tntech.edu/research/research-day

April 8-9, 2019
Hooper Eblen Center

14th Annual Tennessee Tech Research and Creative Inquiry Day

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Tennessee TECH

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 27,000 students nationally and internationally to Tennessee universities, awards over 8,500 graduate student degrees from Tennessee public and private institutions annually, and contributes to the economic growth and stability of the State, generating more than 1.1 billion 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 Lee, Governor of the State of Tennessee, do hereby proclaim the week of February 10 through February 16, 2019, 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 twenty-second day of January, 2019.

Bill Lee

Governor

Tre Hargett

Secretary of State

Foreword

The Office of Research and Economic Development welcomes you to the 14th Annual Research and Creative Inquiry Day. This event provides an opportunity to showcase student research and creative inquiry projects from departments across Tennessee Tech's campus. Student research experiences are important as they stimulate active learning and teamwork, cultivate mentoring relationships, improve critical-thinking skills, and provide students with the knowledge and expertise to evaluate situations creatively. In addition, events such as this enhance presentation skills and provide opportunities for collaboration around areas of mutual interest.

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 Governor Lee of the State of Tennessee proclaimed Feb. 10 – 16 as "Graduate Education Week."

This year's event features posters and paper presentations generated from 222 submitted abstracts on topics as varied as the 23 fields of study from which they originate.

Congratulations to the students and faculty advisors who have worked hard to prepare and present these posters and papers that demonstrate Tech's dedication to excellence in learning and discovery. Thank you to the judges who volunteer their time to evaluate the students' work. This event would not have been possible without the support of the entire campus community.

Special Appreciation & Acknowledgments

Tennessee Tech Offices, Departments and Staff

Dining Services and Catering, Engineering Workstation Lab, Facilities, Hooper Eblen Staff, Information Technology Services, Library Services, Office of Communications and Marketing, Office of Creative Inquiry/QEP, Printing Services, SSC or Custodial Services, Student Services

We would like to extend a special thanks to Kristen Deiter, associate professor of English, for coordinating the paper-presentation portion of the event.

We also wish to acknowledge David and Sherri Nichols for their endowment to support student research and creative inquiry.

Schedule of Events

The 14th Annual Research and Creative Inquiry Day

Monday, April 8

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

TBD: English Department Paper Presentations

Tuesday, April 9

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.)

11 a.m. to noon: Awards Ceremony

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

2019 Judges

Melinda Anderson — Human Ecology
Holly Anthony — Curriculum & Instruction
Steve Anton — Mechanical Engineering
Laura Arias Chavez — Chemical Engineering
Curtis Armstrong — Decision Sciences & Management
Megan Atkinson — Volpe Library
Debbie Barnard — Foreign Languages
Michael Best — Agriculture
Joseph Biernacki — Chemical Engineering
Jeremy Blair — Art, Craft & Design
David Brown — Computer Science
Marilyn Bruckman — Curriculum & Instruction
Andrew Callender — Chemistry
Stephen Canfield — Mechanical Engineering
Amanda Carroll — Chemistry
Derek Cashman — Chemistry
George Chitiyo — Curriculum & Instruction
Rufaro Chitiyo — Human Ecology
Scott Christen — Communication
Yvette Clark — Information Technology Services
O'Andreea Cojocaru — Chemistry
Janet Coonce — Chemistry
Robert Craven — Center for Energy Systems Research
Tania Datta — Civil & Environmental Engineering
Kristen Deiter — English
Ahmed Elsawy — Manufacturing & Engineering Technology
Ismail Fidan — Manufacturing & Engineering Technology
Jerry Gannod — Computer Science
Bahman Ghorashi — Chemical Engineering
Julia Gruber — Foreign Languages
Evan Hart — Earth Sciences
Steven Hayslette — Biology
Ann Hellman — Nursing
Nicole Henniger — Counseling & Psychology
Paula Hinton — History
Adam Holley — Physics
Samantha Hutson — Human Ecology
Stephanie Jorgensen — Chemical Engineering
Ahmed Kamal — Manufacturing & Engineering Technology
Duckbong Kim — Manufacturing & Engineering Technology
Brittany Lafever — Volpe Library
Ethan Languri — Mechanical Engineering
Wayne Leimer — Earth Sciences
Ed Lisic — Chemistry
Leora Loftis — Pace Analytical
Mohamed Mahmoud — Electrical & Computer Engineering
Jennifer Meadows — Curriculum & Instruction
Colleen Mestayer — Communication
Christine Miller — Decision Sciences & Management
Holly Mills — Volpe Library
Gene Mullins — Chemistry
Justin Murdock — Biology
Chris Murray — Biology
Queen Ogbomo — Curriculum & Instruction
Nikki Panter — Biology
Sally Pardue — Mechanical Engineering
Michael Phillips — Exercise Science, Physical Education & Wellness
Kenny Pierce — Agriculture
Mustafa Rajabali — Physics
Chad Rezsnyak — Chemistry
Robby Sanders — Chemical Engineering
Julie Shell — Kimberly-Clark
Doug Talbert — Computer Science
Sandra Terneus — Counseling & Psychology
Indu Upadhyaya — Agriculture
Hannah Upole — Human Ecology
Daniel VandenBerge — Civil & Environmental Engineering
Lenly Weathers — Civil & Environmental Engineering
Clay Wesley — Decision Sciences & Management
Janet Whiteaker — Learning Support Program
Jeanette Wolak — Earth Sciences
Dale Work — Chemistry
Kubra Yeter-Aydeniz — Physics
Xuanzhi Zhan — Chemistry
Liqun Zhang — Chemical Engineering

Abstracts

College of Agriculture & Human Ecology

School of Agriculture

Undergraduate

LEGUME AND GRASSE RESPONSE TO ACTIVATED CHARCOAL AND BROILER LITTER: 2. ROOT NODULATION AND FORAGE REMOVAL BY GRAZING ANIMALS

Primary Author: Lauren Borst, Agriculture

Advisor(s): Pat Bagley

Four legumes (white clover, Will ladino clover, red clover and crimson clover) and three grasses (tall fescue, ryegrass and orchardgrass) were planted on a prepared seedbed with fertility treatments of 0/ control, b4 tons/ acre biochar, and either 4 or 8 tons/ ac of broiler litter. Plant growth observations were taken in 2018 at 2, 3, 5, 6, 7, 9 and 11 weeks post-planting. Yield results through Week 9 were reported last year with growth of 0/ control the least, biochar slightly higher, but a graded response to 4 and then 8 tons broiler litter/acre. At 14 weeks post-planting, representative clover plants were dug up, roots thoroughly washed, and the number of nodules per plant counted. Nodules “fix” atmospheric nitrogen, with more nodulation related to higher forage production. Root nodulation tended to be highest for white and red clover, and lowest for Will ladino. Increasing levels of broiler litter generally caused less root nodulation, apparently causing the legumes to be “lazy” and use the available nitrogen rather than manufacturing their own. There was little to no positive response to biochar. Seemingly, clover perform “best” season-long if encouraged to produce their own root nodules rather than supplying external nitrogen as fertilizers. Following completion of the production data, cattle were given access to the plots for two days, and removal rates estimated. Highest removal rates / voluntary consumption by cattle was highest for all clovers and for tall fescue, and lowest/ least preferred for orchardgrass.

Undergraduate

IMPACTS OF THREE NITROGEN FERTILIZER LEVELS ON GROWTH RATES OF GRASSES AND LEGUMES, AND NODULATION RATES OF LEGUMES

Primary Author: Kortni Ferraro, Agriculture

Co-Author(s)/Collaborator(s): Katherine McNees, Casi Swain

Advisor(s): Pat Bagley

Three nitrogen fertilizer rates (18, 68, and 118 lb/ac of N) were applied to small research plots that had been sprayed previously for weeds and tilled at the Oakley Farm in Livingston, TN. Forage plots were planted to six different grasses (Creeping Red Fescue/ Festuca rubra, Kentucky Bluegrass/ Poa pratensis, “Marshall” Ryegrass/ Lolium multiflorum, Timothy/ Phleum pratense, “Kentucky 31” Tall Fescue/ Festuca arundinacea, and Orchardgrass/ Dactylis glomerata) and five different legumes (Crimson Clover/ Trifolium incarnatum, “Will” Ladino Clover/ Trifolium repens, “Kenland” Red Clover/ Trifolium pratense, common Red Clover/ Trifolium pratense , White Clover/ Trifolium repens). All plots also received the equivalent of 50 lb/ac P2O5 and 50 lb/ac K2O prior to planting. Grasses typically have a graded response to

N fertilizer levels, increasing growth rates as nitrogen is increased. Closer evaluation of the legumes which can "fix" their own nitrogen, to determine if additional nitrogen fertilizer is applied, how it will impact legume growth rates and root nodulation. It has been reported legumes become "lazy" and use the applied nitrogen fertilizer and not nodulate and fix their own nitrogen. Plots will be evaluated every two weeks for germination and percent ground cover, and also for plant heights and estimated dry matter yield. Further, the five legume plots will have individual plants harvested, including the roots, and carefully washed, to count root nodulation in the five legume varieties to evaluate the impacts of nitrogen fertilizer on nodulation amounts for each legume under each nitrogen fertility treatment.

Undergraduate

THE IMPACT OF A UNIVERSITY CONNECTIONS COURSE ON FRESHMAN STUDENTS IN THE SCHOOL OF AGRICULTURE AND HUMAN ECOLOGY

Primary Author: Sarah Harris, Agriculture

Co-Author(s)/Collaborator(s): Melinda Anderson

Advisor(s): Dennis Duncan

During their freshman year of college, students are required to take a connections course linking them to the university as a way to strengthen student involvement, develop an advancement in study skills, and learn more about themselves as well as their goals throughout their college career. Upon completion of the course, College of Agriculture and Human Ecology students were asked to evaluate their perceived level of importance as well as competence for three constructs: communication, leadership, and critical thinking using an instrument that had been pilot tested to determine reliability. The purpose of this study was to identify how students feel their imperative level of importance correlates to their attained level of competence. Students were asked to rank their perception based on a 1-5 scale: 1 (not important/not competent), 2 (of little importance/of little competence), 3 (somewhat important/somewhat competent), 4 (important/competent), and 5 (very important/very competent). In the communication construct, students felt that the top item of most importance was "I actively listen" (96.8%); eighty-four percent felt most competent for the same item. In the leadership construct, students felt that the top item of most importance was "I feel responsible for my actions" (96.8%); however, students felt most competent for "I feel responsible for my decisions" (92.3%). In the critical thinking construct, students felt that the item of most importance was "I strive to be well informed" (96.8%); eighty-nine percent felt most competent for the same item.

Undergraduate

ALTERNATIVES TO HAY PRODUCTION WITH JOHNSONGRASS IN THE FALL FOR BEEF CATTLE

Primary Author: Will Henry, Agriculture

Advisor(s): Pat Bagley

One of the major obstacles in any cow-calf operation is the provision of adequate nutrition during the wintertime months when natural vegetation is sparse. There are several methods by which this may be accomplished, most commonly by the practices of feeding hay or by turning cattle out onto fresh pasture containing stockpiled forage that has been allowed to fully mature. Johnsongrass is a warm-season perennial with high yield potential, but hay-making conditions are poor in fall as temperatures decline. In recent years, another method known as "swath grazing" has seen increased use. This method involves cutting mature forages in the fall and leaving them out in the field for grazing in the wintertime months. This study focuses primarily on determining which method of feeding johnsongrass forage – stockpiling or swath

grazing – presents the better solution for the cattle producer based on plant tissue losses from the weathering process, including freeze-thaw cycles, and the subsequent nutrient leaching that it entails. Over the course of the study, five representative samples were taken from a plot of johnsongrass at Shipley Farm. Samples of standing forage were cut on Oct. 17, Oct. 25, Nov. 1, and Nov. 29, and a sample of forage that had previously been swathed Oct 17 was taken up and measured on Oct. 25. The samples were dried, and masses of seed heads, stems, and leaves were measured. Nutrient content of each sample was also measured to determine the amount of nutrient leaching that had occurred.

Undergraduate

OBSERVATIONS REGARDING MEXICAN SOCIETY AS COMPARED TO THE U.S. BY STUDY-ABROAD STUDENTS

Primary Author: Annalicia Larsen, Agriculture

Co-Author(s)/Collaborator(s): Sarah Jo Pendergrass

Advisor(s): Pat Bagley

In January, 2019, a group of 18 Tech students and two leaders (Pat Bagley and Amy Miller) spent 11 days in Puebla, Mexico as a University sponsored study-abroad program. Students were exposed to various aspects of ordinary life of Mexicans in this upscale city about 60 miles southeast of Mexico City with a population of 3 million people. At the mid-point of the trip, students were addressed by a local businessman who was educated in the US and fluent in English, but runs an electrical supply business and exports to the US. Following the presentation and open questions period, with the total presentation about 1 ½ hours, a questionnaire was administered regarding aspects of Mexican life and relationships to the US. There were four questions with open responses, and six questions asked using a 5-point Likert scale. Selected questions and responses were: 1. Wealth – 100% response as "poorer;" 2. Work ethic: 3/same= 22%, 4/harder = 28%, 5/much harder working = 50%. On the two questions related to whose fault is the illegal drug trade and illegal immigration, respondents were almost exactly split regarding which country is more at fault over this situation. In qualitative responses to questions, respondents cited the fault of the US in the drug trade as the demand for illegal drugs being a root cause of the problem, and also responded they better understood these problems and how Mexicans could be angry with US citizens in causing some of these problems to occur.

Undergraduate

EXPECTATIONS AND REALIZATIONS OF STUDY-ABROAD IN MEXICO FOR STUDENTS

Primary Author: Rachel Ledbetter, Agriculture

Co-Author(s)/Collaborator(s): Shelby Ramsey

Advisor(s): Pat Bagley

In January, 2019, a group of 18 Tech students and two leaders (Pat Bagley and Amy Miller) spent 11 days in Puebla, Mexico as a University sponsored study-abroad program. Puebla is a city of about 4 million people, and is the capital city of the State of Puebla. Students were exposed to many sites around the country, visiting Mexico City, Veracruz, and Cholula, plus the grand pyramids of central Mexico. Studies have shown the impact of study-abroad by University students to be significant. While only a small percentage of college students will go on study-abroad, its impacts are measureable. Students on study-abroad trips have been reported to be 97% employed within one year of travel compared to 49% of college graduates not doing a study-abroad; those in study-abroad had 25% higher starting salaries; 90% got into their first or second choice of graduate school; 80% reported they were better adapted to diverse work environments. The 18

students on this trio to central Mexico were given pre- and post-travel questionnaires. While asked many questions, the two that seemed the most important to students were: a) better understanding other cultures, and b) enhancing the understanding of other cultures. While important, results were not as positive for learning another language, possibly because an interpreter was with the group at all times. Almost all students expressed interests in further travel to foreign countries, and travelling to Mexico made them more aware of situations the rest of the world faces.

Undergraduate

ELECTRONIC IDENTIFICATION FOR THE TRACKING OF BEEF COWS AND CALVES RELATED TO MINERAL AND CREEP FEED CONSUMPTION

Primary Author: Katherine McNees, Agriculture

Co-Author(s)/Collaborator(s): Steven Lawson, Brandon Longmire, Cayleigh York, Jonathon Baca

Advisor(s): Pat Bagley

Managing livestock thru geo-positioning has the potential to improve several aspects of livestock production and management. While there are systems capable of tracking cattle, they are prohibitively expensive, since the average "profit" of a cow-calf operation is about $150 - $200 per year per head and current systems cost at least $100 per animal and needed by both pairs. Industry studies show about $20 per head annually is the maximum beef producers will pay for such technology. Our focus is on relatively simple systems using RFID technology as a base, limited to scanning about 30 inches for Phase 1 of this were we identify cows entering the mineral feeder apparatus. Cattle are identified and weekly electronic files are downloaded showing which animals and how often they access minerals. The mineral feeder also is connected to a sprayer that can apply either cattle insecticide to control ectoparasites or cows can be dewormed twice a year as called for. Insecticide is applied every 18 – 21 days, adjusting for wind and rain situations. Newer technology is used on a "creep feeder" accessible only by calves. It is attached to load cells which will allow constant monitoring of feed removal. Calves have newer technology electronic ID tags, allowing for monitoring when calves actually have their head in the creep feeder, dually monitoring feed disappearance matched to calve ID. The solar-powered feeding stations also have a short-range and long-range camera for visual inspection as directly remotely.

Undergraduate

IMPORTANT EMPLOYABILITY SKILLS OF UNIVERSITY GRADUATES AS PERCEIVED BY INDUSTRY LEADERS

Primary Author: Marisa Phelps, Agriculture

Advisor(s): Dennis Duncan

Any university, regardless of the size of the institution, inherently takes upon itself the responsibility of cultivating the most employable college graduates possible. A university's never-ending quest to stamp its impression upon various industries through their graduates is quintessential to its continuity and the success of its students. This study was conducted amongst 17 prominent, global employers in the agriculture and food industries (e.g. Chick-fil-A, John Deere, Perdue, Yanmar, etc.) in order to magnify what qualities peak their interest as well as what strikes them as opportunities for improvement in recent college graduates. The perceived value of internships and international experiences were also evaluated. Responses were collected using qualitative research methods. Overall, integrity was the leading quality these employers desired by a significant margin followed by leadership potential and work ethic. Meanwhile, communication, initiative, cultural fit and goal-setting were four qualities these organizations report are currently lacking in new hires. All respondents acknowledged merit and value in having

international experiences and personal qualities such as open mindedness, eagerness to learn and maturity were shared by the employers. Additionally, employers see international experiences as a means for enabling students to gain an appreciation for other cultures. Lastly, the majority of respondents stated that a multi-faceted internship should be required for all School of Agriculture students. The evidence presented has profound implications on the School of Agriculture curriculum - how it may be refined in order to produce students who obtain employment with minimal stress and post-graduation unemployment time.

