on the compounds: 1H, 13C, gradient selected COSY, 1H-13C multiplicity, and 1H-13C HMBC. The compounds were then reacted with CuCl to form metal complex [Cu(I-TSC)Cl]. An inhibition assay study on these Isatin ligands and copper compounds for evidence of inhibition of Topoisomerase II α will be presented.

Undergraduate

IMPACT OF VIDEO TUTORIALS ON PREPAREDNESS, ENJOYABILITY, AND EFFORT IN GENERAL CHEMISTRY LABORATIES

Primary Author: Tyler Carr, Psychology

Advisor: Chad Rezsnyak

Co-Author(s)/Collaborator(s): Chad Rezsnyak, Tennessee Technological University

The use of video tutorials to aid in student preparation for laboratory activities in a STEM majors General Chemistry class is investigated. The influence of video tutorials on students' perceived preparedness and perceived enjoyability of laboratory exercises as well as their perceived effort put forth during the exercises are examined through a pretest-posttest survey method.

Undergraduate

PURIFYING TOPOISOMERASE II ALPHA

Primary Author: Nathan Combs, Biochemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Xiaohua Jiang

Co-Author(s)/Collaborator(s): Sarah Bowman, Jessica Hill, Wathsala Medawala

Cancer is defined as uncontrolled cell growth in which a mutation occurs to a cell that allows it to replicate despite the many issues and problems that arise with its unchecked alterations. Topoisomerase II Alpha is an enzyme that allows the circular, supercoiled plasmid DNA in prokaryotes and eukaryotic mitochondria cells to be unwound through “cutting” and “pasting” it back together. Through Topoisomerase II Alpha, the cell’s DNA is able to replicate, but without it the cell would stop and eventually die. In order to test drug compounds that could potentially inhibit topo and kill cancer cells, topo must be isolated or “purified” from cells and tested. In this case, yeast cells are used because they are quickly replicated and grow easily on media. After amplifying millions of yeasts cells a pellet is made and then added to an extraction buffer in which the yeast cells are “blended” up through vertexing them with glass beads releasing its intracellular matrix. Once the cells are broken apart and its topoisomerase released in the solution, the supernatant is rotated overnight with nickel beads which allows the enzyme to get caught inside. Keeping just the beads and extracting the topo in fractions, it is concentrated down into aliquots and is able to be used for other experimentation.

Undergraduate

IONIC SALTS OF JUGLONE FOR HERBICIDAL APPLICATIONS

Primary Author: Ilysa Crouch, Chemistry

Advisor: O. Andreea Cojocaru

Co-Author(s)/Collaborator(s): O. Andreea Cojocaru, Twanelle Majors

Juglone is an organic compound, member of the naphthoquinone family. It occurs naturally in walnut hulls making it commonly found and accessible. Juglone has a range of potential applications including being used as an herbicide, natural hair dye, tumor growth suppressor, and has antimicrobial and antifungal activity. In its neutral form, juglone is an environmental hazard: it is volatile, is toxic to some freshwater fish, and adversely affects plankton and other organisms that are food sources for fish. These undesirable features can be reduced by converting juglone into ionic liquids (ILs, ionic compounds with M.P. < 100 °C) through pairing juglone in its anionic form with hydrophobic cations (surfactants). The presence of a surfactant cation in a juglone-based IL will change the mobility of juglone, decreasing its environmental impact and influencing the absorption of the parent compound. Work to be presented here focuses on combining juglone in its anionic form with different hydrophobic cationic sources (quaternary ammonium, phosphonium cations) to form new juglone ionic compounds. The compounds were synthesized by using two synthetic approaches: the metathesis reaction between juglone anion and a halide salt (e.g., quaternary ammonium halides) and the acid-base reaction of juglone with a hydroxide salt (e.g., quaternary ammonium hydroxides). The solubility of the promising new juglone ionic compounds at different pHs will be investigated, the methods developed here will be applied to juglone extracted from locally sourced walnut hulls, and plant-based IL laboratory exercises for non-majors chemistry courses will be developed.

Undergraduate

THIOSEMICARBAZONE LIGANDS AND THEIR METAL COMPLEXES; COMPOUND CHARACTERIZATION AND TOPOISOMERASE II ALPHA INHIBITORY ASSAYS

Primary Author: Seth Crum, Chemistry
Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Sarah Bowman; Xiaohua Jiang, Tennessee Technological University

Thiosemicarbazone ligands and their metal complex have been seen to inhibit Topoisomerase II-α, a popular target of chemotherapy. This work demonstrates the synthesis and characterization of pyruvic aldehyde-1-oxime thiosemicarbazones: complex formation with Cu(II) and Pd(II). The compounds were then tested in a Topoisomerase II-α relaxation assay. The new thiosemicarbazone ligands, pyruvic aldehyde-1-oxime [x]-thiosemicarbazone (PAO-xTSC's) and metal complexes have been synthesized. The ligands were characterized and analyzed by 1H Nuclear Magnetic Resonance spectrometry (NMR), 13C NMR, 1H13C HSQC, and 1H15N HSQC.

Undergraduate

HUMAN TOPOISOMERASE IIA INHIBITION BY NEW PALLADIUM (II) AND PLATINUM (II) COMPLEXES OF A 2-ACETYLPYRAZINE TERT-BUTYLTHIOSEMICARBAZONE LIGAND

Primary Author: Sarah Grossarth, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Sarah Bowman; Jessica Hill; Xiaohua Jiang, Tennessee Technological University

The new ligand, 2-acetylpyrazine- tert-butylthiosemicarbazone (APT-tBTSC) and its palladium

(II) and platinum (II) complexes have been synthesized. After the synthesis process, the ligand and metal complexes were characterized and analyzed by 1 H Nuclear Magnetic Resonance spectrometry (NMR), 13 C NMR, 1 H- 13 C HSQC, and 1 H- 15 N HSQC. We have determined that this thiosemicarbazone compound ligates to Pd(II) and Pt(II) in a tridentate monoanionic fashion forming a metal complex with the formula [Pd(APZ-tBTSC)Cl] and [Pt(APZ-tBTSC)Cl]. The metal complexes were tested for anti-proliferative biological behavior with a panel of seven microbes. The palladium and platinum complexes are found to be highly active against Gram positive bacteria. Human topoisomerase IIα inhibition solution concentration found is between 2-6 micro-molar.

Undergraduate

VIBRATIONAL SPECTROSCOPY OF ETHANE: IMPLICATIONS FOR TROPOSPHERIC AND PLANETARY CHEMISTRY

Primary Author: Samuel Hines, Chemistry

Advisor: Wilson Gichuhi

Co-Author(s)/Collaborator(s): Lahiru Gamage

As the simplest saturated non-methane Hydrocarbon (NMHC), Ethane (C2H6) is often used as a benchmark molecule to provide insights on internal motions around the C-C bond in complex biological molecules. Sharing similar and concurrent anthropogenic emission sources with methane (CH4), C2H6 is ubiquitous in Earth's atmosphere, with surface atmospheric mixing ratios ranging from 500 to 2200 ppt over the Northern Hemisphere as of the year 2015. The recent detection of C2H6 in the atmosphere of Jupiter, Saturn, and Titan through the v9 degenerate fundamental vibrational band cantered at ~822 cm-1 has elicited a lot of attention by planetary scientists leading to rigorous searches of other vibrational signatures of C2H6 in planetary atmospheres. In this poster, we present detailed analysis of C2H6 ro-vibrational spectra in the mid and near IR window using a natural gas sample. A CH4:C2H6 branching ratio is estimated based on selected portions of the ro-vibrational spectra of methane and ethane.

Undergraduate

DIELS–ALDER REACTION USING A SOLAR IRRADIATION HEAT SOURCE DESIGNED FOR UNDERGRADUATE ORGANIC CHEMISTRY LABORATORIES

Primary Author: Jordan Jones, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Dan Swartling

Co-Author(s)/Collaborator(s): Brian Agee, School of Environmental Studies, Tennessee Technological University; David Crouse, Department of Chemistry, Tennessee Technological University; Taylor Pinto

Recently proposed solar reflectors developed from satellite dishes have the ability to be incorporated into student laboratory procedures to eliminate electricity use while demonstrating green chemistry techniques at the same time. There have been recent attempts to make chemical synthesis procedures more environmentally friendly. As a result, demand to incorporate more green chemistry techniques into student laboratories has increased. Electricity use is one area of environmental concern because fossil fuels are used for the majority of electrical energy in the United States. An effective means for minimizing the amount of electricity needed to drive chemical reactions to completion is proposed through the use of solar parabolic reflectors. A comparative study is conducted using an electrical and solar heat source on the Diels–Alder cycloaddition reaction of maleic anhydride

and anthracene. This reaction is chosen as the test reaction due to its widespread use among many undergraduate chemistry programs. Analysis of the products is performed by NMR spectroscopy.

Undergraduate

SYNTHESIS OF PYRUVALDEHYDE THIOSEMICARBAZONE (TSC) METAL COMPLEXES AND THEIR NMR SPECTRUM DATA

Primary Author: Adam Koch, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Edward Lisic

For years Copper-PTSM, a metal TSC derivative, has been used for brain imaging scans and has been a useful in anti-tumor research. This work consists of synthesizing derivatives of TSC and their respective Ni, Pt, Pd metal complexes through a synthesis reaction. The ligands and metal complexes are then prepared for NMR spectrum analysis. Four different NMR spectra are run (1H, 13C, C and N HSQC) to evaluate the purity and conversion of reactants to the desired products. Analysis of NMR spectra will assist in determination of the symmetry or asymmetry of these products. Initial synthesis and in-depth evaluation of NMR data will be presented.

Undergraduate

SYNTHESIS, NMR ANALYSIS, AND COPPER COMPLEX FORMATION OF INAP-TSC COMPOUNDS

Primary Author: Gabrielle LaSala, Biology

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Sarah Bowman

This poster will present the synthesis and characterization by Nuclear Magnetic Resonance (NMR) spectroscopy of a new series of thiosemicarbazone molecules. We have successfully synthesized the INAP-TSC compounds using α-Isonitrosoacetophenone and an appropriate thiosemicarbazide. This research has experimented with different reaction procedures in the hope of finding the cleanest and most efficient synthesis route. Our use of NMR has enabled us to determine the most appropriate synthesis procedures to ensure the cleanest products. After finding the best synthesis procedure, we have begun making new copper-complex molecules using these synthesized thiosemicarbazones. We then tested these copper-complexes for their ability to inhibit topoisomerase activity. New thiosemicarbazone ligands are important in designing new anti-cancer drugs. This research is providing new molecules for testing against breast cancer cells in the future.

Undergraduate

SYNTHESIS AND NMR CHARACTERIZATION OF ACETYL-PYRAZINE METHYL THIOSEMICARBAZONE AND ACETYL-PYRAZINE ETHYL-THIOSEMICARBAZONE LIGANDS: PD(II) AND PT(II) COMPLEXES

Primary Author: Kari Lawson, Chemistry

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Sarah Bowman, Dylan Gardner

Through experimentation, it has been discovered that thiosemicarbazone ligands and their metal complexes can be used for medicinal uses by inhibiting human topoisomerase IIα, as an alternate treatment for chemotherapy. In this research, acetyl-pyrazine methyl thiosemicarbazone [APZ-MTCS] and acetyl-pyrazine ethyl thiosemicarbazone [APZ-ETSC] ligands were synthesized

and purified. After the synthesis and purification of [APZ-MTCS] and [APZ-ETSC] ligands, the 1H NMR and 13C NMR spectra were obtained using a new 500 MHz NMR spectrometer. Structural information was obtained by running 2D HSQC (heteronuclear single quantum coherence) 1H-13C NMR and HSQC 1H-15NNMR experiments, which provide evidence of our predicted structures. After the analysis was complete, we reacted the ligands with Pd(II) and two synthesis routes of Pt(II), using dichlorobis (benzonitrile) platinum(II) and potassium tetrachloroplatinate(II), to form their metal complexes. Similar NMR experiments were performed on the Pd(II) and Pt(II) complexes. A topoisomerase assay ran with an inhibition concentration between 2-6micro molar on the metal complexes. This poster will present the synthesis of [APZ-MTSC] and [APZ-ETSC] and the reactions with their metal complexes, the NMR characterization, and discussion of the topoisomerase assay results.

Undergraduate

ORGANIC SYNTHESIS OF TRIAZINE SCAFFOLDS

Primary Author: Steven Laxton, Chemistry

Advisor: Jesse Carrick

As the world population grows, so does the demand for energy and therefore the fuels to provide said energy. The nuclear sector is one source of energy that has grown steadily and slowly attracted the attention of the public for various reasons. One of those reasons is that unlike other fuels that combust to produce greenhouse gases, such as carbon dioxide, nuclear fuel leaves a footprint of toxic radionuclides that can have a half-life of thousands of years. This footprint makes up approximately 0.1% of overall weight of used nuclear fuel. With the knowledge of the adverse effects and extremely long half-lives of the radionuclides present in used nuclear fuel, if nothing is done now then our problems will burden future generations. The aim of this project is to create a scaffold that will accommodate the identified radionuclides, such as americium 3+ and other target elements. The scaffold that is being created consists of the three soft Lewis base binding sites that will be able to target and bind the nuclides. Varying substituents will be added and screened on the scaffold to test for solubility, stability, and other properties that will make the molecule a good candidate to refine used nuclear fuel. The core of the molecule that is being created is Bis-pyridinyl-1,2-pyrazoles which will have various symmetric and asymmetric R-groups.

Undergraduate

SYNTHESIS OF [1,2,4] TRIAZINE COMPLEXANT FOR MINOR ACTINIDE SEPARATION FROM SPENT NUCLEAR FUEL

Primary Author: Kyle Lyons, Chemistry

Advisor: Jesse Carrick

As nuclear reactors continue to supply more of the world's power, the issues related to spent nuclear fuel (SNF), radioactivity and heat generation, must be addressed. Reprocessing SNF can reduce the volume needed to be stored in repositories by removing reusable uranium and plutonium, leaving behind lanthanides and minor actinides (MA). The further extraction and purification of MA is of utmost importance not only due to the development of more advanced nuclear fuel but other industrial applications as well. However, this is not an easy feat due to the similarities of lanthanides and MA in atomic radii and trivalence. Furthermore, the environment of this processed SNF is high in acidity and radioactivity. This project's goal is to increase the efficacy of currently studied complexants by reducing the basicity of a nitrogen-binding group which is hypothesized to decrease hydrogenation and therefore increase MA selectivity, of these soft Lewis basic sites. This is accomplished by replacing a triazine of BTP with an indole. Optimization of the synthesis of a novel complexants aimed at increasing efficacy of MA over

lanthanides with subsequent examples including method development, and indole-substrate scope will be presented.

Undergraduate

SYNTHESIS AND NMR CHARACTERIZATION OF NEW ISATIN SULFONIC ACID THIOSEMICARBAZONE COMPOUNDS

Primary Author: Carlynne Methvin, Biology

Advisor: Edward Lisic

Co-Author(s)/Collaborator(s): Emily Rush

This work shows the synthesis and characterization of a series of isatin sulfonic acid thiosemicarbazone compounds, based on the 5-isatin-3-sulfonic acid (ISA) substrate. After synthesis and purification, the 1H NMR and 13C NMR spectra were obtained using a 500 MHz NMR spectrometer. Experimental data was observed using 2D NMR techniques, such as, HSQC (heteronuclear single quantum coherence) 1H-13C NMR and HSQC 1H-15N NMR to give evidence for the structures of these new compounds.
Undergraduate

DESIGN OF BACTERIAL DIHYDROFOLATE REDUCTASE INHIBITORS FOR COMPUTATIONAL DRUG DISCOVERY

Primary Author: Megan Mitchell, Chemistry

Advisor: Derek Cashman

Dihydrofolate Reductase (DHFR) is an essential enzyme for cell growth, and is present in all living organisms. The purpose of this research is to design potential DHFR inhibitors for three bacterial species. The enzyme works by catalyzing the conversion of dihydrofolate to tetrahydrofolate using NADP, an electron carrier, to donate electrons. Utilizing programs such as MOE 2018, the 3D structure of DHFR in B. anthracis, M. tuberculosis, and S. aureus was obtained from the RCSB Protein Data Bank (www.RCSB.org). These 3D structures were then analyzed using the AWSEM-MD Frustratometer (www.frustratometer.tk). This tool, based on Energy Landscape Theory, analyzes each residue of the proteins and determines the levels of energetic frustration that each residue exhibits. The proteins were also analyzed using the Evolutionary Trace (ET) method (www.lichtargelab.org/software/ETserver), which performs a multi-sequence alignment, and compares this alignment with the phylogenetic tree to rank residues in order of evolutionary importance. With these methods combined, and with the presence of NADP in the binding site, the pharmacophore can be identified in all three proteins. Once this is determined, and the individual residues surrounding the pharmacophore are identified, a 3D database search of the ZINC database was performed to identify potential candidate compounds to be used as inhibitors. Having identified compounds to fit in the binding site, compounds can be docked using the docking module of MOE 2018.

Undergraduate

SPECTRAL ANALYSIS OF TETRAPHENYLPORPHYRINS SYNTHESIZED USING SOLAR IRRADIATION

Primary Author: Taylor Pinto, Chemistry

Advisor: Dan Swartling

Co-Author(s)/Collaborator(s): Gene Mullins, Tennessee Tech Chemistry Department

Several tetraphenylporphyrins have been synthesized using solar irradiation focused by a parabolic reflector as the thermal heat source. The porphyrins were analyzed by UV-Vis, MS, 1H NMR, and 13C NMR to confirm that the desired porphyrin was synthesized. The spectra were

also used to compare the porphyrins to those synthesized by conventional electrical heating methods. MS and NMR spectra will be discussed.

Undergraduate

USING IONIC LIQUID STRATEGY TO CONVERT PHENOTHIAZINE DRUGS TO A LIQUID FORM

Primary Author: Lillian Pipkin, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: O. Andreea Cojocaru

Co-Author(s): O. Andreea Cojocaru

The majority of drugs available today are solids. Unfortunately, the solid form can exist in multiple crystalline states, known as polymorphism, which can affect a drug's efficiency. One way to prevent this is to convert the drugs into ionic liquids (ILs, ionic compounds composed of anions and cations with different functionality). ILs are generally described as compounds with MP < 100oC, while in the case of pharmaceuticals they are described as melting below body temperature. When applied to pharmaceuticals, this strategy has many benefits: it eliminates polymorphism, allows for new ways to administer a drug, and the liquid drug can be dual functional (both the cation and the anion retain their functions as drugs).

Due to the presence of basic nitrogen atoms in their structure, phenothiazine drugs (PHZs) can be converted to or exist in a cationic form; when paired with different anion sources, dual-active ILs can be formed. Here, five different PHZs (chlorpromazine, promazine, promethazine, triflupromazine, and trifluperazine) in their cationic form were combined with anion sources (sodium docusate, carboxylic acids and/or metal carboxylates) to form the corresponding ILs. Depending on the anion sources available (carboxylic acids vs. metal salt derivatives), two synthetic paths were used: (a) the acid-base reaction between PHZs as free bases and carboxylic acids and (b) the metathesis reaction between PHZs-HCl and sodium docusate/metal salt derivatives. The products formed were characterized via IR and NMR Spectroscopy and solubility studies of the promising PHZ ILs in water and simulated body fluids were initiated.

Undergraduate

INTERROGATING THE ROLE OF WATER IN METAL ION EXTRACTION INTO ROOM TEMPERATURE IONIC LIQUIDS

Primary Author: Madion Rigney, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Cory Hawkins

Ionic liquids (ILs) have shown promise as the basis of new systems for the separation of 90Sr,displaying unique selectivity for strontium over other metal ions. The mechanisms by which metal ions partition between an aqueous and IL phase are more complex than those observed in molecular solvents, however, and the equilibria remain incompletely understood. In an effort to better define the equilibrium processes involved in Sr(II) extraction by a crown ether (e.g.,dicyclohexano-18-crown-6; DCH18C6) into hydrophobic ILs, we have been evaluating a three-pathway model that is dependent on the aqueous acidity. In a recent study, we observed a linear correlation between the extent of extraction of Sr(II) and the equilibrium concentration of water in the ionic liquid phase. Under the conditions of extraction, metal ion transfer is thought to be limited to two of the three pathways, through which the hydration of co-extracted nitrate ions and the exchange via a hydronium

ion-DCH18C6 complex would predominate. Our goal has been to verify and quantify these mechanisms. To this end, two hydrophobic imidazolium-based ILs, one of them containing an alcohol functionality, have been synthesized as their bis[(trifluoro- methyl)sulfonyl]imide salts. Vibrational and NMR spectroscopy have been employed to interrogate the states of water in these ILs and to explore the competition between acid, water, and metal ions for DCH18C6 dissolved in them. By quantifying the partitioning of various species in the titration of acid and metal ion, it is expected that a more complete understanding of these systems will emerge.

Undergraduate

INCREASING THE SAFETY OF THE RAINBOW FLAME TEST

Primary Author: Abigail Rossi, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Amanda Carroll

The rainbow flame test is meant to capture the attention of chemistry students and show them how flames can be used in identifying salts. However, the danger involved with the test is not to be taken lightly - in the last two years, at least 11 students were injured while conducting the rainbow flame test. Due to the flammability of methanol and the toxicity of barium, the test may soon be abolished because of its safety violations. However, there is a way to continue using the test, and it is through using water as a solvent and readily available household cleaning products as the solutes. Through testing multiple household salts such as boric acid and epsom salts, and using water to dissolve them, we hope to eliminate at least some of the safety concerns concerning the rainbow flame test.

Undergraduate

NEW ROSIN MATERIALS FOR THE DELIVERY OF PHARMACEUTICALS IN LIQUID FORM

Primary Author: Jacob Scantland, Chemistry

Advisor: O. Andreea Cojocaru

Co-Author(s)/Collaborator(s): O. Andreea Cojocaru

The acidic thermoplastic rosin can be isolated from pine trees, and is known to have many properties that could be applied to the production and administrations of active pharmaceutical ingredients (APIs). Rosin is both bio renewable and biodegradable, and research suggests that rosin can be made into many forms, such as films, beads and fibers. These forms can then be used in the controlled release of APIs.

The main component of rosin is abietic acid which contains a carboxylic acid group that can be used in an esterification reaction to form prodrugs out of rosin and active pharmaceutical ingredients (APIs) containing both an alcohol group and an ionizable group. The new rosin ester can be paired with a suitable FDA approved counter ion to form new rosin prodrug ionic compounds that can then undergo hydrolysis within the body to deliver the APIs in ionic liquid form. This will improve the function of the drug due to factors such as: faster delivery, increased solubility, and increased bioavailability. This strategy can be used to develop new rosin materials with considerable applications such as the controlled delivery of APIs in ionic liquid form using API-ILs functionalized rosin films, beads, fibers. This presentation shows our efforts toward the development of these new rosin materials.

Undergraduate

TOPOISOMERASE IIA C-TERMINUS DNA PURIFICATION

Primary Author: Maryo Toma, Chemistry

Advisor: Xiaohua Jiang

As humans, it is essential that our cells replicate as we about our lives. This occurs through DNA replication, which is a process that is dependent upon the topoisomerase enzyme. When DNA is replicated, a lot of torsional strain is put on the double helix as it is twisted. If too much of this strain occurs, the helix cannot move forward with the replication process. This is where the topoisomerase enzyme comes in, making cuts in the DNA, releasing the tension, and then religating the ends. Focusing specifically on Topoisomerase II, there are two kinds, α and β. Topoisomerase IIβ is in most of our body's cells and is involved in neural development. On the other hand, in cancerous cells, Topo IIα is primarily observed. Cancerous cells are rapidly proliferating cells and undergo many more rounds of DNA replication than normal cells. Therefore, compounds can be used to inhibit the functioning of topoisomerase IIα inside cancerous cells, thereby hindering DNA replication, and preventing them from spreading. However, there is a catch. Topoisomerase IIα and IIβ both have very similar structures, and drugs used to inhibit one could inhibit the other. By purifying a truncated version of the Topoisomerase IIα enzyme that only contains the portion of its DNA sequence that is different from that of topoisomerase IIβ's, we can develop compounds that are specific to this cancer involved topoisomerase. The process of how we go about purifying the DNA the codes for this truncated enzyme will be discussed.

Undergraduate

USING THE IONIC LIQUID STRATEGY TO PREVENT DRUG-INDUCED LIVER INJURY

Primary Author: Sarah Visneski, Chemistry

Advisor: O. Andreea Cojocaru

Co-Author(s)/Collaborator(s): O. Andreea Cojocaru

Ionic liquids (ILs) pose new solutions to problems in the pharmaceutical industry, one of which is the elimination of polymorphisms. By conversion to IL form, polymorphism in active pharmaceutical ingredients (APIs), which can occur during the shelf life of the drug, will be eliminated. ILs are synthesized pairing cation and anion precursors and these newly synthesized compounds will have the same biological activity of the parent cation and anions. Drug-induced liver injury (DILI), a side effect of many medications both over-the-counter and prescribed, is the most common reason for drugs to be pulled from the market. Here, we used the IL strategy to eliminate this side effect by combining liver-damaging cation precursors with a liver-protecting anion precursors, leading to the formation of dual active ionic compounds in liquid form that keeps the pharmaceutical activity of the parent drugs. This strategy offers the advantage of revisiting drugs that were pulled from the market because of DILI, as well as revisiting drugs that were never fully tested due to DILI presenting as a side effect in the early stages of clinical trials. The IL strategy will also allow the possibility of developing additional ways to deliver drugs (e.g., transdermal delivery) since the newly formed compound is ionic, making it more soluble in water and thus increasing the drug's bioavailability.

Undergraduate

DEHYDROGENATIVE COUPLING OF FUNCTIONALIZED PYRIDINES TOWARD COMPEXANTS FOR MINOR ACTINIDE SEPARATION

Primary Author: Gabrielle Waters, Chemical Engineering

Advisor: Jesse Carrick

As the world progresses towards a cleaner energy initiative,

nuclear fuel continues to be a major potential source of energy. The drawback is the lack of a proper way to dispose of the radioactive waste produced from this otherwise clean alternative energy source. In recent years, the focus has been on separation techniques that involve separating minor actinides, such as Americium, from the fission products and the lanthanides. This would allow for actinide recycling opportunities as well as reducing the toxicity of the unrecycled waste. Traditional separation techniques are present challenges since the two kinds of elements have the same oxidation states and similar cationic radii. In this work, the development of N-heterocyclic scaffolds such as the bis-triazinyl-bypyridine (BTBP) scaffold, are promising substrates for anticipated liquid-liquid separation process that will work to solve this separation challenge. Dehydrogenative coupling of 5,6-diphenyl-3-pyridin-2-yl-[1,2,4]triazine and similar substrates will be tested using a variety of palladium and nickel catalysts. This reaction pathway works to form carbon-carbon bond between the carbons that are adjacent to the nitrogen on both scaffolds by oxidizing those two carbon-hydrogen bonds affording a functionalized [2,2]-bipyridine scaffold. Reaction optimization and preliminary substrate screening will be presented.

Undergraduate

INCREASING ACCESSIBILITY OF THE RAINBOW FLAME TEST: METHODS OF FLAME DELIVERY

Primary Author: Kaitlyn Wiley, Biology

Advisor: Amanda Carroll

The purpose of the Rainbow Flame test is to inspire young students to take interest in the colorful and fascinating world of chemistry by illustrating observable emission spectra via vivid color displays using a Bunsen burner and salt solutions. Despite its magnificent use as a teaching tool, the Rainbow Flame Test can be highly inaccessible to those not often around a science laboratory due to lack of a gas line and scientific equipment such as a Bunsen burner. This project will explore alternative flame source options such as candles, fuel burners used in catering, and other possibilities available to the public in attempts to make the Rainbow Flame Test available for all who are interested in chemistry. It is expected that the fuel burner used in catering will produce the best temperature and flame size needed to visualize the emission spectra, while remaining affordable and simple to access as a lay person. Through conducting research on potential flame sources, this project seeks to find an affordable and convenient method for making the Rainbow Flame Test more accessible than ever before.