Undergraduate

TRAVEL TO CARITAS FACILITY IN PUEBLA, MEXICO AND THE NEEDS FOR MEDICAL EQUIPMENT

Primary Author: Lauren Reese, Agriculture

Co-Author(s)/Collaborator(s): Savannah Chastain

Advisor(s): Pat Bagley

In January, 2019, a group of 18 Tech students and two leaders (Dr. Pat Bagley and Mrs. Amy Miller) spent 11 days in Puebla, Mexico as a University sponsored study-abroad program. While In Puebla, the group met with and toured two facilities sponsored by the Club Rotario de Puebla Industrial that incudes as day-care center for 4 – 6 year-old children of poor families whose mother work, bit cannot afford day care, and a hospital-like facility where 70 elderly people (35 men, 35 women) are housed who suffered from various maladies related mostly to old age. Almost every one of these patients will pass away while in the facility, rather than living on the street until their lives end. Additionally, medical services are provided to help their pain and suffering, as well as the facility sees about 30 patients each day who cannot afford medical help. The facility is supported by several groups, with only two paid staff. Therapists, dentists, and physicians are all volunteers, with the medical equipment in very poor condition. A list of medical equipment has been requested by the local Rotary Club, and a grant for funding has been requested. To support this grant request of $35,000, we developed and administered a questionnaire to students in the study-abroad trip. Results were on a 5-point Likert scale and showed; a) therapists and physicians were (5) very helpful (92%); b) equipment and beds were very old (1, 86%); c) an upgrade to equipment very important (5, 86%).

Undergraduate

GREENHOUSE BIOASSAY OF SQUASH BUG PREFERENCE WITHIN CUCURBITA PEPO

Primary Author: Chelsea Sanders, Agriculture

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Brian Leckie

One of the most devastating insect pests of summer squash (Cucurbita pepo) is the Squash bug (SB), Anasa tristis De Geer (Hemiptera: Coreidae), a cucurbit specialist. SB can cause severe losses of up to 50% yields in conventional and organic systems. SB preference studies in C. pepo have been performed, although they tested a limited number of cultivars and had unreliable results. The goal of this study was to evaluate a panel of C. pepo cultivars for SB ovipositional preference in small cage assays. A sixteen cultivar panel including two from each of the four of C. pepo market classes in both subsp. pepo and texana was evaluated. Oviposition and insect incidence data was recorded daily for three to five days. Analysis of total egg numbers at 24 hours revealed an ovipositional preference for subsp. texana over subsp. pepo. The most preferred cultivar was Sweet REBA in the Acorn squash

market class (subsp. Texana). Several cultivars in both subspecies experienced no oviposition indicating that they were not preferred. The data clearly demonstrated that SB ovipositional preference exists within C. pepo.

Undergraduate

USE OF DRONES TO SUPPORT "CATTLE TRACKING" ACTIVITIES TO MONITOR LIVESTOCK MOVEMENTS AND WILDLIFE NUMBERS

Primary Author: Casi Swain, Agriculture

Co-Author(s)/Collaborator(s): Katherine McNees, Kotrni Ferraro, Rob Kissell

Advisor(s): Pat Bagley

The Oakley Sustainable Agriculture Center was donated to Tech several years ago. The Farm consists of almost 2,000 ac, and includes 600 brood cows, 150 developing heifers, and assorted calves depending on time of year. Unfortunately several years ago with a large number of cattle stolen. Since then, efforts are underway to "track" cattle more efficiently and to conduct more frequent inventories, and include "electronic boundaries." Also, two additional objectives have arisen and with the aid of RFID ear tags, and work in that area is progressing. With RFID technology, a mineral feeder has been constructed to monitor cattle mineral consumption patterns as well as spray an insecticide for hornfly control. The spray system is connected to the US Weather Station and cows are sprayed with insecticide every 18 – 21 days, except in high wind and rain conditions. Additionally, a creep feeder has been fitter with a "reader" along with load cells where we can monitor feed consumption in a creep feeder by individual calves. The inventory problem is still several generations of technology away, so the group is adding drones to the arsenal to both monitor livestock movements and the births of new baby calves, and also wildlife numbers and movements. Drones seem to offer our best opportunity to develop an inventory system as we await the availability of electronic ear tags with a range of 1 mile or more. This technology is currently available, but is currently only available to military personnel.

Undergraduate

OBSERVATIONS REGARDING THE ROLE OF WOMEN IN MEXICO COMPARED TO THE U.S. BY STUDY-ABROAD STUDENTS

Primary Author: Erin Wakefield, Agriculture

Advisor(s): Pat Bagley

In January, 2019, 18 Tech students and two leaders (Pat Bagley and Amy Miller) spent 11 days in Puebla, Mexico as a University sponsored study-abroad program. Students were exposed to various aspects of ordinary life of Mexicans in this upscale city about 60 miles southeast of Mexico City with a population of 3 million people. Towards the end of the trip, students were addressed by a local businesswoman who was educated in the US and fluent in English. Her mother and father, in about 1955 had purchased an old monastery built in the 15th Century in Puebla, Mexico, and renovated the facility into a hotel. The husband was in charge of the construction, while the wife managed the hotel and the business side. The owner, Maria Louisa retired recently, with their son and daughter now managing the hotel, while the daughter also works in commercial design. She addressed the group of 18 students regarding the role of women in Mexican society. After her discussion a survey was passed out to students and responses were based upon a 5-point Likert Scale. Selected results included: "as compared to US, Mexican women face more discrimination- 72% responded 4 & 5 (yes, more/much more); as compared to US, Mexican women have higher unemployment – 82% responded 4 & 5 (higher, much higher). In qualitative responses, students felt Mexico had very good laws regarding women in the workplace, and after college, both sexes had equal chances at high paying jobs.

School of Human Ecology

Graduate

ANALYSIS OF HEC 3520 PARENT EDUCATION AND CHILD GUIDANCE TO CFLE CURRICULUM STANDARDS AND NAEYC STANDARDS

Primary Author: Emily Bass, Human Ecology

Advisor(s): Melissa Anderson

The purpose of this study was to conduct an in-depth analysis overview of the HEC 3520 Parent Education and Child Guidance course. The main task was to compare the HEC 3520 Parent Education and Child Guidance to the CFLE Curriculum Standards and NAEYC Standards. To begin the process of analysis, every individual course assignment and objective was compared to both sets of standards. The comparison process was overviewed with a system of checking if each objective and standard met with the correlating assignment by highlighting the area it met. When evaluating the course, it was revealed that two course objectives, two CFLE standards, and two NAEYC standards were not met. To correct the missing objectives and standards, new assignments were created to align with the course. The new assignments consisted of a child behavior assessment, a collaborative technology presentation, and online discussion board posts. The newly designed assignments gave a breakthrough for rich and meaningful content by allowing opportunity for the candidate to carry out a mini experience of observing child behavior with the use of assessment and theoretical practices learned, use peer collaboration and technology, and foster peer communication of knowledge regarding content topics. Overall, the findings of this analysis of standards proved to create room for small and few improvements to the HEC 3520 course. The changes made will impact the experience of student learning with more opportunity for the candidate to gain the best expertise possible in the child guidance content.

Graduate

AAFCS BODY OF KNOWLEDGE ASSESSMENT AND IMPLICATION REVIEW

Primary Author: Robin Neese, Curriculum and Instruction (M.A.)

Advisor(s): Melinda Anderson

American Association of Family & Consumer Sciences (AAFCS) has established a Body of Knowledge (BOK) standards which are the basis for the Council of Accreditation (CFA). AAFCS accreditation has three basic purposes which are to advance academic quality, demonstrate accountability and encourage planning and implementation for needed improvement if and when appropriate. Standards based on the foundation of consumer sciences mission and philosophy are to aid in seeking accreditation for bachelor's degree programs in higher education. These standards were designed to emphasize student achievement and all students of family and consumer sciences students should recognize and understand the body of knowledge. Family and Consumer sciences BOK are comprised of three components: core concepts, integrative elements and cross-cutting themes. The core concepts include basic human needs, individual well-being, family strengths and community vitality. The integrative elements include life course development and human ecosystem. Cross-cutting themes addressed are capacity building, global interdependence, resource development and sustainability, appropriate use of technology and wellness. A literature review of each Human Ecology core course was completed to ascertain whether the body of knowledge components that were to be measured in each core course were part of the program of study and also listed on each syllabus as to enable students to readily identify.

Undergraduate

FOOD INSECURITY AMONG YOUNG CHILDREN LEADING TO ACADEMIC STRUGGLES

Primary Author: Esmeralda Amaya, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster examines research articles that investigated the relationship between food insecurity and academic struggles among young children. Food insecurity occurs when the amount of food available to the individual is insufficient for proper dietary and nutrition needs. Between 2007 and 2008, the rate of families suffering from food insecurity increased from 11.1% to 14.6% and has increased from 15.8 to 21% for households with children (Ahn & Bartfeld, 2011, p. 470). Some of the reasons young children face food insecurity include poverty, being raised in a single-parent household, and parent miseducation on proper nutrition and resources to help them. The goal of this research is to bring awareness that food insecurity leads to academic struggles and to promote resources like the National School Lunch program, School Breakfast Program, Supplemental Nutrition Assistance Program (SNAP), and Women Infants and Children (WIC) which are designed to help families who are in need.

Undergraduate

VEGETARIAN DIET AS AN INTERVENTION FOR WEIGHT LOSS AND MANAGEMENT

Primary Author: Chilsea Bindosano, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Samantha Hutson

Overweight and obesity are risk factors for cardiovascular disease, type 2 diabetes, hypertension, and metabolic syndrome. Observational studies have shown that people who practice a plant-based diet usually have lower body weight when compared to those with a regular or nonvegetarian diet. This suggests that a plant-based diet may help in weight reduction or weight management. The purpose of this review was to examine whether practicing a vegetarian diet led to weight loss, and if so, did it lead to more weight loss when compared to other dietary patterns? Tertiary data was collected from the Journal of Academy of Nutrition and Dietetics and PubMed. Several studies showed that a vegetarian diet led to weight loss. The average amount of weight loss from studies included in this paper was 3-4 kg on a 4 to 74 week period. Two studies noted that a vegetarian diet still leads to weight loss even with no caloric restriction or exercise. Therefore, prescribing a vegetarian diet along with exercise and caloric restriction may improve weight loss and long-term weight management outcomes. Further studies need to be conducted regarding whether vegetarian diets have a greater weight reduction when compared to other diets. Although several authors claimed that it does, the evidence could be stronger. In conclusion, vegetarian diets led to weight loss and should be considered as an effective weight loss diet.

Undergraduate

EFFECTIVENESS PSYCHOSOCIAL CARE FOR ADOLESCENTS WITH MENTAL ILLNESS

Primary Author: Jordyn Blackwood, Human Ecology

Advisor(s): Rufaro Chitiyo

Background: Mental illness seems to have increased among the adolescent population within the past decade. Suicide has become a result of such illness in many cases and therefore research conducted towards finding effective treatment must be prioritized. Methodology: Research-

based articles and secondary sources were reviewed for this literature synthesis in order to understand parental perspectives on the effectiveness of psychosocial care provided for their adolescent children with mental illness. Results: The literature shows that psychosocial-based treatments are being administered, but there is a gap with regards to longevity of treatment and its effectiveness. Conclusion: Overall, it appears that there is a growing number of variables in society contributing to mental illness. Consequently, younger patients with mental illness such as adolescents are less likely to seek treatment. Promoting psychosocial treatment through therapeutic relationships and allowing adolescents to contribute to the treatment options being provided should be researched for effectiveness of those treatment options.

Undergraduate

THE RELATIONSHIP BETWEEN SOCIOECONOMIC STATUS AND CHILDHOOD OBESITY

Primary Author: Emily Carter, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Samantha Hutson

Obesity in adolescence is considered to be a growing public health concern due to the high prevalence and the strong association it has with other significant health conditions. A multitude of negative health impacts accompany this disease such as increased risk of cardiovascular disease, sleep apnea, hypertension, hyperlipidemia, and a multitude other chronic conditions. The purpose of this review of literature was to explore the correlation between socioeconomic status and childhood obesity. Research data suggested there are many associated factors that may substantially contribute to the presence of obesity in children. One of those main contributing factors is socioeconomic status. The research studies examined provided further insight to the correlation between childhood obesity rates and socioeconomic status. Factors such as home food environment, food security, and parental influence all played a role in how socioeconomic status contributed to obesity rates in children. All of these research articles pointed to the evidence that it is more likely for parents in low education, low income families to have poor nutritional practices and in turn their children are more likely to be obese.

Undergraduate

CHILDREN WITH SENSORY MOTOR DISORDERS: PARENTS' PERSPECTIVES OF THEIR CHILDRENS COPING SKILLS AND STYLES WHEN EXPERIENCING THE EMERGENCY ROOM OR HOSPITALIZATION

Primary Author: Faith Cisney, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster examines several published articles that report on the experiences of children with sensory motor disorders in hospitals (in-patient) and in the emergency room (emergent/outpatient/emergency department). These articles vary in their use and definition of the term "sensory motor disorder". First, Johnson and Rodriguez (2013) explore the behaviors of hospitalized children with autism spectrum disorder and the challenges that many health care providers may face. Muskat and Riosa (2015) conducted a qualitative research analysis on the challenges for patients with autism spectrum disorder and their families in an acute hospital setting. Furthermore, Wilson and Peterson (2018) discuss the previous healthcare experiences of children with autism spectrum disorder and their parents. Finally, Chinawa and Odetunde (2014) studied the experiences of Nigerian parents of children with Attention Deficit Hyperactivity Disorders in outpatient clinics. Currently, the general consensus among researchers is

that there are few provisions made to differentiate the process according to the needs of children with sensory motor disorders. The research indicates that, in the future, more education of medical staff and accommodations for the patients should be given to aid in the provision of a successful healthcare experience.

Keywords: Hospitalization, In-patient setting, Out-patient setting, Autism Spectrum Disorder, Attention Deficit Hyperactivity Disorder, Sensory Motor Disorder

Undergraduate

THE BENEFITS OF FOLLOWING A VEGETARIAN DIET IN THE PREVENTION OF TYPE 2 DIABETES

Primary Author: Olivia Clements, Human Ecology

Advisor(s): Samantha Hutson

LEARNING OUTCOME: The learner will understand the vegetarian diet and the benefits of following this diet for prevention of Type 2 diabetes.

A well-planned vegetarian diet has been shown to be beneficial towards managing prediabetes and preventing the onset of Type 2 diabetes by weight reduction and laboratory values reaching normal.2 The purpose of this review of literature was to analyze research regarding and investigate whether following a vegetarian diet was an effective method of preventing Type 2 Diabetes in patients who were currently managing prediabetes. Research was gathered using previous literature analyses pertaining to the topic. Those articles were reviewed and synthesized for this review. The research showed beneficial outcomes to patients who participated in a vegetarian diet. In summary, research has shown patients diagnosed with diabetes who consume a vegetarian diet may be more likely to lose weight, increase insulin sensitivity, decrease insulin resistance, and bring the patients' blood glucose level to normal range. These effects will cause an individual with prediabetes to have fewer future complications and decrease likelihood of a Type 2 diabetes diagnosis.

Undergraduate

EXPLORING THE RELATIONSHIP BETWEEN CARBOHYDRATE INTAKE AND WEIGHT LOSS STRATEGIES

Primary Author: Bao Dinh, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Samantha Hutson

The purpose of this review of literature was to further explore the advantages and disadvantages of utilizing a low-carbohydrate diet (LCD) for weight loss purposes. Data from previous researchers was collected and analyzed. Various components of a carbohydrate diet, including fiber, sugars, and starches in the diet was examined. A connection was found between the consumption of sugar-dense foods and beverages and unplanned weight gain. Based on data, although LCDs showed some benefits as a weight-loss strategy, it also had some negative effects. LCDs put the followers in risk of lacking energy source for muscle and brain functions, as well as limit the advantages of fiber and starch in weight loss. There was no evidence of any superior advantage of this diet when compared to other diets.
Learning need codes: 2000, 2070.

Undergraduate

THE ASSOCIATION BETWEEN SUGAR-SWEETENED BEVERAGE CONSUMPTION AND OBESITY-RELATED HEALTH RISKS IN CHILDREN AND ADOLESCENTS

Primary Author: Lauren Gleaves, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Samantha Hutson

Sugar-sweetened beverage (SSB) consumption has increased alongside childhood obesity rates over the past 40 years. SSBs are the largest contributor of added sugar in the American diet. The Dietary Guidelines for Americans emphasizes limiting consumption of added sugars to less than 10% of total daily calories. The purpose of this paper was to determine if there was an association between sugar-sweetened beverage consumption and increased risk of obesity and related health risks in children and adolescents. Today, children and adolescents are consuming more SSBs and less water and milk. High consumption of SSBs in children is associated with lower consumption of protein, fiber, and essential vitamins and minerals including vitamin D, calcium, magnesium, phosphorus, and potassium. Frequent SSB consumption is positively associated with not only weight gain and obesity, but also increased body mass index, waist circumference, type 2 diabetes, hypertension, dyslipidemia, and heart disease. Liquid calories are less satiating and can cause overconsumption, which can lead to weight gain and accompanying chronic diseases over time. While consumption might be a contributing factor to childhood obesity and related health risks, it is more reasonable to state that SSB consumption characterizes overall dietary behaviors, which could be the cause of obesity outcomes. Since more than the recommended 10% of total daily calories are coming from SSB consumption, reducing such consumption should be a focus of childhood obesity prevention. Prevention of childhood obesity and its health risks should be the main goal of parents, educators, health care providers, and policymakers.

Undergraduate

HOW DOES MALTREATMENT IN CHILDHOOD AFFECT RELATIONSHIPS IN ADULTHOOD?

Primary Author: Karly Higgins, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster reviews six different articles discussing maltreatment in childhood and its impact in adulthood. Researchers concluded that mistreatment, abuse, neglect, and many other psychosocial stressors experienced in childhood can and will emotionally and cognitively affect the victims, later in life. Three of the articles chosen cover the impact of childhood abuse and neglect. They explored an array of subtopics like common consequences and problems seen in adulthood that people who experienced abuse suffer from. The other three studies discussed more specific symptoms that occur and that abuse survivors are at risk to. The first one covers adult personality disorders and how the type of maltreatment affects that. Another examined the effects of childhood maltreatment and its association with social information processing and aggression in adulthood. The last article addressed personality types and how psychosocial distress impacts it. I will focus on a variety of preventable childhood stressors and how they can leave long-lasting effects on the child, into adulthood, and even influence sexual orientation, lead to sexual confusion, difficulties in personality, and cognitive processes.

Undergraduate

CAN PARTICIPATING IN SCHOOL GARDENS INCREASE FRUIT AND VEGETABLE INTAKE, SUBSEQUENTLY ENHANCING STUDENTS' ACADEMIC PERFORMANCE?

Primary Author: Victoria Holmes, Human Ecology

Advisor(s): Samantha Hutson

Fruit and vegetable consumption rates among children constantly fail to meet the Centers for Disease Control and

Prevention recommendations. However, school garden programs may offer a solution to this problem. The purpose of this review of literature was to analyze the effects of school garden programs on fruit and vegetable intake among students participating and the effects of increased fruit and vegetable intake on academic performance. Data from original research from 2002-2018 and studies on topics relating to school gardens and academic performance was reviewed. Findings support the claim that school garden programs promote an increase in fruit and vegetable consumption among students participating. In one study, researchers were able to show that nutrition education classes and garden based activities doubled fruit and vegetable servings per day among sixth graders. In another study where students received cooking and gardening classes, the students showed a decrease in diastolic blood pressure, weight loss among overweight and obese, and an increase in dietary fiber. Studies also showed a positive relationship between academic performance and fruit and vegetable consumption. Four studies assessed whether past garden use was related to academic performance; two showed science improvement and one showed math improvement. However, more studies need to be conducted to understand the long term effects of school garden programs may have in influencing fruit and vegetable intake.

Undergraduate

EXAMINING THE RELATIONSHIP BETWEEN ADOLESCENT OBESITY AND METABOLIC SYNDROME

Primary Author: Beau Huddleston, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Melinda Anderson

Although it is clear that childhood obesity can play a part in developing metabolic syndrome in childhood and adulthood, conflicting research has suggested that more research on the topic should be done to determine if adolescent obesity alone is a main cause for metabolic syndrome, and what other factors contribute to the disease. The purpose of this review was to determine whether a link exists between obesity during adolescence and metabolic syndrome in adolescence and adulthood. The findings of the research reviewed are mostly all similar, painting a picture that there is a link between adolescent obesity and metabolic syndrome in both children and adults. The majority of the children who were obese were at a greater risk for metabolic syndrome than children who were not obese. In addition, the children who were obese had at least one of the five factors of metabolic syndrome. A major takeaway from the findings is that a need exists for a guideline for diagnosis of metabolic syndrome for adolescents since one does not exist. In summary, even though most of the research sheds a light on how childhood obesity and metabolic syndrome can be connected, more research needs to be done to firmly link the role of adolescent obesity in the development of metabolic syndrome in children and adults.

Undergraduate

THE EFFECTS OF DIETARY HABITS ON GASTROINTESTINAL HEALTH

Primary Author: Christina Kelley, Human Ecology

Advisor(s): Rufaro Chitiyo

The gastrointestinal tract of multiple species, including humans, is a microbiome of the most numerous microorganisms than any other place in the body. These microorganisms collectively are know as gastrointestinal microbiota, or gut flora. Diversity of the microbiota can provide insight to the health status of the host. The dominant predictor of gut diversity or uniformity of gut flora are dietary habits. Dietary habits that include ingestion of typical Western diet foods have been shown to

decrease flourishment of recognized healthy gut bacteria. Consumption of foods rich in dietary fiber like whole grains, fruits, vegetables, nuts, and legumes have been shown to increase diversity and overall health of the host. The purpose of this literature review is to examine the effects of dietary habits on gastrointestinal health.

Undergraduate

EFFECTS OF COLLEGE STUDENTS' SOCIAL MEDIA USE ON COPING AND OTHER DAILY FUNCTIONS

Primary Author: Ashley Miles, Human Ecology

Advisor(s): Rufaro Chitiyo

The purpose of this poster is to determine what the literature says with regards to whether there is a relationship between college student's social media use and their self-esteem, social skills, time management skills, and coping skills. A secondary purpose is to address the type of relationship if one does exist. With adolescents and young adults spending on average two to three hours a day on social media alone, it is vital to understand the effects that social media use has on daily functions such as self-esteem, social skills, time management skills, and coping. Findings from the literature suggest that although social media use is becoming more popular among young adults, 77% of young adults prefer face to face communication over the internet (Sponcil & Gitimu n.d.). Literature also suggests that, "Social media sites empower users to take an active role in their own socialization process and in constructing their own self-identity" (Sponcil & Gitimu n.d. 5). Although popular belief is that social media only has negative implications to daily functioning, the literature supports the contrary, that social media can have positive effects on self-esteem and does not always hinder a person's communications skills.

Undergraduate

EXPLORING THE BENEFITS OF EXERCISING 150 MINUTES A WEEK WITH TYPE 2 DIABETES

Primary Author: Brenton Miller, Human Ecology

Advisor(s): Melinda Anderson

One of the first things that medical professionals ask their patients who have been diagnosed with type 2 diabetes is if they are physically active. The purpose of this review was to examine the benefits that can be gained from engaging in physical activity for 150 minutes a week in patients with type 2 diabetes. The review of literature explored if there was a positive change in the patient's body mass index(BMI), body composition, Hba1C, lipid profiles, blood pressure or glucose intolerance. Systematic reviews, meta-analysis, original research and position papers were included. It is known that oftentimes weight loss is included in the treatment of type 2 diabetes. Diet was typically the first thing the patient will modify in order to lose weight, but when exercise was also included into the nutrition plan, the likelihood of the patient losing weight increased significantly. With that weight loss the patients saw positive improvements in their lipid profiles, Hba1C, body composition, BMI, blood pressure, hypertension and glucose intolerances. Research consistently showed that physical activity was one of the most important health improving steps for a patient with type 2 diabetes to take.

Undergraduate

ADOLESCENT MOOD IMPACT RESULTING FROM HOSPITALIZATION

Primary Author: Shannon Nuttall, Human Ecology

Advisor(s): Rufaro Chitiyo

How hospitalization affects the overall mood in adolescents

is a very important issue that needs to be evaluated to improve adolescent's well being. Hospitalization diagnosis and treatment often results in distress, poor coping, and social isolation. By investigating how hospitalization affects an adolescent patient's mood, it can help promote coping and boost overall mood.

The literature reviewed relates to how hospitalization affects adolescents, holistic approaches, and therapeutic and emotional care for them. The articles provide valuable research information to help gain a better understanding of how adolescents feel during their hospital experience and how they cope with their diagnosis and treatment. There are many similarities in the articles found such as finding ways to overall improve an adolescent's life through therapeutic, emotional, and holistic approaches. There are also some differences such as psychosocial assessment upon admission and post discharge observations by parents. The articles are all unique in their own way to help gain a full sense of understanding over the entire research topic. Each article works hand in hand with each other to help gain a plethora of information regarding adolescent hospitalization and how this experience affects them. Overall, there is a general consensus that an adolescent's mood can be altered while hospitalized. With the help of hospital staff, their overall mood can be positively impacted through methods of therapeutic and holistic care.

Undergraduate

ENGLISH PROFICIENCY AND SUCCESS IN SCHOOL

Primary Author: Anna Pursley, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster examines fifteen articles that report on the correlation between English proficiency among English language learners (ELLs) and their academic and social satisfaction within the school system. English learners are individuals who are fluent in a language other than English and are not fluent or proficient in the English language. In Tennessee, the number of English Learners (EL) in schools is steadily increasing (English Learners, n.d.). Between 2011 and 2017, the number of EL students increased by 45%. If this trend continues, the number of ELs enrolled in Tennessee schools will exceed 60,000 (English Learners, n.d.). With this increase in ELs, comes the need to investigate ELs' academic achievement and social satisfaction as it relates to their English proficiency. Research shows students who are identified as ELs have lower academic achievement scores and decreased social satisfaction compared to their classmates who are proficient in English.

Undergraduate

DO CHILDREN WHO CONSUME FAST-FOOD HAVE AN INCREASED RISK OF DEVELOPING CHRONIC DISEASES WHEN THEY BECOME ADULTS?

Primary Author: Wesley Randall, Human Ecology

Co-Author(s)/Collaborator(s): Samantha Hutson

Advisor(s): Samantha Hutson

In 2011, the Dietary Guidelines for Americans (DGA) reported that calcium, dietary fiber, potassium, and vitamin-D were not being consumed in adequate amounts by children. Many scholars center their attention on fast-food as a key contributor to rising obesity rates in children. Children who are overweight or obese are at risk for a range of chronic diseases including cardiovascular disease, type II diabetes, as well as certain cancers in adulthood. In order to understand the increase in the prevalence of obesity among children, the foods they consume must be examined. In this review of literature, evidence suggested that consuming fast-food as a child was only one variable that could lead to disease as an adult. Evidence suggested that consuming fast-food as a child is not the only contribution to an unhealthy lifestyle

that can lead to disease as an adult. Dietary preferences, access to food, and food prices are all influences on diet quality. In addition, many children live inactive lifestyles that affect their overall energy requirements. It is widely accepted that an imbalance between energy intake and expenditure will lead to overweight and obesity. Children and adolescents should do 60 minutes or more of physical activity on a daily basis. Muscle and strength training should be implemented into the 60 minutes of physical activity. While fast-food can contribute to obesity, children eat at less nutrient dense foods, and those who lead more sedentary lives were more likely to be overweight. This project had no funding source.

Undergraduate

THE IMPACT THE NICU HAS ON MEDICAL STAFF

Primary Author: Emily Reynolds, Human Ecology

Advisor(s): Rufaro Chitiyo

The neonatal intensive care unit (NICU) is a stressful environment for the infants and their families. While patients and families get to eventually leave the unit, medical staff including nurses, doctors, child life specialists, physical therapists, and chaplains go back every day. Research shows that working on the NICU unit can have psychological and physical effects on staff members due to high demands of the job and collaborating with difficult families. While some research shows that there are negative effects, several articles highlight that with good coping skills, staff can handle the stressors in the NICU effectively to where there is little to none negative impact and they feel the job is rewarding. In this poster, I will identify different stressors in the NICU that have an effect on staff as well as effective coping efforts by the staff proven to combat negative effects. Finally, different ways medical staff stress can be minimized in the NICU will be outlines.

Undergraduate

PARENTS COPING WITH THE DEATH OF THEIR CHILD

Primary Author: Megan Shaw, Human Ecology

Advisor(s): Rufaro Chitiyo

This poster examines four articles that look into to how parents cope with the death of their child. Though this is a subject that a lot of people do not like to acknowledge, and therefore do not acknowledge, the reality is that there are children who die every day. When this happens, there are parents who have just lost a child and who are hurt and feel the effects of this loss for years to come. When a child dies, it interrupts the lives of parents and causes major distress. There are various causes to the dying of these children, and the cause of death affects how the parents of these children cope with their child's death and adjust to life after. Though this specific subject has not been explored in depth very much, research shows that interpersonal and intrapersonal processes are related to the adjustment process of parents after they have lost a child (Meij et al., 2008) but that cause of death does not have much of an effect on how long it takes the parents to adjust after their loss of a child (Fan, Johnson, Lohan, Murphy, & Wu, 2003).

Undergraduate

ADVERSE EFFECTS OF INCLUDING COWS MILK IN AN INFANT'S DIET

Primary Author: Kristine Tuttle, Nutrition and Dietetics

Advisor(s): Samantha Hutson

The purpose of this is to educate on the adverse effect of cow's milk in an infant's diet while emphasizing the benefits of exclusively breastfeeding for up to 6 months. The health risks associated with introducing cow's milk to

infants before 12 months of age include: iron deficiency, iron deficiency anemia, iron depletion, dehydration, excessive renal solute, risk of allergic responses, gastrointestinal problems, risk of obesity and development of Type 1 Diabetes Mellitus (T1DM) or Type 2 Diabetes Mellitus (T1DM) later in life. This is contrasted with the benefits of exclusively breastfeeding for the first six months which include: guarding against ear infections, asthma, bowel difficulties, ear and respiratory infection and Sudden Infant Death Syndrome. Breast milk is also a protective agent against development of T1DM, T2DM and obesity. Breast Milk provides adequate amounts of calcium, energy requirement and omega-3 fatty acids for infants. Breastmilk alone is sufficient for optimal growth, development and health. Even knowing the health risks associated with introducing cow's milk during infancy and the benefits of breastfeeding, mothers are still introducing cow’s milk to their infants and breastfeeding for shorter than the recommended time. This is most likely due to lack of education and support, low socioeconomic status, lack of awareness of the negative health effects of early introduction to cow’s milk during infancy and altering opinions among healthcare providers. If mothers can be more aware of these health problems and have consistent education from health care providers, more support from employers, society and family.

Abstracts

College of Arts & 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, Wildlife and Fisheries Science

Co-Author(s)/Collaborator(s): Keith Gibbs

Advisor(s): 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, samples for 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

ESTABLISHING DIDYMOSPHENIA GEMINATA CELLULAR RESPONSE THRESHOLDS TO WATER QUALITY CHANGES USING FOURIER-TRANSFORM INFRARED (FTIR) MICROSPECTROSCOPY

Primary Author: Samuel Day, Biology (M.S.)

Advisor(s): Justin Murdock

The diatom, Didymosphenia geminata, or Didymo, is considered a nuisance species in coldwater streams across the world. This algae forms thick mats that can blanket stream substrate and homogenize benthic habitat, ultimately altering benthic communities and fish condition. Mats consist of non-living extracellular stalks that cells use to attach to the substrate. Extremely low phosphorous conditions (<2 µg/L) have been linked to stalk production; however, new research suggests that other water quality parameters may be important in mat formation. Unfortunately, standard laboratory bioassays for determining cell response thresholds to water quality is difficult because D. geminata cannot be cultured, and it does not survive long (less than 2 weeks) in laboratory conditions. We are developing a method requiring only short-term (hours to days) incubations of D. geminata cells to determine cellular level responses to changing environmental conditions. Fourier-transform infrared

(FTIR) microspectroscopy is used to determine the molecular changes within single D. geminata cells that lead to cell division and stalk production. The goals of this study are to: 1) determine the environmental conditions that promote D. geminata cell survival, stalk production, and cell division, and 2) develop an FTIR protocol to determine D. geminata cell response to water quality conditions that can be broadly applicable to detecting important triggers of growth and/or toxin production in other harmful and nuisance algae species. Early results suggest that nutrient limitation causes an increase in carbohydrate production in cells, while protein content decreases.

Graduate

INFLUENCE OF ELEVATION ON SOUTHERN FLYING SQUIRREL (GLAUCOMYS VOLANS) RELATIVE ABUNDANCE IN EASTERN TENNESSEE

Primary Author: Jason Wogsland, Biology (M.S.)

Advisor(s): Brian Carver

Southern flying squirrels (SFS) are arboreal, nocturnal rodents often associated with mast-producing trees such as American Beech (Fagus grandifolia), oaks (Quercus spp.), and hickories (Carya spp.). These trees provide key resources such as food and den sites within the SFS distribution. While SFS are widespread in Tennessee, the mountains of Eastern Tennessee provide unique habitat types not typically found in their range. As elevation increases the tree community gradually transitions into forests more characteristic of more northern latitudes, and at the highest elevations Red Spruce (Picea rubens) and Fraser Fir (Abies fraseri) dominate. These relict boreal forests represent refugia for northern species such as the Carolina Northern Flying Squirrel (CNFS, Glaucomys sabrinus coloratus). While typically isolated, SFS may overlap and compete with CNFS at the highest elevations. The objective of this study is to address the influences of elevation on relative abundances of SFS. Three survey methods (live traps, camera traps, and acoustic detectors) were deployed at low-, middle-, and high-elevation sites; and captured individuals, pictures taken, and acoustic recordings were combined to determine relative abundance of SFS. Research is ongoing, however relative abundances of SFS were highest in middle-elevation forests. High-elevation forests may be less suitable for SFS which could result in lower relative abundances. Conversely, increased abundances of SFS at higher elevations may have detrimental effects on CNFS exacerbating the decline of this federally endangered subspecies.

Graduate

DISTRIBUTION OF DIDYMOSPHENIA GEMINATA IN SOUTHERN APPALACHIAN WATERSHEDS

Primary Author: Spencer Womble, Biology (M.S.)

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

Advisor(s): Justin Murdock

Tailwaters of hypolimnetic release dams in the southeastern U.S. are often cooler and have less nutrients than unregulated streams in the region. These differences allow tailwaters to function as an important recreational trout fisheries; however, some tailwaters also support Didymosphenia geminata mats that can cover substrata, alter benthic food webs, and may degrade fish habitat. Didymosphenia geminata's distribution in the Southeast has not been extensively delineated as reports often only come when mats have developed. Therefore, this diatom can go unnoticed if only cells are present. Recent studies suggest multiple environmental variables may be facilitating its presence in the Southern Appalachians. Surveys were conducted to determine D. geminata cell and mat presence in eastern Tennessee and western North Carolina rivers from May - September of 2015, 2016, and 2018. Random Forest analysis was used to relate water

chemistry and habitat characteristics to D. geminata distribution. Conductivity, temperature, wetted width, turbidity, and calcium had the strongest relationship with cell presence. While previous studies have identified low amounts of phosphorus as the primary driver of stalk development, factors associated with the underlying geology of Appalachian watersheds appear to have a stronger effect on cell colonization than phosphorus. Given that mats cannot form without cells being present, further delineating the environmental parameters necessary for cell colonization will improve natural resource agencies' ability to identify streams susceptible to nuisance mats.

Undergraduate

TRAINING SHELTER DOGS FOR SERVICE AND THERAPY WORK

Primary Author: Hannah Buckner, Biology

Co-Author(s)/Collaborator(s): Brooke Barnett, Tyler Marcrum, Sarah Bingham

Advisor(s): Nikki Panter

Are shelter dogs' reliable candidates for service work, and what is the best way to utilize the dogs selected to be successful in the field of work? In this research project we were able to broaden our data by temperament testing more dogs in the Putnam County Animal Shelter, using three steps of evaluation. We tested behavioral issues such as fear, fear aggression, food aggression, dog aggression, lack of confidence, etc. With the selected few dogs, we were able to pursue training in the areas or diabetic detection, cancer detection, peanut detection, and therapy work. With these selected dogs, the goal was to remove them from a shelter setting as quickly as possible; to increase chances of success with this project, some of the researchers adopted the dogs to further train in the tasks assigned to the dog. For the full duration of the research project, the team continuously evaluated dogs as they cycled into the shelter. The most important attribute of the dogs was confidence and ability to engage with the handler in new environments. Throughout the entire process of evaluations, the dogs were introduced to new environments slowly to decrease the amount of stress and help with developing communication with the handler. The dogs had to pass through four phases of evaluations. For conditioning dogs to odor and scent discrimination we have investigated designing a scent wall to minimize the contact the handler has with the odor source.