Department of Earth Sciences

Undergraduate

RAILS WITH TRAILS HYDROLOGY

Primary Author: Ellie Fetzer, Environmental and Sustainability Studies

Advisor: Ping-Chi Li

Co-Author(s)/Collaborator(s): Cindy Hendry, Kathleen Thompson

The Tennessee Central Heritage Rail Trail, completed in October 2016, is a 4.23 mile long mixed-use bike trail that is envisioned to run 19 miles from Baxter to Monterey. Currently, the trail starts at the Cookeville Train Depot Museum, passes through Tennessee Tech University, and ends at the Algood Community Library and Senior Citizen Center. After an initial exploratory examination of the trail, a selection of low-lying areas was visually identified as potential hazards during a storm event based on their estimated likelihood of flooding or sedimentation. Data was gathered manually in the form of geolocated ground photographs and GNSS GPS points during a walk of the trail by the researchers. Collected data was then analyzed in association with flow accumulation data derived from USGS 3DEP LiDAR data collected for the Upper Cumberland region in December 2015 and January 2016. However, since the LiDAR data was collected prior to the trail's completion, the researchers used it to delineate a separate set of potentially hydrologically hazardous areas along the trail. The two sets of areas were then compared to one another, resulting in a final shortlist of locations along the trail deemed most important to be addressed by trail planners. Other locations were also identified as being successes where remotely sensed data indicated potential drainage issues, but trail planners had adequately mitigated the drainage issues during construction.

Undergraduate

DEVELOPMENT OF WATERSHED MODELS FOR THE TRIBUTARIES OF CUMMINS FALLS TO AID IN FLASH FLOOD WARNING SYSTEM

Primary Author: Nicholas Fleishour, Geosciences

Advisor: Evan Hart

Co-Author(s)/Collaborator(s): Lonie Young

In the summer of 2017, Cummins Falls State park experienced a flash flood, which led to the death of 2 people. To better understand when floods could occur in this area, models of the two watersheds that contribute to the river flowing into Cummins Falls could help in providing early warnings for flood events. The goal in our research is to create models for both East and West Blackburn Fork, the 2 tributaries of Cummins Falls, using Win-TR 55 and HEC HMS in order to determine the amount of discharge that would be required in order for a flood to occur at the falls.

ArcGIS was used to analyze land use data and overlay it on the two distinct watersheds. Spatial data was entered into Win-TR 55 where we could run rainfall events to simulate flooding for each catchment.

Due to limitations of Win-TR 55, HEC HMS is an alternative program, designed to analyze larger watersheds. This new application will allow us to further analyze the watershed with more accurate results. Results will give emergency officials estimates of the timing of flash floods, in order to better issue warnings and evacuations.

Undergraduate

HYDROCHEMICAL EVALUATION OF HUMAN AND SEASONAL EFFECTS ON KARST CARBONATE GROUNDWATER

Primary Author: Anna Foster, Geosciences

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Joseph Asante

Co-Author(s)/Collaborator(s): Joseph Asante, Tennessee Tech University; Karaline Deaton, Tennessee Tech University

This study uses current and historical physico-chemical data collected from City Lake Spring at Cookeville in Tennessee, which drains Mississippian limestone aquifer systems, to determine effects of seasonal changes and human activity on the karst groundwater quality and karstification. Seasonal effects on the water quality and karstification is evaluated by comparing data collected during the summer of 2017 and winter 2015. Human and hydrogeological influences of water quality are evaluated by comparing data collected in 2015-2016 and historical data in 2009. Principles of aqueous chemistry and statistical methods are used in analyzing and interpreting these data. The physical parameters measured are temperature, pH, electrical conductivity, and oxidation-reduction potential; and the chemical parameters are calcium, magnesium, sodium, potassium, chloride, sulfate, phosphorous, sodium, dissolved organic carbon, nitrate, bromide, and alkalinity. This study could help determine if human activity (urban development, waste disposal, run-off water with fertilizer, road salt, etc.) are affecting the ground water quality. In addition, this research will give a better understanding of the local hydrogeology, karstification, and tracing of urban contamination.

Undergraduate

PALEOCLIMATE RECONSTRUCTION FROM PEDOGENIC CARBONATES FROM THE EARLY MIOCENE WAYANDO AND KIAHERA FORMATIONS, RUSINGA AND MFANGANO ISLANDS, LAKE VICTORIA, KENYA AND THE IMPACT ON EARLY APE EVOLUTION

Primary Author: Kayla Hillis, Geosciences

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Lauren Michel

Co-Author(s): Alexsis Bowen, Kimberly Chang

Changes to climate and resulting changes to ecosystems are thought to be stressors leading to evolutionary adaptions. Early Miocene deposits on Rusinga and Mfangano Islands, Kenya, are ideal for studying the impact of environment on evolution and adaptation within early apes. Despite decades of geological and paleontological research there, however, paleoclimate reconstructions have been conflicting, ranging from open and arid to closed and ever-wet environments. Here, we present results from paleosol-bearing deposits in the two oldest fossiliferous units, the Wayando Formation, on Mfangano Island and Kiahera Formation on Rusinga Island. Results show that the Wayando Fm. contains interbedded ashes, groundwater nodules, and carbonate-forming fossil soils (paleosols). In modern soils, pedogenic carbonate is found in environments where evapotranspiration is greater than precipitation – common in semi-arid to arid environments. Results from the Kiahera Fm. show a more violent volcanic history, with volcanic brecca common in the lower units. In the upper Kiahera Fm. there are common paleosols containing vertic features which are in modern soils with seasonal water budget surpluses and deficits. Some paleosols contain pedogenic nodules,

though they are much better developed then those found in the Wayando Formation. These formations with semi-arid to arid climate and possibly season climates differs sharply from paleoclimate and habitat reconstructed for the younger Hiwegi Fm., which include woodlands and closed-canopy forests. These results add to a growing body of data showing that Rusinga Group strata contain a wide variety of paleoenvironments in which Ekembo and other early Miocene catarrhines were living.

Undergraduate

A WORKFLOW FOR NOVICE TO INTERMEDIATE INDIVIDUALS CREATING DIGITAL ELEVATION MODELS USING THE NASA AMES STEREO PIPELINE

Primary Author: Shelby Smith, Computer Science

Advisor: Jeannette Wolak

Co-Author(s)/Collaborator(s): Amber Patterson; Jeannette Wolak, Tennessee Technological University

Terraced fans are an unusual sedimentary deposit on Mars. One way to analyze these features is by using digital elevation models, also known as DEMs. Creating a DEM is a complex process, however, and requires knowledge of Unix commands and familiarity with Integrated Software for Imagers and Spectrometers (ISIS3). The steps needed to convert raw data from a satellite – in this case the Mars Reconnaissance Orbiter – into the appropriate formats can be time-consuming and computationally intensive. The purpose of this poster is to document the process for making DEMs using data from the Context Camera (CTX; resolution 6 m/pixel) and High Resolution Science Experiment (HiRISE; resolution 0.3 to 0.6 m/pixel). While the United States Geological Survey has tutorials covering some of the steps, the workflow shown here is for novice to intermediate users who have never created a DEM before. Two flow charts are presented: one to document the production of a CTX DEM and a second to document the production of a HiRISE DEM. The products of these workflows will be used for geologic mapping of terraced fans on Mars.

Undergraduate

GRAIN-SCALE STRAIN ANALYSIS OF ROCK IN MIDDLE TENNESSEE

Primary Author: Kathleen Thompson, Geosciences

Advisor: Michael Harrison

Co-Author(s)/Collaborator(s): Michael Harrison, Tennessee Tech University; Lori Nabors

Rock deformation begins at the grain scale. Grain-scale deformation can be expressed as finite strain—the total strain affecting the rock over time. Finite strain can be quantified by a geospatial technique known as Fry analysis that assesses the geometric arrangement of rock grains with respect to each other. Fry analysis is used to measure the amount of strain and the direction of shortening and extension.

In this study, 8 oriented samples that included Hartselle Formation quartz arenite and Monteagle Limestone grainstone were collected for Fry analysis. Four samples were collected east of Cookeville, TN and 4 samples were collected from Brown Gap quarry 20 kilometers south of Crossville, TN. Polished slabs of the bedding plane were scanned and imported into EllipseFit for Fry analysis. Six samples yielded shortening directions of east-west to northwest-southeast (azimuth of 257-346 degrees) and one sample showed a shortening direction of 207 degrees (the final sample was too fine grained for the analysis). The strain ratio, a measure of strain magnitude, ranged from 1.1-5.9. The grain-scale deformation was accomplished

principally by microfracturing, pressure-solution and calcite- twinning mechanisms. The shortening direction measured in these samples is consistent with the tectonic deformation associated with the Alleghanian orogeny 320-280 million years ago.

Undergraduate

PETROPHYSICAL PROPERTIES OF THE FORT PAYNE FORMATION (MISSISSIPPIAN), TENNESSEE AND KENTUCKY

Primary Author: Garrett Winkle, Geosciences

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Jeannette Wolak

Co-Author(s)/Collaborator(s): Hannah Blaylock; Jeannette Wolak, TTU Earth Sciences Department

The Fort Payne Formation is a Middle Mississippian unit that outcrops in north-central Tennessee and south-central Kentucky. Two study locations are presented in this research: an outcrop south of Celina, Tennessee on TN 52 and an outcrop south of Burkesville, Kentucky on KY 61. In these locations, the formation consists of primarily mixed carbonate and siliciclastic shale lithologies. The most common facies observed in the Fort Payne are crinoidal grainstones and interbedded siliciclastic and carbonate mudstones. The purpose of this work is to characterize petrophysical properties of the Fort Payne Formation to assist with hydrocarbon exploration in the region.

A handheld gamma ray scintillometer was used to collect data from both study areas. In the Celina location, paleochannels are incised into carbonate and siliciclastic mudstones. The Burkesville site has been interpreted as a Waulsortian-type carbonate mound. In addition to measured stratigraphic sections, the scintillometer provides information on potassium, uranium, and thorium content as well as total gamma ray response. All data are plotted against rock type, allowing for stratigraphic analysis of the Fort Payne Formation using petrophysical properties (i.e. gamma ray response).

Radioactive elements (potassium, uranium, and thorium) increase when analyzing finer clay-rich siliciclastic and carbonate mud, and decrease when analyzing coarser grainstones. This likely reflects an increase in siliciclastic material into the system during periods of quiescence on the Mississippian slope. Given that the Fort Payne is a mixed carbonate-clastic system, analysis of petrophysical properties will allow calibration with drilling results in Tennessee and Kentucky allowing global models,

Department of English

Graduate

ELEMENTS OF THE GOTHIC IN DAVID B.'S EPILEPTIC

Primary Author: Brandi Kriebel, English (M.A.)

Advisor: Anthony Baker

In graphic novels, Gothic elements are primarily studied in the graphic horror genre. However, graphic novels that reside outside of horror also contain Gothic elements such as fear, terror, horror, the sublime, Neutral Territory, and characteristics of the monstrous.

David B.'s graphic memoir, Epileptic, follows the Beauchard family through the ups, downs, twists, and turns after Jean-Christophe's diagnosis with epilepsy. Studying aspects of the main characters, Jean-Christophe and Pierre-Francois, and applying Gothic concepts gives these characters more dimension and allows for more interpretation. David B. uses symbolism, black and white imagery, and descriptive captions to tell his story. This graphic memoir uses key elements of the Gothic which allows readers the ability to develop more individualized insight into understanding the characters and the plot.

Graduate

MARGARET ATWOOD'S MALE NAVIGATORS: PRISONS, POWER, AND PATRIARCHY

Primary Author: Tyler McNew, English (M.A.)

Advisor: Brian Williams

This is the introduction to my MA thesis on male navigators in Atwood's fiction. Margaret Atwood's fiction often reveals a power play between characters who seek to abuse other characters for personal gain and those characters who suffer under and/or fight back against that power. Patriarchal societies function much like a prison system, meaning a hierarchy that binds men and women into roles of privileged and unprivileged power. Atwood responds to the patriarchy and structures of binary confinement with her use of the 'navigator' in her fiction. Navigators are driven by a need for self-navigation, and they can only help navigate others within the patriarchy if they can successfully navigate for themselves. Navigation requires the fluidity of adopting new roles and breaking out of the binaries that confine wardens and captives. The studied male characters in Atwood's fiction struggle with their own place and identity within the patriarchal system where they attempt to employ navigation as a means to express and manage their own anxieties. If a navigator can successfully surpass their own anxieties, they can then lead captives out of their captivity and subvert the patriarchy by destabilizing the binary. Navigation captures the idea that men can subvert the patriarchy by adopting an altruistic fluidity more complex than merely solving their own anxieties.

Undergraduate

CREATION AND COMMUNITY IN HAWTHORNE AND POE

Primary Author: Shannon Buford, English

Advisor: Michael Burduck

The role of the artist and the nature of creation serve as recurring themes in the works of both Nathaniel Hawthorne and Edgar Allan Poe. This paper presents two opposing representations of the artist figure as depicted in Hawthorne's "The Artist of the Beautiful" and Poe's "The Oval Portrait." In Hawthorne's tale, Owen Warland represents an ideal artist who aspires to create beauty while retaining a connection with his community, while Poe's portraitist yearns to lionize himself through art as he rejects humanity. This paper was originally written for Nineteenth Centure American Literature.

Department of Mathematics

Graduate

MU-RANK OF NONCOMMUTATIVE QUADRATIC FORMS ON FOUR GENERATORS

Primary Author: Jessica Prince, Mathematics (M.S.)

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Padmini Veerapen

In 2010, Cassidy and Vancliff extended the notion of commutative quadratic forms to the noncommutative setting. This led to a definition of a notion of a rank, referred to as mu-rank, for quadratic forms on two and three generators. For quadratic forms on four generators, a definition for mu-rank was developed by Frauendienst and Veerapen. In this project, we examine this further. We take our field to be algebraically closed with characteristic not equal to two.

Graduate

EVALUATING THE STATISTICAL SIGNIFICANCE OF PEDESTRIAN CROSSINGS ON SUPERSTREETS USING D-VALUES INSTEAD OF P-VALUES

Primary Author: Meghan Sigler, Civil Engineering (M.S.)

Advisor: David Smith

Restricted Crossing U-turn Intersections, RCUTs, also known as Superstreets, are an innovative interchange system that eliminate the need for left turn and through movements from the minor streets of a roadway by turning them into U-turns instead. A study by Hummer (2014) looked to integrate pedestrian crossings into Superstreets. The study considered four pedestrian crossings, and within these crossings, different signal offsets, cycle lengths and splits, and length to U-turn were considered. A total of sixteen scenarios were considered, and the "best" pedestrian crossing was chosen based on the p-value found when comparing three mean measurements of efficiency for each scenario.

The current practice for measuring statistical significance between means is to calculate a p-value. Recently, there has been a lot of research into the misuse of the p-value. The questions regarding the p-value stem from the fact that the p-value is often driven by the sample size of the study, and it is well known that large sample sizes result in p-values that suggest statistical significance. A recent study by Demidenko (2016) developed a D-value of measuring statistical significance that eliminates population size as one of the variables considered within the model. This D-value allows for evaluation of significance on an individual level rather than a group one. This paper looks to reevaluate the level of significance from the Superstreet project by considering the D-value of each of the crossing types instead of the p-value.

Graduate

A STUDY OF THE VALIDITY OF D-VALUES FOR SAMPLES OF DIFFERENT SIZES AND NORMAL AND NON-NORMAL ERRORS

Primary Author: Kayla Sims, Mathematics

Advisor: David Smith

The p-value is broadly used for testing statistical significance in a variety of settings. It is well known that statistical significance is easily achieved with a large enough sample. Additionally, the p-value can only be used to make conclusions for the means of the groups rather than on the individual level. This may be important for studies

in the comparison of medical interventions where the goal is to assess improvements made to the health of individuals rather than groups.

A complement to the p-value is the D-value. The D-value is an empirical version of the theoretical value of $\delta=\phi((\mu\_y-\mu\_x)/(\sigma\sqrt{2}))$ where $\phi(\cdot)$ is the cumulative distribution function of the normal distribution. Note that the D-value does not depend on sample size and provides an effect size on a probability scale for the individual rather than the group.

Sample size still affects the sampling distribution in the D-value. We will be investigating this question by using the bootstrap method. First we will use resampling to compute an approximation of the sampling distribution of D. From the sampling distribution of D we can compute the D-value. The simulation will be expanded to include non-Normal of D errors for a One Way ANOVA. Finally we will compare the results of the D-values for non-normal errors for different sample sizes.

Department of Physics

Undergraduate

34MG DECAY CHAIN ANALYSIS

Primary Author: Donald Chaney, Physics

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Mustafa Rajabali

Co-Author(s)/Collaborator(s): Benjamin Luna

The project aimed to measure the properties of 34Mg and its decay chain. In particular, we measured the half-lives for all the nuclei in the decay-chain, as well as the energy scheme for the excited states of each nuclide in the decay chain. The experiment that was run collected information on the timing and energies of gamma rays and beta particles that were observed from these decays.
A data sorting program, GRSISort, was used to manipulate the measured data into histograms.This allowed us to analyze the measurements with a visual interface and further sort through the data files to discover a variety of information.

The data was filtered to get rid of background noise in our measurements, and to arrange the data in a useful manner to find a the properties of the analyzed decays.
we have successfully rid our data set from most bad data, and we can effectively use gates to remove In this ongoing research project, we will continue to build a level scheme, and find the half-lives of each nuclide, preparing the way for future analysis to reveal much more complicated and nuanced information about each of these nuclides.

Undergraduate

MATERIAL DEPOLARIZATION OF ULTRACOLD NEUTRONS IN COLLISION WITH GUIDES WITHIN AN AMBIENT MAGNETIC FIELD

Primary Author: Damien DeArmitt, Physics

Advisor: Adam Holley

Material depolarization of “ultracold” neutrons (UCN), neutrons with energies of ~100neV, is studied to understand and control systematic effects in experiments where polarized UCN interact with materials, such as polarized beta-decay experiments. A number of “PPM

Depol" experiments have been performed by the Los Alamos National Lab UCN team to test the probability of depolarization per bounce of UCN within material test guides. In one of these experiments, different guides were mounted within a varying ambient longitudinal holding field adjustable from 10G to 260G, which allowed the measurement to be repeated with different holding field strengths. Following analysis of the data from this experiment, Monte Carlo simulations were used to investigate systematic effects associated with poorly-constrained properties of the experiment, such as guide specularity and guide loss per bounce, and the UCN energy spectrum. The method of analysis as well as extracted depolarization probabilities per bounce for copper guides of various surface preparations and stainless steel guides, all as a function of holding field strength, will be presented. Comparisons between simulations and data will also be used to discuss systematic effects present in the analysis.

Undergraduate

APPLICATION OF GAUSSIAN ELIMINATION TO DETERMINE FIELD COMPONENTS WITHIN UNMEASURED REGIONS IN THE UCN-TAU TRAP

Primary Author: Joseph Felkins, Physics

Advisor: Adam Holley

Co-Author(s)/Collaborator(s): Adam Holley, Tennessee Technological University

Determining the average lifetime of a neutron gives information about the fundamental parameters of interactions resulting from the charged weak current. It is also an input for calculations of the abundance of light elements in the early cosmos, which are also directly measured. Experimentalists have devised two major approaches to measure the lifespan of the neutron, the beam experiment, and the bottle experiment. For the bottle experiment, I have designed a computational algorithm based on a numerical technique1 that interpolates magnetic field values in between measured points. This algorithm produces interpolated fields that satisfy the Maxwell-Heaviside equations for use in a simulation that will investigate the rate of depolarization in magnetic traps used for bottle experiments, such as the UCN-tau experiment at Los Alamos National Lab. I will present how UCN depolarization can cause a systematic error in experiments like UCN-tau. I will then describe the technique that I use for the interpolation, and will discuss the accuracy of interpolation for changes with the number of measured points and the volume of the interpolated region.

Undergraduate

PRELIMINARY ANALYSIS OF MAGNETIC FIELD DATA FROM THE UCNTAU EXPERIMENT

Primary Author: Keegan Hoffman, Physics

Advisor: Adam Holley

The free neutron lifetime tau_n is a physical constant that is associated with a variety of experimental tests for new physics. For example, if tau_n is known to within 0.01% (an error of about +/- 0.1 s) it can be combined with other beta-decay observables to test the Standard Model. The UCNtau experiment has the ultimate goal of measuring the free neutron lifetime with this precision. The experiment uses a trap composed of a bowl-shaped Halbach array of permanent magnets inside of a vacuum jacket surrounded by field coils to contain polarized, ultracold neutrons (UCN), which are allowed to decay inside the trap. The magnetic array, in conjunction with gravity, keeps the UCN from escaping while the field coils prevent the UCN from depolarizing. However, there will be a systematic error if UCN leave the trap for a reason other than decay. This could occur if UCN become depolarized by interacting with magnetic field zeroes or if some surface region of the array has a magnetic field insufficient to repel trapped UCN. To check for this, a magnetic mapper was deployed

to make an examination of the field in the UCNtau trap. We will describe the preliminary analysis of the magnetic field maps recorded this Spring.

Undergraduate

COMPARING SIMULATED AND EXPERIMENTAL DATA FROM UCNτ

Primary Author: Dezrick Howard, Physics

Advisor: Adam Holley

The UCNτ experiment is designed to measure the average lifetime of a free neutron (τ n) by trapping ultracold neutrons (UCN) in a magneto-gravitational trap and allowing them to β-decay, with the ultimate goal of minimizing the uncertainty to approximately 0.01% (0.1 s). Understanding the systematics of the experiment at the level necessary to reach this high precision may help to better understand the disparity between measurements from cold neutron beam and UCN bottle experiments (τ n 888 s and τ n 878 s, respectively). To assist in evaluating systemics that might conceivably contribute at this level, a neutron spin-tracking Monte Carlo simulation, which models a UCN population's behavior throughout a run, is currently under development. The simulation will utilize an empirical map of the magnetic field in the trap (see poster by K. Hoffman) by interpolating the field between measured points (see poster by J. Felkins) in order to model the depolarization mechanism with high fidelity. As a preliminary step, I have checked that the Monte Carlo model can reasonably reproduce the observed behavior of the experiment. In particular, I will present a comparison between simulated data and data acquired from the 2016-2017 UCNτ run cycle.

Undergraduate

DEVELOPMENT OF NEW HIGH RESOLUTION NEUTRON DETECTOR

Primary Author: Leonard Mostella III, Physics

Advisor: Mustafa Rajabali

Beta-delayed neutron emission is a prevalent form of decay for neutron-rich nuclei. This occurs when an unstable nucleus undergoes beta decay, but produces a daughter nucleus in an excited state above the neutron separation energy. The daughter nucleus then de-excites by ejecting one or more neutrons. We wish to map the states from which these nuclei decay via neutron spectroscopy using NEXT, a new high resolution neutron detector. NEXT utilizes silicon photomultipliers and 6 mm thick pulse-shape discriminating plastic scintillators, allowing for smaller and more compact modular geometries in the NEXT array. Timing measurements for the detector were performed and a resolution of 500 ps (FWHM) has been achieved so far. Aspects of the detector that were investigated and will be presented here include scintillator geometry, wrapping materials, fitting functions for the digitized signals, and electronic components coupled to the silicon photomultipliers for signal shaping.

Abstracts

College of Business

Department of Economics, Finance and Marketing

Undergraduate

THE UNITED STATES TRADE DEFICIT WITH CHINA - SOLUTIONS?

Primary Author: Hannes Vohn, Economics

Advisor: Alma Hales

Many American economists, politicians and citizens are afraid of a widening trade deficit with China. Deep political conflicts regarding how to do business with the People's Republic dominate current news. Many think of protectionism as the solution to decreasing the trade deficit because protectionist measures can counter China's unfair trade practices. The question asked is whether there is a solution which decreases the trade deficit while increasing the American economic output.

The goal of this thesis is to offer deeper insight into the United States trade deficit with China to examine the efficiency of protectionist measures. The thesis begins with a review of the historical, as well as the current, trade and political environment between the US and China. Additionally, the thesis provides a detailed discussion on China's business practices. Furthermore, this study explores the pros and cons of protectionism. Special emphasis will be placed on macroeconomic developments, how China treats American businesses and solutions to lower the trade deficit. Furthermore, the advantages of free trade theories such as effects of the Heckscher-Ohlin model will be discussed.

Ultimately, this thesis proposes that the best option for the United States is a bilateral investment treaty with China because protectionist measures would benefit select industries but slow overall economic growth.

Abstracts

College of Education

Department of Counseling and Psychology

Graduate

CONCEPTUALIZING CRITICAL THEORY IN COUNSELING EDUCATION

Primary Author: Leslie Bohn, Educational Psychology and Counselor Education (M.A.)

Advisor: Tony Michael

Counselors-in-training could be well-served by studying cultural, social, and critical theory and philosophy in addition to the core counseling theories. While most of the latter are the applications of the former, engaging with different critical theories would better equip future counselors to conceptualize the many factors affecting a client, make ethical and appropriate decisions in treatment, and enter into ongoing conversations within or about the profession. I will provide examples of how these critical theories are already part of some counseling theories and how knowing the critical theories separately from the counseling ones can broaden counselor understanding and the language they have access to in order to describe problems and processes.

Graduate

FIRST EXPERIENCES IN LAOS

Primary Author: Laslie Phongsa, Educational Psychology and Counselor Education (M.A.)

Advisor: Matthew Zagumny

Expounding upon Earnest E. Boesch's chapter in Psychology and Culture, "First Experiences in Thailand," I will be providing an outlook similar to his regarding another country: Laos, Thailand's neighboring country. As a first-generation Laotian-American, I visited my family's home country for the first time as a teenager. I will discuss my first experiences in Laos and how, in retrospect, they connect with different aspects of psychology and culture. The topics discussed include, but are not limited to, overall Laotian culture in relation to American culture, priming different cultural mindsets when experiencing events, and the importance of food in the Laotian culture. References to Hofstede's Cultural Dimensions will also be used to analyze my first experiences in Laos.

Undergraduate

THE IMPORTANCE OF CULTURAL VALUES IN THE STIGMATIZATION OF MENTAL ILLNESS

Primary Author: Chassidy Overstreet, Psychology

Advisor: Matthew Zagumny

Co-Author(s)/Collaborator(s): Matthew Zagumny, Tennessee Technological University

Research indicates that people often have negative perceptions towards those with a mental disorder. Otto (1999) concluded that when mental health consumers (N = 1,301) self-reported how they experience stigma; they were

commonly hurt by "stigmatizing comments of depictions of mental illness" with 80% overhearing hurtful comments about mental illness. The current study examined perception of mental illness and attributions made about those with mental health diagnoses. Three-hundred and nine American and International students completed online stigma related questionnaires: The Beliefs towards Mental Illness Questionnaire (BMI), Perceived Stigma Questionnaire (PSQ), The Inventory of Attitudes Toward Seeking Mental Health Services (ATSMHS), the Physicians Trust Scale, and the Shortened Schwartz Value Survey (SSVS). Separate multiple regression analysis were performed on the BMI and PSQ, with personal relationship, respondents' gender and ATSMHS, and SSVS as predictors using the backward elimination method. PSQ scores resulted in a best prediction equation PSQ = -0.08 (PersonalRelationship) + 3.39. Regression analysis of BMI scores yielded a best prediction equation of BMI = .22(PersonalRelationship)-0.11(Gender) + 0.05(Power) + 0.04(Achievement) - 0.06(Self-Direction) + 2.33. This result suggests those who do not personally know someone with a mental illness, males, those who place more importance on the values of Power and Achievement, and place less importance on the value of Self-Direction report significantly greater stigma towards those diagnosed with mental illnesses. These findings emphasize the significance of personal contact, cultural values, and how popular media, enculturation processes, and cultural differences require future research.

Department of Curriculum and Instruction

Graduate

BETWEEN CASE EFFECT SIZES TO COMBINE GROUP AND SINGLE CASE DESIGNS: A REVIEW OF REVIEWS OF READING INTERVENTIONS FOR STUDENTS WITH EMOTIONAL AND BEHAVIORAL DISORDERS

Primary Author: Argnue Chitiyo, Exceptional Learning (Ph.D.)