Undergraduate

DETERMINATION OF THE SPECIES OF STAPHYLOCOCCUS FROM HUMAN ISOLATES

Primary Author: Tyler Hendrick, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Adam Nakamoto, Utseoritselaju Sophia Ikomi, Jessica Smith, Collin Simmons, David Beck

Advisor(s): David Beck

Purpose: The goal was to learn to use PCR to isolate the DNA from Staphylococcus and determine the species using multiplex PCR.
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: Previously we screened participants for SCV Staphylococcus. Gram positive cocci were identified. We purified the DNA and screened by multiplex PCR for Staphylococcus genus, S. aureus, S. epidermidis, and S. haemolyticus.
Results: This year we have characterized 368 to species. 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: We have learned how to purify DNA and do multiplex PCR on Staphylococcus. 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.

Undergraduate

ASSESSING LAND-USE INFLUENCES ON NATIVE FISH COMMUNITIES USING METABARCODING SURVEILLANCE

Primary Author: Emily Huntley, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Robert Paine

Advisor(s): Carla Hurt

In freshwater ecosystems, rare and threatened species are often difficult to detect using traditional aquatic sampling methods, such as electrofishing and seining. Additionally, traditional methods can be harmful to both target and non-target organisms. Environmental DNA (eDNA) surveillance of entire fish communities is a cost-effective and non-invasive technique that has been used to help wildlife managers monitor the biota in entire ecosystems. However, whether eDNA surveillance can be used to assess human impacts to native communities and ecological processes has yet to be explored. Water samples were collected from 10 locations along the Clinch River in Tennessee. A bioinformatic pipeline was developed to identify DNA sequences to a species level. A total of 391,921 sequences were identified at the genus and/or species level. Fish communities will be statistically analyzed for differences at each sampling location based on the surrounding land-use variables at set distances ranging from 100 – 1000 m.

Undergraduate

LIFE HISTORY STRATEGIES OF FRESHWATER MUSSELS ALONG LONGITUDINAL GRADIENTS IN THE MERAMEC RIVER, MISSOURI

Primary Author: Lauren Kelley, Wildlife and Fisheries Science

Co-Author(s)/Collaborator(s): Kayla Key, Amanda Rosenberger

Advisor(s): Amanda Rosenberger, U.S. Geological Survey, Tennessee Cooperative Fisheries Research Unit, Department of Biology

Life history theory provides insight to the adaptive significance of an organism's response to environmental pressures. Understanding the life history strategies within mussel communities can therefore help inform conservation and management actions for vulnerable assemblages. Prior work indicates that dominant life histories of mussel assemblages change with river size, between large and small rivers, and within rivers, from headwaters to downstream. Mid-sized rivers act as a transitional zone. Our goal in this study was to examine upstream to downstream patterns of mussel life histories in the Meramec River drainage in Missouri, a high-priority conservation area. Using surveys from the Missouri Department of Conservation database and Haag's 2012

descriptions of life history strategies, we investigated proportional changes in life history strategies of freshwater mussels longitudinally, from headwaters to downstream, in the Meramec, Big, and Bourbeuse Rivers in Missouri. We present our findings for each river and compare patterns of life history strategies within the Meramec River to the proposed patterns by Haag 2012. Our results can help to inform conservation of mussels by increasing the understanding of mussel species' habitat selection in relation to life history, essential information for successful propagation and reintroduction efforts.

Undergraduate

MORPHOMETRIC AND DIETARY COMPARISONS OF CO-OCCURRING TROUT IN TWO ADJACENT WATERSHEDS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

Primary Author: William Ponder, Environmental and Sustainability Studies

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Christopher Murray

Advisor(s): Keith Gibbs

Food webs are intricate systems produced by evolving networks of community members and trophic interactions. This study investigates dietary shifts of trout in response to changes in foraging competition. Both the Little Cataloochee and Correll Branch watersheds in the Great Smoky Mountains National Park have supported competing populations of brook trout (Salvelinus fontinalis) and rainbow trout (Oncorhynchus mykiss). Trout were sampled from both systems before removal of rainbow trout from Little Cataloochee Creek. Geometric morphometric measurements were recorded for 15 landmarks before specimens were dissected to determine sex and extract stomach contents. Prey items were identified to taxonomic order and dietary compositions were compared between species and watersheds. Morphometric differences were tested with Procrustes Analysis of Variance in MorphoJ and dietary differences were tested with Analysis of Similarity conducted in Primer. Significance was set at $\alpha=0.05$. Brook trout exhibited highly significant morphometric differences among watersheds ($p<0.0001$) and ontogenetic shifts from juveniles to adults ($p=0.0005$), whereas rainbow trout did not. Diets were also significantly different between watersheds ($p=0.022$), but not significantly different between species, gender, or age. The morphometric differences may be due to phenotypic plasticity and genetic diversity of native brook trout compared to the potentially reduced genetic variation of the introduced rainbow trout. Differences among diets between watersheds is most attributed to the presence of terrestrial ants, which may represent a stochastic event that increased their availability in Correll Branch. This study's findings can be useful for future brook trout conservation and management efforts.

Department of Chemistry

Graduate

RECIPROCAL REGULATION OF MAPK ON UPSTREAM MKK

Primary Author: Kristen Carter, Chemistry (M.S.)

Co-Author(s)/Collaborator(s): Eric Hall

Advisor(s): Xuanzhi Zhan

Phosphorylation is a process in which kinase proteins add phosphate groups to proteins. The addition of a phosphate group modifies the activity and function of the proteins. Mitogen-activated protein kinases (MAPKs), including C-Jun N-terminal kinases (JNK), are kinases that play a role in many cellular functions including apoptosis, differentiation, and survival. Mitogen-activated protein kinase kinases (MKKs) are substrates of MAPKs. Our group recently found that downstream MAP kinases can enhance the activation of upsteam MKKs. This interesting regulation can be explained by two alternative mechanisms: (i) MAPK directly phosphorylate MKK, and (ii) binding of MAPK enhances the auto-phosphorylation of MKK. To determine the phosphorylation mechanism, a kinase-dead JNK3 mutant in which the lysine is replaced with an Arginine (J3K93R) was isolated and purified. The phosphorylation of MKK7 was then tested separately in the presence of both the wild-type JNK3 and the mutant J3K93R through kinase assays and western blotting techniques. We found that phosphorylation does not transpire in the presence of J3K93R while phosphorylation does occur in the presence of the wild-type JNK3. The phosphorylation pattern strongly suggests that the presence of JNK3 is required for MKK7 phosphorylation instead of auto-phosphorylation. A better understanding of the phosphorylation process will facilitate additional research to more fully characterize the role that the MAPK pathway plays in differentiation, apoptosis, and survival as well as the many other cellular responses that have contributions from MAPKs.

Graduate

PURIFICATION OF A SINGLE CYSTEINE ARRESTIN3 (ARR3) VARIANT FOR 19F NMR STUDY

Primary Author: Nathan Combs, Chemistry (M.S.)

Advisor(s): Xuanzhi Zhan

Non-visual arrestins (arrestin 2 & 3) scaffold mitogen-activated protein kinase (MAPK) cascades. Although all three canonical MAPK families are mediated by arrestin3, the structural basis of these interactions remain largely unknown. In order to study the potential binding-induced conformational changes of arrestin3 by MAP kinases, we developed a thio-based 19F-NMR by incorporating 19F into cysteine residue on arrestin3 by covalent-modification. We first have to construct and isolate the arrestin3 variant with single cysteine residue. Here we reported our initial effort to purify a single cysteine arrestin3 variant (Arr3-V8C) by using Heparin-sepharose, Q-sepharose and SP-sepharose.

Graduate

PARTITIONING OF BIOGENIC AND ANTHROPOGENIC CO2 SIGNALS USING CO TRACER TECHNIQUE

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

Co-Author(s)/Collaborator(s): Ha Nguyen

Advisor(s): Wilson Gichuhi

The poster reports a CO:CO2 ratio technique in the estimation and quantification of biogenic CO2 (CO2 bio) and anthropogenic CO2 (CO2 anth) signals in an urban setting following continuous dry mixing ratio measurements of carbon dioxide (CO2) and carbon monoxide (CO) using a wavelength-scanned cavity Ring-Down spectroscopic (CRDS) technology. The measurements were carried out in different days during the spring, summer, and winter of 2017 and 2018 at a height 15 m above the ground. The CO:CO2 correlation ratios (β values) were evaluated using regression analysis after subtracting the region's background concentration based on a 5th percentile background subtraction technique. For the year 2017, β values (ppb:ppm-1) of 9.7 ± 0.4, 5.3 ± 0.4, and 2.0 ± 0.2 were obtained for the winter, spring and summer seasons, respectively. In 2018, a similar trend in the β values was observed where values of 8.7 ± 0.5, 7.4 ± 0.7, and 2.6 ± 0.5 measured in winter, spring, and summer seasons, respectively. Correlation values (r2) of 0.9, 0.8 and 0.6 were obtained for winter, spring and summer seasons respectively, indicating the strong biospheric CO2 exchange during summertime. This strong biospheric signal is brought about by the strong photosynthetic activity in the summertime as opposed to the dominant respiratory carbon fluxes that dominate the winter season.

Graduate

INCORPORATION OF UNNATURAL AMINO ACIDS VIA PROTEOMICALLY INFORMED SELECTIVE PRESSURE TECHNIQUES

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

Co-Author(s)/Collaborator(s): Amy Brown

Advisor(s): Jeffrey Boles

Determining the three-dimensional structure of a protein using x-ray crystallography can be enhanced by complete or partial incorporation of unnatural amino acids into a target protein. Most naturally occurring atoms do not have sufficient mass to diffract electrons, therefore, heavy atom derivatives of target proteins are required. The Incorporation of unnatural metalloid containing amino acids provide a clear solution to the problem. A proteomic analysis of telluromethionyl Escherichia coli was carried out using the methionine auxotroph E. coli DL41(DE3) (pCock) expression system. Both telluromethionine and methionine exposed cultures were analyzed with the objective of identifying differentially expressed proteins. Analysis was carried out using 2D separation with isoelectric focusing serving in the first dimension and SDS polyacrylamide gel electrophoresis in the second. In-gel tryptic digestion followed by peptide mass fingerprinting using nano-ESI/qTOF/MS allowed identification of differentially expressed proteins. A few of the differentially expressed proteins identified as down-regulated in systems exposed to TeMet were UPase, ZnuA, phosphoserine aminotransferase, and fructose-bisphosphate aldolase. Understanding the biological roles of differentially expressed proteins was used to improve methods of TeMet bioincorporation using the selective pressure technique.

Graduate

ASSEMBLY OF ASK1-MKK4-JNK3 COMPLEX

Primary Author: Md Sariful Islam Howlader, Chemistry (M.S.)

Co-Author(s)/Collaborator(s): Dishaben A. Patel

Advisor(s): Xuanzhi Zhan

Apoptosis signal-regulating kinase I (ASK1, also called MAP3K5) is a mitogen-activated kinase kinase kinase (MAP3K) that plays pivotal roles in cellular stress and immune response. Active ASK1 can directly phosphorylate downstream mitogen-activated kinase kinases (MKKs)

from both stress-activated protein kinase (SAPK) pathways: c-jun N-terminal kinase (JNK). The structural of these three kinase complexes (JNK, MKK4, and ASK1) remains still unknown. For this reason, the present study has been designed to find out the assembly of ASK1-MKK4-JNK3 firstly using computational docking based on the Protein Frustratometer combined with the sequence identity calculations of Evolutionary Trace forms along with rigid docking (Cluspro) followed by experimental design. To verify the proposed computational model of ASK1-MKK4-JNK3 complex, we designed a series of maltose binding protein (MBP) fusion peptides, which contains different peptide fragments derived from MKK4: MBP-P1, MBP-P2, MBP-P3, MBP-P4 and MBP-P5. We then transformed into E-coli-BL21- DE3 to express those proteins via Isopropyl β-D-1-thiogalactopyranoside (IPTG) and then subsequently purified those proteins using Amylose-sepharose chromatography. We intend to develop direct pull-down assays to evaluate the interactions between these fusion peptides with ASK1 and JNK3, respectively to find out the binding interaction among these purified proteins.

Graduate

HEAVY METAL REMEDIATION FROM AQUEOUS SOLUTIONS BY NEW SILICA-IMMOBILIZED THIOSEMICARBAZONE MATERIALS

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

Co-Author(s)/Collaborator(s): Cory Hawkins

Advisor(s): 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 focused 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. The extraction efficiency of each of the five materials was then evaluated by analyzing the uptake of two radioisotopes, Cd-109 and Ni-63, across a wide range of pH levels. Overall, the compounds displayed an increased affinity for Cd-109 with an increase in pH, however, Ni-63 extraction was limited. Successful extraction of heavy metals by these newly produced SIT materials could lead to more efficient remediation of toxic substances in water.

Graduate

INCORPORATION OF 19F-TRYPTOPHAN FOR JNK3 NMR SPECTROSCOPY

Primary Author: Tylar Thompson, Chemistry (M.S.)

Advisor(s): Xuanzhi Zhan

Among mitogen-activated protein kinases, the c-Jun NH2-terminal kinases (JNKs) are of particular interest due to their involvement in cell signaling pathways associated with diabetes, cancer, and cellular apoptosis. When looking at JNK3 specifically, the surrounding cascade mechanisms include numerous partner enzymes that regulate its activity via phosphorylation, and these interactions alter JNK3's protein conformation. Understanding the movements associated with forming these complexes will shed light on the mechanism by which these enzymes act. These molecular movements can be studied with the use of 19F NMR techniques, but the JNK3 molecules must first have 19F incorporated into their structure. To that end, we will develop a method

to incorporate 19F into JNK3 in vivo, then confirm the location of the labeled amino acids with 19F NMR and mutagenesis studies, and then we will use 19F NMR to study the complexes formed between JNK3 and its upstream regulatory enzymes.

Graduate

DBU-ASSISTED INTERMOLECULAR [3 + 2] DIPOLAR CYCLOADDITION OF TERMINAL ALKYNES WITH TOSYLHYDRAZONES TOWARDS THE SYNTHESIS OF FRUSTRATED PYRAZOLYL-PYRIDINE-1,2,4-TRIAZINE COMPLEXANT SCAFFOLDS FOR MINOR ACTINIDE SEPARATIONS

Primary Author: Giri Babu Veerakanellore, Chemistry (Postdoctoral Researcher)

Advisor(s): Jesse Carrick

Nuclear energy production is a safe, clean, and sustainable energy source but poses threat to people and the environment. In addition, the spent nuclear fuel (SNF) has different nuclides of both lanthanides and actinides, among which separation of long-lived trivalent actinides from short-lived lanthanide fission products is extremely difficult owing to their similar chemical properties. Soft-Lewis basic complexants, such as nitrogen heterocycles, possess strong binding affinity towards the minor actinides and can facilitate their chemoselective separation from lanthanides using liquid-liquid separations processes. As a result, the radiotoxicity and the SNF volume can be reduced and storage volume in a repository minimized. Frustrated complexant pyrazolyl-pyridine-1,2,4-triazine scaffolds have advantages over traditional scaffolds for separation of minor actinides. The present work involves the synthesis of unsymmetric frustrated scaffolds via intermolecular [3 + 2] dipolar cycloaddition of terminal alkynes with tosylhydrazones in toluene solvent. Synthesis optimization, substrate scope, a scale-up reaction, downstream functionalization, and purification will be reported.

Undergraduate

ACETONE AND ETHANOL AS ALTERNATIVES: EXTRACTION OF JUGLONE FROM BLACK WALNUT HULLS

Primary Author: Meredith Borst, Pre-Professional

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborator(s): Rachel M. Paris; Cory H. Rogers; Ilysa L. Crouch; Ginger T. L. Majors, Warren Country High School, McMinnville, TN 37110; O. Andreea Cojocaru; Twanelle W. Majors

Advisor(s): O. Andreea Cojocaru

Juglone, an organic compound belonging to the naphthoquinone family, is found in black walnut hulls. It has a wide variety of antimicrobial and herbicidal properties; unfortunately, due to the cost of synthetic juglone, these properties are difficult to exploit. Extracting juglone from plant matter will allow one to fully take advantage of juglone's properties. Efficiency of the extraction depends on the solvent used. Polar solvents such as chloroform and methanol and less polar solvents such as ether and hexane have been reported in the literature to extract juglone from various plant materials. Those solvents are undesirable in most educational settings. However, the use of safer solvents (e.g., isopropanol, ethanol, water, acetone) in the extraction of juglone is highly desirable. Preliminary results indicate that two commonly used solvents, deionized water and 70% isopropanol, can be used to extract juglone from fresh black walnut hulls. In that work it was determined that 70% isopropanol (relative polarity = 0.546) was a better solvent than water (relative polarity = 1.000) for extraction of juglone from black walnuts.
This presentation focuses on the extraction of juglone by using two solvents of different polarities: ethanol, a more

polar solvent (relative polarity = 0.654) and acetone, a less polar solvent (relative polarity = 0.355). The extract was characterized using UV-VIS and compared with previous solvents, deionized water and 70% isopropanol, for juglone concentration. Future applications of this work include development of an extraction and characterization scheme suitable for inexperienced students.