Advisor: Seth King

A research to practice gap in special education shows that teachers and practitioners rarely use practices supported by scientific evidence. In order to address such a gap, policy makers have instituted Evidence Based Practice in order to encourage teachers and practitioners to find most effective interventions for their clients. Some key tenets of EBP include; (1) that researchers of interventions use research designs that show clear functional relationships between interventions and outcomes of interest, and (2) demonstrate in quantitative terms, the effect sizes of the interventions. Research designs meeting such a requirement in Special Education include single case designs (SCD) and Group Experimental Designs. Although SCDs facilitate identification of EBPs, they have previously been excluded from Meta-Analyses and systematic reviews owing to some limitations associated with their measures of effects. However, a novel effect size addressing the limitations has been suggested. Between Case Effect Size (BCES) enables researchers to aggregate effects across group and SCDs, thereby expanding the pool of studies from which to pick studies to meta-synthesize. This paper discusses some of the features of BCES and provides a review of reviews of reading interventions for students with behavioral and emotional disabilities to examine effect size methods have been used in the past. Students with EBD exhibit acute academic deficits, including reading and math, and interventions to address these deficits can improve academic gains for them. BCESs will help policy makers to better ascertain efficacy of reading interventions for EBD.

Graduate

THE STATUS OF TENNESSEE FOSTER PARENT TRAINING AND SUPPORT INCLUDING FOSTERING CHILDREN WITH NEONATAL ABSTINENCE SYNDROME (NAS) AND THE RELATIONSHIP OF FOSTER PARENTS' PERCEIVED ABILITIES, MOTIVATIONS, AND LIKELIHOOD TO CONTINUE FOSTERING

Primary Author: Elizabeth Ramsey, Exceptional Learning (Ph.D.)

Advisor: Jane Baker

This correlational study used a survey to gather data across Tennessee from 164 foster parents to describe the status of foster parent training and support, and how the training and support related to the perceived abilities, motivations, and willingness to continue fostering. A secondary purpose was to gather data on and describe Tennessee's training and support for those who foster infants with Neonatal Abstinence Syndrome (NAS). The participants were 82.7% female, 88.9% white, and 75 of the 164 foster parents reported caring for an infant with NAS. Data revealed that foster parents in Middle Tennessee reported less training in NAS topics than their East and West Tennessee counterparts. Twenty percent of foster parents caring for infants with NAS reported being trained by their foster parent agency, while 46.6% reported not being trained to care for infants with NAS. Despite the lack of training in NAS, 90.3% foster parents felt confident to meet the needs of the children placed in their care. There was no relationship between the types and amounts of training with the foster parents' likelihood to continue fostering children.

Graduate

WOMEN'S STORIES OF MAINTAINING DRUG RECOVERY

Primary Author: Cassie Woodward, Exceptional Learning (Ph.D.)

Advisor: Holly Anthony

Drug and alcohol addiction is a prevalent problem in the world today. It affects not only the individual but also the individual's family, community, and more. Therefore, understanding how some people overcome addiction could help in planning effective treatment and recovery programs. This research explored the experiences of three women in the Upper Cumberland region of Tennessee who overcame addiction and maintained recovery from addiction for at least five years. The study used narrative inquiry with semi-structured interviews, documents, and a photo elicitation interview to understand the participants' experiences and their journey of recovery.

Department of Exercise Science, Physical Education and Wellness

Undergraduate

THE DIFFERENCE IN STEP FREQUENCY IN SHOD VS. UNSHOD RUNNING

Primary Author: Johnny Perkins, Pre-Professional

Advisor: Michael Phillips

Co-Author(s)/Collaborator(s): Brianna Peach

The purpose of this study is to determine if there is a significant difference in step frequency between shod and unshod running. Unshod running has been shown to lead to a lower risk of injury and observing the physiological differences may help trainers, coaches, and athletes to decide the best state in which to train. Participants in the study were asked to run the length of a basketball court in both the shod and unshod conditions. Video was taken during these runs and later analyzed to count step frequency and determine a statistical difference between the two states. This study helps to show the kinematic changes in running gait that occur in the unshod condition and their effects on injury rate among athletes.

Abstracts

College of Engineering

Department of Chemical Engineering

Graduate

REVIEW - THE INFLECTION POINT OF ENGINEERING EDUCATION AND THE IMPACT OF INNOVATIVE PEDAGOGICAL TECHNIQUES TO SHIFT TOWARDS A LEARNING-BASED CULTURE

Primary Author: Bobby Adams, Chemical Engineering (M.S.)

Advisor: Pedro Arce

The expectation of an engineer's abilities in today's workforce is rapidly expanding into a very dynamic role; an engineering professional in today's society is more than a problem solver, s/he is also a problem identifier. This shift can largely be attributed not only to the recent advances in technology, improved rate of data manipulation, as well as the availability of new systems for accessing information but also to demanding societal needs for personalized medicine, personalize learning and saving energy. These technological challenges (and advances) motivate the people's capability for having more keen insights into effectively identifying challenges and solving problems and thus the potential for more innovative solutions is created. However, the methods and techniques that are needed in today's engineering education, although many available in the literature, have not kept up with the demands of society to develop engineering professionals capable of delivering the outcomes sought. This review focuses on identifying key successful efforts found at the college level and how leading universities are implementing them to develop a more holistic style of engineering professional. One goal is to present a systematic analysis of the transition from a traditional lecture-based culture into a modern learning-based. Moreover, efforts focused on developing an innovative, adaptable and societal impactful professional will be highlighted. Efforts centered on understanding the engineering education transformation towards a holistic style of engineering professional are vital for the success of future engineers that meet societal needs. Key examples related to these efforts will be illustrated.

Graduate

MODELING HEAT TRANSFER USING AN INTEGRAL EQUATION APPROACH VIA GREEN'S FUNCTION: APPLICATION TO CANCEROUS TUMOR UNDERGOING HYPERTHERMIA TREATMENT

Primary Author: Nastasia Allred, Engineering (Ph.D.)

Advisor: Pedro Arce

Co-Author(s)/Collaborator(s): Pedro Arce, Yung-Way Liu, Robby Sanders

In recent years, studies have been performed in which cancer tissues are exposed to high temperatures in order to damage/kill cancer cells. This treatment is referred to as hyperthermia, and the goal of this work is to develop a model that describes the heat transfer and temperature profile throughout a cancerous tumor undergoing hyperthermia. The model consists of two portions: linear and nonlinear aspects. The linear aspects of this transient model involve the accumulation and conductive transport terms of the model, while the nonlinear aspect of the

model involves the heat sources term resulting from applied hyperthermia treatment. The resulting model equation is a second-order, non-homogeneous partial differential equation and is challenging to solve using standard methods such as separation of variables, etc. Instead, a Green's function approach is employed which allows the problem to become decoupled and solved through the use of integral equations and associated eigenvalue problems.

Graduate

UNDERSTANDING THE ROLE OF DIFFUSION IN EFFECTIVE DRUG DELIVERY TO CANCEROUS TUMORS

Primary Author: Samantha Blanton, Engineering (Ph.D.)

Advisor: Pedro Arce

Co-Author(s)/Collaborator(s): Pedro Arce, Robby Sanders

Malignant tumors can be characterized by their highly disorganized, irregular vasculature. This disorganization leads to a toxic microenvironment and a host of drug delivery transport barriers are introduced. In order for effective drug delivery to occur, the fundamental role that diffusion plays in the reaction taking place in the tumor treatment must be analyzed. This will be helpful to better understand drug selection and drug delivery from the transport view point. The work presented here is aimed at understanding the role of diffusion and reaction at a fundamental level in a complex system like a cancerous tumor. Certain classes of tumors can be modeled as a hollow cylinder with a flow through the center. The hollow center represents an artery, and the annular region represents a segment of tumor tissue wrapped around it. The drug arrives by convective-diffusive transport in the artery and moves, by radial diffusion, towards the tumor domain. This “donut-style” domain may be modeled as a porous media with effective transport coefficients; such as in classical catalysis. In order to keep the analysis simple and general, a first order reaction is assumed. Included in this model are parameters such as the Thiele Modulus; that involve kinetic, transport and geometrical parameters of interest. This parameter can then be employed to find the Effectiveness Factor, which describes the restrictions and significance of diffusion and reaction within the tumor tissue. Details about the formulation, assumptions, results and implications of the study will be presented.

Graduate

THERMOMECHANICAL BEHAVIOR OF POLYMER FILMS AT CRYOGENIC TEMPERATURES

Primary Author: Bo Bonning, Engineering (Ph.D.)

Advisor: Holly Stretz

Co-Author(s)/Collaborator(s): Jordan Blackburn, Tennessee Technological University

The purpose of this study was to develop a theoretical approach to estimating mechanical properties of polymer films at cryogenic temperatures. Time-temperature superposition (TTS) was used as a mathematical tool for data extrapolation. TTS is commonly used to extrapolate polymer data taken at high temperatures to experimentally difficult to obtain data at long times. Here, however, the method is used to extrapolate data taken at short times to experimentally difficult to obtain data at very cold temperatures. A liquid crystal polymer (LCP) and a polyimide were tested on a TA Instruments Q800 Dynamic Mechanical Analyzer to obtain creep compliance data, which was then analyzed using TTS. The Arrhenius equation was used as the basis for this TTS model. Master curves were generated for the polyimide and for the machine and cross-machine direction for LCP by first calculating time-based shift factors for each set of isothermal creep data. Activation energy of flows, Ea,

were then calculated using the Arrhenius model. The effects of thermal history were also explored and found to affect the compliances. All data were accumulated within the range of testing temperatures varying from -140 to 20oC. Both polymers were found to have relaxation transitions within this range and predictions therefore initiate from the colder side of the transition temperature rather than the total range of data collected. Predictive equations, extrapolations of compliances to 4 K, as well as comparison of the value of the theoretical method versus empirical fitting approach will be discussed.

Graduate

ROLE OF ELECTRICAL FIELDS IN THE PRE-TREATMENT OF POLYACRYLAMIDE GELS FOR ENHANCING PROTEIN SEPARATIONS

Primary Author: Anfal Haris, Engineering (Ph.D.)

Advisor: J. Robby Sanders

Co-Author(s)/Collaborator(s): Pedro Arce, Caroline Ellis

Gel electrophoresis is usually used in separation of charged macromolecules, such as protein and DNA, based on their size, charge or both. Polyacrylamide gel electrophoresis (PAGE) is a widely used technique in protein-separations. Different techniques have been developed for modifying the porous structure of polyacrylamide gel, such as varying the concentration of acrylamide, using a templating technique, and introducing nanoparticles to the gel, to improve the separation of different protein sizes. In this research, the effect of electrical fields in pretreating the gels, i.e. pre-electrophoresis, to enhance protein-separation was investigated. Pre-electrophoresis is the application of an electrical field with constant voltage to the gel before protein-separations by electrophoresis take place. The influence of pre-electrophoresis was studied by comparing the separation results of multiple proteins of different sizes in two types of gel samples with the same acrylamide concentration. The only difference was that one gel sample was subjected to pre-electrophoresis prior to protein-separation, while the other was directly used for protein-separation without the pre-electrophoresis step. Three different gel concentrations were tested: 6%, 9% and 12%. The results showed that the application of the pre-electrophoresis had a significant effect on the protein-separations. The pre-electrophoresis technique enabled the resolution of all 10 proteins within a ladder of different sizes in polyacrylamide gels for low acrylamide concentration, while without this technique only 12% was able to separate all proteins. The novel effect of pre-electrophoresis has the great potential of reducing considerably the amount of gel material needed to conduct a separation.

Graduate

LEVERAGING SURPLUS ENERGY FROM NUCLEAR POWER GENERATION FOR SEAWATER DESALINATION: A CASE STUDY

Primary Author: Hunter Himes, Chemical Engineering (M.S.)

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Laura Arias Chavez

Co-Author(s)/Collaborator(s): Mary Adkisson, Katie Massie, Katlyn Schubert, Kristin Tilson

Nuclear power plants represent a large, untapped supply of low grade waste heat that could be utilized for seawater desalination. These facilities convert only 33% of the thermal energy generated into electrical energy, with the remaining 67% disposed of as unwanted heat. If an appropriate partner processes can be identified, this thermal energy can be used to desalinate seawater, enhancing coastal water supply without significantly

increasing energy demand. To effectively utilize the waste heat, a number of desalination technologies were investigated, including reverse osmosis, forward osmosis, multi-effect distillation, multi-stage flash distillation, membrane distillation, and adsorption / desorption distillation. These technologies were chosen for consideration as they each offer different advantages such as high recovery rates, energy efficiency, reliability, commercial availability and startup cost. We modeled the energy requirements and water production of these technologies using MATLABTM software to determine the best configuration to potentially pair with a nuclear power generation facility. The evaluation considered economic potential, environmental impact, product water quality, tolerance for energy intermittency and waste heat utilization as applied to a 300-megawatt thermal nuclear power plant in southeastern Florida.

Graduate

SEPARATION OF INORGANIC COMPONENTS FROM INDUSTRIAL WASTEWATER VIA A HYBRID FORWARD OSMOSIS – REVERSE OSMOSIS SYSTEM

Primary Author: Doug Huttes, Chemical Engineering (M.S.)

Co-Author(s)/Collaborator(s): Xi Zhe Ong, Leif Templeton

Advisor: Laura Arias Chavez

Driven by increasing need for sustainable water and energy, new technologies are being developed to provide these critical resources without waste. Renewable bio-feedstocks can be pyrolyzed to generate energy along with wastewater containing residual hydrocarbons and inorganics. Here we assess the potential for a hybrid forward osmosis (FO) - reverse osmosis (RO) system to reclaim all components of this complex wastewater. Fouling-resistant FO performs the first separation while RO regenerates the FO draw solution. Solute transport through each of these membranes can also be customized by independently adjusting the pH of the feed (wastewater) solution and the NaCl draw solution. By exploiting the pH-dependency of speciation for different contaminants, wastewater components can be sequestered in different parts of the hybrid system to achieve optimal fractionation. We quantified the transport and recovery of ammonia, cyanide, nickel, and zinc containing species across commercial and hand-cast FO membranes as a function of pH, recovery, and draw solution concentration. Transport of inorganic solutes depends on a complex combination of factors, in particular pH and the type of membrane used. We were able to gain insight into the specific composition of the wastewater by comparing pH dependency of solute transport with that expected for particular compounds (e.g., free cyanide vs. organic cyanides). These preliminary results suggest that the FO-RO hybrid system could be an effective process for reclamation of industrial wastewater and that additional study of this approach is warranted.

Graduate

MOLECULAR DYNAMIC STUDY OF INTERFACE PROPERTIES OF WATER- ASPHALT SYSTEM

Primary Author: Yi-Lun Lee, Chemical Engineering (M.S.)

Advisor: Liqun Zhang

Asphalt is a complicated mixture of millions of compounds. It is originally from crude oil distillation and is widely applied in road pavement and roof patching. One of the new developments in the asphalt technology is Warm Mix Asphalt, an environmentally benign and energy efficient technology compared with the state of practice of Hot Mix Asphalt (HMA). In warm mix asphalt technology, water was injected to behave as the lubricant to help asphalt mix with aggregate efficiently at

relatively low temperature. The interface formed between asphalt and water can affect the mixing process and the long-term properties of asphalt pavement. Thus, studying the interface properties of the water-asphalt system is important. In this project, we plan to understand the chemical composition of asphalt, microstructure and major physical properties of the interface between asphalt and water at different temperature conditions with the goal to improve the warm-mix asphalt process. As a first step, molecular dynamics simulations have been performed to work on the interfaces between the major components in asphalt and water. The surface tension of the interfaces, the interaction energy between different components, radial distribution function of different kinds of molecules along with other physical properties has been calculated. Those simulation predictions will be compared with experimental data. The result may suggest the best remedy to improve the warm mix asphalt technology.

Graduate

POLYMER GRAFTER NANO PARTICLES AND BARE NANOPARTICLES DYNAMICS IN POLYMER NANOCOMPOSITES

Primary Author: Koteswararao Medidhi, Engineering (Ph.D.)

Undergraduate Research and Creative Activities (URECA) Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Venkat Padmanabhan

Study on Polymer Nanocomposites (PNCs) increased prominently over past few decades because of their properties. Using LAMMPS simulation we investigated the thermo-mechanical properties of nanocomposites containing polymer grafted and bare nanoparticles. Our results indicate that presence of bare particles in the melt significantly affects the dynamics of polymer-grafted nanoparticles and the change is sensitive to grafting density and polymer backbone rigidity.

Graduate

CATALYTIC ACTIVITY AND STABILITY OF PT/TIO2, PT/TIN, AND PT/TIC CATALYSTS FOR OXYGEN REDUCTION REACTION IN PEM FUEL CELLS

Primary Author: Gholamreza Mirshekari, Engineering (Ph.D.)

Advisor: Cynthia Rice

Proton exchange membrane fuel cells (PEMFCs) are electrochemical energy devices which have become a major source of clean energy for automotive applications. Despite significant recent advances, the instability of carbon supported Pt nanoparticle cathode catalyst due to carbon support corrosion and weak metal-support interaction is still a critical problem. In order to address this issue, TiO2, TiN, and TiC supported Pt nanoparticles catalysts were synthesized using a simple polyol process. The oxygen reduction reaction (ORR) activity and durability of the synthesized catalysts have been investigated in acidic media of PEMFCs using rotating disk electrode (RDE) technique and compared with the commercial carbon supported Pt catalyst. The average Pt nanoparticles sizes are 1.95, 2.30, and 2.63 nm for the Pt/TiO2, Pt/TiN, and Pt/TiC catalysts, respectively. Among these three synthesized catalysts, the Pt/TiC catalyst has the highest stability and best catalytic performance with higher ORR current, electrochemical surface area (ECSA) and mass specific activity. The ORR performance of the synthesized Pt/TiC catalyst is found to be promising with higher area specific activity (Is) of 252 μA cm-2Pt and slightly lower mass specific activity (Im) of 0.16 A mg-1Pt than that of the

Pt/C with Is of 235.5 μA cm-2Pt and Im of 0.17 A mg-1Pt. Additionally, the Pt/TiC shows the outstanding stability with no reduction in ORR performance and 10.1% increase in ECSA after accelerated stress test (AST).

Graduate

MODELING OF CEMENT PASTE FOR 3-D PRINTING APPLICATIONS

Primary Author: Abdul Salam Mohammad, Engineering (Ph.D.)

Advisor: Joseph Biernacki

Fresh concrete consists of a cement paste matrix and fine and coarse aggregates. The rheological properties of concrete are dependent on the shape and gradation of the aggregates (coarse and fine) and the rheology of the cement paste matrix. Although aggregates play an important role on the characteristics of concrete flow, concrete flow properties are largely controlled by changes made to the cement paste rheology. The rheological parameters, which characterize the cement paste are the yield stress "τ0," which corresponds to the stress required to initiate fluid flow, and the plastic viscosity "μ0," which describes the paste resistance to flow under external stress. To study the rheological behavior of cement paste with respect to τ0 and μ0, a non- Newtonian Bingham Plastic model is used. Numerical simulations using COMSOL Multiphysics are being developed to describe the flow behavior of fresh cement paste in geometries (2D & 3D) relevant to the printing of cement. Various validation benchmarks were demonstrated prior to simulation of paste flow of spherical and cylindrical forms.

Graduate

TOWARDS SENSITIVE FLUORESCENT METAL NANOSENSORS, IR RANGE, FOR DUAL DETECTION OF NITRATES IN WATER

Primary Author: Mahdi Mohammadizadeh, Chemical Engineering

Advisor: Holly Stretz

In recent decades, the use of nutrients and fertilizers for agriculture has increased exponentially at a global scale with detrimental consequences on freshwater and marine ecosystems. Nitrate and Phosphate based nutrients cause serious health problems such as different forms of cancer, increasing Algae and eutrophication. Detection of these chemicals in water and soil has been a prominent field of research worldwide. In this study development of a dual sensor using both surface plasmon resonance (SPR) and fluorescence is introduced. Five different metal nanoparticles were tested in solution for spectroscopic properties and two were identified with potential as dual sensors, Egyptian blue and gold nanoparticles. The sensor will be designed to show emission in the infrared range. Subsequent results will be discussed where the nanoparticles were tethered to a glass surface using aminopropylsilane chemistry. These coatings are will not rinse off and are scratch resistant as well. The fluorescent and SPR response are both exhibited even in the form of a thin film. Future investigations will involve attachment to a prism surface and analysis of the sensitivity of the SPR and fluorescent simultaneous signal to nitrate ion in water.

Graduate

CEMENT PASTE DEVELOPMENT AND APPLICATION TO 3-D PRINTING OF CEMENTITIOUS STRUCTURES

Primary Author: Babajide Onanuga, Chemical Engineering (M.S.)

Advisor: Joseph Biernacki

Co-Author(s)/Collaborator(s): Joseph Biernacki, Matthew Whitaker

Building 3-D printed concrete structures is on the verge of transforming the construction industry. Researchers in China, the United Kingdom and the US have recently demonstrated the printability of large-scale structural components. Nonetheless, research on the fundamental materials science of printed cementitious bodies already lags years behind. Among the most fundamental questions to be asked involves the printability and microstructural continuity of such additively manufactured materials. A team of researchers including members from Tennessee Technological University (TTU), Vanderbilt University and Purdue University are presently pushing to find the limits of such fabricated structural elements by printing on the smallest length-scale possible. Part of this work requires the development of well-formulated cement-admixture systems and understanding their flow properties through experimental rheology, e.g. extracting yield stress and plastic viscosity under idealized conditions, as well as printing to obtain optimal print parameters including extrusion speed, layer thickness and print rate. The goal of this research is identification of suitable polymeric admixtures for effective printing. A TA Instruments rheometer and a Hyrel standard resolution 3-D printer were employed for flow testing and printing of the experimental pastes respectively.

Graduate

ORGANIC TRANSPORT AND FOULING IN FORWARD OSMOSIS SEPARATION OF INDUSTRIAL WASTEWATER

Primary Author: Xi Zhe Ong, Chemical Engineering (M.S.)

Advisor: Laura Arias Chavez

Co-Author(s)/Collaborator(s): Douglas Huttes, Leif Templeton

Fully reclaiming industrial wastewater instead of sequestering or degrading its components could broadly enhance sustainability across society. These wastewaters, containing high hydrocarbon concentrations, can be challenging to separate due to their complex composition and tendency to foul membranes. Forward osmosis (FO), like reverse osmosis (RO), uses a semi-permeable membrane to achieve highly selective separations. FO is driven by an osmotic pressure gradient, such that a "draw" solution is used to induce water flux through the membrane and into the draw solution. FO is therefore less prone to severe fouling than is RO, which is driven by an applied hydraulic pressure. We present a preliminary assessment of a hybrid FO-RO system to reclaim water, hydrocarbons, and inorganics from wastewater of a fast pyrolysis biomass-to-fuel production facility. The wastewater is concentrated with FO while RO regenerates the draw solution. To better understand the challenges and opportunities associated with separating this complex wastewater, performance was investigated as a function of draw solution concentration. Sodium chloride was selected as the draw solute. When raw wastewater with 4 wt% total organic carbon (TOC) was paired with a 1 M NaCl draw solution, water flux across a pristine thin-film composite membrane stabilized at 2 L m^{-2} h^{-1} after two hours of flux decline. TOC was rejected by the FO membrane at up to 90%. These preliminary results indicate that the FO-RO hybrid system may have potential for reclamation of complex wastewaters with high foulant concentrations at modest but stable water fluxes.

Graduate

INVESTIGATION OF STREAMING POTENTIAL FLOW OF HEAVY METAL ION CONTAMINANTS IN SOIL MATRIX: AN AREA-AVERAGING APPROACH

Primary Author: Oluwatosin Owoseni, Engineering (Ph.D.)

Advisor: Pedro Arce

Several electro-kinetic phenomena such as electro-viscous effects, streaming potential, electro-kinetic dispersion, etc. are some of the phenomena that occur during the flow of fluids and electrolytes in capillary channels having surface charges. When the dimensions of this capillary are on the same order of magnitude as the electrical double layer, EDL formed during such flows, the effects and phenomena cannot be ignored and they add up to define the characteristics and properties of the system.
For soil electrokinetic cleaning, the system under consideration is a contaminated soil matrix made up of capillaries of rectangular (or other geometries) with walls having (frequently) constant and uniform surface charge. The pressure-driven flow of heavy metal contaminants in the presence of an in-situ streaming potential is the subject of investigation in the study. The mathematical framework for this study is based on the area-averaging approach. By taking advantage of the disparate axial and transverse length scales of the microchannel pores found in the soil matrix, this approach helps to facilitate the development of a mathematical model that is based on effective parameters by which parametric studies can be conducted. The results would provide insight into the effect of combined pressure-driven and electroosmotic flows for electro-kinetic soil remediation. The effect on the effective velocity of macro-heterogeneities, related to the orientation of individual pores in the soil matrix is also investigated and illustrated

Graduate

ADVANCED OXIDATION OF HERBICIDES CONTAMINANTS: TESTING A NEW APPROACH FOR THE DEGRADATION BY PHOTOCATALYTIC METHODS VIA TIO2 THIN FILMS (WITH SIMULTANEOUS PRODUCTION OF HYDROGEN)

Primary Author: Sunil Rawal, Environmental Sciences Chemistry (Ph.D.)

Advisor: Pedro Arce

The ability to produce energy from contaminated water treatment is new effort on the Energy-Water Nexus. Especially, contamination from agriculture uses of herbicides and pesticides contaminated our clean water supply. A four- step technology is being developed to recycle contaminated water and produce hydrogen as potential use in fuel cells. The technology is based on the use of TiO2 thin films to replace the current costly use of nanoparticles in batch-designed systems that requires elimination of the particles by filtration. The four steps involved in the technology include a- Manufacturing and characterization of the thin films, b-Testing the production of Hydrogen and comparison with other techniques, C-Testing the degradation of agricultural-based contaminants herbicides via thin films and d-Combination of step b and c to simultaneously produce hydrogen and decontaminate water. The production of H2 via the thin films has been achieve based on pure water. This work is focuses on the use of advanced oxidation techniques, specifically the use of photo-catalytic degradation processes via TiO2 nanoparticles to degrade herbicides. The reactor equipped with UV-lamp and the TiO2 nanoparticles has been applied to the degradation of contaminant via UV-photocatalytic methods on different concentration of catalyst and herbicide. Favorable conditions for contaminant degradation (~60%) were identified at high concentration of contaminants vs high concentration of titanium dioxide at 90 minutes of treatment.

The next work will be focused on the reduction kinetics of the pollutants by using UV-Photocatalytic processes suitable for the potential simultaneous production of H2(g) from herbicides contaminated water.

Graduate

MOLECULAR DYNAMICS SIMULATIONS OF LIGNIN-MODIFIED MODEL ASPHALT

Primary Author: Kolawole Sonibare, Chemical

Engineering (M.S.)

Advisor: Liqun Zhang

Approximately 18 billion tons of asphalt goes into the paving of American roads. Road construction requires large amount of materials as well as huge energy cost, not forgetting the implications of the construction on the environment. Crude oil, a major source of asphalt binder becomes expensive to obtain and refine, thus increasing the cost of road construction material. In order to promote sustainability and reduce construction costs, there is a need to integrate greener materials into the production of asphalt mixtures to design long-lasting asphalt at specific road condition.

Lignin is a class of organic aromatic polymers responsible for the rigidity and strength of plants. In order to design the optimum biomass-modified asphalt, understanding the relationship between the chemical composition, microstructure, and major physical properties of lignin-modified asphalt is important. In this project, molecular dynamics simulations of the lignin and model asphalt mixtures have been carried out. The asphalt model consists of three components: the asphaltene, aromatic, and saturate. The lignin model consists of long-chain guaiacyl units. Major physical properties include density, viscosity, thermal conductivity, expansion coefficient, and microstructure such as the radial distribution function will be predicted for lignin-asphalt mixtures at different temperatures. The simulation prediction from this study will be compared to reference data. The result will help to design the best biomass-modified asphalt.

Graduate

DIFFUSION AND CONCENTRATION PROFILES FOR LOADING DL-PROPANOLOL IN A CROSSLINKED DRUG CARRIER, POLY(N-ISOPROPYL ACRYLAMIDE) HYDROGEL

Primary Author: Hajar Taheri Afarani, Engineering (Ph.D.)

Advisor: Holly Stretz

As drug carriers, hydrogels feature the ability to hold a large quantity of a hydrophilic drug with highly tunable release profiles by adjusting the physicochemical properties of the polymer. Thermally sensitive polymeric hydrogels composed of poly (N-isopropylacrylamide) (PNIPAm) have attracted the attention of researchers recently due to its temperature-dependent phase transition properties. The drug in the present research was DL-propranolol hydrochloride, a synthetic beta-adrenergic receptor blocker. In this study the diffusion coefficient of drug in water was both modelled and experimentally determined The mass transfer experiment used a syringe method. UV-visible spectra of the DL-propoanolol showed a characteristic peak at 290 nm. The spectra at 8, 10 and 14 hours showed characteristic time dependent concentration profiles. An equilibrium partition coefficient was also measured at much longer times. These data will be used to parameterize a COMSOL-based model to understand the real-time loading of the drug in a massively arrayed microfluidic environment under continuous flows.

Graduate

UTILIZING DESALINATION BRINE FOR CONCENTRATION OF ORANGE JUICE VIA FORWARD OSMOSIS

Primary Author: Haley White, Engineering (Ph.D.)

Advisor: Laura Arias Chavez

Co-Author(s)/Collaborator(s): Shelby Jones, Leif Templeton

Forward osmosis (FO) is a water separation process

utilizing a natural osmotic pressure gradient to induce flux through a semi-permeable membrane. When compared with other water separation technologies, FO is exceptionally energy efficient unless regeneration of the draw stream is required. To avoid regeneration, highly concentrated 'waste' streams can potentially be leveraged as single-use draw streams. We investigated one potential implementation of this strategy by concentrating orange juice in a bench-scale FO system using commercial membranes and NaCl draw solutions that simulate 60% recovered seawater desalination brine. Water was extracted from the juice at ~1 L m-2 h-1 at 25 °C with 1 M or 1.2 M NaCl draw solutions. The performances of both pristine and fouled membranes were characterized by measuring water flux with a DI water feed and NaCl draw solutions before and after juice concentration. Fouling associated with juice concentration was highly reversible, with over 97% of initial water flux recovered after juice exposure. Juice concentrates satisfied quality standards at up to 32% recovery. FO experiments were completed at 25 °C and 15 °C to estimate the osmotic pressure of orange juice and the sensitivity of water flux to draw solution dilution and juice concentration. From this data, we can predict the maximum juice concentration that can be achieved in FO using desalination brine as the only significant source of energy. This proof of concept study shows the untapped potential of waste streams to drive forward osmosis separations for increased sustainability at the water-energy-food nexus.

Graduate

STUDY OF THE INTERACTIONS OF HUMAN B DEFENSIN TYPE 3 PROTEIN WITH POPS AND POPC MEMBRANE

Primary Author: Rabeta Yeasmin, Chemical Engineering (M.S.)

Advisor: Liqun Zhang

Co-Author(s)/Collaborator(s): Liqun Zhang

Human β defensin type 3 (hBD-3) is a cysteine rich small peptide, which has 45 residues and a charge of +11. It can form dimer or higher order oligomer in solution. It has a broad spectrum of antimicrobial activities against virus, fungus, and both Gram-positive and Gram-negative bacteria even at high salt concentrations. Its antibacterial activity is believed to depend on its interaction with biological membrane. In order to understand the interaction mechanism of hBD-3 with lipid membrane, in this study, the interactions of hBD-3 dimer with 1 -Palmitoyl-2-oleoyl-sn-glycero-3 –phosphatidylserine (POPS) bilayer, which resembles negatively charged bacterial membrane and 1 -Palmitoyl-2-oleoyl-sn-glycero-3 –phosphatidylcholine (POPC) bilayer, which resembles neutrally charged human red blood cell membrane are investigated using all- atom molecular dynamics simulations. Inserting hBD-3 dimer into the center of the POPC lipid bilayer and POPS lipid bilayer, 55 ns all-atom molecular dynamics simulations were performed on each system. Analyzing the RMSD and RMSF on hBD-3 dimer, it is found that hBD-3 dimer is more flexible in POPS lipid bilayer than in POPC bilayer. Calculating the hydrogen bonds formed between hBD-3 dimer and lipids, hBD-3 dimer forms more hydrogen bonds with POPS lipid than with POPC lipid. The insertion of hBD-3 dimer into lipid bilayer causes membrane thinning, which is stronger in POPS lipids around the hBD-3 dimer than in POPC lipid bilayer. Besides that, it is found that almost same number of water molecules transpass through POPS and POPC lipid bilayer.

Graduate

MOLECULAR DYNAMICS SIMULATION STUDIES ON THERMAL CONDUCTIVITY OF ORGANIC MOLECULES

Primary Author: Chuanxing Zhan, Chemical Engineering

Advisor: Liqun Zhang

Thermal conductivity is an important property of polymer nano-composite materials. Both materials with high thermal conductivity and low thermal conductivity have board applications in OLED screen, solar cell, conductivity nanopaper and heat insulant. In order to design composite material with the desired thermal conductivity, understanding the structure factors and mechanism of those factors influencing the thermal conductivity in molecular detail is important. Doing molecular simulations is the appropriate method to work on it first. Since the molecule functional groups can affect the thermal conductivity of organic molecule, in this work, molecular dynamics simulations were conducted to study the thermal conductivity of materials with different functional groups. The models of molecules (Benzene,1-Propylamine, Acetone, Methoxyethane, Methyl acetate, Propionic acid, Propionaldehyde) were built in MCCCS Towhee program and the thermal conductivities were predicted by all-atom molecular dynamics simulations using Lammps program. The thermal conductivity predicted were compared with available experimental data. Satisfying agreement has been reached. In the future work, the influence of mixing carbon nanotube (CNT) filler in ethylene-vinyl acetate (EVA) would be investigated using the same strategy.

Graduate

THE KINETIC OF BIOMASS FAST PYROLYSIS USING NOVEL MICROSPHERE MICRO-REACTOR TECHNOLOGY

Primary Author: Ali Zolghadr, Chemical Engineering

Advisor: Joseph Biernacki

Biomass fast pyrolysis promises to be an effective and environmentally sustainable path to renewable energy and organic starting materials, i.e., a replacement for petroleum. In biomass fast pyrolysis, the reactor is the performance-controlling process and a variety of alternatives have been considered at all scales, laboratory, pilot and pre-commercial/commercial. Factors including gas and condensed-phase residence time, type and amount of pyrolysis products and geometry of particles have not been clearly correlated. To close this gap, a novel laboratory-scale microsphere micro-reactor (MSMR) fast pyrolysis technique and associated technology for production of manufactured biomass microspheres was designed and manufactured. The MSMR was used to study fast pyrolysis of whole biomass (switchgrass and tall fescue) and cellulose at different temperatures (500-900°C) and a continuum-base model developed to investigate the effect of transport conditions, e.g. temperature inside the biomass microsphere, for different size particles (100-400 μm) during the highly dynamic process. Finally, the kinetics of the reaction and time-domain chemistry changes during fast pyrolysis was studied to understand the mechanism of fast pyrolysis by coupling the micro-reactor with a fast flame ionization detector (fast-FID) and fast scan speed, low residence time mass spectrometer at Pacific Northwest National Laboratory (PNNL). Also, biomass microspheres were used to study the dynamic shrinkage of biomass during slow pyrolysis and the uniformity of microsphere particle is examined by several measures of merit.

Undergraduate

ENGINEERING VARIANT FORMS OF ALPHA-1-ANTITRYPSIN

Primary Author: Abigail Collins, Chemical Engineering

Advisor: J. Robby Sanders

Co-Author(s)/Collaborator(s): Bryan Materi, Amber Monroe

Alpha-1-antitrypsin deficiency (A1AD) is a genetic condition that can lead to early onset emphysema and with some versions of the condition, can also lead to complications such as liver cirrhosis. A1AD affects around 100,000 people in the U.S., with a diagnosis rate of less than 10 percent. Diagnosis is complicated and time-consuming, and the symptoms of A1AD mimic those of asthma which may delay diagnosis and treatment. This suggests a need for new diagnostic tests.

The "normal" form of the alpha-1-antitrypsin protein (i.e., the M form) is expensive but otherwise readily available commercially for purchase and study. However, the mutated versions (i.e., variants of the protein associated with A1AD or total absence of the protein) are not available, which leads to the need to produce these mutated forms. To do so, we acquired plasmid DNA containing genes for both the M form and the Z form which is the variant most often associated with A1AD. These plasmids will allow expression of the M and Z forms in mammalian cells, but this is expensive. Thus, to enable the variants to be produced in non-pathogenic bacteria (which represents a much cheaper alternative), these plasmids were cut using restriction enzymes such that the genes for the M and Z forms could be isolated and inserted into a plasmid to allow for propagation in chemically competent E. coli cells. Herein, we report on the progress to date in the production of normal and variant forms of A1AT.

Undergraduate

EXPLORATION OF MUTATIONS OF ALPHA-1-ANTITRYPSIN

Primary Author: Shelley Edwards, Chemical Engineering

Advisor: J. Robby Sanders

Alpha-1-Antitrypsin is a protein that functions as a protease inhibitor specifically for neutrophil elastase, an enzyme which breaks down elastin in the lungs. Mutations in the Alpha-1-Antitrypsin gene can ultimately result in various liver and lung diseases from deficient or ineffective protein. Literature searches were conducted to (1) gather information on normal and abnormal amino acids and corresponding codon sequences in the gene, (2) effects on the body, and (3) susceptibility of disease for the most prevalent mutations that cause a deficiency in Alpha-1-Antitrypsin. Having this resource of information divided into four categories (normal, deficient, null, and dysfunctional) will aid in creating a library of mutated forms of Alpha-1-Antitrypsin in the laboratory. Understanding and having access to the null mutant form, Hong Kong which results in a truncated form of Alpha-1 Antitrypsin, as well as other mutated versions will allow for future studies of inhibitory capacity of various forms of Alpha-1 Antitrypsin. Studies to be conducted in the near future include: (1) using a restriction enzyme other than EcoRI in an effort to cut the Null-Hong Kong gene from a plasmid stored in the lab (a process that has not worked using EcoRI), (2) checking that the plasmid has the correct gene sequence that codes for the truncated form, and (3) exploring the viability of an alpha complementation experiment to confirm that the mutated form is inserted into the plasmid.

Undergraduate

STRUCTURAL COMPARISON OF HUMAN BETA DEFENSIN TYPE 3 IN VACUUM, IMPLICIT AND EXPLICIT SOLVENTS USING NAMD, FMO-DFTB3 AND CHARMM

Primary Author: Mouhmad Elayyan, Chemical Engineering

Advisor: Liqun Zhang

Co-Author(s)/Collaborator(s): Stephen Irle, Oak Ridge National Labs; Liqun Zhang

The primary defense system of the human body for fending off invasive organisms, such as bacteria, viruses and fungi, is known as the “Immune System”. Although the immune system is comprised of specialized cells and tissues, one crucial component that is located in the stomach and intestine lumen, as well as the epidermis, are epithelial cells. Pertaining to secretion and protection, epithelial cells release an antimicrobial peptide in the mucus bilayer known as “Human Beta Defensins”, or noted as HBD’s, and are tasked in the warning, resistance and amelioration of foreign organisms.

The method of recording HBD’s performance during attacks on foreign organisms is accomplished through different simulation techniques that monitor the stability, motion and dynamics of HBD interaction with its surrounding environment. This is done by employing energy calculations, root mean squared deviations, root mean squared fluctuations and other parallel calculations. The three types of simulation that will be used throughout the research are: Nano Molecular Dynamics (NAMD), Chemistry at Harvard Molecular Mechanics (CHARMM) and Fragment Model Orbital method using Density Functional Tight Binding (FMO-DFTB3). Virtual Molecular Dynamics (VMD) is also utilized for the visualization of structural changes While each of the program’s computational techniques vary, the predicted results will show an overlap in HBD - environment interactions. As well, Preliminary results show an overlap in vacuum and explicit results. Ergo, the operating purpose is to monitor and compare the structure of HBD-3 in a vacuum and implicit and explicit solvents using NAMD, FMO-DFTB3 and CHARMM respectively.

Undergraduate

MOLECULAR SIMULATION ON HUMAN BETA DEFENSIN TYPE 3 INTERACTION WITH LIPID MEMBRANES

Primary Author: Christopher Elson, Chemical Engineering

Advisor: Liqun Zhang

Defensins are cationic cysteine rich small molecules with molecular masses in the range of 3-5 kDa. They belong to the innate immune system. Mammalian defensins can be classified into α, β, and θ categories. Human β defensin type 3 (hBD-3) is mainly secreted from the epithelial cells. It has antimicrobial activities by killing virus, fungus, both gram-positive and gram-negative bacteria even at high salt concentration. It is known the hBD-3 kills bacteria by directly interacting with the lipid membrane, but the molecular details are still unknown.

In this study, all-atom molecular dynamics simulations are performed to investigate how hBD-3 interacts with different kinds of lipid membranes. To achieve this goal the defensin is currently being modeled interacting with both neutrally charged lipid bilayers such as POPC which represents the normal red blood cell membrane, negatively charged lipid bilayers such as POPS, and POPG which represent bacterial membranes. The initial systems were set up using CHARMM-GUI online program and, all-atom NAMD molecular dynamics simulations were conducted. VMD has been applied to analyze the simulation trajectory. Up to now, around 10 nanoseconds of simulations have been performed. Approaching of hBD-3 to lipid membranes has been observed. The binding between hBD-3 and POPS and POPG is much stronger than with POPC lipid bilayer. The result will help in understanding the selectivity of hBD-3 interaction with different kinds of membranes, the binding dynamics of the hBD-3 with lipid membrane, and will help designing improved antibiotics in the future.

Undergraduate

BATCH-SCALE SYNTHESIS OF A NEW INORGANIC SORBENT FOR EXTRACTING LITHIUM FROM BRINE

Primary Author: Tessa Eskander, Chemical Engineering

Advisor: Parans Paranthaman

Giga factories are being built around the world to meet the growing demand for lithium batteries – but despite increasing demand, the domestic supply of lithium (Li) remains relatively constrained. The limited sources of Li now make this metal strategically important. Natural sources of Li include spodemene minerals and salt-lake brines. Both of these processes for securing Li are costly and time-consuming. A new method is now being developed to extract Li from salt-lake brines, using well-crafted sorbents. A Li sorbent is a material that extracts Li ions selectively from an aqueous solution, while leaving other ions, such as sodium, calcium and potassium, in solution. When absorption sites on the sorbent are loaded with Li, the Li can be desorbed by rinsing the sorbent with Deionized-H2O. Our project focused on synthesizing Lithium-Aluminum Layered Double Hydroxide Chloride, xLiCl*2Al(OH)3*mH2O (Li/Al LDH). Li/Al LDH is highly selective for Li, and should be readily scalable to industry needs. We also synthesized and tested 3 manganese-based sorbents. For large-scale synthesis of Li/Al LDH, we determined concentration, time, and quantity needed in a 750-ml capacity batch reactor. We successfully synthesized ~ 200 g of Li/Al LDH in a single batch. X-ray diffraction data revealed the presence of a single LDH phase. We are currently testing Li sorption from bine solutions through Li concentration measurements made by inductively coupled plasma optical emission spectrometry. By scaling the Li/Al LDH sorbent process to pilot-scale production, American industries can now better meet the rapidly increasing demand for Li.

Undergraduate

TOWARD 3-D PRINTING OF AMPHORA AND GOLD-CORE/IRON-SHELL NANOPARTICLE COMPOUND SENSORS

Primary Author: Ryan Johnson, Chemical Engineering

Advisor: Holly Stretz

Co-Author(s)/Collaborator(s): Holly Stretz

3-D printing is a newer technology in the emerging field of additive manufacturing. The potential to expedite customized production of anything exists provided there is a 3-D printer capable and a filament viable to use in the print. In this case, the target polymer compound to be printed is composed of an optically clear Amphora polyester blended with gold-core/iron-shell nanoparticles which has potential applications in 3-D printing of sensors. This research is about developing a process to effectively form the filament from a DSM microcompounder, and specifications for the formed filament for use in a Makerbot Replicator 2X include a tight tolerance on the filament diameter of 1.75 mm. The filament produced must have the nanoparticles dispersed within it, maintain the nanoparticle sensing properties despite thermal cycling at about 240oC, and maintain optical quality transparency critical to the sensors' successful operation. Future work involves printing a sensor-embedded part from the formed filament and measuring the optical properties of the finished product.

Undergraduate

DIRECT CARBONATION OF CA(OH)2 USING SUPERCRITICAL CO2 AT DIFFERENT TEMPERATURES

Primary Author: Daniel Klingenberg, Chemical Engineering

Advisor: Joseph Biernacki

Co-Author(s)/Collaborator(s): Ali Zolghadr

The production of portland cement is responsible for about 7% of the global carbon dioxide (CO2) emissions. Roughly one ton of CO2 is produced for every ton of cement. The direct carbonation of calcium hydroxide Ca(OH)2 has recently been suggested as a possible CO2-neutral replacement for portland cement in some applications, e.g. prefabricated cement-based construction components. The art of burning limestone (CaCO3), the formation of slaked lime (calcium hydroxide) and subsequent carbonation has been practiced since at least Roman times as a form of cement. The process, however, is generally too slow to be practical for most modern applications. This study examines the use of supercritical carbon dioxide at three different temperatures at a constant pressure. The different temperatures were chosen to study how temperature effects the acceleration of carbonation while in the supercritical state. Discs of Ca(OH)2 were compacted at various pressures and thicknesses (different mass) to produce samples of different density and size. The primary goal of this study was to determine the practical limits of carbonation of Ca(OH)2 and to collect relevant kinetic and morphological (microstructural) information. X-ray diffraction and electron microscopy was used to characterize carbonated samples. A full-scale heat and material balance for a pilot plant that utilizes this technology was also conducted in order to determine its feasibility on the industrial scale.

Undergraduate

DETECTION OF LEAD CONTAMINATION IN WATER USING FLUORESCENCE OF FUNCTIONALIZED GOLD NANOPARTICLES

Primary Author: Parker Lusk, Chemical Engineering

Undergraduate Research and Creative Activities (URECA) Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Holly Stretz

Co-Author(s)/Collaborator(s): Erick Kapamas; Corey Stafford; Martha Wells, Emeritus Professor of Chemistry, TTU

External Collaborator(s): Martha Wells, Emeritus Professor of Chemistry Tennessee Technological University

The goal of this research was to determine whether functionalized gold nanoparticles can be useful as a sensitive residential fluorescent sensor for lead contamination in drinking water. In the future, such nanoparticles could be dispersed into a membrane visible through a window inside a household tap filter. A large body of work exists in the literature concerning use of gold nanoparticles to detect lead. Almost all of these depend on a visible color shift, which is less sensitive compared to fluorescence and can confuse the consumer. The 5 nm diameter gold nanoparticles (GNPs) were functionalized with 11-mercaptoundecanoic (MUA) acid. Controls and MUA-GNPs were exposed to lead ion/water concentrations as low as the EPA drinking water limit, 15 ppb. The fluorescent response was tested using excitation/emission matrix spectroscopy (EEMS). Corrections were performed on the data for inner filtering and Raman and Rayleigh scattering of water. The GNPs were shown to detect lead at varying concentrations, enhancing the fluorescent intensities of fluorophores at some concentrations and quenching at others. This result is possible if the lead ion was changing the state of aggregation of the colloidal solution in a concentration-dependent manner for the ranges tested and concentration therefore affected the distance at which the ion was adsorbed/spaced from the

GNP surface.
Undergraduate

MODELING EVAPORATION FROM DESALINATION BRINE PONDS TO ACHIEVE ZERO LIQUID DISCHARGE

Primary Author: Katie Massie, Chemical Engineering

Advisor: Laura Arias Chavez

The global water supply is not sufficient to support our current population and projected population growth. Desalination can be used to increase water supply, but it can be energetically, economically, and environmentally costly, in part because of its production of concentrated brine streams. Brine evaporation ponds could potentially eliminate the brine stream and its associated costs, achieving zero liquid discharge. However, slow evaporation rates can make the physical footprint of evaporation ponds prohibitively large. We propose that evaporation rates can be increased by using waste heat from a nuclear power plant to warm the pond. A model of evaporation from saline ponds as a function of pond temperature was developed. This equation also considers salinity, air temperature, humidity, and wind speed in predicting evaporation flux from the pond surface. Results from this model can be used to analyze the feasibility of waste-heat-accelerated evaporation ponds for reducing desalination brine impacts.

Undergraduate

SIMULTANEOUS PHARMACEUTICAL ENCASEMENT IN NIPAM-BASED HYDROGELS

Primary Author: Casey McCormick, Chemical Engineering

Advisor: Holly Stretz

Co-Author(s)/Collaborator(s): Logan Gardner, Dusty Henson, Conner Hintze

Hydrogels are a network of polymeric chains which trap water within their matrix and have wide-spread use within the biotechnology sector. Novel hydrogel technologies are a key area of study for polymer researchers in both polymer chemistry, materials science, and polymer engineering because several of these have shown promise as pharmaceutics technologies. Several NIPAM-based hydrogels were synthesized simultaneously with hydrocortisone sodium succinate (steroid medication) and propranolol (beta-blocker) to determine batch process formulation for further work in microfluidic environments. Analyses were carried out with UV-VIS and several fluorescence techniques for steroid concentrations were explored. Data showed propranolol did not incorporate as well based on kinetics observations, but that steroids are more promising for this novel technology.

Undergraduate

IMPROVED ANODE CATALYST FOR FORMIC ACID FUEL CELLS

Primary Author: Kailey Pemberton, Chemical Engineering

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Cynthia Rice

The use of direct formic acid fuel cells (DFAFCs) in portable electronic devices can improve available power density and convenience, compared to today's rechargeable batteries. Unfortunately, current DFAFC anode catalysts either have high parasitic overpotentials and/or deactivate over time. This deactivation causes a decrease in sustained performance of the catalyst over

time. A typical anode catalyst used in these DFAFC consists of carbon supported platinum nanoparticles with a sub-monolayer of bismuth (Pt/C-Bi). Over time, bismuth is oxidized and lost from surface resulting in deactivation of the catalyst nanoparticles, which leads to the DFAFC losing performance. Initial studies with citrate have demonstrated strong surface adsorption to Pt. Linear sweep voltammetry in formic acid shows minimal electro-oxidation performance on pure Pt and a full monolayer of citrate. However, for a submonolayer of citrate the activation overpotential is reduced to 0.2 V vs. RHE due to the significant contribution to the direct reaction pathway. The goal of this project is to continue exploring stable alternative adsorbates to replace bismuth in order to maximize power density and durability of DFAFCs.

Undergraduate

A METHODOLOGY FOR ASSESSING THE INTERNAL CONSISTENCY OF KINETIC DATA

Primary Author: Jackson Penfield, Chemical Engineering

Advisor: Joseph Biernacki

In the present work a mathematical technique is suggested for examining the internal consistency of a chemical kinetic dataset. As an example, a kinetic dataset provided for biodeisel synthesis was used which is thought to have internally inconsistent rate laws. The method utilizes a rigorous formalism for establishing the correct number of balanced stoichiometric reactions needed to fully descibe the material balance between N species. A number of problems persist in the kinetics literature including inconsistent reaction schemata, incomplete reaction schemata and inconsistent rate laws. The proposed mehodology provides a strategy for testing the internal consistency of such kinetic information.

Undergraduate

SIMULATION OF MICROFLUIDICS IN A MEANDERING CHANNEL AND VIABILITY OF A MANUFACTURED MICROFLUIDIC DEVICE FOR MEDICAL APPLICATIONS

Primary Author: Dennis Piercy, Chemical Engineering

Advisor: J. Robby Sanders

Co-Author(s)/Collaborator(s): Kurt Dunham

A study was conducted on microfluidic mixers for the medical applications of screening alpha-1 antitrypsin deficiency and wound transport phenomena. A micromixer utilizes a microfluidic channel to mix feed streams, such as elastase and substrate or fibrinogen and thrombin. There are several micromixer designs, the simplest being a zig-zag channel. The research focuses on exploring how the design of microfluidic channel affects the mixing, using experimental and simulation approaches. A microfluidic mixer must be constructed to conduct microfluidics experiments, and a simulation is built using software as a precursory step to experimentation. The simulations were constructed and calculated using ComSol® . After building the initial mixer channel, the particular physics and conditions were applied in order to produce a concentration profile. The steps to manufacture a micromixer include: designing the zig-zag template, preparing a PDMS gel, submerging the template in PDMS, curing PDMS, dissolving the template, then running microfluidic experiments. Inconsistencies were found in the produced PDMS gels for each trial. Some gels were solid and firm, while others remained viscous. Also, the ABS templates were not easily dissolved with acetone. The simulations yielded results about the relationship between geometry, diffusion coefficient, degree of mixing, and residence time. To further the research, the procedure must be refined to produce gels that are consistent for each trial. Some recommendations include: finding

the ideal ratio of elastomer to curing agent, finding the ideal oven temperature and heating time, finalizing a micromixer geometry, and finding the solubility of ABS in concentrated acetone.

Undergraduate

TIO2/CDS PHOTOCATALYTIC DEGRADATION OF CARBAMAZEPINE, A PHARMACEUTICAL CONTAMINANT IN WASTEWATER

Primary Author: Rebekah Preshong, Chemical Engineering

Advisor: Pedro Arce

Co-Author(s)/Collaborator(s): Nastasia Allred; Pedro Arce, Tennessee Tech University; Kristina Jevtic

Substantial usage of pharmaceuticals and personal care products (PPCPs), which cannot be successfully broken down by traditional methods of water treatment, is leading to contamination in wastewater, groundwater, and even drinking water, posing potential harm to people and to aquatic life. Photocatalytic degradation is an advanced oxidation process (AOP) that provides an effective method for degrading these substances. The goal for this research project is to examine the degradation of carbamazepine (CBZ), a model PPCP, by titanium dioxide (an inexpensive, non-toxic, and popular wide-bandgap semiconductor) combined with cadmium sulfide (which has a smaller bandgap). To this end, this research seeks to determine (1) to what degree the addition of CdS extends—desirably into the visible spectrum—the range of light that can activate the photocatalyst, (2) the optimal ratio of CdS to TiO2, and, of most interest, (3) the possible pathway by which the composite photocatalyst will degrade the model contaminant. This research will primarily focus on analyzing possible pathways based on literature reports and presenting the preliminary designs of experiments to obtain information about the conditions involved in CBZ degradation. The third goal mentioned above can be the focus of more extensive future research involving an analysis of the movements and roles of the electrons and holes of the combined semiconductors, the extent to which hydroxyl radicals effect CBZ degradation, and perhaps also the intermediates involved as CBZ is degraded.

Undergraduate

USE OF EXCESS ENERGY FROM NUCLEAR POWER GENERATION FOR SEAWATER DESALINATION VIA FORWARD OSMOSIS

Primary Author: Katlyn Schubert, Chemical Engineering

Advisor: Laura Arias Chavez

Due to the rising global population and increasing demand for potable water, the need for desalination is growing. Desalination is an intrinsically energy intensive process, which makes it unsustainable for long-term, widespread use. We propose the use of excess energy from nuclear power production to desalinate seawater as a solution to this problem. Two-thirds of the thermal energy released from a nuclear reactor is discharged as waste heat under typical operation. Forward osmosis (FO) is a highly selective membrane process that can desalinate high salinity brines while being powered almost exclusively by low temperature thermal energy. In order to assess the feasibility of waste-heat-powered FO, a MATLAB model of material flows through an FO system was created. This model was based on a pilot demonstration described in the literature. In this demonstration, water from a highly concentrated brine passes through a membrane into an ammonia – carbon dioxide draw solution that has a much higher osmotic pressure. The diluted draw stream is then distilled using waste heat to obtain purified water and a

reconcentrated draw solution, which can then be recycled back to the membrane. Osmotic pressures of the draw and feed streams were estimated and used to predict water and solute fluxes across the membrane. These results enable us to analyze the overall technical performance of the system in leveraging waste heat for seawater desalination.