Undergraduate

ASSESSING CELL GROWTH IN A MICROTITER PLATE READER WITH SELECTIVE PRESSURE INCORPORATION OF UNNATURAL SELENIUM AND TELLURIUM CONTAINING AMINO ACIDS

Primary Author: Amy Brown, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

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

Advisor(s): Jeffrey Boles

Metalloid-containing unnatural amino acids, when incorporated into target proteins, provide a means of solving for three-dimensional structure by MAD or SAD techniques. The use of Tellurium-containing amino acids are of special interest since they can also be exploited by more traditional MIR techniques, which don't require travel to synchrotron centers. Tellurium, when incorporated into protein as telluromethionine, generally induces toxicity to E. coli. Selenium, when incorporated as selenomethionine, induces much lower toxic effects to cell culture but remains problematic, at times. Altering growth conditions can potentially reduce such toxicity. This study demonstrates a rapid screening method for biosynthetic incorporation of unnatural amino acids by various forms of selective pressure.

Undergraduate

INVESTIGATION OF N-DONOR ORGANIC LIGANDS FOR SELECTIVE MINOR ACTINIDE SEPARATIONS

Primary Author: Morgan Brown, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborator(s): Jesse Carrick, Cory Hawkins

Advisor(s): Cory Hawkins

The development of improved extractants for metal ion separations will aid in the closure of nuclear fuel cycles. New nitrogen-donor compounds are being designed, synthesized, and characterized as ligands for f-element separations, in a collaboration between synthetic organic (TTU), radioanalytical (TTU) and computational (U. Alabama) teams. The radioanalytical component encompasses a two-stage screening process that has been devised to test the viability of the ligands. The first phase is focused on screening of ligand solubility and solution stability. The second is to measure trivalent actinide/lanthanide (An(III)/Ln(III)) solvent extraction selectivity. The ligands were first screened for solubility in toluene, 1-octanol, trifluoromethylphenyl sulfone (FS-13), and tert-butyl benzene. When a compound is reasonably soluble, it is then screened for stability and metal ion solvent extraction, using 154Eu and 241Am radiotracer solutions to determine distribution ratios (DM) and Am/Eu selectivity. Compounds that meet reasonable criteria move on to systematic evaluation, in which solvent extraction slope analysis and spectroscopic experiments are carried out to understand the two-phase equilibrium chemistry. Conditions for the first phase screening process, using 3,3′-dimethoxyphenyl-bis-1,2,4-triazinyl-2,6-pyridine (MOB-BTP) as a benchmark ligand, have been optimized. Thus far, seventeen compounds have been screened. A new tridentate ligand 4,4′-dimethylphenyl-bis-1,2,4-triazinyl-

2,6-pyridine (SC-B-31) provided 30% greater Am/Eu selectivity and a 10-fold larger DAm (4.7) than those of MOB-BTP in FS-13. Although its structure only differs by the distal ring substituents, SC-B-31 is approximately 10-fold less soluble in FS-13 than MOB-BTP. Results from these experiments are informing the design of structures with improved solubility and separation efficacy.

Undergraduate

CLASSIFICATION OF GRAINS OF THE WORLD

Primary Author: Tyler Burden, Chemical Engineering

Co-Author(s)/Collaborator(s): Benjamin Dixon, Dennis Lyle, Daniel Klingenberg, Andrew Callender

Advisor(s): Derek Cashman

Although most people can identify grains as a key ingredient in the brewing process of beer, a vast majority do not realize the level of specificity to which these can be classified. In this project, we focus on analyzing the production and implementation of 6-row malted barley and 2-row malted barley in beers throughout the world. Due to the nature of the growth of these two kinds of barley, there are very specific areas in the world where it is viable to grow. These areas are mostly temperate climates that are relatively close to water. However, the amount of proteins, sugars, and carbohydrates in the barley can greatly vary depending on the region it is grown. This also affects the taste, mouth feel, ABV, and many other aspects of the beer. Different grains were sorted by region, and the amount of grains produced per region is also dependent on how much is needed not only for brewing, but for trade, domestic use, and for use a way to feed farm animals.

Undergraduate

IMPROVEMENTS ON THE METHODOLOGY OF 19F PROTEIN LABEL DETECTION BY NMR SPECTROSCOPY

Primary Author: Brian Chong, Chemistry

Co-Author(s)/Collaborator(s): James Dethero

Advisor(s): William Carroll

19F NMR is a powerful tool that used to determine protein structure and dynamics. This tool has been applied to the study of proteins including arrestin and faced some challenges regarding label stability and experiment duration. In this work, we optimize the NMR acquisition parameters for better experiment times and limit of detection in order to use limited resources more efficiently. The stability the protein label was also investigated by time dependent NMR analysis to assess its purity and lifetime. The outcome of both of these studies is reported here.

Undergraduate

ABSORPTION SPECTRA OF JUGLONE IN ITS ANIONIC AND NEUTRAL FORM IN AQUEOUS SOLUTIONS OF BASIC pH

Primary Author: Ilysa Crouch, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

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

Advisor(s): O. Andreea Cojocaru

In its neutral form, juglone, a compound from the naphthoquinone family, is found naturally in walnut hulls,

leaves, and roots. Although juglone's allelopathic properties can be exploited and the compound can be used for weed management, the neutral form of juglone presents negative environmental effects such as: toxicity to aquatic species, runoff and drift, worker exposure. These disadvantages can be addressed through the conversion of the neutral juglone into an anionic form by pairing it with surfactant cations (phosphonium cations, quaternary ammonium cations) to overcome undesirable features of the parent compound. In our research group, the main focus is to synthesize new juglone salts that will change juglone's mobility and therefore will decrease its environmental impact. To be able to test the synthesized compounds as potential herbicides and infer impact on the environment, the mobility and water solubility in soils of different pHs (acidic, neutral, and basic) needs to be determined. We previously showed that, at neutral pH (6.99), juglone in anionic form has a higher water solubility than neutral juglone. Here we will present our solubility study along with the absorption spectra of the two forms of juglone (neutral, juglone free acid, and anionic, tetrabutylphosphonium salt of juglone, [PBu4][Jug]) in aqueous solution of pH = 9 at room temperature.

Undergraduate

SYNTHESIS AND CHARACTERIZATION OF PYRUVIC ALDEHYDE-1-OXIME THIOSEMICARBAZONES AND THEIR COMPLEX FORMATION WITH Cu(II)

Primary Author: Seth Crum, Biology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborator(s): Sarah Bowman, Edward Lisic, Xiaohua Jiang

Advisor(s): Edward Lisic

Thiosemicarbazone ligands and their metal complexes have been seen to inhibit Topoisomerase II-α, a popular target of chemotherapy, as has been described in the literature. The new thiosemicarbazone ligands, pyruvic aldehyde-1-oxime [x]-thiosemicarbazone (PAO-xTSC's) and their metal complexes with Cu(II) have been synthesized. The ligands were characterized and analyzed by 1H Nuclear Magnetic Resonance spectrometry (NMR), 13C NMR, 1H13C HSQC, and 1H15N HSQC. The compounds were then tested in a Topoisomerase II-α relaxation assay, and this poster will present our findings.

Undergraduate

DOUBLE SALT IONIC LIQUIDS BASED ON PHENOTHIAZINE CATIONS AND VARIOUS ANIONS

Primary Author: Eva Etheridge, Pre-Professional

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

Advisor(s): O. Andreea Cojocaru

Ionic liquids (ILs) are generally considered as being simple ionic salts, comprised of a cation and an anion in a 1:1 molar ratio and with melting points below 100 °C. Double salt ionic liquids (DSILs, ionic compounds liquid at temperatures below 100 °C) are complex ILs that contain in their structure more than two types of ions: one anion and several cations; one cation and several anions; or several anions and several cations. Although a DSIL can be synthesized by melting/mixing simple ILs, it is considered as being one pure compound. Moreover, DSILs have different physical and/or chemical properties than the ones exhibited by their component single salts. Some properties (e.g., solubility) depend on the chemical interactions between the ions; changing the molar ratio between the component ions can lead to new coulombic interactions between the component ions and to new properties. Therefore one can easily take advantage of this behavior

and develop new task specific DSILs.
We previously showed that one can successfully synthesize new simple phenothiazine ILs by using various phenothiazine hydrochlorides as cation precursors and metal carboxylates as anion precursors. Our presentation focuses on applying the DSIL strategy to phenothiazine drugs. We'll discuss the synthesis and spectroscopic characterization of new DSILs formed by varying the molar ratio between the phenothiazine cation promazine and anions such as docusate (a known penetration enhancer) and various carboxylates (i.e., non-steroidal anti-inflammatory drugs, NSAIDs).

Undergraduate

ALLOXAN ETHYLTHIOSEMICARBAZONE AND ALLOXAN TERTBUTYLTHIOSEMICARBAZONE LIGANDS: REACTION WITH COPPER (II)

Primary Author: Michael Gray, Biology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): Edward Lisic

The research to be presented describes the synthesis of alloxan thiosemicarbazone compounds, which can act as ligands for transition metal complexes. Two different alloxan thiosemicarbazone ligands were synthesized, alloxan ethylthiosemicarbazone (ALL-ETSC) and alloxan tert-butylthiosemicarbazone (ALL-tBTSC) from alloxan monohydrate and either 4-ethyl-3-thiosemicarbazide or 4-tertbutyl-3-thiosemicarbazide starting materials. These reactions gave good yield of products. We utilized several NMR experiments to gather evidence for the structures of our new compounds, the results of which will be presented in detail. Once the identity of the products were verified, both of the ligands were then reacted separately with copper (II) chloride to produce new metal complexes. To further support our conclusions of the structure and molecular composition of the compounds synthesized, mass spectroscopy was performed on both the ligands and metal complexes.

Undergraduate

PROGRESS TOWARDS ELECTROPHILIC CYCLIZATION OF HETEROCYCLIC HYDRAZONE DERIVATIVES TO AFFORD UNSYMMETRIC, FUNCTIONALIZED, 5,6-DIPHENYL-3-(PYRIDIN-2-YL)-1,2,4-TRIAZINYL COMPLEXANTS

Primary Author: Zachary Gulledge, Chemistry

Advisor(s): Jesse Carrick

In continuation of this lab's pursuit towards soft-Lewis basic complexant molecules for separating minor actinides from lanthanides contained within spent nuclear fuel, the feasibility of synthesizing unsymmetrical complexants bearing a 5,6-diphenyl-3(pyridine-2-yl)-1,2,4,-triazine core was explored and is reported herein. Oxidation pathways were screened for previously described Sonogashira coupling adducts to convert them to their corresponding ketones. Further derivatization to either a hydrazone or an oxime was then performed, affording the possibility to form a 1,2-pyrazole or 1,2-isoxazole, respectively, through an adapted iodine-mediated intramolecular electrocyclization procedure. The efficacy of this cyclization reaction was tested against a variety of substituted hydrazone examples. The possibility of utilizing Suzuki-Miyaura cross-coupling conditions on the resulting 4-iodo-3-phenyl-1,2-pyrazole (or 4-iodo-3-phenyl-1,2-isoxazole) for downstream functionalization was tested, and chromatographic purification protocols for the hydrazone derivatives and their successfully cyclized products were developed. Additionally, a copper-catalyzed cycloaddition pathway towards 1,2,3-triazoles was investigated. The current extent of method optimization relevant to production of starter materials and products will be discussed.

Undergraduate

EQUILIBRIUM GEL FILTRATION TO MEASURE ARRESTIN-3 BINDING OF INOSITOL HEXAPHOSPHATE

Primary Author: Eric Hall, Chemistry

Co-Author(s)/Collaborator(s): Samuel Lefave, James McRee

Advisor(s): Xuanzhi Zhan

Arrestins are multi functional adapter proteins that orchestrate a vast array of cellular functions including MAPK signaling, receptor trafficking, and transcriptional regulation. Inositol hexaphosphate (IP6) is a naturally occurring phosphorylated carbohydrate that is abundant in almost all plant and mammalian cells. Previously studies showed that IP6 interacts with arrestin proteins, and regulates arrestin-mediated signaling. More interestingly, binding of IP6 affects four arrestin isoforms deferentially. Here, we report an equilibrium gel-filtration method to evaluate the interaction between arrestin and IP6. The interaction of arrestin3-IP6 can be further investigated by the method reported to determine the binding stoichiometry and binding affinities.

Undergraduate

SYNTHESIS AND CHARACTERIZATION OF NOVEL RHENIUM(I) COMPLEXES FOR PDT AND PACT

Primary Author: Megan Keane, Chemistry

Advisor(s): Chad Rezsnyak

In recent studies, rhenium(I) complexes have shown promise to be effective anticancer agents. In particular, rhenium(I) tricarbonyl complexes have demonstrated ability as photodynamic therapy (PDT) and photoactivated chemotherapy (PACT) photosensitizers when coordinated with diimine and phosphine ligands. The phosphine works to labilize the trans-carbonyl of the complex, allowing for release of carbon monoxide which permits another pathway for additional cytotoxicity. The specific complexes in question are Re(CO)3(N-N)(PR3) complexes (where N-N is a substituted phenanthroline and PR3 is a phosphine such as 3,3′,3″-phosphanetriyltris(benzenesulfonic acid) trisodium salt (TPPTS)) have the potential to act as anticancer agents with dual pathways for treatment. The synthesis, characterization, and photophysical properties will be described.

Undergraduate

NMR CHARACTERIZATION OF PYRUVALDEHYDE THIOSEMICARBAZONE (TSC) AND THEIR METAL COMPLEXES

Primary Author: Adam Koch, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): 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 primarily consists of NMR Characterization of derivatives of TSC and their respective Ni, Pt, Pd metal complexes that have already been synthesized. 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 the complexes. In-depth evaluation of NMR data will be presented.

Undergraduate

ACCESSING POLYROMANTIC RADICALS FROM BELOW: A SHOWCASE FOR A HARMONIC MODEL IN FRANCK CONDON SIMULATION OF PHOTOELECTRON SPECTRA OF POLYAROMATIC RADICAL ANIONS

Primary Author: Zachary LaPlant, Physics

Advisor(s): Wilson Gichuhi

As one of the most abundant forms of carbon in the universe, polyaromatic hydrocarbons (PAH) play a central role in the field of Biochemistry and Astrochemisty. In this work, we present a Franck–Condon analysis of the vibrational structure in the negative ion photoelectron spectra of naphthalene as a prototype for analysis of a photoelectron spectra of a system containing a rigid ring structure. The Franck–Condon profiles of the anion photoelectron spectra are simulated using the PESCAL program that uses the theoretical geometries, normal mode vectors, and vibrational frequencies of the anion and neutral states calculated using the GAUSSIAN 09 software package. These simulations are based on a harmonic oscillator approximation model that utilizes the Duschinsky rotation between the normal mode vectors of the anion and neutral. This harmonic approach very accurately simulates electronic spectra that involve relatively small displacements of equilibrium geometries of the neutral relative to the anion of a large cyclic system like naphthalene.

Undergraduate

QUALIFYING CANNABIS USING THIN LAYER CHROMATOGRAPHY

Primary Author: Courtney LaPointe, Chemistry

Advisor(s): Jeffrey Boles

The passage of the 2018 Farm Bill, legalizing cannabis containing less than 0.3% THC (Hemp), creates problems for law enforcement. Due to the conflicting legality of cannabis across the United States and emerging use of hemp by the public, law enforcement needs to acquire the ability to distinguish between hemp and marijuana using a presumptive test kit. Our approach involves the development of an efficient, mobile, simple, thin layer chromatography (TLC) kit that provides presumptive (qualitative) forensic evidence of the chemical contents of a bud, oil, or edible. The evidence would later be sent to a crime lab for definitive analysis of tetrahydrocannabinol (THC) content, the psychoactive compound in marijuana. Preliminary research has focused on the utilization of silica TLC plates, a mobile phase made up of 1:2, dichloroethane and chloroform, and a commercial stain. CBD and THC are clearly resolved under these conditions by TLC.

Undergraduate

MECHANISM STUDIES OF THIOSEMICARBAZONE INHIBITION ON HUMAN TOPOISOMERASE IIα

Primary Author: Kyle Lyons, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Maryo Toma, Edward Lisic

Advisor(s): Xiaohua Jiang

Proteins possess a high diversity of functions within cells which can be regulated by small molecule binding. The protein topoisomerase II within humans is responsible for the higher order structural regulation of DNA and has been the target of small molecule anti-cancer therapies including thiosemicarbazones such as etoposide, a commercially available interfacial poison of topoisomerase II. However, these therapies present significant, detrimental side effects thought to be imposed by the inhibition of both isoforms,

alpha and beta, found throughout the body. Indeed, significant evidence suggests inhibition of the mitotic-associated alpha isoform negatively regulates cancer cell proliferation while inhibition of the interphase-associated beta isoform is the cause of side effects. By selectively targeting the alpha isoform with novel metal-ligand complexes of thiosemicarbazones a therapy which retains efficacy but disposes of undesired effects is hoped to be achieved. Presented is a series of DNA assays of varying concentrations of thiosemicarbazone complexes.

Undergraduate

SPECTRAL CHARACTERIZATIONS AND INDIVIDUAL ASSIGNMENTS OF MOLECULES IN STEROID COMPOUNDS

Primary Author: Sarah Mendoza, Pre-Professional

Co-Author(s)/Collaborator(s): Dylan Gardner, William Carroll

Advisor(s): William Carroll

This is part of an ongoing research project on how well current methodology can distinguish the stereochemistry of RDC's of the stereoisomers of steroid compounds. Different stereoisomers have different pharmacological properties, thus having the correct assignment is vital for the development of new drugs. Determining the stereochemistry of candidate pharmaceutical molecules is no easy task. Many spectra are taken per molecule to determine its configuration correctly. The goal of this research is to develop a measure of merit to evaluate our structures for the correct assignment of their stereochemistry. This work focus on achieving this empirically through blind comparisons to control molecules. The work presented here develops the assignments and spectral characterizations of our control molecules.

Undergraduate

SYNTHESIS AND NMR CHARACTERIZATION OF NEW TERT-BUTYL THIOSEMICARBAZONE COMPOUNDS AND CORRESPONDING PALLADIUM COMPLEXES

Primary Author: Carlynne Methvin, Biology

Advisor(s): Edward Lisic

This work shows the synthesis and characterization of a series of tert-Butyl thiosemicarbazone compounds, based on the 4-tert-Butyl-3-thiosemicarbazide substrate. The corresponding palladium complexes of this series of ligands were obtained via a reaction with Palladium(II) Chloride. 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 (hetero-nuclear single quantum coherence) 1H-13C NMR and HSQC 1H-15N NMR to give evidence for the structures of these new compounds.