Undergraduate

ASSESSING THE WATER-ENERGY IMPACT OF IMPLEMENTING FORWARD OSMOSIS INTO THE SODA PRODUCTION PROCESS

Primary Author: Kaleb Stroud, Chemical Engineering

Advisor: Laura Arias Chavez

Water scarcity is one of the most significant challenges that the globe currently faces, despite advancements in water treatment technologies in recent years. This ever-growing problem has led to increasing dependence on traditionally unusable water resources, such as seawater or municipal wastewater, for fresh water production. Seawater desalination processes like reverse osmosis are energy intensive. The natural phenomenon of forward osmosis (FO) is inherently more sustainable because it requires no additional energy input; it relies on an osmotic pressure gradient to drive pure water through a highly selective membrane into a concentrated “draw solution”. This research assesses the feasibility of implementing FO by using concentrated soda syrup as a draw solution to extract water from municipal wastewater. The selectivity of FO membranes prevents small, water-borne pathogens in the wastewater from passing into the soft drink product. Water reclaimed from this wastewater will displace existing use of municipal drinking water, reducing the overall water demand. The impact of implementing FO at the Southeast Bottling facility in Dade City, Florida was analyzed. Southeast Bottling can produce up to 288,000 bottles (96 fl oz) per day at maximum capacity, consuming an estimated 0.180 Mgal/d of drinking water that could be displaced by wastewater reclaimed in FO. This water represents 28.2% of Dade City’s water use, equivalent to the daily water needs of ~2,000 people. Reducing Dade City water demand also reduces energy consumption at the nearby Tampa Bay Seawater Desalination Plant by 684 kWh/d.

Undergraduate

THE EFFECTS OF CRYSTALLINITY AND PARTICLE SIZE ON PYROLYSIS RATE

Primary Author: Patricia Wamea, Chemical Engineering

Advisor: Joseph Biernacki

Co-Author(s)/Collaborator(s): Michael Adenson, Joseph Biernacki

The effects of crystallinity and particle size on pyrolysis rate of switchgrass and tall fescue were studied. Pyrolysis is the thermal degradation of biomass in an inert environment for the production of fuels, chemicals, and char. In previous work, particle sizes of the biomass feedstock were reduced from mm size grains to between 750 and 50 µm via a mild milling operation before the particles were then aggressively milled to 15 µm. The crystallinity of the biomass was subsequently measured using an X-ray diffractometer and the pyrolysis rates were determined using derivative thermogravimetric analysis (DTG). The temperature of maximum rate of thermal decomposition (TDTG-max) was used to characterize the rate of decomposition of the biomass. It was found that crystallinity changed by an order of magnitude due to aggressive milling of biomass and the corresponding TDTG-max was found to shift to lower temperatures.

Regression analysis shows that TDTG-max is strongly and confidently correlated to cellulose crystallinity only and not particle size for particles in the range 15 to 750 µm regardless of how the particle size reduction was attained. However, there is uncertainty concerning the milling temperature and effect of milling temperature. Furthermore, ball milling for prolonged times between 4 and 8 hours caused the particles to agglomerate. Addition of rest periods during milling and a cooling device might be used to avoid overheating of the sample. In this work, the effect of milling time on sample temperature was investigated.

Department of Civil and Environmental Engineering

Graduate

SHEAR MODULUS AND DAMPING RELATIONSHIPS FOR DYNAMIC ANALYSIS OF COMPACTED BACKFILL SOILS

Primary Author: Moatez Alhassan, Civil Engineering (M.S.)

Advisor: Daniel VandenBerge

Co-Author(s)/Collaborator(s): Daniel VandenBerge

Dynamic analysis of structures using numerical methods should consider the effects of soil-structure interaction, including the shear modulus and damping ratio of the soil. Structures that extend below grade will interact with both the natural soil and the compacted backfill surrounding the substructure. While the in situ properties can be measured, the properties of the backfill are rarely available at the time of design. This study provides a practical means of estimating properties for compacted coarse-grained soils based on relative density. The results of more than 400 tests on reconstituted or compacted coarse-grained soils have been collected from the literature for this purpose. In particular, the data were used to develop correlations between the small strain shear modulus, Gmax and relative density for both sand and gravel. Most of the sand data plots below existing correlations from the literature, while most of the gravel data has higher values of Gmax. Thus the proposed correlations are better at distinguishing between the behavior of sand and gravel. Based on a subset of the collected data, updated curves are also presented for the variation of normalized shear modulus and damping ratio with shear strain.

Graduate

A LOOK INTO THE MICROBIAL COMMUNITIES OF THREE WWTFS IN TENNESSEE DURING DIFFERENT PHASES OF OPTIMIZATION FOR NUTRIENT REMOVAL

Primary Author: Grace McClellan, Engineering (Ph.D.)

Advisor: Tania Datta

Eutrophication, a result of nutrient pollution in water, has been a challenge for the water and wastewater industry. Currently, the Tennessee Department of Environment and Conservation (TDEC) is planning to implement regulations that require WWTFs to lower the amount of nutrients in their effluent. TDEC has agreed to allow for WWTFs to try to optimize their existing process and infrastructure. Biological nutrient removal (BNR), a process employed by microorganisms, is usually the primary focus of such optimizations.

Presently, we have the opportunity to evaluate three WWTFs in Tennessee that are in three different phases of optimization. The WWTF in Maryville, TN is designed and optimized for BNR; Cookeville's WWTF is currently

undergoing optimization for BNR; and Etowah's WWTF is looking to implement optimizations for BNR. We hypothesize that as WWTFs change their chemical and operational parameters, the microbial community will shift in both diversity and function to accommodate BNR. Currently, we have analyzed samples collected during the winter season that represent the influent characteristics and operational and chemical parameters of each WWTF. Microbial diversity is currently being examined through metagenomic analysis of the V4 region of both Bacterial and Archaeal 16s rRNA. Results will be presented at conference.

Graduate

ALTERNATIVE METHODS FOR ESTIMATING SEASONAL FACTORS AND THEIR ACCURACY IN PREDICTING ANNUAL AVERAGE DAILY TRAFFIC FROM SHORT PERIOD TRAFFIC COUNTS

Primary Author: Mamaa Monney, Civil Engineering (M.S.)

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The annual average daily traffic (AADT) is a key transportation performance measure used in guiding the allocation of federal funds to US states. It is estimated from daily traffic volume counts recorded over a year. Given its importance, the Federal Highway Administration (FHWA) requires each state to estimate AADT for various sections of their road network. Each state department of transportation (DOT) therefore has a traffic monitoring program for collecting traffic data. It comprises: a permanent traffic count (PTC) program, and a short period traffic count (SPTC) program. PTC volume data are used to estimate AADT, and seasonal factors (SFs). SFs are used to adjust SPTC into AADT estimates.

Most states develop SFs using the most recent year's PTC data only. However, a few use multiple years' PTC data. Tennessee Department of Transportation (TDOT) is in the latter category. TDOT's method implicitly assumes equal reliability of SFs over a five-year period. The objectives of this research were: First, to develop a new procedure for combining SFs from multi-year data by relaxing the assumption underlying TDOT's method; second, to investigate which SF development method yields more accurate AADT estimates. Data from TDOT and Maryland Department of Transportation were analyzed.
The new procedure developed in this research for combining multi-year SFs predicts AADT most accurately. It is followed by TDOT's method.

Graduate

ASSESSING THE IMPACT OF DIFFERENT SUBSTRATES AND VOLATILE SOLIDS LOADING RATE ON BIOGAS PRODUCTION

Primary Author: Juliet Ohemeng-Ntiamoah, Engineering (Ph.D.)

Advisor: Tania Datta

Anaerobic co-digestion has received significant attention in recent years as a process of enhancing biogas yields from water resource recovery facilities. Although the process has several environmental and economic benefits, variable and complex organic substrate characteristics can inhibit the key microbial communities from functioning effectively. Aside the potential impact of substrate characteristics on the anaerobic digestion process, operational factors such as volatile solids loading rate (VLSR) can also affect the digestion process. In this study, the effect of substrate characteristics and VSLR on a stable anaerobic digestion process was assessed using three 10L bench scale anaerobic digesters. All three were initially fed with waste activated sludge (WAS) at low VSLR (0.67kg VS/m3.day) until process stability was reached. Once stabilized,

digester one was maintained as a control digester and fed continuously with WAS at a higher VSLR (4kg VS/m3.day) while digester two and three were fed with 75% foodwaste (FW) and 25% WAS and digester three was fed with 75% fats, oils and grease (FOG) and 25%WAS respectively. The results showed that while the daily biogas production remained almost the same in the control digester, biogas production in digester three completely seized indicating an inhibition had occurred due to the overload of fats, oils and grease in the digester. Digester two, which was fed with foodwaste was found to be unstable with inconsistent biogas production. The second phase of this study will delve into assessing the microbial community shifts that may have occurred in the three digesters.

Graduate

PARAMETRIC STUDY OF LEVEE SATURATION FOR UNDRAINED RAPID DRAWDOWN ANALYSIS

Primary Author: Kalie Poston, Civil Engineering (M.S.)

Advisor: Daniel VandenBerge

As infrastructure continues to age and natural disasters highlight weaknesses in this infrastructure, there has been an increased focus to analyze levees for rapid drawdown (RDD) failure; however, practitioners are lacking the guidance to do so. Geotechnical engineers have typically used multistage undrained methods to analysis the RDD condition in dams. In order to analyze the RDD condition for a levee with multistage undrained methods, the likely saturated zone within the levee must be determined, followed by the shear strength for both the saturated and unsaturated zones. The saturated zone can be estimated using transient seepage analysis. However, as there are more than 100,000 miles of levees in the United States alone, it is impractical to perform transient seepage analyses for multiple flood scenarios along every levee reach. Taking into account the considerable extent of levee reaches and the variance in material properties, levee geometry, and flood scenarios that may be experienced, it would be beneficial to have a quick and simple method to determine the approximate extent of the saturated zone within a levee at the end of a flood (i.e., the start of drawdown). In support of this broader goal, a chart-based method is presented that can be used to quickly estimate the saturated zone in a levee following a flood based on the soil properties, flood hydrograph, and levee geometry. This saturated zone can then be used as a starting point for undrained RDD analysis.

Graduate

COMPARISON OF FEA AND ANALYTICAL METHODS FOR DETERMINING GLOBAL STABILITY OF A RAP SUPPORTED MSE WALL

Primary Author: Emily Reed, Civil Engineering (M.S.)

Advisor: Daniel VandenBerge

Co-Author(s)/Collaborator(s): Daniel VandenBerge, Tennessee Tech University

Global stability is one of the failure modes that must be analyzed for retaining walls. Finite element analysis (FEA) of walls provides the most accurate solution but can be time-intensive and expensive. The primary aim of this project is to compare the results of FEA models with the simpler analytical Meyerhof bearing capacity method. In particular, cases were examined where rammed aggregate piers (RAPs) support a mechanically stabilized earth (MSE) retaining wall. For this project, several FEA models replicating these cases were created. Geometric parameters included the ratio of RAP to matrix soil, or “replacement ratio”, and the dimensions of the MSE wall. Each geometric configuration was then iterated over a range of undrained strength for the matrix soil, resulting in a different factor of safety for each model. A spreadsheet was also created containing the necessary calculations for the Meyerhof bearing capacity method. The factor of safety

from the Meyerhof method was compared to the factor of safety computed for each corresponding FEA model. The results show an excellent relationship between FEA models and the analytical method, especially for factors of safety ranging from 1 to 1.5 which had only a 5% average difference. The major implications of this research are that a complex FEA model can potentially be replaced by the simpler analytical Meyerhof bearing capacity method. The benefit of this is that wall designers can quickly check the global stability of a retaining wall without spending the time and money on more expensive FEA modeling.

Graduate

EFFECT OF LEVEE FOUNDATION CONDITIONS ON THE SATURATED ZONE DURING FLOODING FOR RAPID DRAWDOWN ANALYSIS

Primary Author: Prince Turkson, Civil Engineering (M.S.)

Advisor: Daniel VandenBerge

Analysis of the rapid drawdown loading condition for dams and levees typically assumes full saturation prior to drawdown. This assumption is likely incorrect for levees due to the relatively short duration of floods prior to drawdown; and hence requires that methods be developed to estimate the extent of the saturation zone within levees after floods for undrained rapid drawdown analysis. Levees can be founded on soils with a range of permeability, and therefore it is important to investigate how levee foundations influence levee through-seepage under transient conditions. A very important parameter which dictates response and extent of saturation in levees is the coefficient of consolidation, cv. This parameter is a function of soil hydraulic conductivity and volumetric compressibility, and dictates how quickly or otherwise water flows through levees and their foundations during floods. Numerical transient seepage models were analyzed with cv values for the foundation soils (cvf) ranging from 50 cm2/s (sand-like soil) to 1×10-3 cm2/s (clay-like soil). The levee models considered a silt-like levee on (i) sand foundation, (ii) silt foundation, (iii) clay foundation, and (iv) impermeable foundation. Similar to the theory of consolidation settlement, for a given levee soil, a rapid build-up of pore pressures and subsequent establishment of steady-state conditions in foundation soils for increasing values of cvf under changing boundary conditions forces upward seepage through levees due to the high total heads developed in the foundation soils. Decreasing ratios of levee soil and foundation soils cv values resulted in increasing saturation zone area within levees.

Undergraduate

SUSTAINABLE HOUSING WITHOUT BREAKING THE BANK **(VIDEO SHOWCASE FEATURE)**

Primary Author: Aaron Walker, Civil Engineering

Advisor: Tania Datta

One of the hardest parts of building sustainable homes is offering them at an affordable price. Builders want to maximize the efficiency of these homes while keeping the cost of construction to a bare minimum. Often times these interests collide. In order to reconcile the two, project engineers often have to exercise their creativity in obtaining building materials, transporting these materials, and assembling and testing the final product. The purpose of this research project was to conduct a literature review and case analysis of a Habitat for Humanity development in Baltimore, Maryland. Following the analysis, a short video presentation was prepared to propose potential construction alternatives which may have helped the project be more sustainable or affordable.

Following the analysis of the case study in question, it was determined that affordability was compromised in order to meet sustainability requirements. To maintain affordability,

HFHC could have used local materials and manufacturers. The homes also failed to incorporate energy independence as a facet of construction, usually a staple in modern, green development. With a few minor adjustments, all issues with the affordability and inadequacies of this housing complex could have been avoided. The goal of this study is to encourage engineers to exercise their creativity to meet project goals that will benefit the causes of equity and social justice.

Department of Computer Science

Graduate

VISUALIZATIONS OF ADMINISTERED HEALTH SERVICES IN MEDICARE

Primary Author: Mazen Alwadi, Engineering (Ph.D.)

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Ania Kaczka

The CMS Data Entrepreneurs' Synthetic Public Use File (DE-SynPUF) provides sample data from Medicare beneficiaries and their claims. This data, while synthetic, provides us with the means to generate useful tools and visualizations that can be applied accurately to real Medicare data. Demographic, clinical, and financial data included in the data set will provide reasonable bounds and expectations of real Medicare data. However, multivariate analysis proves to be difficult as specific patterns were removed to avoid reidentification risks for beneficiaries. Yet, multivariate analysis will still show interesting applications toward real data. We hope to be able to demonstrate a visual analytics approach that will help reveal important underlying patterns across multiple variables throughout the three years of data provided.

Graduate

CONTINUOUS AUTHENTICATION FOR SMART PHONE USERS

Primary Author: Anshu Bhattarai, Computer Science

Advisor: Ambareen Siraj

Most authentication systems (password and biometric feature based) use one-time static authentication methods. Such systems are susceptible to masquerade attacks, where unauthorized users can take over a user's identity after initial authorization compromising the user's security and privacy. A real time continuous authentication system provides better security control where the user is continuously authenticated based on the user's behavior after initial authorization. Monitoring more user features have shown to yield more accurate results. For continuous authentication of smart phone users, in this work, we evaluate micro movements, orientation and the grasp of user's hand as a set of behavioral features, which can be easily collected from smart phone sensors like the accelerometer, gyroscope, and magnetometer to continuously authenticate users. We demonstrate the use of Machine Learning to design a continuous authentication system.

Graduate

GENERATION AND ANALYSIS OF BREAST TUMOR DATA USING DISTANCE WEIGHTED DISCRIMINATION AND SUBGROUP DISCOVERY

Primary Author: Farzana Ahamed Bhuiyan, Computer Science (M.S.)

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Paul Tinker, MD Bulbul Sharif

For the first time in history, mankind has the capacity to capture and analyze biological information at the genetic level. Using this genomic data for disease prognosis and diagnosis is arguably one of the most important application of this knowledge. However, several problems currently exist that impede the ability of researchers to effectively analyze such data sets. One issue is the difficulty in obtaining sufficient sample data in this domain. Due to the expense, both monetary and temporal, involved in the collection and processing of biological samples, most result sets are comprised of very few samples. These few samples, however, typically contain many thousands of genetic features. This has led some researchers to explore methods for merging data sets from various studies into a single, cohesive set. Given the differing objectives of the research, variations in sampling protocols, and no universal standard for data curation, however, unifying these data sets is not trivial. Our proposal is three-fold; First, to replicate a study conducted at the University of North Carolina that used an approach called distance weighted discrimination (DWD) to fuse multiple, disparate breast cancer data sets into a single validation set. Second, we will replicate the generation of an intrinsic gene list based upon gene expression rates. And lastly, we will perform subgroup discovery on this validation set to compare with the clusters generated by that research.

Graduate

EVENT MINING OF HPC LOG DATA

Primary Author: Swen Boehm, Computer Science

Advisor: William Eberle

High Performance Computer (HPC) systems generate a vast amount of log data, like system resource utilization, usage of resources by applications and abnormal events (i.e. critical conditions, faults, errors and failures). Analyzing the log data can give insight into the overall system health and can aid in finding the root cause of failures. The tremendous amount of log data produced makes root cause analysis difficult and a time consuming task. In this paper we present event data mining techniques to analyze the log data from the Titan supercomputer at the Oak Ridge National Laboratory. We utilize a log data analysis framework developed at Oak Ridge National Laboratory to correlate events in the log data and to analyze system events.

Graduate

PHYSICAL PROCESS MONITORING FOR INTRUSION DETECTION IN INDUSTRIAL CONTROL SYSTEMS

Primary Author: Kathryn Burks, Computer Science (M.S.)

Advisor: Terry Guo

Co-Author(s)/Collaborator(s): Animesh Dahal, Connor Gannon

Industrial Control Systems(ICS) of the past have been shielded from network intrusions by means of an “air gap” separating the system from the open internet. However, this protection is no longer universally present in modern networked ICS. With the development and execution of new malware targeting Programmable Logic Controllers (PLC) in ICS, it has become increasingly urgent for new techniques for discovering and identifying industrial and manufacturing behavior indicative of a malicious intrusion. We aim to develop a modular and process-isolated sensor-based addition to current Intrusion Detection Systems. We plan to design and implement an “add-on” IDS aimed at monitoring the physical processes controlled by the PLC. Our proposed system will be isolated from the potentially compromised PLC, and shall be monitoring the behavioral patterns of physical processes by processing the data collected from the sensors that are isolated from those controlled by the PLC, in order to detect potential presence of anomalies.

Graduate

DATA-DRIVEN PROGNOSIS FOR RELIABILITY CENTERED MAINTENANCE OF VEHICLES

Primary Author: Rereloluwa Fatunmbi, Electrical and Computer Engineering (M.S.)

Advisor: William Eberle

Advances in sensor technology, internet-of-things and computational capabilities have created a radical change in the way the health of vehicles is monitored and managed. Today, vehicle users replace their engine oil based on mileage covered and not the degradation of the lube. This practice is wasteful, could lead to major engine damage, and it increases the carbon footprint. The same can be said for coolant, inlet air, fuel and lube filters. With live data from oil quality and pressure sensors, the degradation of these consumables can be monitored. By deploying pattern recognition algorithms, the remaining life of these consumables is forecasted. This would increase the longevity of the vehicle and meet the needs of customers demanding higher vehicle availability. To establish a business case for this project, sentiment analysis is applied to Twitter data to determine the potential market value of monitoring engine consumables.

Graduate

GRAPH CLUSTERING WITH ASYMMETRIC COMMUNITIES

Primary Author: Jeffrey Graves, Engineering (Ph.D.)

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Ramakrishnan Kannan, Oak Ridge National Laboratory; Rina Singh

Data involving complex networks, such as social networks, academic citation networks, biological networks, and technology networks, are growing at an alarming rate while becoming more prevalent across disciplines. Exploring these networks and extracting useful knowledge in a timely manner is an important task. In the past few decades, many researchers have studied and revealed several crucial properties of real-world networks, such as power law degree distributions and network connectivity. Another useful method for analyzing and understanding the information found in a network is to organize the nodes into clusters or communities; a community refers to a collections of nodes within the network that have more connections with each other than the rest of the network. The key hypothesis in community detection is that communities of source and destination nodes influence each other. For example, a community of celebrities influence their twitter followers and vice-versa. While there has been a considerable amount of research involving community detection in graphs, all of the existing approaches seem to require that the number of "source" communities be the same as the number of "destination" communities. Our research focuses on the relaxation of this constraint though the use of non-negative matrix factorization (NMF) by imposing difference ranks on the matrix factors. We have applied NMF for community detection on several smaller networks and compare the communities obtained, using various community quality metrics, against those discovered by other community detection algorithms.

Graduate

SAFETY ANALYSIS FOR UAV NETWORKS

Primary Author: A H M Jakaria, Computer Science

Advisor: Mohammad Rahman

Co-Author(s)/Collaborator(s): Mohammad Rahman

The recent trend of collaborative operations of a network of Unmanned Aerial Vehicles (UAVs) to achieve a common objective has attracted the researchers, as well

as commercial vendors. It has revolutionized the means of data collection to maximize mission performances. However, the collaborative UAVs need to be safe from cyberattacks to prevent catastrophe. They need to be able to collaborate with each other to avoid potential failure of a mission. As these smart devices are always targets of adversaries, they need to maintain safe communication with each other while avoiding fuel outage and mid-air collisions, as well as reducing the possibilities of being hacked. In this work, we present the idea of a formal verification tool that takes different UAV parameters, safety requirements, and resource constraints as input and verifies the network's safety.

Graduate

AUTONOMOUS TAGGING OF STACKOVERFLOW QUESTIONS

Primary Author: Prajjwal Kandel, Computer Science (M.S.)

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Moumita Kamal

With the massive volume of text available online these days, text categorization has become a very useful technique for managing and handling text data. Text categorization can be used to classify documents, extract useful information and identify connections in text data. In this project, we are using question-answer data from stackoverflow to try and identify tags from the question text. Once the tags for questions is identified based on its content, we can use it to recommend to the users. We can also add tags to existing questions which are not tagged and thus categorize questions better. In the current implementation, stackoverflow only suggests tags to the users after they start typing first letter(s) of a tag. Apart from finding tags, we will also try to see correlations among the tags present on the questions. We will also see which tags questions are the most answered ones and which tags are likely to get more upvotes and downvotes.

Graduate

SMART GRID SURVEILLANCE WITH UNMANNED AERIAL VEHICLE (UAV) USING K-RESILIENCY MODELING

Primary Author: Rahat Masum, Computer Science (M.S.)

Advisor: Mohammad Ashiqur Rahman

Co-Author(s)/Collaborator(s): Mohammad Ashiqur Rahman

Smart grid being a widely distributed engineering system may run through deep forests to long rivers, and over the cities as well. Physical damage to the power line from natural calamities or, cyber attacks by malicious people on the control system will hamper the functional integrity of the power grid. To ensure the usual operational flow, the control center needs to take immediate steps caused by these phenomena. Hence, inspection of the power line provides a means for the smart grid surveillance. Since any physical damage to the power network can be occurred in hardly reachable remote areas, understanding the amount of impairment will be time-consuming. Autonomous systems like Unmanned Aerial Vehicles (UAV), instead of the traditional human patrol, are one way to enable regular monitoring of the safety critical situations. The critical lines will be monitored by a fleet of UAVs to ensure a resilient surveillance system. In this work, we present a formal model for UAV surveillance resiliency over the power lines with a set of k UAVs from the whole set. The proposed approach at first considers the n-1 contingency analysis using actual system data, and state estimation procedures. By using linear sensitivity factors, we find the critical transmission lines in the smart grid and in accordance with that, placements and communication topology of the UAVs are done. Then, we evaluate k-resiliency for the UAV surveillance to cover all the critical lines satisfying the circumstances in case of k

failure in the fleet of UAVs.

Graduate

TEST, EVALUATION, AND DEMONSTRATION (TED) PLATFORM FOR VEHICLE SECURITY

Primary Author: Cordell Medlin, Computer Science (M.S.)

Advisor: Sheikh Ghafoor

Co-Author(s)/Collaborator(s): Jordan Johnson, Mohammad Arman Ullah, David Yantis,

Modern vehicles consist of up to 100 Electronic Control Units (ECUs), communicating via the Controller Area Network (CAN) protocol over a bus-based network. These vehicles have approximately 100 million lines of software code used to control the devices in the network and to keep the vehicle operating efficiently and safely. The CAN protocol was built to be low-cost, reliable, and have real-time properties. However, it has been discovered to not be secure and is susceptible to many security vulnerabilities. Attacks on these vulnerabilities could cause injury or loss of life in real-world scenarios. In order to mitigate these vulnerabilities, we are designing and building a platform that can be used to test, evaluate, and demonstrate security solutions involving this protocol. This platform will be beneficial to those performing research in vehicle security by enabling flexibility and reconfigurability in various design configurations. Traditional test solutions typically use one of three methods: software only, hardware only, or simulated hardware only. Software-based solutions simulate a CAN system, providing flexibility but not realistic results. Hardware-based testing is performed on actual vehicles which is realistic, but not flexible and cost prohibitive. Simulated hardware uses flexible, low-cost equipment to represent a real-world network but still does not provide realistic results. We intend to use a hybrid approach, which combines the best aspects of each method. This network will be comprised of both real and simulated ECUs to provide accurate results while allowing for flexibility and maintaining low costs.

Graduate

SECURITY CHALLENGES WITH ZIGBEE COMMUNICATION NETWORK IN INDUSTRY 4.0

Primary Author: M. Rayhan Ahmed Mithu, Computer Science

Advisor: Ambareen Siraj

Co-Author(s)/Collaborator(s): Gustavo Alonso, Angeles Davila

The paper reviews the implementation of ZigBee network in the industry and possible attacks that can be done to Zigbee Networks. As the industry is leaning towards smart technology with the idea of products controlling their production environment, more and more must be thought on the security issues regarding them. This paper will describe how can we detect when an attacker adds or deletes a node from the network, and how can be impede an attacker from sniffing data from our network. Since Zigbee Networks are low powered, we have considered this scenario to be close proximity attacks or insider attacks. These kinds of attacks can detriment the productivity in the industry, by adding a note that congests the network or by deleting one, and losing the data needed to continue production. Gathering information can lead to leaks if the information gathered by the attacker is sensitive. This paper will also provide analysis of Intrusion Detection Systems (IDS) within the ZigBee network. The analysis includes the implementation of IDS in ZigBee, compatibility of the IDS in the network and results of the implementation. In order to test this, we have created a mock IoT environment using sensors and a hub. We have used a star topology, since it is widely used in the industry. We collected information from different sensors and uploaded them to the cloud using Microsoft Azure.

Graduate

MINING HETEROGENEOUS GRAPH FOR PATTERNS AND ANOMALIES

Primary Author: Ramesh Paudel, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): William Eberle, James Park

Knowledge discovery from disparate data sources can be very useful for gaining a better understanding of the real world. One potential way of discovering patterns and anomalies is to represent data as a graph. In addition, a better understanding of patterns and anomalies associated with a person, place, or activity, cannot be realized through a single graph. For instance, in social media, one can discover interesting patterns of behavior about an individual through a single account, but better insight into their overall behavior is realized by examining all of their social media actions simultaneously. Graphs are a logical choice for representing such data. In this project we will investigate a novel framework capable of discovering patterns in multiple graphs. Our objective is not only to show that known patterns and anomalies in individual sources can still be discovered efficiently, but also that new patterns and anomalies consisting of information from multiple data sources can be identified. We will use real-world data collected over several months from multiple sources consisting of top daily news stories and associated tweets in order to evaluate our methods.

Graduate

TIME BASED GRAPH MINING TO DETECT INSIDER THREATS

Primary Author: Niraj Rajbhandari, Computer Science (M.S.)

Advisor: William Eberle

Insider threats such as sabotage, theft, espionage, fraud and competitive advantage are accomplished by abusing access to the organization's network, system or data, theft of materials and mishandling of physical devices. This kind of threat negatively affects the confidentiality, integrity or availability of the organization's information or information system. In this paper, we try to identify anomalous insider activity which can be malicious in the email communication of the organization. We use graph mining to identify these anomalous instances. Our approach incorporates the time element to the analysis process to identify anomalous instances. In this paper, we discuss about the dataset being used for the experiments. We also discuss about data preprocessing approaches being used, experimental setup and the results obtained from the experiments.