Undergraduate

INVESTIGATION FOR PHOSPHORIC ACID IN SODA USING RAMAN SPECTROSCOPY MEASUREMENTS

Primary Author: Bethann Oberlander, Chemistry

Co-Author(s)/Collaborator(s): Luke Bartlett

Advisor(s): Andrew Callender

Certain circumstances prevent utilizing an acid-base titration for determine an acid's concentration. Analyzing the contents of a pharmaceutical tablet intended for sale, or corrosive solutions used in electrochemical plating and finishing are both examples where detecting acid concentrations using an acid-base titration would be

implausible. In this study, a Raman Spectrometer was utilized to determine the concentrations of phosphoric acid and dihydrogen phosphate ion within soda samples and external standards. The soda samples used in this study were Pepsi, Mountain Dew, and Sierra Mist. The external standards were formed through parallel dilutions of stock phosphoric acid samples with hydrochloric acid solution. The Raman Spectrometer results were then organized into a calibration model using Microsoft Excel, which provided a graphical representation of the relationship between the concentration of phosphoric acid present and the intensity of light scattered by the sample as it was tested. The represented relationship displays that while dihydrogen phosphate ion was detected in the Pepsi samples tested with the Raman Spectrometer, further testing may be required to validate these results.

Undergraduate

COMPARATIVE UV-VIS ANALYSIS OF JUGLONE EXTRACTED FROM FROZEN VERSUS FRESH BLACK WALNUT HULLS

Primary Author: Rachel Paris, Pre-Professional

Co-Author(s)/Collaborator(s): Cory Rogers; Meredith Borst; Ilysa Crouch; O. Andreea Cojocaru; Twanelle Majors; Ginger Majors, Warren Country High School, McMinnville, TN 37110

Advisor(s): Twanelle Majors

The purpose of this study is to compare the concentration of juglone, 5-hydroxy-1,4-naphthoquinone, extracted from frozen plant material versus fresh plant material. Juglone is a compound with a wide variety of properties (herbicidal, antibacterial, antifungal) found naturally in black walnut hulls, leaves, and roots. Although its extraction from frozen plant material has been previously reported in the literature, this study focuses on extraction of juglone from frozen walnut hulls of Juglans nigra using solvents that pose less risk than the solvents used in the previous studies. Immature black walnuts were collected during the months of June, July, August, and September of 2018 from tree canopies in Warren County, Tennessee and immediately placed in a deep freezer for six months. Frozen walnut hulls were finely grated to pulp. Deionized water, acetone, 70% isopropanol, and ethanol were used to extract juglone. Samples were protected from light and stirred overnight. The extracts were filtered and then characterized using UV-VIS. Juglone concentrations were compared to extracts taken from fresh walnut hulls processed using the same methods.

Undergraduate

INVESTIGATING THE USE OF FLOW CHEMISTRY FOR THE SYNTHESIS OF 15N LABELED AMINO ACIDS FROM SIMPLE STARTING MATERIALS

Primary Author: Taylor Pinto, Chemistry

Advisor(s): William Carroll

The use of flow chemistry was investigated to synthesize amino acids. The excellent kinetic control of flow chemistry was used to include 15N in amino acids starting with primitive reagents containing isotopically enriched nitrogen. The use of simple 15N sources was a cost effective alternative to purchasing more complex labelling reagents.

Undergraduate

SOLUBILITY STUDIES OF DUAL FUNCTIONAL PHENOTHIAZINE IONIC LIQUIDS

Primary Author: Lillian Pipkin, Chemistry

Creative Inquiry Summer Experience (CISE)

Award Recipient

Co-Author(s)/Collaborator(s): Eva Etheridge

Advisor(s): O. Andreea Cojocaru

Recent studies have shown that converting an active pharmaceutical ingredient (API) into an ionic liquid (IL, an ionic salt with MP below body temperature) provides many advantages to its effectiveness such as: increased solubility in simulated body fluids and/or water; improved bioavailability and/or dissolution; increased therapeutic efficacy and a more effective delivery of the API through a skin-mimicking membrane, which could lead to the development of a new drug delivery mechanism. Another feature of this conversion is dual-functionality, where the IL is made up of different pharmaceutical ions that retain their properties as APIs but can also have synergistic effects.

Phenothiazine drugs are known to have several biological effects (e.g., anti-inflammatory, tranquilizers, antitumor, etc.) but no analgesic effect, and as a result, are administered in combination with analgesics for the desired result. We previously showed that new dual functional phenothiazine ILs can be synthesized by pairing phenothiazine cations with anion sources, such as non-steroidal anti-inflammatory drugs (NSAIDs). The research presented here focuses on the solubility of the newly synthesized compounds in water and simulated body fluids such as phosphate-buffered saline (PBS, pH = 7.4, a buffer solution that mimics body fluid) at room temperature. Knowing the solubility of the compounds in PBS will allow us to investigate their membrane permeability through a silicone membrane that mimics skin.

Undergraduate

DEVELOPMENT OF INEXPENSIVE GRAPHITIC CARBON ELECTRODES FOR USE BOTH AS AND IN UNDERGRADUATE CHEMISTRY LABS

Primary Author: Jonah Ralston, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Jonathan Moldenhauer

The purpose behind this experiment is ultimately to design cheap electrodes from materials one could buy from a hobby shop. Ultimately the electrodes produced should be cost-effective compared to commercially available electrodes for laboratory research. Cyclic voltammetry was performed to evaluate the performance of the in-house constructed electrodes. Based on the electrodes performance the design of the electrodes could be evaluated and compared to results from a commercially available model. Multiple electrodes were designed with different geometries and electroactive surface areas. Ideally the in-house built electrodes will perform similarly to commercially available models. These designs focus on the use of graphite for the electrode's electroactive surface. This material was chosen based on reduction potential of graphitic carbon, and allows for a larger potential window than most noble metals. The ultimate goal is to design a cheap electrode from easily obtained materials that can produce results similar to those available commercially.

Undergraduate

SYNTHESIS AND SPECTROSCOPIC CHARACTERIZATION OF DOUBLE SALTS IONIC LIQUIDS OF QUINIDINE

Primary Author: Thomas Robertson II, Chemistry

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

Advisor(s): O. Andreea Cojocaru

Polymorphism, the interconversion of solid state material between different crystalline forms, can reduce the effectiveness of solid state drugs. Injury caused by medications is the leading cause of death in the United States. Drug induced liver injury is any form of liver injury caused by medication. A common solution to these problems is the conversion of the solid state drugs into their liquid forms via an ionic liquid (IL) formation; an active pharmaceutical ingredient (API) and a FDA approved compound or two APIs can be combined in their cationic or anionic form into a single ionic compound leading to the formation of new dual active APIs in liquid form (API-IL, ILs that melt below 37 °C) that will retain the pharmaceutical properties of the original APIs. Combining three or more drugs into one single ionic compound, namely a double salt ionic liquid (DSIL), would allow one to add additional properties to the final liquid drug. Our research focuses on applying the DSIL strategy to pharmaceuticals that cause liver injury (quinidine) by combining them with drugs that offer liver protection properties (N-acetyl-L-cysteine, NALC), and compounds that will increase their permeability (sodium docusate, NaDoc) adding a new delivery mechanism to the drug. This presentation shows the synthesis and spectroscopic characterization of new DSILs formed by combining quinidine in its cationic form with NALC and NaDoc in their anionic form in different cation to anion molar ratios.

Undergraduate

DEVELOPMENT AND ANALYSIS OF A WALNUT EXTRACTION METHOD FOR INCREASING JUGLONE YIELD WHILE REDUCING COST BARRIERS OR HAZARDS

Primary Author: Cory Rogers, Chemistry

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

Advisor(s): Twanelle Majors

Traditionally, hulls from the black walnut tree, Juglans nigra, are considered a waste product in the harvesting process; however, these hulls are a great source of juglone (5-hydroxy-1,4-naphthoquinone) a compound with herbicidal, anti-microbial, and anti-fungal properties. In addition to agricultural and medicinal applications, juglone can be readily deprotonated to form an anion; this allows one to combine juglone in its anionic form with quaternary ammonium cations (or QUATs) to form a new single compound, namely an ionic liquid, with distinct properties and uses. Albeit a versatile chemical, purchasing juglone is quite expensive. Developing inexpensive, simple extraction techniques using household chemicals suitable for a high school or non-majors chemistry laboratory setting is highly desirable.

Methanol, chloroform, acetone, and ethanol are cited as successful juglone extraction solvents. Due to the inherent hazards of these solvents, safe and efficacious alternatives exist and are favorable in a high school laboratory setting. This would limit the use of chemicals which require special storage, ventilation, and protective equipment. To that end, this study focused on developing adapted techniques using friendly solvents, such as isopropanol, for the extraction of juglone from walnut hulls without sacrificing yield. Varying concentrations of isopropanol were employed to extract juglone, and its concentration in the isopropanol extracts was determined using UV-Vis Spectroscopy. In addition to solvent selection, the processing methods (agitation vs. no agitation; gravity filtration vs. standard vacuum filtration) were also explored. Comparative yields in the extracted juglone were used to suggest the most classroom-relevant and cost efficient extraction techniques.

Undergraduate

INCREASING THE ACCESSIBILITY OF THE RAINBOW FLAME TEST BY UTILIZING HOUSEHOLD CHEMICALS

Primary Author: Abigail Rossi, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Amanda Carroll

The rainbow flame test is a demonstration conducted to demonstrate the different colors produced when salts containing various metal cations are sprayed into a flame. The demonstration serves as an exciting and visual method of introducing the concept of electron transitions in atoms. This project began with an inquiry into increasing the safety of the rainbow flame test and was continued by investigating mixtures different salts to create new colors previously unavailable in the flame test. This portion of the project assesses the viability of using household chemicals to produce similar results as the rainbow flame test when conducted with laboratory grade chemicals. Some of the substances considered are Windex, Borax, Wite-Out Liquid Paper, table salt, and a salt substitute. This research seeks to incorporate green chemistry principles, as well increase the accessibility of the demonstration to K-12 teachers and homeschool students since all chemicals utilized can be found at big-box stores.

Undergraduate

IONIC SALT COMBINATIONS OF ALBUTEROL WITH CARBOXYLATE NSAIDS

Primary Author: Jacob Scantland, Chemistry

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): O. Andreea Cojocaru

The asthma drug albuterol is often used with corticosteroids, which present several disadvantages (drug addiction; side effects such as weight gain, headaches, sore throat, etc). Non-steroidal anti-inflammatory drugs (NSAIDs) are used as an alternative to corticosteroids, being prescribed before steroids in the treatment of headaches, fever, neuropathy, etc. Like most drugs, NSAIDs and albuterol drugs are in solid state; the active ingredients are paired with inert inorganic counter ions such as chloride and sulfate anions (Cl- and SO4-) or sodium and potassium cations (Na+ and K+). This, along with the presence of an amine site in the structure of albuterol and a carboxylate anion in NSAIDs, positions these drugs as ideal compounds to be converted into an ionic liquid, a strategy known to overcome the drawbacks of the solid drugs. We previously showed that new dual active albuterol-NSAID ionic salts can be synthesized either via a metathesis reaction (between albuterol hydrochloride and sodium salt derivatives of NSAIDs) or via an acid base reaction (between albuterol free base and NSAIDs as free acids). The new dual functioning asthma drugs provide a safer alternative to corticosteroids and could be delivered transdermal. Therefore the solubility of the compounds in simulated body fluids needs to be investigated. This presentation focuses on the solubility of the synthesized compounds in water and phosphate saline buffer (pH = 7.4) a simulated body fluid that mimics blood, at room temperature and at 37 °C.

Undergraduate

FRUSTRATED COMPLEXANT SCAFFOLDS OF 2-(6-[1,2,4]TRIAZIN-3-YL-PYRIDIN-2-YL)-1H-INDOLES TOWARD MINOR-ACTINIDE SEPARATIONS

Primary Author: Mariah Tedder, Chemistry

Co-Author(s)/Collaborator(s): Zachary Gulledge, Jesse Carrick

Advisor(s): Jesse Carrick

Recycling of spent nuclear fuel (SNF) continues to be of great environmental importance, particularly due

to the increased recent interest in transitioning away from non-renewable fossil fuels toward renewable cleaner energy sources. The use of nuclear fuel as a primary fuel source has one significant drawback, the environmental concerns over the handling of SNF. Soft-Lewis basic complexants have been evaluated as possible solutions to aid in this process of separation and recycling of fuels due to their ability to participate in effective chemoselective separation of minor actinides over lanthanides. The separation of minor actinides is important due to lanthanides having the ability to adsorb neutrons, rendering them unsuitable enough for usage in more commonplace fuels. This project aims combine soft-Lewis basic starting materials previously synthesized in this group with indole boronic acids to afford a lessened basic nature which could potentially enhance chelation efficacy and radiolytic stability. All of the complexants synthesized in this project have not been reported in the primary literature. Diversification has been accomplished by varying both scaffold, indole, and variations of both. Optimization of synthesis and purification protocols has been completed alongside characterization of these new compounds. A standard example of the Br-MTP-Phen scaffold combined with the unfunctionalized indole boronic acid will be studied for solubility and chelation ability. Current synthetic reports, optimization, and downstream functionalization will be reported.

Undergraduate

SYNTHESIS AND SPECTROSCOPIC CHARACTERIZATION OF ALBUTEROL DOUBLE SALT IONIC LIQUIDS

Primary Author: Jacob Thorn, Chemistry

Co-Author(s)/Collaborator(s): Jacob Scantland

Advisor(s): O. Andreea Cojocaru

Many of the marketed pharmaceuticals are in solid, crystalline form. Unfortunately, most of these drugs have low bioavailability, poor transdermal delivery or dissolution. This is generally due the inherent properties of their solid state such as polymorphic interconversion and their easy conversion into solvates. Numerous research papers show that the ionic liquids strategy can be successfully applied to pharmaceuticals to overcome many of these disadvantages. Ionic liquids (ILs, low melting ionic salts with high thermal stability and low vapor pressure) are compounds comprised of two ions, a cation and an anion, in a 1:1 molar ratio. Double salt ionic liquids (DSILs) are complex ILs that contain in their structure more than two types of ions in different molar ratios (one anion and several cations; one cation and several anions; or several anions and several cations). This ratio can vary in any considerable way contributing to the variety of chemical and physical properties of DSILs.

Our research focuses on applying the DSIL strategy to albuterol, an asthma drug, to form new asthma drugs with improved solubility and transdermal delivery. Several new DSILs were successfully synthesized by utilizing albuterol hydrochloride (cation precursor) and sodium salicylate and sodium docusate (anion precursors) in varying ratios. Here we present the synthetic procedures and the spectroscopic characterization of the novel compounds.

Undergraduate

SYNTHESIS OF THIOSEMICARBIZONE LIGANDS

Primary Author: Lake Underwood, Biology

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Advisor(s): Edward Lisic

According to literature, thiosemicarbazones and their ligands have shown certain properties that demonstrate anti-cancer activities. The focus of this work was around the synthesis and characterization of four new compounds:

5-fluoroisatin-4-tert-butyl-3-thiosemicarbazone (5FI-tBTSC), 5-fluoroisatin-4-ethyl-3-thiosemicarbazone (5FI-ETSC), 7-fluoroisatin-4-tert-butyl-3-thiosemicarbazone (7FI-tBTSC), and 7-fluoroisatin-3-ethyl-4-thiosemicarbazone (7FI-ETSC). These compounds were all characterized using NMR spectroscopy. Future syntheses will be completed to form Pd complexes with each of the four ligands, and these complexes will be analyzed to determine if any biologic activity exists, particularly inhibition against the topoisomerase-II- enzyme. If successful, these compounds could lead to new chemotherapeutic agents.

Undergraduate

INFORMATION AND CLASSIFICATION OF HOPS VARIETIES

Primary Author: Julia Vesely, Human Ecology

Co-Author(s)/Collaborator(s): Isaac Reff, Jared Allen, Jacob Winton, Derek Cashman, Andrew Callender

Advisor(s): Derek Cashman

Hops (the flowers of the Humulus lupulus plant) are an important and essential part of the beer brewing process as well as in the taste and fragrance of the final product. During the brewing process, hops are isomerized into alpha and beta acids that balance out the sweetness of the malt by providing bitterness, measured in International Bittering Units (or IBUs) or aroma respectively. Based on geographical location or strain of hop grown, the flower can provide numerous different flavor and aroma profiles, as well as essential oils, flavonoids, and antimicrobial properties . In addition, the time and temperature at which hops are added during the brewing process can dramatically change the taste or smell of the beverage produced. The flavors and aromatic properties in each kind of hop also contribute to the style of beer produced. Some varieties are better than others (or should be completely avoided) for some beer styles, but a few of them can also be used interchangeably, as arranged on the Flavor Profile Wheel of Hops Varieties. These findings led to the creation this diagram to help give a visual showcase of how hops could be classified.

Undergraduate

SOLUBILITY STUDIES OF DUAL ACTIVE IONIC LIQUIDS WITH POTENTIAL TO ELIMINATE DRUG-INDUCED HEPATOTOXICITY

Primary Author: Sarah Visneski, Biology

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

Advisor(s): O. Andreea Cojocaru

Ionic Liquids, with regard to pharmaceuticals, are ionic salts with melting points less than 37 °C. The conversion of solid pharmaceuticals to ionic liquids have the potential to solve problems in the pharmaceutical industry, including the removal of polymorphisms which can occur in the solid form of active pharmaceutical ingredients. This could potentially increase the shelf life of these drugs and allow for storage in a wider variety of climates. One of the most common side effects of many drugs is drug-induced liver injury, or drug-induced hepatotoxicity. We previously showed that the ionic liquid strategy can be used to form new dual active drugs, namely prophylactic ionic liquids, by combining the liver-damaging properties of several known cation precursors with the liver-protecting properties of several known anion precursors. This strategy enables potentially liver-damaging drugs to be given without risk of liver injury. The research presented here focuses on the solubility properties of the most promising prophylactic ionic liquids. The solubility of the chosen compounds in de-ionized water (pH = 7) and simulated body fluids was conducted by following literature protocols, with phosphate buffered saline (PBS, pH = 7.4) being the primary simulated body fluid used. PBS is a

solution containing sodium chloride (NaCl), potassium chloride (KCl), and phosphate buffer that mimics the pH and ion concentrations found in the human body. These studies will help us determine if the newly synthesized prophylactic ionic liquids have a higher or lower bioavailability than the commercially available drugs.