Graduate

DETECTING MALICIOUS BLOCKCHAIN TRANSACTIONS UTILIZING ANOMALY DETECTION TECHNIQUES

Primary Author: Ryan Shivers, Computer Science (M.S.)

Advisor: William Eberle

Co-Author(s)/Collaborator(s): A H M Jakaria, Zachary Wallace

One of the largest emergences in modern technology is the use of cryptocurrencies, which are recorded transactions in a structure called Blockchain. Of these currencies, one of the largest is called Ethereum, which is a framework built to handle the use of smart contracts, or programs that are run on the Blockchain. Since this is a newer idea, there are many security flaws that come along with the adoption of it. While most of the transactions on the Blockchain can be recorded as legitimate, some are malicious, such

as those in the recent DAO attack. In this paper, we want to use anomaly detection to help detect these malicious transactions. We use sites such as etherscan.io, which records all of the transactions on the Ethereum framework, to scrape the necessary data to establish a baseline of what a legitimate transaction should look like. Our goal is to conduct research to find malicious transactions and utilize clustering technology to help us detect when these malicious transactions are taking place.

Graduate

UNDERSTANDING HEALTHCARE TRAJECTORIES THROUGH SEQUENTIAL PATTERN MINING

Primary Author: Rina Singh, Computer Science
Advisor: Doug Talbert

Co-Author(s)/Collaborator(s): Jeffrey Graves, Doug Talbert

Due to the increasing adoption of electronic healthcare records, a large interest in healthcare data analytics has arisen among computer scientists, clinicians, and the government. When a patient is diagnosed with a disease, they want information on treatment choices and related outcomes, in addition to the best care available. This requires clinicians to have a precise understanding of the connections between treatment decisions and expected outcomes. In an attempt to further enhance the understanding of various healthcare trajectories, we have applied a variant of sequential pattern mining, called frequent suffix mining, to uncover interesting patterns that describe common outcomes associated with various treatment options. We begin by selecting a treatment option of interest, and then proceed to mine all frequent suffix-patterns using the selected treatment as a prefix; a sequential pattern is called suffix-pattern if it begins with a user specified prefix. However, the combinatorial nature of sequential pattern mining often produces a large number of redundant patterns, making it difficult to identify useful results. While techniques have been developed to address this issue, none consider the interestingness of the results. And so, we have leveraged techniques from subgroup discovery to mine the top-k most interesting sequential patterns. Despite this, many results are still highly redundant. In an attempt to eliminate some of the redundancy, we have adapted some diversity mining techniques used in subgroup discovery to sequential pattern mining. In addition, we have developed a visualization to help users examine the tradeoff between pattern interestingness and diversity.

Graduate

MOVIE META-DATA MINING

Primary Author: Lijun Sun, Computer Science (M.S.)

Advisor: William Eberle

There is a substantial amount of money to be made or lost in predicting a movie's success. Movie meta-data contains a wealth of features that can be mined in order to determine what attributes correlate with their success. These attributes include the director, the producer, cast, genre, budget, etc. These various attributes then result in differing revenue, ratings and reviews. In this paper, we obtain movie meta-data from The Movie Database(TMDB). We discuss the movie meta-data attributes with a focus on finding which attributes correlate with movie profit. The findings from the research can provide movie producers with information about what makes movies profitable.

Graduate

APPLYING DEEP NEURAL NETWORKS TO SHORT ESSAY SCORING

Primary Author: Paul Tinker, Computer Science

Advisor: Bill Eberle

Developing a computer system capable of interpreting and understanding language, both written and aural, has been a goal of machine learning research for decades. Prior to recent years, most natural language processing involved generating probabilistic models based upon the number and type of words found in a document body. These models, though potentially capable of offering moderate power to classify documents, lacked the ability to truly assess and quantify a language. However, recent developments in the field of deep learning and natural language processing have allowed for the creation of machine learners capable of much greater cognition. The applications of such systems are numerous, including language translation, semantic classification, and information extraction. One other area where this technology would be of great benefit is that of short answer and essay test scoring. These tasks require a learner to have a deep understanding of the given language and to be capable of not only assessing the individual words in an answer, but their comprehensive meaning in context of the question as well. Such a system would be a great boon to educators and various test administrators. Therefore, I propose to develop and compare two deep neural networks tasked with the scoring of several short answer questions designed to measure a subject's ability to think critically.

Graduate

SOFTWARE ASSURANCE FOR BLOCKCHAIN CONTRACTS

Primary Author: Zachary Wallace, Computer Science (M.S.)

Advisor: Ashiq Rahman

Co-Author(s)/Collaborator(s): Ryan Shivers, Samuel Wehunt

Blockchain technology is rapidly developing and, with proper execution, is on its way to widespread adoption in many areas outside of the technology sphere. Blockchains have many use cases and one function that can be provided is the idea of "smart contracts". Smart contracts are applications that are stored on the blockchain that allow trustless transactions between peers. There are risks involved with utilizing these contracts because they can be developed and deployed by anyone with a working knowledge of common programming languages. This leads to issues because once these contracts are pushed to the blockchain it is impossible to change them without a hard fork. This means that vulnerable smart contracts must remain on the blockchain indefinitely, where they are open to exploitation by malicious parties. One suggestion to mitigate this issue is to have a clause that invalidates old contracts if a signed update is pushed. This solution is workable, but this project's goal is to prevent this problem entirely by developing a testing suite that will allow smart contract developers to assure that their software is as error-free as possible before deploying it to the blockchain. This paper will analyze several popular blockchain platforms that support smart contracts, common vulnerabilities in smart contracts, and the cutting edge of smart contract assurance tools. We will be aggregating and extending this data to create the proposed testing suite.

Undergraduate

UNDERSTANDING ONLINE AUTOMOTIVE LEAD PERFORMANCE

Primary Author: Ilan Arroyo, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Tyler Bennett, Thanin Irnasavongsa, Shaun Starnes

Close rate performance is essentially a metric measuring the number of successful sales over the total number of presentations representatives give to customers. Many firms are now looking into researching this dilemma to increase more sales. We will be observing high and low close rates depending on the data's characteristics being given to us by the company, Urban Science. Our

primary objective is to observe a correlation from the characteristics, of the data set, that could help determine whether the dealerships' close rate end up high or low. Observing the data's characteristics correlated with high or low close rates can help us discover solutions that prevent a lower turnout of sales. We will be using data analytic tools such as R Studio and Tableau to create visualizations.

Undergraduate

MULTI-TASK CORRELATION-BASED FEATURE SELECTION FOR GENE EXPRESSION DATA

Primary Author: Katherine Brown, Computer Science

Advisor: Doug Talbert

DNA microarrays are common tools to measure gene expression levels in diseases such as cancer; however, such microarrays typically express a multitude of genes, and too many genes can degrade predictive accuracy rather improve it. To remedy this problem, a feature selection technique, such as Correlation-based wrapper feature selection (CFS), is utilized. Wrapper feature selection techniques use accuracy metrics from predictive models to evaluate candidate feature subsets, making them expensive. This problem is compounded when studies involve multiple microarray platforms, each with a unique set of genes, since the expense of wrapper-based CFS is multiplied by the number of platforms in the study. We hypothesize that a multi-task learning approach can improve the efficiency of wrapper-based CFS across multiple simulated microarray platforms without substantial loss in prediction accuracy. Our method, Multi-Task Correlation-Based Feature Selection, or MT-CFS, performs CFS on genes shared across multiple platforms with pooled data. We evaluate this technique on randomly generated platforms and platforms that are probabilistically biased towards genes highly correlated with class membership. For both platform sets, MT-CFS ran in less than 10% of the time required for CFS on all the platforms separately, and the largest drop in predictive accuracy was less than 1% using 10-fold cross-validation.

Undergraduate

OPTIMIZATION OF FORECASTING ENERGY CONSUMPTION MODELING

Primary Author: Jesse Finley, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Haylee Hicks, Marshall Lambeck, Dakota Wilkerson

In today's society there is a major need for reducing energy consumption and greenhouse gas emissions so that the use of electrical energy is as efficient as possible. The increase in energy consumption from every country has made accurate energy forecasts a major focus of research. The complex nature of energy consumption necessitates comprehensive modeling. The aim of this research is to provide an accurate model to predict future energy consumption of a building with the use of minimal data. We will be applying methodologies in data science - such as machine learning, linear regressions, and logistic regressions - to develop a working model allowing us to predict energy consumption with minimal data. For the analysis we will utilize historical weather and consumption data from over 200 buildings as well as calendar information and the type of building being analysed. Use of this model will hopefully provide increased efficiency and accuracy to current working models and lead to improved energy-saving policies and optimized building operations.

Undergraduate

USE OF DATA SCIENCE TO PREDICT SURVIVAL OF TITANIC PASSENGERS

Primary Author: Leonard Garrison, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Amanda Carpenter, Jeremy Chosie, Jon McClung

The fields of data science and machine learning have experienced unprecedented growth over the previous decades. The demand for accurate and practical techniques to analyze and learn from large datasets will likely continue to grow in the future. We discuss some of the opportunities and challenges provided by common machine-learning techniques. In particular, we study the case of the famous Titanic disaster, which resulted in the loss of one of the finest luxury cruise ships of the era and the lives of 1,517 passengers and crew. Using standard machine-learning techniques, we attempt to predict the survival of its victims based on data including age, gender, cabin number, and so on, and analyze the effectiveness and practicality of these techniques. The exercise demonstrates the merit of an exploratory approach for study. We discuss the scalability and generality of our approach. Our results provide a solid foundation for understanding the utility of data science as a means to predict future outcomes.

Undergraduate

HUBWAY VISUALIZATION CHALLENGE

Primary Author: Eljon Gasmen, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Anh Dao, Luke Lambert

In July 2011, The city of Boston introduced Hubway rental bike system, and since then Hubway's system has recorded detailed information about riders and their rides from more than a hundred stations inside the city. In 2012, Hubway, in collaborating with the Metropolitan Area Planning Council (MAPC), created the Hubway Data Visualization Challenge to get submissions of innovative ways to visualize their data set of rides taken on their bikes. Although the challenge is over, Hubway has released their data to the public. With the same goal, we decided to take on this challenge ourselves to create a visualization of hubway traffic spatially (by station location) and temporally (by time of day). This can be beneficial for Hubway to have a good indication of their user population. In particular, they would be able to learn about popular venues that may need additional stations and stations that need to be removed due to lack of use. Another visualization is the graphs indicating the demographics of users so that Hubway has a good idea of its user base and develop advertisements targeting these demographics. We hope to be able to properly visualize these models as well as possible other models from our analysis of this data in order to generate meaningful insights on Hubway's bike usage.

Undergraduate

RECRUIT RESTAURANT VISITOR FORECASTING

Primary Author: Mark George, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Mina Abdelnour, Arthanios Ghaly, Antoun Hanna

Restaurants may experience difficulties predicting the busiest times of the week and may end up being understaffed and at times even run out of their most requested food. This research involves exploring patterns in customer reservation dates, visits, and other information to forecast future restaurant visitor totals on a given date. Results will be demonstrated with visualizations and statistical methods to show patterns such as times with high customer reservation volume and relations explaining the reason for the increase in customer reservations. This will help restaurants be more efficient and allow them to focus on creating an enjoyable dinning experience for their customers.

Undergraduate

SECURITY ANALYSIS OF ROBOTIC ARMS USED IN SMART MANUFACTURING

Primary Author: Weston L. Smith, Computer Science

Advisor: Ambareen Siraj

Co-Author(s)/Collaborator(s): Kirill Kozlov, Evan D Bjorn

As smart manufacturing is becoming the industry standard, many production systems now face digital threats unlike any before. Systems that were once closed off are now being opened up to remote connections, often without upgrading the system's security to handle the change to a smart manufacturing environment. One such system that is in urgent need of security enhancements is industrial robotics. With robotics, not only is proprietary production data at risk of digital theft, but now cyber attacks can interface with the physical world using the last-generation implementation of robotic systems. The purpose of this project is to explore potential vulnerabilities with industrial robotics in effort to establish a preliminary defensive strategy in the event of a cyber attack. This will be accomplished through security analysis of a robotic arm and investigation of defense strategies applicable thereafter. This robotic arm will be used for extensive penetration testing to gather attack data and ultimately be used as an experimental tool for the implementation of defensive solutions.

Undergraduate

EXTENDING REINFORCEMENT LEARNING FEUDAL NETWORKS

Primary Author: Nathan Martindale, Computer Science

Advisor: Doug Talbert

In a publication by DeepMind, FeUdal Networks for Hierarchical Reinforcement Learning, a technique known as FeUdal Reinforcement Learning, involving running multiple Reinforcement Learning algorithms at different levels of spatial or temporal resolution, was extended by applying deep learning with the same principles. The two different layers of networks in the architecture operated at different time scales, allowing a higher level manager network to run at a more abstract "overarching" level. FeUdal networks achieve significantly higher scores than other deep reinforcement learning architectures on Atari games that are traditionally difficult, such as Montezuma's Revenge. In this poster, we explore two extensions to this architecture and determine how they affect performance. The first extension we look at is utilizing more than two layers of networks. The second is to experiment with how the modularity of this design can be exploited. We look at whether pretrained low-level networks can be plugged into a manager network to improve training time, and whether manager networks can be switched between environments to allow for transfer learning.

Undergraduate

PREDICTING URGENT CARE PATIENT VOLUME AT SATELLITE MED

Primary Author: Anceito Rivera, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Carl Evans, Andrew Harris, James Park

Satellite clinics, such as Satellite Med, often find a hard time in having the right amount of staff on hand to face a certain patient volume. Finding an optimal balance between the two is critical since it will give speedier treatments and lower costs, which passes the savings onto the patients. The problem we are trying to solve is optimizing the amount of staff on hand in anticipation of predicted patient volume over time. We will consider the patient volume and types of visits during different

parts of the day, week, month, and year. We will also be considering external factors such as weather to see if there is a correlation. We aim to solve this problem by utilizing clinic visit data that has been provided to us by Satellite Med which contains the datetime of the visit, reason for the visit, and the staff member that treated the patient. Along with this data, we have obtained weather and flu outbreak data, from Weather Underground and tn.gov respectively, to analyze potential external factors. To run our experiments, we will be utilizing R-Studio, DEEDS (Design Environment for Event Driven Simulation), and Python Script. We hope our findings will help create more efficient patient treatment services in the satellite clinic industry and lower operating costs of these clinics to lower treatment costs for the patients.

Undergraduate

VEHICLE SALES DATA INSPECTION

Primary Author: Robert Scollon, Computer Science

Undergraduate Research and Creative Activities (URECA) Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor: Wiliam Eberle

Co-Author(s)/Collaborator(s): Anthony Kniazewycz, Amber Patterson

Urban Science, our client company, seeks a process to analyze automotive sales data as it is received, prior to being used in a project, and to detect data issues so that a mitigation plan can be implemented earlier in the project. The purpose of this project is to use data analytics in the language R to discover falsehoods, mistakes, and missing data in a sample set comprised of vehicle sales for the company. We will also create a set of metadata that will help identify any serious shortcomings before Urban Science does primary analysis of the data.

Undergraduate

MODELS FOR PREDICTING DISEASE STATE FROM SNPS

Primary Author: Kaley White, Computer Science

Advisor: William Eberle

Co-Author(s)/Collaborator(s): Jordan Roth, Joshua Vick

"Big genomic data" is a buzzword in the Genomic Revolution, an age in which exponentially decreasing costs of computing complement exponentially decreasing costs of human genome sequencing. A key effort in the "big genomic data" domain is to predict disease state from DNA. In this paper, we present our analysis of single nucleotide polymorphisms as predictors of disease state. A single nucleotide polymorphism (SNP) is a one-nucleotide difference in DNA (for example, an A instead of a T), often encoded in binary as a 1 for the less common nucleotide and a 0 for the more common. Given this binary data, disease state prediction is a binary classification problem. We apply various statistical and machine learning techniques to build models that attempt to predict, given the SNPs of this portion of an individual's genome, whether he is diseased. Each model is trained on the partial genomes of 26,500 individuals, each containing over 4,000 SNPs, and tested on 13,250 partial genomes. Our evaluation metric is the area under the ROC curve (AUC) for the test data predictions. We obtain a relatively high AUC for models generated using several of our techniques, indicating high discrimination in these models. That is, disease state can be fairly accurately predicted from the SNP statistics of the partial genomes in our sample. Our findings confirm previous amateur analyses of the data.

Department of Electrical and Computer Engineering

Graduate

AN ARTIFICIAL NEURAL NETWORK FRAMEWORK TO PREDICT PATIENTS WITH HIGH LIKELIHOOD OF CHRONIC KIDNEY DISEASE

Primary Author: Faisal Alkhaldi, Engineering (Ph.D.)

Advisor: Chun-An Chou

Chronic kidney disease (CKD) is an important health and healthcare system problem. The ability to predict which patients will develop CKD is a difficult task due to the complex nonlinear relationships among related factors. Using artificial neural networks (ANN), applied to a population 17 through 90 years of age, we achieved 97% accuracy in classification, based on standard laboratory test and patient data. The technique was also helpful in determining which features of the data are most predictive; 75% of the features were sufficient to reach this high level of accuracy.

Graduate

EFFICIENT AND COLLUSION-RESISTANT DETECTION OF SYBIL ATTACKS IN VANETS

Primary Author: Niclas Bewermeier, Electrical and Computer Engineering (M.S.)

Advisor: Mohamed Mahmoud

In vehicular ad-hoc networks (VANETs), vehicles communicate with each other and with road-side units (RSUs), enabling a variety of applications such as collision avoidance and smart traffic management. In traffic management application, drivers should report their route that contains current and future locations. Using this information, the traffic management systems (TMS) can predict future congestions and slow traffic and send traffic guidance to drivers who can change their routes to prevent making congestions. Since vehicles are personal, the identity of the vehicles should be anonymous to preserve the drivers' location privacy. This can be done by providing each vehicle with a large number of different and unlinkable certified identities with public and private keys. However, the abundances of identities can be misused by attackers to launch Sybil attacks. In these attacks, a malicious vehicle can use the unlinkable identities to pretend as different Sybil vehicles to send wrong routes, which can make the TMS broadcast wrong traffic predictions. A very promising approach to detect this attack requires vehicles to provide a sequence of timestamped location evidence authorized by RSUs, called trajectories. However, a malicious RSU is able to issue arbitrary trajectories, supporting a colluding vehicle in successfully launching Sybil attack. In this research, we aim to devise an efficient and collusion-resistant scheme for the detection of Sybil attacks. Specifically, we study the use of aggregate signature and threshold signature schemes to generate trajectories by multiple RSUs (instead of only one), while keeping the required communication bandwidth and computational resources low.

Graduate

DEVELOPMENT OF HYBRID SYSTEM FOR MINIMALLY INVASIVE SURGERIES

Primary Author: Uddhav Bhattarai, Engineering (Ph.D.)

Advisor: Ali T. Alouani

Minimally Invasive Surgery(MIS), although advantageous compared to open cavity surgery in many aspects, is not widely accepted by surgeons for clinical application. This is due to cost and required complex training of the currently practiced technology. The main challenges in reducing cost and amount of training is to have an accurate inner body navigation advisory system along with the use of a flexible robot arm to safely perform such surgery. As a first step in making minimally invasive surgery affordable and easy to use, quality images inside the patient body as well as accurate position of the surgical tool should be provided in real time. An array of asynchronous sensors is required to successfully and safely perform real time inner body navigation. Furthermore, it is necessary to have flexible surgical arm capable of following curved paths to avoid damaging patient organs when moving the surgical tools inside the body. In this work, three asynchronous sensors are calibrated and information were fused together in real-time spatially and temporally in such a way that the fused information will be useful to perform successful MIS. Furthermore, a complete design of the flexible surgical arm system is proposed. It is believed that the result of this work will have practical impacts on making MIS more affordable, and flexible surgical arms more accurate and user friendly than existing counterparts.

Graduate

AN APPLICATION OF NEURO-FUZZY ALGORITHMIC MODELING FOR STATE OF CHARGE ESTIMATION

Primary Author: Jacob Fesmire, Electrical and Computer Engineering (M.S.)

Advisor: Indranil Bhattacharya

Co-Author(s)/Collaborator(s): Indranil Bhattacharya, Bibek Tiwari

A method for modeling state of charge (SOC) of sodium ion batteries, using a Neuro-fuzzy modeling algorithm is explored. Due to batteries being non-linear systems, producing accurate models requires unique and extensive computation, which is why a neuro-fuzzy algorithm (artificial intelligence) is implemented. Knowing this, MATLAB was used to program the necessary algorithm to estimate an accurate SOC. Both the Neuro-Fuzzy Designer application and manual coding were tested using data from multiple sodium-nickel-manganese-cobalt-oxide (NaNMC) batteries. However, this method will work for any type of battery systems, provided the desired data is available. Four input parameters were used to generate a single output. The inputs are voltage, current, capacity, and the integral of voltage, and the output is the SOC of the battery. This data was compiled and entered into the Neuro-Fuzzy Designer and the SOC was estimated. For comparison, the ANFIS function in MATLAB was coded to do the same task as the Neuro-Fuzzy Designer application. Both of these methods estimated SOC accurately, but manually coding the algorithm produced an estimation in a fraction of the time and was much less computationally intensive. The root-mean-square error (RMSE) was found to be 0.002504. In conclusion, the Neuro-fuzzy algorithm was explored and tested to generate an accurate and faster estimation of SOC.

Graduate

IMPLEMENTATION METHODS OF ECC ON FPGA CHIPS

Primary Author: Katie Groves, Electrical and Computer Engineering (M.S.)

Advisor: Omar Elkeelany

When it comes to encryption, low propagation error and high throughput with minimum resources are the goals to have for any cryptosystem. One type of encryption that fits these properties is elliptic curve cryptography (ECC). While ECC uses very little resources and is reliable for securely encrypt data, implementation onto a field programmable gate array (FPGA) further reduces physical resources required to stream line the efficiency of ECC. The purpose of this literature review is to research different ways ECC is being used, like in point multiplication, and how it is implemented onto FPGA chips along with what kinds of FPGA chips. A more in depth analysis on why having ECC on FPGA is being sought after will be explored. Having a comparison of efficiency and resources will be taken into account during this review. Also, noting any limitations that may exist having ECC on a FPGA chip and how some researcher have developed answers to these problems.

Graduate

ANALYSIS AND DESIGN OF AN INDUCTIVE WIRELESS POWER TRANSFER SYSTEM

Primary Author: Utkarsh Kavimandan, Engineering (Ph.D.)

Advisor: Satish Mahajan

Wireless Power Transfer (WPT) to the devices is safe, reliable and convenient as compared to the traditional wired systems. WPT is a system in which electromagnetic (EM) energy is transferred from a power source (e.g. tesla coil) to an electric load. WPT system works on electromagnetic induction (governed by Faraday and Ampere's laws) phenomenon to transfer power through a small air gap between closely spaced primary and secondary coils of a transformer. A capacitor is usually added to both primary and secondary coils in order to achieve resonance that leads to an optimum performance of the system. However, any changes in the system parameters (such as distance between the coils, frequency, load condition, etc.) affect the resonant condition. This in turn, greatly affects the power transfer and overall efficiency of the system. Different techniques are used to improve the WPT system performance (such as impedance matching, frequency tuning or load regulation). The control schemes are implemented on primary side, secondary side or a combination of both. The designed WPT system was simulated using MATLAB/Simulink and the results were obtained. A dual independent control (primary and secondary) scheme as against the traditional single control scheme was implemented. The effect of variations in different parameters related to system performance were analyzed.

Graduate

STABILITY ENHANCEMENT USING PSS TO DAMP OUT LOW FREQUENCY OSCILLATIONS WITH SVC CONTROLLER AND OPTIMALLY PLACED PMU

Primary Author: Joseph Nikhil Raj Koppula, Electrical Engineering

Advisor: Ghadir Radman

Low-Frequency Oscillations (LFOs) are one of the main reasons behind the infamous blackout of West USA/ Canada (1996), with a low frequency oscillation around 0.224 Hz, and also the blackout of 14 August (2003), which had an oscillation frequency of about 0.17 Hz. These low frequency oscillations pose potential threats to the stability of Power Systems.

Applying various mathematical methods like Forward Fourier Transform (FFT), Prony analysis etc., these LFO are damped using devices like Static VAR Compensator, Static Synchronous Series Compensator (SSSC), Thyristor controlled Series Compensator (TCSC), and Power System

Stabilizer (PSS). With the advent of Phasor Measurement Units (PMUs), monitoring of power system became easier and more efficient due to the high rate of sampling of which proved to be advantageous. PSS has been good at damping the LFO but it has not been used along with FACTS devices and PMUs.

This paper proposes using the PSS to achieve optimal damping of LFO by improving the small signal performance of the PSS, along with SVC controller and PMU. It is anticipated that the proposed control scheme would achieve better results in damping out the oscillations. Software tools like MATLAB, PSAT and SIMULINK are being used.

Graduate

NICKEL DOPED P2-TYPE [NA]_(0.67) [FE]_(0.5) [MN]_(0.5) O_2 CATHODE MATERIALS FOR SODIUM ION BATTERIES

Primary Author: Miguel Lastres, Electrical and Computer Engineering (M.S.)

Advisor: Indranil Bhattacharya

Co-Author(s)/Collaborator(s): Indranil Bhattacharya, Bibek Tiwari

Layered P2 -type [Na]_0.67 [Fe]_0.5 [Mn]_0.5 O_2 is regarded as a promising cathode material for sodium ion batteries. This layered transition metal oxide material is susceptible to structural instability and suffers from poor capacity retention. In this work P2 -Type [Na]_0.67 [Fe]_0.5 [Mn]_0.5 O_2 cathode material was prepared by the citric acid assisted sol-gel method. To ameliorate the stability of the structure and cycling performance, Manganese (Mn) was partially doped with Nickel (Ni) to form P2 -type [Na]_0.67 [Fe]_0.5 [Mn]_(0.5-x) [Ni]_x O_2. The increased Ni content reduced the reversible capacity but improved cyclability. The improved electrochemical performance of the [Na]_0.67 [Fe]_0.5 [Mn]_(0.5-x) [Ni]_x O_2 electrode is attributed to the Ni doping, which alleviates the Jahn-Teller distortion of [Mn]^(3+) thereby corresponding to a lower capacity decay rate. For long term cycling, it is beneficial to cycle within the voltage range of 1.5V-4.0V, to minimize the strain on the P2-type crystal structure. If the cut-off voltage is any higher even though it may show a higher reversible capacity, decay rate will be further exacerbated, resulting in a decreased coulombic efficiency. The initial discharge capacity for [Na]_0.67 [Fe]_0.5 [Mn]_0.5 O_2 is 125mAh/g and is expected to improve once the pure phase P2 -type crystal structure has been formed. The Ni substituted [Na]_0.67 [Fe]_0.5 [Mn]_(0.5-x) [Ni]_x O_2 potentially serves as a feasible high capacity and stable cathode material for sodium ion batteries.

Graduate

ELECTRICITY THEFT DETECTION IN AMI NETWORKS

Primary Author: Mahmoud Mahmoud, Engineering (Ph.D.)

Advisor: Mohamed Mahmoud

Modern smart grids rely on advanced metering infrastructure (AMI) networks for monitoring and billing purposes. However, such an approach suffers from electricity theft cyberattacks. Different from the existing research that utilizes shallow, static, and customer-specific-based electricity theft detectors, this paper proposes a generalized deep recurrent neural network (RNN)-based electricity theft detector that can efficiently thwart these cyberattacks. The proposed model exploits the time series nature of the customers' electricity consumption to implement a gated recurrent unit (GRU)-RNN, hence, improving the detection performance. In addition, the

proposed RNN-based detector adopts a random search analysis in its learning stage to appropriately fine tune its hyper-parameters. Extensive test studies are carried out to investigate the detector's performance using publicly available real data of 107,200 energy consumption days from 200 customers. Simulation results demonstrate the superior performance of the proposed detector compared with state-of-theart electricity theft detectors.

Graduate

ANOMALY DETECTION IN IoT DEVICES USING DATA MINING TECHNIQUES

Primary Author: Hawzhin Mohammed, Engineering (Ph.D.)