Undergraduate

ULLMAN-TYPE COUPLING OF FUNCTIONALIZED 1,2,4-BISTRIAZINYL-BIPYRIDINES TOWARD STRATEGIC COMPLEXANTS FOR MINOR ACTINIDE SEPARATIONS

Primary Author: Gabrielle Waters, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Jesse Carrick

The potential for nuclear fuel to be a sustainable source of energy is predicated on the prospective remediation and recyclization of spent nuclear fuel. Thus, fully closing this linear process would dramatically decrease the volume of radiotoxic waste and operating cost of mining fresh uranium or transformation of fissile materials. Minor actinides present in spent nuclear fuel do not make up a large portion of the fuel; however, these highly radioactive and unstable nuclides, as well as the neutron-absorbing lanthanides, are the main reason behind the inability to reuse spent nuclear fuel. At this time, spent nuclear fuel that contains radioactive minor actinides has the potential to be separated using liquid-liquid extraction techniques being facilitated by lewis-basic heterocyclic complexants that possess minor actinide binding affinity. Therefore, complexants, such as bis-triazinyl-bipyridine (BTBP) scaffolds, present possible advantages for liquid-liquid separations of minor actinides. Previous work in our lab focused on traditional condensation techniques to afford symmetric complexants. Our current work is centered on convergent strategies with modular synthons to afford symmetric and unsymmetric BTBP scaffolds. Our approach to the synthesis of BTBP scaffolds involves an optimized metal-mediated Ullman-type coupling of two 3-(6-bromo-pyridin-2-yl)-5,6-diphenyl-[1,2,4]triazine (MTP) scaffolds. Further functionalization of BTBPs, as well as broadening the scope to pyridinyl substrates, has been successful with the reported conditions. Additional substrate scope will focus on the synthesis of unsymmetric functionalized BTBP scaffolds. Method optimization, experimental procedures, substrate scope, purification analysis, and future goals are will be disseminated.

Undergraduate

NUCLEAR MAGNETIC RESONANCE OPTIMIZATION OF ORGANIC CHEMISTRY REACTIONS

Primary Author: Ashley Williams, Chemistry

Co-Author(s)/Collaborator(s): William Carroll

Advisor(s): William Carroll

Our focuses on optimizing organic reactions to decrease waste and give higher product yields more reliably through the use of Nuclear Magnetic Resonance (NMR). Many organic reactions produce large amounts of waste in labs. In our research we are optimizing reactions by conducting experiments in NMR tubes. This allows us to conduct reactions on a small scale and decrease the overall amount of waste generated from an experiment. By using NMR tubes we are able to monitor the reaction as it takes place through the use of NMR spectroscopy. Since experiments are conducted in the NMR tubes the amount of chemicals used is decreased and the overall waste created in lab minimized. With NMR spectroscopy “snapshots” of the experiment are taken during each step of the reaction to see how the experiment is proceeding. This gives a visual aspect to future students during lab which can help facilitate learning. Results for optimizing reactions are ongoing, and once more data obtained design of experiment will be used to optimize the reactions.

Department of Earth Sciences

Undergraduate

MEASURING A CHANNEL OUTCROP WITH A SCINTILLOMETER IN THE FORT PAYNE FORMATION, TENNESSEE

Primary Author: Austyn Allen, Geosciences

Co-Author(s)/Collaborator(s): Jason Gentry, Gabrielle Miller, Jeannette Wolak, Larry Knox

Advisor(s): Jeannette Wolak

The location of study was near Celina, Tennessee on Highway 52, specifically at latitude 36.50263, longitude -85.44836, and elevation 268 meters. The purpose was to collect gamma ray scintillometer data from a channel outcrop and compare the collected data to nearby well logs to search for any methods of identifying what a channel would look like on well log data. We collected our data in a grid with a hand-held scintillometer that measures potassium, uranium, thorium, and dosage rate measurements. To create the grid we used Jacob staffs to measure out and mark 20 cm vertical increments with chalk. The measurements were collected from 2 stratigraphic columns 8 meters apart; the left column had 13 points of measurement and the right column had 25 points of measurement.

We were able to successfully collect all of the data from our intended points of measurement. The next step was searching the Tennessee Oil and Gas database for well log data. Although many wells in the area penetrate the targeted Fort Payne Formation, most well logs were collected below our point of elevation. Future work will focus on: (1) searching for well logs with more shallow data to compare to the scintillometer measurements; (2) searching for well logs in Kentucky where the Fort Payne is deeper and was likely logged; and (3) comparing our outcrop scintillometer data to subsurface well log data.

Undergraduate

COMPOSITIONAL ANALYSIS OF A MARTIAN TERRACED FAN IN CAMICHEL CRATER

Primary Author: Allison Bohanon, Geosciences

Co-Author(s)/Collaborator(s): Natalie Robbins, Shelby Smith, Jeannette Wolak

Advisor(s): Jeannette Wolak

The Camichel Crater terraced fan deposit is located on the northern rim of Camichel Crater in Xanthe Terra, Mars (latitude 2.69°N, longitude 308.33°E). We studied this fan using ArcGIS Pro to map dunes covering the Camichel Crater fan and CRISM data to identify different minerals exposed on the surface. Our goal is to test the hypothesis that the mineral composition of the Camichel Crater Fan is non-uniform and layers at the base of the fan do not show the same composition as layers at the top of the fan.
We imported HiRISE and CTX images of the Camichel Crater Fan into ArcGIS Pro to begin mapping. In ArcGIS Pro, we used a scale of 1:18000 for geologic mapping and a scale of 1:4000 for line work on the HiRISE image. At the 1:4000 scale we mapped dunes on the entire fan unit to see which areas have experienced heavy amounts of wind erosion and deposition. Dunes were most common in sheltered topographic regions on terraces and were distributed evenly over the rest of the fan unit.
We then imported CRISM data into ArcGIS Pro to analyze mineral composition of the Camichel Crater Fan. Using the CAT extension in ENVI Classic, we were able to set parameters to view the presence of various minerals based on visible to near-infrared wavelengths from the Compact Reconnaissance Imaging Spectrometer for Mars. From this data, we found that the mineralogy of a lower deposit

differs from the upper deposits on the fan.

Undergraduate

PALEOCLIMATE RECONSTRUCTIONS OF THE EARLY MIOCENE FROM STRATIGRAPHIC AND X-RAY DIFFRACTION ANALYSIS OF PALEOSOLS FROM THE KIAHERA FORMATION, RUSINGA ISLAND, LAKE VICTORIA, KENYA

Primary Author: Kimberly Cheng, Geosciences

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Hunter Summers, Lauren Michel, H. Wayne Leimer

Advisor(s): Lauren Michel

The early Miocene deposits on Rusinga Island, Lake Victoria, Kenya have been continuously studied for over 80 years to learn more about the paleontology, including early hominids, such as the ape Ekembo. Most of the previous research has focused on the Hiwegi Formation, where the vast majority of fossils have been discovered, leading to understudying other formations including the Kiahera Formation which recently has been revealed as invaluable for the preservation of climate information. The Kiahera Formation contains many fossils and fossilized soils (paleosols), and a climatic history can be reconstructed through a combination of stratigraphic mapping and x-ray diffraction of the clay minerals of the paleosols. Lower members of the site observed, R73, are composed of volcaniclastics including igneous rock fragments, volcanic breccias, volcanic bombs, and ash which we interpret as evidence of active volcanism. The younger member is made up of alternating strata of cross-bedded sandstones that scoured into the underlying layers and paleosols which we interpret as evidence of the volcano ceasing to erupt, and evidence of climate. Within the Kiahera Formation two paleosol types are found: Calcisols and Vertisols; the former suggests a semi-arid to arid climate in which evaporation was greater than precipitation and the latter suggest a seasonal water budget surplus and deficit. X-ray diffraction analysis of the paleosols determines a composition of montmorillonite, kaolinite, and illite which is similar in composition to modern Vertisols. These results suggest paleoclimates dominated by monsoonal conditions, possibly the East African Monsoon which today dominates the region.

Undergraduate

SURVEY OF CARBONATE MUD MOUNDS OF THE FORT PAYNE FORMATION

Primary Author: Jason Gentry, Geosciences

Co-Author(s)/Collaborator(s): Austyn Allen, Gabrielle Miller, Jeannette Wolak, Larry Knox

Advisor(s): Jeannette Wolak

Carbonate mud mounds of the Fort Payne Formation range from southern Illinois through Kentucky, Tennessee, and southeast into northern Alabama. This research was conducted on mud mound outcrops of Center Hill Lake near Smithville, Tennessee. Our goal with this research was to collect general data and samples of mud mounds to build a database of confirmed mounds and observe if there is a trend in mound size from northwest to southeast. Using unpublished coordinates from field work done in the 1990's, each location on Center Hill Lake was visited and its location confirmed using GPS. Samples were collected at field locations for general composition analysis. A description including size and lithology of each mud mound location was recorded. Over 100 photographs were taken to catalog and form photo mosaics of each located structure. This data was added to a file system, a Google Earth file, and a spreadsheet for future analysis. For future work, more data collection at each site is needed

along with a more detailed analysis of the lithologies that appears at the base of each mound. Electronically stored results will enable easier access to the data on each mud mound as it is located and recorded. The final results would be utilizing ArcGIS Pro to build a searchable database and enable detailed mapping of sites as they are cataloged. We can then use this data to make observations about the mounds, including size trends possibly indicating their proximity to the paleo shoreline of the Mississippian period.

Undergraduate

COMPARISON OF THE CHATTANOOGA SHALE FORMATION INSIDE AND OUTSIDE THE FLYNN CREEK CRATER, JACKSON COUNTY, TENNESSEE

Primary Author: Stone McCoy, Geosciences

Advisor(s): Jeannette Wolak

The Flynn Creek crater is a 200 meter deep impact structure estimated to be formed in the Devonian period approximately 360 million years ago. The impact structure is 3.8 kilometers in diameter and is located 8 kilometers south of Gainesboro, in Jackson County, Tennessee (36°17' N, -85°40' W). When the impact occurred, the area was a shallow marine environment. The deposition of the Chattanooga Shale Formation was deposited after the impact occurred. The units effected by the impact were flat lithified Ordovician limestones and dolomites. The Chattanooga Shale near the Flynn Creek area is mainly black in color and can reach up to 55 meters in thickness. This research will test the hypothesis that the Chattanooga Shale formation inside the Flynn Creek crater may be older than the Chattanooga Shale formation outside of the crater. For this hypothesis, a hand-held Gamma Ray scintillometer was used to collect spectral data from the shale. Thirty-six measurements with the scintillometer will determine the amount of potassium (%), uranium (ppm), thorium (ppm), and overall gamma ray dose rate (nGy/h) for the two shale outcrops at Flynn Creek. Eighteen measurements were taken inside of the impact crater. The average gamma ray dose rate for this outcrop averages 172.13 nGy/h. Future field work will collect the remaining eighteen measurements outside of the Flynn Creek Crater. The average gamma ray dose rate of that outcrop will determine whether the two outcrops of Chattanooga Shale differ from one another in age.

Undergraduate

GAMMA RAY ANALYSIS OF A CARBONATE MUD-MOUND ON CENTER HILL LAKE, TENNESSEE TECHNOLOGICAL UNIVERSITY

Primary Author: Gabrielle Miller, Geosciences

Co-Author(s)/Collaborator(s): Jason Gentry, Jeannette Wolak, Larry Knox

Advisor(s): Jeannette Wolak

The purpose of this project is to use wireline logs to determine the presence or absence of Maury Shale and carbonate mud mounds at the base of the Fort Payne Formation (Mississippian) in central Tennessee. For this project, we chose a mud mound in a well-exposed carbonate system on Center Hill Lake, latitude 35.85N and longitude 85.64W. The method employed to acquire data was a hand-held gamma ray scintillometer, an instrument that determines the percentages of potassium, uranium, thorium, and total dose rate of gamma rays.

Initial fieldwork was completed during the summer of 2018, and scintillometer results from five measurements showed low values for each element and total dose rate. These results suggest that the outcrop lacks significant shale deposits. The general stratigraphy for the mud mound was an upper slab section and lower "chippy" section. Typical

facies of this outcrop include crinoidal packstone and grainstone, massive fenestrate bryozoan coral, crinoidal wackestone and gray-green fossiliferous shale. Future work will focus on additional measurements across the mound to characterize lateral and vertical compositional trends.

Undergraduate

FOSSIL CONTENT ANALYSIS OF IMPACT BRECCIA IN THE FLYNN CREEK CRATER, JACKSON COUNTY, TENNESSEE

Primary Author: Caleb Stuber, Geosciences

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborator(s): Jason Gentry, Austyn Allen, Larry Knox, Jeannette Wolak

Advisor(s): Jeannette Wolak

The Flynn Creek crater is a 360 million year old impact structure that is located 8 km south of Gainesboro in Jackson County, Tennessee. This structure is 200 m deep and has a diameter of 3.8 km, and formed in what was then a shallow marine environment. The timing of the impact event that formed the crater is closely associated with the deposition of the Chattanooga Shale Formation. The pre-impact conditions of units in the area were consolidated and flat lying, and the units impacted include Ordovician limestones and dolomites that overlie crystalline basement along with earliest sediments of the Chattanooga Shale. The resulting impact breccia found in the study area weathers to a light gray with granule to boulder-sized clasts found throughout. The current hypothesis for formation history of this structure is that the Chattanooga Shale was deposited right after the impact event.

This study tests the hypothesis that Ordovician fossil content can be found in the impact breccia of the Flynn Creek crater. Previous workers have documented the presence of brachiopods, bryozoans, trilobites, bivalves, crinoids, and corals in angular carbonate clasts. For this project, five rock samples were collected, cut into thin sections, and analyzed using a petrographic microscope. Resulting microphotographs of fossils show that most material is well-preserved. This suggests that pressures and temperature associated with the impact were great enough to shatter the pre-existing carbonates but not great enough to destroy all primary textures.

Department of English

Graduate

CHAMPIONING THE FEMALE BODY: AN INVESTIGATION INTO THE RHETORIC OF DESIGN IN LEAGUE OF LEGENDS

Primary Author: Lyndsey DeBoard, English

Advisor(s): Mari Ramler

In the past, video games, while frequently topics of societal debate, have been considered by gamers and many scholars as virtual spaces distinctly separate from the real world wherein everything that occurs can be attributed to harmless play. However, in recent years technical communicators have become increasingly aware of and interested in video games as rhetorical spaces that reflect the values of their creators and have meaningful impacts on their players. With this in mind, this study centers on the importance of character model design as a complex act of technical communication and the ways in which this act may impact a significant and growing minority within gaming culture: women. Specifically, the epicenter of this study finds itself at the gaming studio, Riot Games, responsible for the development of League of Legends, the world's top-grossing online game, in which female characters are grossly oversexualized. Through a close reading of the game and character models, I come to argue that, by continuously hypersexualizing female champions in League of Legends, Riot Games is complicit in the perpetuation of a gaming culture that objectifies, marginalizes, and ultimately dehumanizes women. Moreover, I argue that while many hold the view that League of Legends is "just a game," the hetero male-centric and misogynistic attitudes embedded in the game and its contents by its developers have repercussions that reach beyond the game's immediate player base and ripple through the real world.

Undergraduate

THE EFFECT OF DER STRUWWELPETER'S ILLUSTRATIONS ON CHILDREN'S LITERATURE THROUGH TIME

Primary Author: Ian Ilgner, English

Co-Author(s)/Collaborator(s): Joseph Hunt

Advisor(s): Shirley Laird

Der Struwwelpeter is a classic German children's story with gruesome illustrations and depictions of naughty children. We have taken interest in its illustrations, which give it a unique style and the ability to persist to this day. After some preliminary research, we have decided to delve deeper into the influence that der Struwwelpeter may have had on other children's literature, both its contemporaries and current-day stories. We would like to compare der Struwwelpeter to current-day literature and literature of the past. We expect to see similarities between der Struwwelpeter and its contemporary European literature, and ripples of its influence in current-day literature. We believe that the illustrations in der Struwwelpeter has had a much wider influence on the culture of children's literature than many people would expect.

Undergraduate

TOXIC ATTITUDES: MARTINEAU'S "CRITICISM ON WOMEN" AND THE RHETORIC OF SHAME

Primary Author: Kinsey Potter, English

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Kristin Pickering

Martineau's view that patriarchal society limited women's status coincides with Wollstonecraft's observation of how female minds were dulled in a society that prohibited them education. Martineau also saw that women choose an obedient place over education. Contemporary studies of shame, like Merleau-Ponty's, which observe shame causes a woman to "lose ... [a] sense of reality" (165), explore shaming of women-- still a powerful tool in discrediting women. Both Martineau and Wollstonecraft demonstrated intrinsically in their works that society needed to be analyzed and perfected before women could achieve rights. Both expressed their vision of a better future for women, and the more liberated position of women today is undeniably due to them. Paradoxically, both writers underscore Kristeva's conclusion that shame can "preserve what existed in the archaism of pre-objectal relationship" and allow women to embrace their power as a real human being (15) by subverting patriarchal power structures.

Department of Foreign Languages

Undergraduate

DER STRUWWELPETER'S VIOLENCE COMPARED TO ANOTHER WELL-KNOWN EUROPEAN WORK

Primary Author: Amadeus Gaby, Civil Engineering

Advisor(s): Julia Gruber

Project Topic: Der Struwwelpeter, a German children's classic, published in 1845, seems to have had constant controversy surrounding its suitability for its young intended audience. Der Struwwelpeter is considered to be graphic by some, and there has always been much debate on whether or not this book crosses the line when it comes to how much children should be exposed to. The criticism is directed toward both the text and the illustrations in this children's book. Indeed, this work seems to have had more controversy surrounding it than any other children's book of its time. Thus, I will be comparing this work to another well-known children's book which originated from about the same time and place: Grimm's Fairy Tales. Opponents seem to focus on the content in Der Struwwelpeter as if it were more extreme or graphic than other popular children's books of its time. I hope to however, through this comparison, show if Der Struwwelpeter truly deserves the negative views that have surrounded it over the years, or if it was in reality similar to its contemporaries.