Advisor: Syed Hasan

Co-Author(s)/Collaborator(s): William Eberle, Tennessee Technological University; Tolulope Odetola

Internet of Things (IoT) devices are used to transmit data over a network. IoT device usage has grown and has been adopted in healthcare, smart homes, smart grids, connected cars and so on. However, IoT devices have security vulnerabilities and cannot provide a 100% guarantee of data privacy. They are prone to hacks and hardware Trojans that can lead to data theft. Hence there is a need to find ways to help solve the challenges of IoT devices. This paper proposes an approach that investigates how fraud, data theft, or fault, can be detected through the power profile of IoT devices in different operation modes using data mining techniques. Different cases will be made based on the behavior of the IoT device in terms of power consumption. These cases will be dependent on the mode of data transfer. Data mining techniques will be used to develop a model capable of detecting malicious behaviors and any form of the anomaly in power profiles of IoT devices.

Graduate

REDUCING REFLECTIVE LOSSES BY TEXTURING PEROVSKITE-SILICON SOLAR CELL LAYERS

Primary Author: Micah Rentschler, Electrical Engineering

Advisor: Indranil Bhattacharya

With the discovery of the light absorbing properties of perovskite, a new door has opened to economical and efficient multi-junction solar cells. Towards that end, we sought to improve the quantum efficiency of a perovskite-silicon tandem solar cell by reducing the reflection loss. In previous research we have shown that approximately 12% of losses in a perovskite-silicon solar cell are due to reflection. Many claim that reflection can be reduced by artificially texturing the surface of certain layers within the cell to increase light transmitted through layer boundaries. Ray-tracing is a common method of analysis but does not account for the interaction of reflected and incident waves. We analyze a textured boundary using Maxwell's equations and finite element analysis. The results indicate that texture boundaries improve the performance of perovskite-silicon solar cells and significantly reduce reflective losses. In fact, after optimization and current matching the overall efficiency of the cell can be increased well above 30%.

Graduate

ON SUBSYNCHRONOUS INDUCTION GENERATOR EFFECT MITIGATION IN A WIND ENERGY SYSTEM USING CURRENT SOURCE CONVERTER BASED STATCOM

Primary Author: Eseme Sota, Electrical and Computer Engineering (M.S.)

Advisor: Ghadir Radman

Recent practice of inserting series capacitors in long distance transmission lines reduces line inductance and boost power transfer capability. However, when such

lines are connected to wind farms utilizing turbine driven induction generators, it can result in a significant adverse effect referred to as subsynchronous resonance (SSR). SSR is a phenomenon whereby the electric network exchanges energy with a turbine generator at one or more subsynchronous frequencies of the combined system. It causes electrical instability as well as turbine shaft failures. Flexible Alternating Current Transmission System (FACTS) controllers have proven to provide an effective solution to alleviate SSR. Among the FACTS devices, static synchronous compensators (STATCOM) has been the focus of many studies. However, STATCOM, realized as voltage source converter (VSC) has been the dominant topology employed to dampen SSR. In this study, a current source converter based STATCOM device with a controller is utilized to dampen oscillations due to subsynchronous induction generator effect (SSIGE). The CSC topology has distinct advantages over the VSC some of which are inherent short circuit current protection and direct control of the STATCOM output current. The proposed method would provide faster and improved damping of oscillations when compared with existing methods. Eigenvalue analysis is used to assess the system potential for SSR and the results will be validated by time domain simulations in MATLAB.

Graduate

COPPER SUBSTITUTED HIGH CAPACITY AND STABLE P2 – TYPE CATHODE MATERIAL NA0.7NI0.3MN0.59CO0.1CU0.01O2 FOR SODIUM ION BATTERY TECHNOLOGY

Primary Author: Bibek Tiwari, Engineering (Ph.D.)

Advisor: Indranil Bhattacharya

Co-Author(s)/Collaborator(s): Indranil Bhattacharya

Due to the abundance of sodium in nature and lower cost, Sodium Ion Battery Technology can be an alternative to the current Lithium Ion Battery Technology. We synthesized a novel P2-type layered oxide sodium ion transition metal oxide Na0.7Ni0.3Mn0.59Co0.1Cu0.01O2 (SIB) cathode material using the sol-gel method. It provided a high reversible discharge capacity and a better capacity retention than the state-of-the-art SIB. The XRD patterns confirmed the successful insertion of copper ions in the lattice structure of Na-Ni-Co-Mn layered oxide. The material exhibited a high reversible discharge capacity of 150 mAhgm-1 through a voltage window of 1.5-4.0 V. The use of copper reduces the Mn3+ concentration, which has a strong Jahn- Teller effect and will result in distortion of the crystal structure. Thus reduction of this Mn3+ helped to achieve better structural stability and higher conductive cathode material. Thus obtaining the higher discharge capacity and better cycle retention from the battery. The battery was able to retain its 94% of the maximum discharge capacity even after 80 cycles.

Department of Manufacturing and Engineering Technology

Undergraduate

DESIGN AND IMPLEMENTATION OF SAFETY SOLUTION FOR HANDS OFF LATHE MACHINING OF TORQUE CONVERTER HUBS

Primary Author: Justin R. Brown, Electrical Engineering

Advisor: Ahmed Elsawy

Co-Author(s)/Collaborator(s): Wyatt Gravitt, Christian Molina, Austin Ochi, Chelse Smith

TRANSTAR DACCO is a Re-Manufacturing company specifying in Torque Converters here in Cookeville, TN. The company has been a historically unsafe environment relative the industry's standards. The team's goal was to improve company safety by implementing light curtains and a hands off approach to polishing the converter hub on a lathe. Our design consists usage of various burnishers, a cleaning tool and an automatic lubricator for the tool. The lathe will not be able to operate if the light curtain is broken. All polishing and machining will be done away from moving parts preventing injury to the operator.

Undergraduate

DESIGN AND METAL CASTING OF THE TAU ALPHA PI HONORS SOCIETY EMBLEM

Primary Author: Frances Cherry, Engineering Technology

Advisor: Ahmed Elsawy

Co-Author(s)/Collaborator(s): Hunter Hinshaw, John Mackel, Anthony Patterson II, Jarred Smith

Tau Alpha Pi is the national honor society for engineering technology. It is fostering Excellence in Engineering Technology Education. The MET Department just get Tau Alpha Pi chapter approved by TTU's student organization and the goal of this project is to design and create the Tau Alpha Pi Emblem to be placed in front of Lewis Hall. The dimensions for the emblem were received from Tau Alpha Pi national organization. This project will involve 2D and 3D solid model designing, pattern printing and casting a bronze Honor Society Emblem. Our team was able to contact a High Tech Foundry in Arkansas, which has the ability to cast the larger pieces of the Emblem. Our group will be responsible for casting the remaining pieces of the Emblem here at Tennessee Technological University. Nowadays, foundries are using newer, more abstract means of patterning molds for metal casting. Recent developments in additive manufacturing and robotics are being implemented as a replacement for traditional mold making techniques. The construction of the Tau Alpha Pi emblem for display in front of Lewis Hall will utilize these new techniques. Additively manufactured patterns and robotic milled molds will be utilized in the metal casting process. Casting will occur both on Tennessee Tech's campus and off-site at Southern Cast Products in Jonesboro, Arkansas. The manufacturing of the Tau Alpha Pi emblem takes traditional methods and combines them with innovative techniques to produce an accurate, near-net-shape product.

Undergraduate

INCREASE PRODUCTION RATE OF THE BIODIESEL USING A SOLAR POWERED THERMALLY-EFFICIENT HIGH-YIELD ULTRASONIC PROCESSOR

Primary Author: Warren Klapp, Engineering Technology

Advisor: Ahmed ElSawy

Co-Author(s)/Collaborator(s): Robbie Mannankara, Caleb Parker, Anthony Taylor, Kareem Williams

Production of biodiesel from waste vegetable oil is an economical, and benign environmental option to use as an alternative energy source and reuse of waste vegetable oil. This study has two objectives. First, increasing the production rate biodiesel using sonication to reduce the processing time and utilizing a high voltage to reduce the biodiesel/glycerin separation time. Second, reducing the energy needed for the production of biodiesel using solar energy beside electric energy. The processing rate will be improved using a Raspberry Pi 3 Model B in place of the current Arduino Mega for better process control. This will allow simultaneous tasks to be executed. Furthermore, with the addition of larger diameter piping will allow for higher rates of fluid to be transferred from storage containers. With the addition of a second separation tank to increase the amount of separation of the biodiesel and glycerin mixture. This paper will discuss the improvements and suggestions for future improvement.

Undergraduate

DEVELOPMENT OF A HYBRID WATER DESALINATION SYSTEM

Primary Author: Brandon McMahan, Engineering Technology

Advisor: Ahmed Elsawy

Co-Author(s)/Collaborator(s): David Beaty, Nicholas Byrd, Nhan Nguyen, Devin Scott

With the scarcity of freshwater in some parts of the world, water desalination is becoming a necessity. Water desalination is a process that converts saltwater into drinkable potable freshwater is becoming human necessity. The ultimate goal of this project is to develop a hybrid-water desalination system using vacuum tubes solar collector and supplemented by electrical energy. We will be using thermal evaporation/condensation method. The water evaporator is a modified 40-gallon water heater in which we inserted a copper coil and pumping glycol to a vacuum tube solar collector located on the building roof. Through solar radiation, the vacuum tubes heats up the glycol which in return heats up the seawater in the 40-gallon hopefully to boiling temperatures. The tank is also equipped with two inserted heating elements to supplement the solar energy needed for evaporate the seawater. The boiling tank is further equipped with two insulated drum heater - fixed Temp 145 F as a supplement heat source on the evaporation thank. In the condensation tank, the water vapor flowing in another copper coil heat exchanger will be cooled by the seawater being pumped from the source, causing the vapor inside the tube to condense and be stored separately from any brine byproduct.. The timing of the pumps, solenoid pumps, heating elements and other system components controlled by a Raspberry Pi controller.

Undergraduate

NASA HUMAN ROVER EXPLORATION: AN ENGINEERING DESIGN CHALLENGE CHANGING THE FUTURE

Primary Author: Tyler Wilson, Engineering Technology

Advisor: Ahmed Elsawy

Co-Author(s)/Collaborator(s): Justin Finks, Kyle Monnin, Gordon VanHoy, Macy Williams

NASA's engineering design challenge focuses on current plans to explore planets, moons, asteroids, and comets through advanced surface missions, once the space shuttle has landed on the planet's surface. The challenge's focus is on designing, fabricating, and evaluating technologies for mobility devices to perform in the harsh extraterrestrial conditions that astronauts experience. This provides

practical, real world experiences that engage students in critical thinking and the engineering design process, while allowing NASA to observe and review new potential ideas that can be used as the basis for research and development on new technologies that can be used on future missions into outer space. TTU's team participated in this competition for over two decades. While in the past they have been a fierce competitor, recently they have placed lower than expected. This challenged this year's team to design and manufacture a highly competitive rover. We put an entirely new twist on the rover design this year, straying from complicated suspension and parts to simple and durable components in hopes to see fewer failures during the running of the course this April. Along with a simpler suspension design, the middle latch of the rover has been completely rebuilt to avoid failures and motion in the frame. Higher quality components such as bearings and gearing systems have also been added this year, contributing to our confidence and helping to ensure the team to place higher than previous years.

Department of Mechanical Engineering

Graduate

EFFECTS OF ANGLE OF ATTACK ON AIRFOIL VELOCITY PROFILE

Primary Author: Mushrif Choudhury, Engineering (Ph.D.)

Advisor: Jie Cui

Corrosive effects of high-speed air as wind pressing against an airplane wing lead to wing degradation and failure at a much faster rate than the aging of an idle wing. For this reason, the velocity profile of a NACA 0012 airfoil cross-section subjected to high velocity wind was developed and analyzed.

In this analysis, the effects of angle of attack on the overall wind velocity profile of an airplane moving in one direction were assessed. The highest steady-state wind velocity was found to occur at the airfoil edge region between the airfoil tip and the location positioned at the aforementioned angle of attack. This means that a ten-degree angle of attack produced the highest velocity at the airfoil section from the airfoil tip to ten degrees from the tip, a section of area larger than the maximum velocity area for a four-degree angle of attack. The magnitude of the maximum corresponding airfoil velocity was also directly related to the angle of attack.

In conclusion, in order to minimize the corrosive effects of high-speed wind on airplane wings, the wind angle of attack on the airfoil should be minimized as much as possible. This could be achieved by altering the wing shape to a less-round edge or installing a mechanism that can easily adjust wing position according to wind direction.

Graduate

INVESTIGATION OF NEURAL-NETWORK-BASED INVERSE KINEMATICS FOR A 6 DOF SERIAL MANIPULATOR WITH NON-SPHERICAL WRIST

Primary Author: Wesley Demirjian, Mechanical Engineering (M.S.)

Advisor: Stephen Canfield

Co-Author(s)/Collaborator(s): Stephen Canfield, Tennessee Technological University, Dept. of Mechanical Engineering; Benjamin Hargis; Matthew Powelson

This study proposes using an Artificial Neural Network (ANN) to train a 6 DOF serial manipulator with a non-spherical wrist to solve the inverse kinematics problem. In this approach, an ANN has been trained to determine the configuration parameters of a serial manipulator that correspond to the position and pose of its end effector. The network was modeled after the AUBO i5 robot arm, and the experimental results have shown the ability to achieve millimeter accuracy in tool space with significantly reduced computational time relative to an iterative kinematic solution when applied to a subset of the workspace. Furthermore, a separate investigation was conducted to quantify the relationship between training example density, training set error and test set error. Testing indicates that, for a given network, sufficient example point density may be approximated by comparing the training set error with test set error. The neural network training was performed using the MATLAB Neural Network Toolbox.

Graduate

A MODULAR IMPACT-BASED EXPERIMENTAL SETUP FOR EVALUATION OF EMI BASED STRUCTURAL HEALTH MONITORING AT HIGH RATES

Primary Author: Ekramul Haque Ehite, Mechanical Engineering (M.S.)

Advisor: Steven Anton

Co-Author(s)/Collaborator(s): Steven R. Anton, Dynamics and Smart Systems Laboratory, Tennessee Technological University

This poster investigates the application of the electromechanical impedance (EMI) method for detecting changes in the dynamic state of engineering structures. A low-cost, modular, instrumented, impact-based experimental setup is proposed, which creates a collision between a pneumatically actuated moving striker bar, and a static instrumented incident bar at different impact velocities. The setup is made user-configurable with options for configuring the boundary condition of the incident bar and the dimension and material of the incident and striker bars. The velocity of the striker bar is controlled by varying the driving gas pressure, and the impact velocity is measured by a photoelectric sensor-based measurement system. A piezoelectric transducer attached to the incident bar is utilized for detecting the changes in dynamic state at the interface between the two bars by utilizing the EMI method. Impedance data is continuously acquired and processed during impact using a custom-made measurement and analysis suite. The measurement results are used to examine the capability of the developed system to generate customized, repeatable impact events and also monitor the impedance response of the piezoelectric sensor. The long-term goal of this research is the use of the impact-based experimental setup for examining damage detection in structures operating in highly dynamic environments. This will be done by coupling the setup with a measurement system capable of microsecond data acquisition and signal processing.

Graduate

E-SAIL TETHER DEPLOYMENT EXPERIMENT AND SIMULATION

Primary Author: Benjamin Hargis, Mechanical Engineering

Advisor: Stephen Canfield

Co-Author(s)/Collaborator(s): Stephen Canfield, Mechanical Engineering Department, Tennessee Technological University

Tether deployment of the prototype 6U system introduces complex dynamic responses within the tether. In order to provide information about these responses to the design

team, a massed tether model was created using the bead and string concept with equations of motion derived from Lagrange's Method. Simulations were conducted for different deployment profiles with the intent of providing the information necessary to define the flight test operating parameters for the prototype 6U system. Three different simulation profiles were explored; (1) propulsive separation with one 6U fixed, (2) propulsive spin-up with one 6U fixed, and (3) propulsive spin-up with both 6Us free. The simulations performed varied deployment speed, tether tension, maximum angular velocity, and tether length at spin-up initialization. Based on simulation data, it is recommended that the prototype deployment flight test stage (1) be conducted with 0.5m/s maximum separation velocity with a quadratically reducing reel out profile. Stages (2) and (3) simulations indicated that spin-up initiation should begin at full deployment length with a maximum angular velocity to 0.25 rad/s

Graduate

THERMAL DISTILLATION USING HEAT LOCALIZATION

Primary Author: Divya Susmitha Jaladi, Mechanical Engineering

Advisor: Ehsan Languri

Co-Author(s)/Collaborator(s): Ehsan Languri, Tennessee Tech University; Tea Phillips

Thermal desalination using solar energy is one of the most propitious application in renewable energies and a viable solution for treating the waste water to meet the present-day water standards. This work demonstrates the re-using of waste water by using the laboratory designed low-cost desalination system under 1 sun solar concentration condition, a double layer structure comprising carbon foam and exfoliated graphite are used for solar thermal conversion, Where heat is localized to top layer get heated and evaporated due to the capillary action of the porous structure at the top, vapor is allowed to condense and fresh water is collected. This is eco-friendly and low cost due to solar energy and grid-free operations and great option for the semi- arid and drought prone regions.

Graduate

MODELING HEAT EXCHANGER PERFORMANCE WITH APPLICATION TO DESALINATION USING A VACUUM TUBES SOLAR COLLECTOR

Primary Author: Kiran Lankalapalli, Engineering (Ph.D.)

Advisor: Stephen Idem

Co-Author(s)/Collaborator(s): Ahmed Elsawy

One goal of this project is to develop a steady state sensible performance analysis of multi-pass cross-flow finned-tube heat exchangers. The investigation considers various flow circuiting, such as counter cross-flow, parallel cross-flow, and cross-flow where the tube-side flow is in parallel. A previously developed matrix approach is used to evaluate the heat exchanger performance in each tube pass. A consistent criterion is proposed for each case, wherein increasing the NTU beyond a certain threshold value does not significantly improve heat exchanger thermal performance. Another goal of this project to devise an inexpensive, portable means of desalinating water using vacuum tubes solar collector. An evaporation/condensation process shall be employed to achieve desalination. It will incorporate an existing rooftop vacuum tube solar collector located in Lewis Hall to promote evaporation of a brine solution, and shall likewise utilize a cooling coil to condense pure water from the evaporated brine solution.

Graduate

LOW-COST CORROSION AND OXIDATION RESISTANT COATINGS FOR IMPROVED RELIABILITY OF TURBINE ENGINE COMPONENTS

Primary Author: Giovanni Mainardi, Mechanical Engineering (M.S.)

Advisor: Ying Zhang

Co-Author(s)/Collaborator(s): Brian Bates, Tennessee Tech/CMR R&D Engineer; Ying Zhang, Tennessee Tech/Mechanical Engineering Faculty

In order to improve high-temperature oxidation and corrosion resistance of critical superalloy components in turbine engines, innovative processing methods must be devised to improve coating and materials properties at higher reliability and lower costs. Electrolytic codeposition is a promising low-cost non-line-of-sight technique for manufacturing MCrAlY coatings (where M = Ni, Co, or Ni + Co). The process involves codeposition of CrAlY-based particles and a metal matrix of Ni, Co, or (Ni,Co), followed by a diffusion treatment to convert the composite coating to the desired MCrAlY microstructure. Recent coating development progress from a collaborative research effort between Tennessee Tech University and Faraday Technology Inc. is presented. Two Ni-based alloys with different chromium levels (Inconel 718 and Nimonic 105) were coated. The coated specimens were evaluated in oxidation testing at 800°C and in hot corrosion tests at 760°C with mixed Na2SO4-MgSO4 salt solution on the specimen surface.

Graduate

THERMAL MANAGEMENT USING DIAMOND NANOFLUID

Primary Author: Farzin Mashali, Mechanical Engineering (M.S.)

Advisor: Ehsan Languri

Co-Author(s)/Collaborator(s): Gholamreza Mirshekari

Detonation diamond nanoparticles have been characterized using TEM, XRD, FT-IR and EDS analysis and then dispersed in deionized water in various concentrations to interrogate their thermo-physical properties, including viscosity and effective thermal conductivity. The viscosity and thermal conductivity were measured at different temperatures using an A&D SV-10 Viscometer Japan and KD2 thermal conductivity meter Decagon United States, respectively. The results suggest an optimum point at which maximum thermal improvement is obtained with a minimum penalty in viscosity increment. In the next step, a heat transfer loop was designed to evaluate the convective heat transfer characteristic of nanofluid in a turbulent flow regime. Comparing the result of DI water and 0.05 wt. % diamond nanofluid, a 25% enhancement in convective heat transfer for diamond nanofluid samples in the same flow rate is observed. Furthermore, with an identical heat transfer rate between the hot surface and liquid, 25% reduction in pumping power for the diamond nanofluid has been observed compared with DI water. These results suggest a very desirable improvement for such a low concentrated nanofluid.

Graduate

A STUDY OF THE EFFECTS OF SULFUR IN ELECTRO-CODEPOSITED MCrAlY COATINGS

Primary Author: Elliott Normand, Mechanical Engineering (M.S.)

Advisor: Ying Zhang

Demands for higher efficiency and lower emissions require higher operating temperatures in aircraft, land-based, and nautical power generation gas turbines. Gas turbine operating temperature is increasing due to advances in knowledge, materials development and cooling techniques. The superalloy technology alone cannot provide metals with the high-temperature performance necessary to sustain operation. The key to meeting these new demanding goals is to provide an insulating thermal barrier coating (TBC) to lower the surface temperature of the superalloy underneath. MCrAlY overlay coatings have been used as the bond coat for TBCs, which form a protective oxide scale during service. This scale allows the substrate to withstand the high temperatures while also increasing the corrosion resistance. Electrolytic codeposition is a promising alternative process for fabricating these MCrAlY coatings. Compared to current coating processes, electrolytic co-deposition has many advantages such as low cost, non-line-of-sight, consuming much less energy with little waste, and the fabrication of dense, adherent coatings. Traditionally, a "Watts Bath" solution has been used to produce these coatings. While these coatings have had success, they can still be improved. The "Watts Bath" contains traces of sulfur in the solution which can adversely affect the coating oxidation performance. The use of a sulfur-free solution is investigated in this study. If the results are positive, this innovative approach to synthesizing these multiphase coatings will expand the knowledge and usage of the electro-codeposition technique in the area of high-temperature protective coatings.

Graduate

IMPEDANCE-BASED STRUCTURAL HEALTH MONITORING OF TOTAL KNEE ARTHROPLASTY

Primary Author: Robert Ponder, Mechanical Engineering (M.S.)

Advisor: Steven Anton

Co-Author(s)/Collaborator(s): Mohsen Safaei

Total Knee Replacement (TKR) is a medical procedure with high prevalence within the United States. In spite of advanced medical techniques, almost 20% of TKR patients are dissatisfied with their outcomes. This dissatisfaction can result from a number of causes including mechanical failure of the implant. A variety of in vivo techniques have been proposed and implemented to detect and quantify issues such as loosening in TKR. These techniques have largely focused on detecting the intra-joint forces between the tibia and femoral implant components. An alternative to measuring compartmental forces in TKR is to perform active Structural Health Monitoring (SHM) to sense the conditions of the knee implant and its surrounding structures. One form of SHM, which has previously seen little implementation in the biomedical world, utilizes the electromechanical coupling of piezoelectric transducers, called the Electro-Mechanical Impedance Method (EMI). In this work, validation of the EMI method with orthopedic structures is investigated. Validity is determined by testing the effectiveness of the EMI method in materials present in a simulated cemented orthopedic implant system. Various damage conditions are introduced to the system to investigate measurement sensitivity. The final objective of this study is to provide a foundation for research and innovation in the world of orthopedic medicine.

Graduate

DIRECT IMAGE MONOCULAR CAMERA LOCALIZATION USING DEEP LEARNING

Primary Author: Matthew Powelson, Mechanical Engineering (M.S.)

Advisor: Stephen Canfield

Co-Author(s)/Collaborator(s): Stephen Canfield, Tennessee Technological University

Feature based localization is a common avenue of robotics research. While historically this has been carried out in a 2D space using sensors such as lidar, with the rise of highly mobile sensor packages – for example cell phones or UAVs – the use of 3D feature maps is an area of increasing interest. This poster presents a deep learning approach that estimates the pose directly from a single monocular camera image. This is done by using transfer learning to leverage pretrained models at minimal computational cost. A common convolutional neural network architecture typically used for image classification is adapted to act as a regressor that can directly predict pose from raw RGB pixel values. Introductory tests show effectiveness in 1D with computational speeds sufficient for real time application.

Graduate

EXPERIMENTAL ANALYSIS OF BIO-INSPIRED THERMAL ENERGY STORAGE SYSTEM USING PHASE CHANGE MATERIAL

Primary Author: Vinit Prabhu, Engineering (Ph.D.)

Advisor: Ehsan Languri

The importance to enhance the performance of utilities and limit the use of energy during peak load periods is very much essential due to the excessive cost of energy during this time. The thermal energy storage (TES) systems work in storing the excess thermal energy during non-peak load time and supply this energy during the peak load period. The TES system used in this research includes the use of phase change material (PCM) to utilize its latent heat for the storage of thermal energy. The inspiration for the TES system came from the biological systems found in nature such as elephant ears, venation of leaves etc. which are very effective in transfer of heat. The models of different configurations of TES are built based on different aspect ratios and surface area for experimental analysis. The experimental analysis of various configurations are compared with a base case which is a straight pipe heat exchanger surrounded by PCM. The rate of charging and discharging are studied for each configuration. The purpose of this research is to effectively store the thermal energy with less charging and discharging rates with minimal added costs.

Graduate

COMPARTMENTAL FORCE AND CONTACT LOCATION SENSING WITH PIEZOELECTRIC TRANSDUCERS IN TOTAL KNEE ARTHROPLASTY

Primary Author: Mohsen Safaei, Mechanical Engineering

Advisor: Steven Anton

Co-Author(s)/Collaborator(s): Robert I. Ponder

Total Knee Arthroplasty (TKA) has been a choice for the people who suffer from knee disease such as arthritis and knee injuries for more than three decades. One of the most important factors, which affects the outcomes of the TKA, is joint alignment during the surgery. Due to the importance of the alignment, numerous studies have been performed in order to establish a universal technique, which is adoptable for patients with different musculoskeletal structures. Although computer modeling, cadaver testing, and limited in vivo measurements have provided some useful information, establishment of a comprehensive model has not yet been achieved. The reason for the abovementioned issue is a lack of sufficient in vivo data obtained from the knee joint after the surgery. In this study, the application of embedded piezoelectric transducers in the bearing of a TKA is suggested in order to obviate the current limits. The piezoelectric elements can provide several functions including sensing, energy harvesting, and structural health monitoring. In particular, six piezoelectric sensors are placed on the bottom surface of the bearing and the sensing performance of the proposed device is investigated in this work. As a sensor, piezoelectric transducers are designed to measure the

compartmental forces as well as the location of the contact points between the femoral and tibial components of the knee implant. The sensing performance of the system is studied via a combination of finite element analysis and experimental tests.

Undergraduate

NANODIAMOND NANOFLUIDS IN A TURBULENT FLOW REGIME

Primary Author: Fahad Alkhaldi, Mechanical Engineering

Advisor: Ehsan Languri

Co-Author(s)/Collaborator(s): Farzin Mashali

This study investigates thermal properties and convective heat transfer coefficient of functionalized nanodiamond dispersed in deionized water as the base fluid to form diamond nanofluid. The nanofluid is flowing in a conduction cold plate under turbulent flow regime. A voltage regulator is used to apply heat to the conduction cold plate through six cartridge heaters with a constant heat transfer rate. A cooling tank is used to keep the inlet temperature constant. The primary experimental study was conducted with deionized water, and the results were compared to Dittus Boelter correlation to make sure that all system components are working well. Then, nanodiamond fluid flowed in the loop in different flow rates and different amounts of heat were applied. The results indicated a higher convective heat transfer coefficient and Nusselt number for diamond nanofluid compared with DI water at the same flow rate. The enhancements were increasing with increasing the flow rate and Reynolds number. The Nusselt number for this experiment is fitted with Gnielinski's correlation equation, and the experimental results indicate a higher improvement.

Undergraduate

P-SSHI TECHNIQUE IN A SELF-POWERED ENERGY HARVESTING CIRCUIT FOR USE IN TOTAL KNEE REPLACEMENT

Primary Author: Elijah Barrett, Electrical Engineering

Advisor: Steven Anton

Co-Author(s)/Collaborator(s): Robert Ponder, Mohsen Safaei, Michaela Williamson

Total knee replacements are a standard procedure used to alleviate knee pain and increase function. Despite its pervasiveness, a sizeable amount of TKR patients continue to be dissatisfied with surgery outcomes. To improve the knee replacement, it is advantageous to collect data on relevant joint forces that make up the ligamentous balance. For doctor and patient convenience, self-powered in vivo knee implant force sensors should be utilized for minimal change in surgical procedure. The embedded sensors are powered by converting mechanical compression from the knee to electrical energy through the use of piezoelectric material. The conditioning circuitry required should include rectification of the voltage before being subject to storage. Digital logic circuitry detects the polarity of the piezoelectric material's current, followed by the parallel synchronized switch harvesting on inductor technique (P-SSHI) for rectification. To simulate how the designed circuit would function in an actual knee replacement, a realistic knee load profile will be applied to an instrumented knee implant connected to the circuit using a load frame. This work investigates the implementation of this method and includes a comparative analysis of pre and post-conditioning measurements in the hopes of designing a simpler, more efficient energy harvesting circuit.

Undergraduate

COMPARISON OF MATLAB AND TENSORFLOW MACHINE LEARNING METHODS

Primary Author: Justin Carlson, Mechanical Engineering

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Stephen Canfield

It can be found on the news, running our machines, and analyzing our browsing history. Machine learning is everywhere and with the recent widespread implementation of various machine learning software it is easier than ever for someone with basic programming knowledge to start building their own machine learning models. People who are new to machine learning may wonder what the various types are, what their differences are, and how they can start doing their own machine learning projects. The present study utilizes two different common machine learning techniques to build models that can predict the location of a Wi-Fi connected device through that device's incoming router information. The first technique being used will leverage MATLAB's vast library of prebuilt machine learning algorithms to create a model. The second type of model is a neural network, it is built using Google Brain Team's TensorFlow 1.6. The data obtained for the models was taken throughout Tennessee Tech's campus. This study outlines the initial data collection process used to train the models, and the processes used to create the models. The difference between neural networks and prebuilt machine learning algorithms is examined, the results of the two different methods is displayed and analyzed, and the processes used to create the machine learning models is shown as well. The models created in this study have various potential applications if used in real time on personal devices, the models could be useful for campus tours, or even adviser location for graduate students.

Undergraduate

BIOMIMETIC JOINT DESIGN AND TESTING

Primary Author: Micah Hardyman, Mechanical Engineering

Advisor: Stephen Canfield

Commonly within engineering design, material strength is the defining factor for a device's performance. However, as shown by the following research, certain design methods may utilize only certain material properties allowing for a much wider material selection and far greater performance. Often many materials are ignored during the design process based upon only one or two of their strengths such as a low tensile or compressive strength. Though, by allowing a part to dislocate via a ligament system certain material properties may be ignored. For example, after 3D printing a replica of the human hand with ligaments instead of pinned joints it was found that in normal loading a finger could support tens of pounds of force, as the bones only experience compressive loading. However, when a bending force from the side of the joint was applied it supported less than ten pounds before dislocating. As the bending strength of printed plastic is quite low had not the design dislocated the parts would have quickly failed. With this dynamic behavior the design is able to act rigidly and compliantly. Because of these characteristics there are many different applications for this research. Currently this design method is being implemented via prosthetics as it allows a 3D printed design to achieve similar and often better performance within high impact environments than traditional steel prosthetics. This design can also be implemented in many designs that should require flexible yet strong joints, greatly reducing the cost of the system while simultaneously increasing its life.

Undergraduate

FABRICATION OF MICROFIBRILLAR MATERIAL

Primary Author: Shane Terry, Mechanical Engineering

Advisor: Stephen Canfield

Co-Author(s)/Collaborator(s): Hou Chan, The Cooper Union; Matthew Powelson

On a microscopic scale, geckos have numerous setae extrusions extending from their footpads allowing them to climb particularly smooth surfaces. These hairlike structures are the working basis for directional dry adhesives. This adhesive is desired for applications such as climbing robots for its ability to adhere to many types of dry smooth surfaces. The current primary method for producing this material is through photolithography. This poster focuses on a micromachining-based process that is economical compared to the photolithographic process and utilizes precise movements in the XY plane in which to cut negative features out of a material with a thin rotating disc into the desired shape. These recesses are then filled with a silicone elastomer and cast to produce a directional dry adhesive. The process proposed in this paper is far less expensive than the traditional photolithographic process that was used to obtain similar features. The micromachining based process produces a controllable-shear-based adhesive where normal adhesion increases when loaded parallel to the plane.

Undergraduate

PARAMETRIC TESTING OF SURROGATE KNEE REPLACEMENT BEARINGS WITH EMBEDDED PIEZOELECTRIC TRANSDUCERS

Primary Author: Zachariah Tiberi, Mechanical Engineering

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Steven Anton

Co-Author(s)/Collaborator(s): Justin Carlson

Total Knee Replacement (TKR) is a common surgery, yet often times the long-term results are less than satisfactory due to misalignment of the knee. Within the first few years of surgery about 20% of knee replacement recipients report discomfort or undesired functionality. One major underlying cause of this ligamentous imbalance is lack of numerical data for surgery. This study tests the force location and magnitude estimation capabilities of knee replacement bearings with embedded piezoelectric transducers. In this study, two different manufacturing methods are used to build bearing prototypes: Fused Deposition Modeling (FDM) 3D printed from PLA, as well as Computer Numerical Control (CNC) machining from UHMW polyethylene. These prototypes are compared in their ability to sense applied force inputs given certain test parameters. The prototypes are tested in a fixture designed to replicate the knee as it goes through normal and irregular gait cycles. The fixture can position between 0 and 90 degrees of flexion and can replicate axial rotation as well as lateral translation between the femoral component and knee bearing interface; this permits simulation of a knee with correct alignment and simulation of misaligned knees. This study provides a comparison between predictions from the piezoelectric sensors and actual measurements from the load frame for force magnitude and contact locations. The aim of this study is to give insight to the feasibility of a 6-sensor array within a patient's actual knee bearing, and how well surgical teams will be able to utilize this novel application of piezoelectric transducers.

Abstracts

College of Interdisciplinary Studies

School of Environmental Studies

Graduate

QUALIFICATION AND QUANTIFICATION OF VARIOUS OPIOIDS IN URBAN WASTEWATER TREATMENT PLANT AND RIVER BY UTILIZATION OF SOLID PHASE EXTRACTION (SPE) TECHNIQUE AND LC-MS/MS

Primary Author: Faranak Mahmoudi, Environmental Sciences Chemistry (Ph.D.)

Advisor: Tammy Boles

Co-Author(s)/Collaborator(s): Tammy Boles

Opioid based pain killers are being prescribed at an alarming rate across the United States, and they are being used and abused at epidemic proportions. Traces of almost everything we eat, smoke, drink, ingest, or absorb are excreted in urine or stool. They travel through the sewage system and end up at wastewater treatment plants (WWTP). In this study, we took influent and effluent water samples from the Cookeville WWTP to measure the concentration of morphine, heroin, oxymorphone, hydromorphone, hydrocodone, and oxycodone in the samples. Additionally, we took water samples from Pigeon Roost Creek above and below the WWTP to determine whether the compounds were completely removed by the WWTP processes. We filtered the samples, extracted them using solid phase extraction (SPE) and analyzed them by liquid chromatography-tandem mass spectrometry (LC-MS/MS) to qualify and quantify these compounds.

Undergraduate

ANALYSIS OF MICROHABITAT PREFERENCE OF THE MOUNTAIN MADTOM, NOTURUS ELEUTHERUS

Primary Author: Jennifer Caudle, Wildlife and Fisheries Science

Advisor: Hayden Mattingly

Co-Author(s)/Collaborator(s): Sarah Kenney, Formerly TTU; Hayden Mattingly, TTU; Grady Wells; Jeannette Wolak, TTU

The mountain madtom (Noturus eleutherus) is a small, benthic catfish occurring in several drainages in the eastern United States. Very little is known about this species' life history and ecology. In this project, we specifically examined water column depth and substrate preferences of the mountain madtom in the Clinch River, Tennessee, during summer months. Knowledge gained from our project may provide insight for understanding microhabitat preferences of the endangered pygmy madtom (Noturus stanauli) because it has been associated with the mountain madtom in past collections. Madtoms were collected by kick-seining, depth was measured in kick-seined area, and sediment was collected using the shovel method. The water depth category most frequently used by mountain madtoms was 31–40 cm; however, there were no statistically significant differences among depth categories. In addition, there was not a strong preference for a particular substrate size. These results provide a better understanding of habitat of the mountain madtom during the summer.

Undergraduate

SCREENING METHOD DEVELOPMENT FOR THE IDENTIFICATION OF DESIGNER DRUGS BY GC-MSN AND LC-MS/MS

Primary Author: Madison Fulmer, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Tammy Boles

Co-Author(s)/Collaborator(s): Jeffrey Boles, Tammy Boles

Recreational use of synthetic drugs is a problem not just in Tennessee, but nationwide. Two types of synthetic drugs are the biggest problem: cannabinoids (synthetic marijuana) and cathinones (bath salts). The criminal justice system is having a hard time keeping up with the detection of all of these "designer drugs" because they are constantly being altered with slight variations, creating a new drug that is technically not illegal. Because many of the compounds have similar structures, they are difficult to separate chromatographically. Drug laboratory personnel need verifiable published analytical methods for the compounds in order to be able to have applications for forensic purposes. This research focuses on developing easier, faster methods for detecting cathinones using instrumentation currently available in forensic chemistry labs. Previously published methods for the GC-MS were analyzed and replicated. Once a method was replicated successfully, methods for GC-MSn and LC-MS/MS were developed and tested using known standards of cathinone and methcathinone of various concentrations. Unknown samples received from the Tennessee Bureau of Investigation were then extracted and analyzed using the developed methods.

Undergraduate

INITIATIVE FOR AN ALTERNATIVELY FUELED BUS AT THE APPALACHIAN CENTER FOR CRAFT

Primary Author: Currie Nowell, Environmental and Sustainability Studies

Advisor: Steven Sharp

Co-Author(s)/Collaborator(s): Micah Conatser, Noah Kaye, Jedidiah Scott, Michele Williams

Alternative fuel transit bus systems, also referred to as Low-No (low to no emissions) buses, are one way to improve upon urban air quality in the world today. By removing the diesel engine, you are also removing the tailpipe emissions that release harmful greenhouse gases – but what do you switch to: a battery-powered transit system.

This switch will constitute a sharp decrease in air emissions, as well as help to save money and reduce carbon outputs in the region. A lot of students at the Appalachian Center for Craft depend upon the student shuttle bus to transport them to and from campus for classes, so improving the quality of this system will only add benefit to the environment. This will also constitute significant financial savings once implemented.

Battery-powered buses may seem inefficient, but thanks to new engineering feats, some of these systems are now relying on fast-charge batteries which can provide enough electricity to power the bus for an hour of driving in only 4 minutes of charging time – however this data analysis is based upon the average, according to the Wall Street Journal of, "18 kilowatt hours per mile," (WSJ, 2011.) Our poster demonstrates the savings that this change could allocate for the Appalachian Center for Craft through comparative analysis of charts, diagrams, and real-world case studies as well as federal and state grant opportunities to explore this sustainable technology.

Undergraduate

ANALYSIS OF WASTEWATER SAMPLES FOR ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD) MEDICATIONS BY LIQUID CHROMATOGRAPHY-TANDEM MASS SPECTROMETRY (LC-MS/MS)

Primary Author: Waverly Parker, Chemistry

Undergraduate Research and Creative Activities (URECA) Award Recipient

Advisor: Tammy Boles

Prescription rates for attention deficit hyperactivity disorder (ADHD) medications for both adults and children have been steadily increasing over the last two decades. Widely used ADHD medications include methylphenidate hydrochloride (Ritalin and Concerta), amphetamine (Adderall), and lisdexamfetamine dimesylate (Vyvanse). Urine excreted within 48-96 hours can contain 78-97% of the intact drug or metabolites. Because the drugs and their metabolites may not be removed from influent by conventional wastewater treatment, detectable concentrations can be found in wastewater effluent and in surface water, becoming an environmental problem. This research focuses on the detection of amphetamine, hippuric acid, methylphenidate, and ritalinic acid in wastewater. Influent and effluent wastewater samples were collected and filtered prior to solid phase extraction (SPE) using Oasis HLB cartridges. HLB is an all-purpose, strongly hydrophilic, reversed-phase, water-wettable polymer. Known concentrations of amphetamine-D5, methylphenidate-D9, and benzoylecgonine-D3 were added to all samples and to all calibration standards to serve as internal standards. Half of the collected samples were spiked with known concentrations of amphetamine, methylphenidate, and ritalinic acid, and the remaining half were not spiked. All samples were analyzed using a Varian ProStar210 high-performance liquid chromatograph system interfaced with a Varian 320 MS triple quadrupole mass spectrometer.

Undergraduate

IDENTIFYING SOLUTIONS FOR SUSTAINABLE AND EFFICIENT OUTDOOR LIGHTING AT THE APPALACHIAN CENTER FOR CRAFT

Primary Author: Emily Samples, Environmental and Sustainability Studies

Advisor: Steven Sharp

Co-Author(s)/Collaborator(s): Michaila Evans, Elias Vaden

The purpose of this research project was to replace, update, and install more outdoor lighting fixtures at Tennessee Tech's Appalachian Center for Craft. The issues of safety, sustainability, and visibility were considered and addressed while taking cost and student health into consideration. Updating and converting the outdoor lighting fixtures already present on campus to LED lightbulbs was found to potentially save the Appalachian Craft Center energy and money. We also found that installing appropriate new outdoor lighting to poorly lit areas would greatly increase visibility and student safety at night. The problem of LED lighting altering sleep patterns was identified, and the appropriate color temperature was found. We have determined that applying for grants from Tennessee Tech's Sustainable Campus Committee, as well as other environmental or industry entities, is the best way for the Appalachian Center for Craft to cover expenses, and we have guided them through the application process. Through these processes, together we have given the Appalachian Center for Craft the tools to create a safer and more sustainable campus through outdoor lighting.

Undergraduate

MODERN EFFICIENT BOILERS: REDUCING EMISSIONS

Primary Author: Levi Williams, Environmental and Sustainability Studies

Advisor: Steven Sharp

Co-Author(s)/Collaborator(s): Johnathan Nixon, Shelby Thomas

The overarching goals of the project are to help the Appalachian Center for Craft reduce their carbon footprint and save on energy costs. The initial focus is on the boiler system, which heats an area of 87,000 sq. ft., produces an output of 1,600,000 BTUs, and is thirty years old. While the current boiler has been meticulously maintained, it is likely far less efficient than newer models due to advancement in technologies. Specific tests to determine the exact efficiency have not been conducted. However, according to energy.gov, similar-age models have an energy efficiency rating of 51-70%. In contrast, many current models with similar energy outputs have efficiency ratings of 88-98%. Another factor to be considered is space available. New piping has recently been added to the boiler room and getting a new boiler through a 36-inch-wide door is of concern. Research encompassed more efficient boilers, including gas models, biomass boilers, and hybrid-fuel source boilers. The pros and cons of each boiler are compared, including issues of cost, maintenance and potential funding.

Undergraduate

ESS CAPSTONE PROJECT 2017-2018

Primary Author: Kristin Willis, Environmental and Sustainability Studies

Advisor: Steven Sharp

Co-Author(s)/Collaborator(s): Alyssa Dalton, Molly Kramer, Lindsay Mills, Gabby Pack

In summarizing our project, the 2017-2018 ESS Capstone students would like to revamp the existing recycling bins in the Appalachian Center for Craft campus along with introducing composting to the campus. After evaluating the existing recycling bins on the campus, it was decided to offer a new system of color coded bins that the Office of Sustainability could easily provide. This would replace the old bins and offer more of them to residents and other areas of the campus to provide ease of access and more incentive to recycle. Composting was introduced to the Craft Center for their on-site restaurant, The Blue Water Grille, to begin recycling their waste for future use of soil on their own grounds. This would educate residents and staff on composting and provide the campus the opportunity to be more environmentally friendly. Both projects would provide the campus with environmental benefits for almost no cost due to the Office of Sustainability providing all recycling and composting bins.

School of Interdisciplinary Studies

STIGMA AS A BARRIER TO CARE IN THE HIV+ AND TRANSGENDER COMMUNITIES

Primary Author: Bryson-Higgins Kelpe, Interdisciplinary Studies

Advisor: Ashley Allison

Introduction: Stigma from internal and external sources may cause negative health outcomes for people experiencing the stigmas. Barriers to healthcare are exacerbated by the stigma experienced in the special populations of people living with HIV and AIDS, as well as stigma experienced by members of the Transgender community.

Methods: The research began with a search of several electronic databases as well as key publications in infectious disease, gender studies, public health, and psychology. Reviews of literature, as well as past key informant interviews were utilized for the current study. Original surveys focusing on stigma were administered to people living in East Tennessee in the target populations. 135 people were surveyed; 65 identified as transgender and 70 identified as People Living with HIV & AIDS. The survey consisted of questions where respondents expressed how feelings of stigma related to HIV status or being transgender kept them from accessing healthcare and health seeking behaviors.

Results: People living with HIV and AIDS experience profound levels of external and internal stigma which are comparable to the level of stigma experienced by members of the Transgender community. Both populations, as well as those in the intersection of both groups experience stigma that can create barriers to healthcare, linkage to care, and healthcare outcomes.

Conclusion: The populations studied experience internal and external stigmas that create barriers to healthcare and linkage to care. Healthcare providers can actively reduce stigma by creating an empathetic and judgment free environment for patients from the HIV+ and Transgender communities.

Abstracts

Whitson-Hester School of Nursing

Undergraduate

THERE'S NO "I" IN TEAM

Primary Author: A. Caroline Henderson, Nursing

Advisor: Susan Piras

Co-Author(s)/Collaborator(s): Kirsten Beasley, Jennifer Montgomery

Background: The Joint Commission reports communication errors as a leading cause of sentinel events in the U.S. Breakdown in communication across various health fields has been attributed to a lack of teamwork amongst healthcare professionals. Undergraduate health science students rarely have opportunities to work with other disciplines; this lack of opportunity is related to a lack of teamwork. To foster interprofessional teamwork, in 2017, an interprofessional case study event was conducted with undergraduate nursing, nutrition, childlife, social work, and OT/PT students at Tennessee Technological University.

Purpose: The purpose of this quantitative, one group (n=130) pre/post test research study was to determine the effects of undergraduate interprofessional educational opportunities on students' perceptions of interprofessional teamwork.

Methods: The case study event consisted of nursing, nutrition, childlife, social work, and OT/PT students at Tennessee Technological University. We gathered data using the SPICE-R2 Instrument to gather quantitative data regarding students' perceptions of interprofessional team-based practice. The self-report survey was administered before and after the interprofessional case study event to compare pre-event and post-event scores. Our results support statistically significant improvement in students' perceptions of teamwork.

Conclusion: These results indicate the interprofessional case study event helped students realize that interdisciplinary teamwork improved their collaboration and view of teamwork. This increase in communication may decrease the amount of future sentinel events, creating a safer healthcare environment for patients. Due to the statistically significant improvement in students' perceptions of teamwork, we recommend these events be included in health science students' educations semesterly.

Undergraduate

WHO'S WHO IN THE ZOO: DEFINING ROLES AND RESPONSIBILITIES OF A COLLABORATIVE HEALTH CARE TEAM ABSTRACT

Primary Author: Gloria Hinton, Nursing

Advisor: Susan Piras

Co-Author(s)/Collaborator(s): Shannon Mooney, Morgan Porter, Abigail Webster

In 2017, 10,748 patients in the acute care setting experienced a sentinel event (The Joint Commission, 2017). As reported by the Joint Commission, 70% of these events could be avoided with a clear understanding and

proper communication of the roles and responsibilities of each member of the healthcare team. With clearly defined roles and responsibilities of each team member, nurses can better utilize each member to increase the quality of patient-centered care delivery. To facilitate rich interprofessional communication among students of various health care disciplines (nursing, social work, nutrition, pre-OT/PT, and child life), an Interprofessional Case Study Event was conducted. Participants worked through three phases of care from a case study scenario in which fostering effective communication among the students was vital. We hypothesize that participation in an Interprofessional Case Study Event at the undergraduate level will increase students' knowledge of the roles and responsibilities of the various health care team members. Design: A quantitative one-group, pre/post test case study event was conducted with various undergraduate health care students enrolled at Tennessee Technological University. Data were collected using the SPICE-R2 self-report questionnaire.

Results: Our analysis supports a statistically significant difference in students' perceptions of the roles and responsibilities for collaborative practice pre/post Interprofessional Case Study Event.

Conclusion: The implications of this study suggests that providing collaborative learning opportunities for students of health disciplines will increase the understanding of roles and responsibilities of each health professional, resulting in more effective interdisciplinary communication that will lead to improved patient care.

Undergraduate

AN INTERDISCIPLINARY CASE STUDY: PROMOTING COLLABORATION BETWEEN UNDERGRADUATE NURSING AND OCCUPATIONAL THERAPY STUDENTS

Primary Author: Katie Howell, Pre-Professional

Advisor: Susan Piras

Co-Author(s)/Collaborator(s): Hailey Burke, Peyton Curtis

Background: Interdisciplinary care is essential to deliver effective, holistic care to patients. Literature suggests that 50% of Americans have a musculoskeletal condition and 90% of rehabilitation patients are discharged. It is vital for occupational therapists (OT) and nurses to understand collaborative roles to achieve optimal patient outcomes. Purpose: The purpose of this case study is to determine whether participating in the case study event improved undergraduate OT and nursing student's perception of interprofessional collaborative practice.

Sample: The undergraduate students of various healthcare majors at Tennessee Technological University were given a case study scenario requiring utilization of effective communication to provide care for a patient in the acute, rehabilitative, and at-home care phases.

Methods: The Interprofessional Education instrument (SPICE-R2) was used to collect data regarding students' perceptions of interprofessional collaborative practice. The SPICE-R2 (alpha=0.83) is a 10-item self-report questionnaire that uses a 5-point Likert scale. The SPICE-R2 was administered to undergraduate OT and nursing students pre/post case study event (n=50). Results: The pre/post-study analysis suggests a statistically significant increase in nursing and OT student's perceptions of interprofessional collaborative practice. Recommendation: Our recommendation is continued promotion of clinical opportunities for nursing and OT students to work together to enhance understanding of roles and contributions between different disciplines. Conclusion: The Case Study Event provided an opportunity for Nursing and OT students to learn about each

other's role in the interdisciplinary team. Furthermore, opportunities for interprofessional students to work together will enhance their understanding of roles and contributions from different disciplines.

Undergraduate

INTERDISCIPLINARY STUDIES AND PATIENT OUTCOMES

Primary Author: Kody Smitherman, Nursing

Advisor: Susan Piras

Co-Author(s)/Collaborator(s): Whitley Battles, Jennifer Condra

Background: The Joint Commission reports, 70% of sentinel events are attributed to poor communication and a lack of care planning collaboration. Furthermore, approximately 53% of patients who experienced a sentinel event ended in death. Improved interdisciplinary teamwork and communication may decrease the incidence of sentinel events and thus patient mortality. Integration of interdisciplinary education at the foundational stages in the healthcare education can promote better understanding of each interdisciplinary role, therefore positively impacting patient outcomes.

In 2017, an interdisciplinary case study was conducted at Tennessee Technological University with undergraduate students from various fields (nursing, pre-occupational therapy, social work, child life specialist, and nutrition students). This case study event included a patient scenario through various care trajectories with rich interdisciplinary student communication after each care phase.

Design: This was a quantitative one-group pre/post-test study design.

The SPICE-R2 Instrument was used to collect student's perceptions of the effect of interdisciplinary education on patient care outcomes. This survey tool measures student's perceptions regarding how interprofessional teamwork affects patient outcomes.

Results: Our results indicated a statistically significant difference in student's perceptions when comparing pre and post case study results.

Conclusion: Using interdisciplinary communication can decrease the incidence of sentinel events, thus improving the rate of patient mortality. The interdisciplinary day allowed participants to understand the complexity and importance that each major concentrate on and how they can together improve how the healthcare system functions. The results showed a statistically significant difference, which supports the possible integration and implementation of interdisciplinary actions within healthcare.

Notes

#researchday2018

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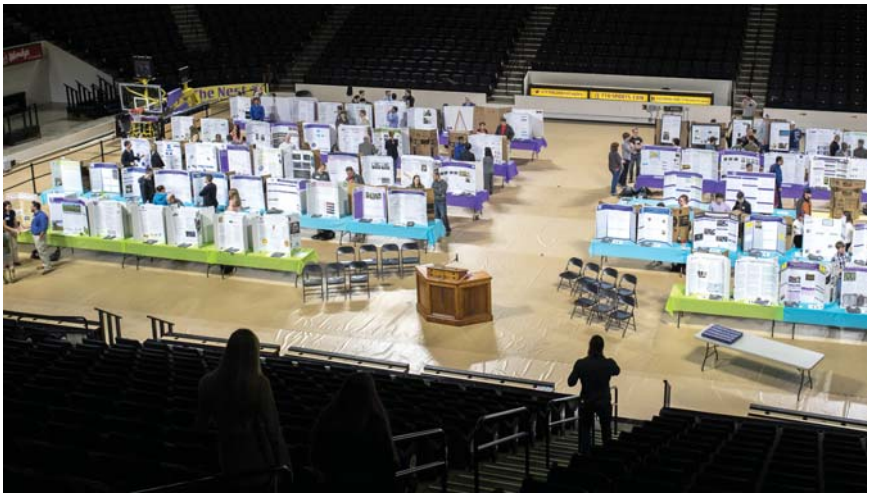
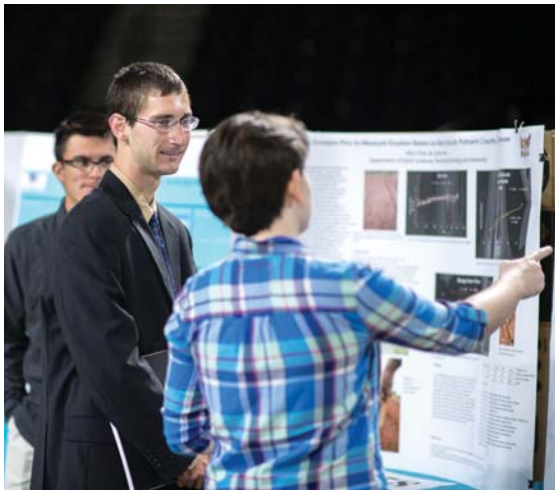
Research & Creative Inquiry Day 2017





National Medal of Technology & Innovation

The National Medal of Technology and Innovation is the nation's highest honor for technological achievement, bestowed by the President of the United States on America's leading innovators.

The medal is awarded annually to individuals, teams, companies or divisions of companies for their outstanding contributions to America's economic, environmental and social well-being. The purpose of the National Medal of Technology and Innovation is to recognize those who have made lasting contributions to America's competitiveness, standard of living, and quality of life through technological innovation, and to recognize those who hav emade substantial contributions to strengthening the nation's technological workforce. By highlighting the national importance of technological innovation, the meda is also meant to inspire future generations of Americans to prepare for and pursue technical careers to keep America at the forefront of global technology and economic leadership.

Established by the Stevenson-Wydler Technology Innovation Act of 1980, the medal was first awarded in 1985. The first National Medals of Technology were also issued in 1985; among the first recipients were technology giants Steve Jobs and Stephen Wozniak, founders of Apple Computer. The America Competes (Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science) Act of 2007 amended Section 16 of the Stevenson-Wydler Technology Innovation Act of 1980, to change the name to the "National Medal of Technology and Innovation."

The National Medal of Technology and Innovation is the work of medalist and sculptor Mico Kaufman. The obverse side depicts the technologist as something of a modern "wizard," with a concentrated beam bouncing off the palm of his hand representing the input and the output of technology and of the innovation process. On the reverse is an eagle clutching an olive branch and arrows encircled by the inscription "AWARDED BY THE PRESIDENT OF THE UNITED STATES OF AMERICA."

www.uspto.gov/learning-and-resources/ip-programs-and-awards/national-medal-technology-and-innovation/national.html