Undergraduate

FROM STRUWWELPETER TO POLITICS

Primary Author: Thomas Hudson, History (B.A.)

Co-Author(s)/Collaborator(s): Prinya Tep

Advisor(s): Julia Gruber

This project will examine the change from the children's book Struwwelpeter, written in 1845 by Dr. Heinrich Hoffmann, to the political satire written by Edward Harold Begbie in 1899 known as The Political Struwwelpeter and how it is used. Hoffmann's book Struwwelpeter contains stories and illustrations for children and their parents and was created by the author to substitute the lack of children's books. The book was intended to be used by parents to teach children moral lessons and good behaviors. In Begbie's The Political Struwwelpeter, the targeted audience becomes the people of Great Britain in 1899 as it makes fun of the country's social and political landscape. This project aims to examine the shift from children's literature into a political satire and highlight the similarities and differences by comparing the texts and illustrations from both works. This project will also investigate the different cultures and symbols of Great Britain and Germany and examine how the different cultures affects Begbie's interpretation of Struwwelpeter. This project will also examine the political and social landscape of Great Britain in 1899 to provide context for The Political Struwwelpeter's illustrations and stories.

Undergraduate

CHILDREN'S LITERATURE AND ITS USE TO CONTROL GIRLS

Primary Author: Jordan Wright, Foreign Languages

Co-Author(s)/Collaborator(s): Katrina Mauk

Advisor(s): Julia Gruber

While reading Der Struwwelpeter, a classic German children's book, we were struck with the near absence of females, and the treatment of the little girl, i.e. the only female in the entire book. It appears that females in children's literature around this time (1840s) either do not

have a role or are used to enforce the societal standards that have been put in place for women. Noticing this trend, we are curious to see if this treatment is the same in comparable literature of the time, and to what extent it has also impacted today's depiction of girls in children's literature.

We propose to compare Der Struwwelpeter to the original Little Red Riding Hood and other female fairy tale/ children's book characters to point out similarities and differences. In Der Struwwelpeter, the single female role is subjected to a harsher end result (death by burning) compared to the male characters. We ask whether by reading or being read to, little girls' were led to believe that their actions would be more severely punished than their boy counterparts, who were as or even more disobedient than them? Were these storybooks used to teach girls' complacency and enforce obedience? Through our research we hope to find the link between societal factors, such as what was/is expected of girls as opposed to boys, and the way these factors and expectations are conveyed in children's books now and then.

Department of History

Undergraduate

K-POP EVOLUTION

Primary Author: Kaitlynn Marshall, Secondary Education

Advisor(s): Edward Driggers

Korean popular music, or K-pop, is the generalization for all of Korean music. This means that the classification is much more diverse than people think. The genre of K-pop encompasses electronic dance music, ballads, rap, hip-hop, R&B, and rock along with the pop that is generally associated with it. K-pop is unique in the way of marketing. Every platform of the market is addressed to highlight what the group will bring to the table next. If an artist or group is debuting, marketing will focus on what that group is all about as well as the style of music. One specific technique used by K-pop artists and companies is the album contents. ." K-Pop started in South Korea and has branched out all over the world to become a worldwide phenomenon. It has gained new fans. With its new fans, it has gained more capital and has become a mega industry. Although it has some flaws with the way idols are treated and how much they work, companies seek solutions to these problems. Idols share the burden of expectations, fan service, and constant work, but in the end, this industry is the most desired among the young people of South Korea. Soon, this industry will be the most desired not only for South Korean youth, but also for youth from all over the globe.

Department of Mathematics

Undergraduate

ON THE LOCATION-SCALE GAUSSIAN MIXTURE OF THE LAPLACE DISTRIBUTION WITH APPLICATIONS

Primary Author: Seth Agee, Mathematics

Advisor(s): David Smith

The Laplace distribution has historically had statistical applications in image and speech recognition, hydrology, and finance. The distribution is characterized by having a sharper peak at the center than that of the Normal distribution. Ding and Blitzstein (2016) present a novel and simple approach based on moment generating functions and conditioning to show the Laplace distribution could be represented using a mixture of Exponential and standard Normal variables. We extend their approach to include a scale and location parameter and model to fit highway speed data. The symmetry of the Laplace distribution does not appear to represent the data well. Further modeling efforts employ an asymmetric Laplace distribution. We compare the goodness of fit of the symmetric and asymmetric distributions on the speed data using the Akaike information criterion.

Department of Physics

Undergraduate

SIMULATING A UCN "PPM DEPOLARIZATION" EXPERIMENT TO VERIFY THE INTEGRITY OF AN ANALYSIS MODEL

Primary Author: Sanjay Chakrabarty, Physics

Advisor(s): Adam Holley

The depolarization probability per bounce (DPB) is used to understand systematic and statistical effects in experiments requiring polarized ~100 neV 'ultracold' neutrons (UCN). To predict this effect, experiments were performed at Los Alamos National Laboratory to determine the DPB of UCN upon interaction with material guides as a function of the ambient holding field. To account for systematic effects in the experiment, the analysis model must be verified through a Monte Carlo computer simulation. In such simulations, a high-fidelity model of the UCN production source and the experimental geometry are used to simulate the effects of UCN angular and energy distributions. Other variables, such as loss per bounce and specularity, must be calibrated to match the simulation to data. After the simulation is verified to be consistent with the experiment, simulated data that is representative of experimental data can be created by varying DPB. If the analysis model fails to correctly predict the programmed DPB, the simulation can guide changes to the analysis model. The simulation method and a comparison to the experimental data will be presented, along with results from tests of one possible analysis model.

Undergraduate

SEMICLASSICAL SIMULATION OF SPIN EVOLUTION IN THE UCNτ EXPERIMENT

Primary Author: Jeremiah Ginder, Computer Science

Advisor(s): Adam Holley

The free neutron lifetime τn is a β-decay observable used in Big Bang Nucleosynthesis predictions of light element abundances, and along with other β-decay observables allows testing of the unitarity of the CKM matrix. The goal of the UCNτ experiment is to measure τn with a maximum uncertainty of 0.01% (an error of about 0.1 s). The experiment uses a magneto-gravitational trap consisting of a permanent magnet Halbach array within a vacuum jacket to hold low-field-seeking, ultracold neutrons (UCN) which undergo β-decay inside the trap. To achieve a high precision measurement, UCN must not leave the trap for reasons other than decay. One possible reason for UCN to leave the trap is depolarization, which is when UCN become high-field-seeking and get sucked into the walls of the trap instead of being repelled by them. In order to reduce the number of UCN depolarizing, the vacuum jacket is surrounded by coils that produce a magnetic holding field perpendicular to the Halbach field. To better understand the spin dynamics of UCN within the trap, two different spin-tracking simulations were developed; one uses a Monte Carlo Wave Function (MCWF) approach and the other integrates the Bloch equations to evolve the expectation value of the spin. These were first applied in modeling depolarization rate dependence on holding field strength. Calculations will be presented using the semiclassical approach and compared to results of the MCWF approach and empirical data.

This work was supported by the National Science Foundation, grant PHYS-1553861

Undergraduate

DETERMINATION OF THE NEUTRON CAPTURE CROSS SECTION OF 134Xe at En=4.2 AND 5.5 MeV

Primary Author: Andrew Hall, Physics

Advisor(s): Mary Kidd

Neutrinoless double beta decay experiments using 136Xe contain a signi cant amount of 134Xe. Understanding backgrounds in double beta decay experiments is extremely important. The ultimate goal of this experiment is to determine the neutron capture cross section of 134Xe. This calculation will aid in correcting for neutron-induced background in measurements. After activating 134Xe in a neutron beam, rays from the resulting decay of 135Xe are measured over time. This decay allows us to determine how much 135Xe was produced, and calculate the neutron capture cross section of 134Xe. The immediate goals of data analysis were to calibrate detectors used, determine their e ciency, and calculate neutron capture cross section of 134Xe.

This work is supported by NSF PHY-1614348 and DE-FG02-97ER41033.

Undergraduate

NEXT: THE FUTURE OF NEUTRON DETECTION

Primary Author: Cole Howell, Physics

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Joseph Owens; Joe Heideman, University of Tennessee Knoxville; David Loureiro, University of Tennessee Knoxville; Robert Grzywacz, University of Tennessee Knoxville

Advisor(s): Mustafa Rajabali

In recent years, neutron detection has become more important in studying nuclear structure and processes. In beta delayed neutron emission, neutron energies provide important information about the parent nucleus and the decay process. Neutron energies are calculated by measuring neutron time of flight (ToF) between two detectors. The energy resolution is therefore dependent upon the ToF resolution and the position resolution within the detector. The Neutron dEtector with Tracking (NEXT) is a segmented neutron detector based on pulse shape discriminating (PSD) plastic coupled to segmented photomultipliers. The NEXT design will improve energy resolution by increasing particle localization and ToF resolution. Current research focuses on determining PSD and timing capabilities of different detector designs. Results of timing and PSD dependence on scintillator type and geometry will be shown.

Funding Statement:
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Undergraduate

THE STRUCTURE OF 34Mg

Primary Author: Benjamin Luna, Physics

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Mustafa Rajabali

In the chart of nuclides, there exists an area near the N=20 shell closure where some isotopes' ground states

exhibit characteristics of deformed nuclei with an intruder configuration rather than being spherical. This area is known as an “island of inversion”, and the deformed ground states that characterize it are caused by particle hole excitations made possible by a greatly reduced shell gap. This project was part of the ongoing investigation into the island of inversion though gaining more knowledge on how nuclei in and around the island are shaped. The beta-decay of 34Mg into 34Al was observed and the data from this decay was used to make progress towards the creation of a decay level scheme for the excited states of 34Al. To collect the products of this decay, a beam of 34Mg was sent to plastic scintillators (SCEPTAR) and surrounded by high-purity germanium detectors (GRIFFIN) at TRIUMF in Vancouver, BC. The data from this decay was collected into ROOT files, energy calibrated, corrected for gain differences and shifts, and sorted into a coincidence list of transitions in preparation for a decay level scheme. These coincidences between gamma transitions are currently being sorted into angular correlation spectra primarily to make a determination of whether enough statistics were present to continue further analysis, which would involve the assigning of spins and parities to the energy states of 34Al.

Undergraduate

NEXT DETECTOR SIGNAL AMPLIFICATION

Primary Author: Joseph Owens, Electrical Engineering
Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Cole Howell; Joseph Heideman, University of Tennessee; David Loureiro, University of Tennessee; Robert Grzywacz, University of Tennessee, Oak Ridge National Laboratory

Advisor(s): Mustafa Rajabali

The Neutron dEtector with Tracking (NEXT) is an experimental detector designed to provide high neutron energy resolution with neutron-gamma discrimination filtering. The detector works with a Time of Flight (ToF) energy measurement system, and Pulse Shape Discrimination (PSD) algorithms to remove gamma ray data. To maintain affordability, modularity, and volume reduction, the detector uses Silicon Photo Multipliers (SiPM) as a light readout system. The signals produced by the SiPMs must be amplified and filtered, while maintaining accurate pulse shape for PSD, so acquisition equipment can accurately collect the details of the pulses. The amplification circuits used prior to this study worked to the desired specification. However, the goal of this study is to find possible modifications to the circuitry to achieve greater than desired performance from the detector. In this contribution, advances toward this goal will be presented.

Department of Sociology & Political Science

Undergraduate

HOMANS' EXCHANGE THEORY AND GANG VIOLENCE

Primary Author: Presley Alford, Sociology

Advisor(s): Shelley Brown

The present text examines the correlation between Homans' Exchange Theory and gang violence. The relationship between reward and behavioral modification is examined in the context of the violent counterculture that is gang activity. Gangs promote violence through a system of costs and rewards. Homans' Exchange Theory is comprised of five propositions that investigate how costs and rewards result in behavioral modifications.

Abstracts

College of Business

Department of Accounting

Graduate

EFFECTS OF THE AFFORDABLE CARE ACT AND MEDICAID EXPANSION ON HOSPITALS' UNCOMPENSATED CARE

Primary Author: Clayton Chapman, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Bethany Burgess

Advisor(s): Sid C. Bundy

The Affordable Care Act (ACA) of 2010 mandated health insurance coverage for all Americans and increased Medicaid funding for people who could not otherwise afford health care coverage. Because everyone would have access to health insurance, policy makers and economists predicted a decline of uncompensated hospital care. However, fourteen US states chose not to participate in Medicaid expansion of the ACA. Since then seventy-two hospitals in those fourteen states have closed versus twenty-nine hospitals in the other thirty-six states. Often, hospital closures negatively affect access to health care for the people who live in those communities. We analyze the effect of state-level decisions to accept or decline Medicaid expansion on not-for-profit hospitals' financial health and their ability to continue services. We analyze financial information from the Internal Revenue Service's Form 990 for ten not-for-profit hospitals in Kentucky, ten in Virginia, and ten in Tennessee. In addition, we explore data from the Tennessee Department of Health on ten Tennessee hospitals that have closed since the ACA was enacted in 2010. We examine the reported amount of uncompensated care as a percentage of total revenue. Exploring those ratios over time illustrates the effect implementation of the ACA had on uncompensated care in not-for-profit hospitals. Furthermore, comparing hospitals' ratios from states that accepted versus those that declined additional Medicaid funding demonstrates the effectiveness of Medicaid expansion on uncompensated care. Preliminary results from our research indicate that hospitals from states that did not participate in Medicaid expansion demonstrate significantly higher volumes of uncompensated care.

Graduate

IMPACT OF TARIFF ANNOUNCEMENTS ON STOCK RETURNS: EVIDENCE FROM CHINESE STEEL AND ALUMINUM

Primary Author: Bryce Hammer, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Cole Harris

Advisor(s): Sid C. Bundy

Recent political developments in the United States offer a unique opportunity to examine the role of news media on stock returns. We analyze the effects of news articles concerning imposed tariffs for imported steel and aluminum on China. Our primary sample set consist of a combined forty companies from the NYSE and NASDAQ. These organizations came from various industries exposed to Chinese aluminum and steel products in their supply chains. Following collection of the average market returns

before and after the events, we evaluate change in market value by using cumulative abnormal returns over varying windows of time. We utilize hypothesis testing to (1) understand if the imposed tariffs have any statistically significant effect on the company's market value, and (2) quantify the extent of impact on these companies. We find that these media announcements affect overall market value and increase trading volume.

Graduate

FACEBOOK AND MATCH GROUP – HOW DOES FACEBOOK'S CRISES AFFECT MATCH GROUP?

Primary Author: Shannon Kelley, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Logan Randolph

Advisor(s): Sid C. Bundy

Over a billion active members make Facebook the most well–known social media platform. As the goliath of social media, do niche social media companies emulate Facebook? The world's leading provider of online dating products, Match Group Inc's (Match) portfolio consists of over 45 brands each designed to increase their users' likelihood of finding a romantic connection. The objective of my research is to determine the extent of Facebook's effect on Match. As a third-party with whom Match does business, Facebook's privacy issues have both direct and indirect implications for Match. In June 2018, a Facebook bug changed privacy settings of up to 14 million users. In September 2018, hackers exploited the bugs to access around 50 million Facebook profiles. Then in December 2018, another Facebook privacy breach exposed private photos of up to 6.8 million users. My project analyzes Match's Balance Sheet, Income Statement and Statement of Cash Flows, including horizontal analysis of the company's quarterly and annual reports from 2016 to 2018. I evaluate the impact of these privacy related news stories on Match. I estimate cumulative abnormal returns (CAR) for the company around Facebook's announcements of data breaches. I also utilize the five–factor DuPont Analysis to reveal a deeper understanding of Match's return on equity. The occurrence of Facebook's privacy issues had an adverse effect on Match's financial condition and results of operations.

Graduate

JUST RESEARCH! AN EXAMINATION OF UNDERARMOUR

Primary Author: Levi Melton, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Karas Cowley

Advisor(s): Sid C. Bundy

Nearly 80% of Under armour's (UA) total sales occur in the US. However, sales in the US are declining. Overall revenue for UA is increasing, fueled by increases in overseas sales. On the other hand, UA markets to athletes around the globe – not just in the US. UA's ultimate goal is growing sales for the entire globe. Unlike UA, Nike is already well-balanced in oversea and in the US market. I examined their sales, inventory, revenue included in their balance sheet, statement of cash flows, and income statement. I utilized the following fundamental financial analysis tools to provide empirical evidence of a decline in UA's profitability and sales: ROE, ROA, inventory turnover ratio, profit margin, average days inventory outstanding. From the years 2015 to 2018 respectively ROE has dropped from Approximately 13.9 to a -2.3, ROA from 8.1 to -1.1, days inventory outstanding has jumped from 117.8 to 139.3, profit margin dropped from 5.87 to -0.89, Gross profit margin dropped from 4.81 to 4.51. This data suggests that UA needs to increase sales of their products, expand in their wholesale distribution, grow in direct to

consumer sales, and continue expansion in the international market.

Graduate

SURVIVAL OF THE FITTEST: FINANCIAL ANALYSIS OF BARNES & NOBLE'S SURVIVAL STRATEGY

Primary Author: Jacob H. Phillips, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Jacob S. Donegan

Advisor(s): Sid C. Bundy

Internet retailers changed the economics of modern retail by offering low prices and extreme variety. CNBC reported that more than 20 retail companies failed in 2017. A market research firm, CB Insights, identified 57 retail company failures since 2015, including retail giants Sears and Toys R Us. Traditional brick-and-mortar retail businesses struggle to keep up with Internet platforms like Amazon. Retailers seek new strategies to stay relevant while watching others lose the fight. In the shadow of Amazon, this project examines the struggle of two traditional bookstore chains: Barnes and Noble (B&N) and Borders.

How did B&N stay afloat when other retail booksellers fell? Are they destined for the same fate as other retailers in a world of online giants? Using fundamental financial statement analysis, we compare B&N, one of the last publicly traded retail booksellers, to the now-defunct Borders. We identify similarities and differences between B&N's financials and those of Borders before its closure. Specifically, we observe B&N outperforming Borders in the cash conversion cycle, days inventory turnover, and long-term debt over equity. We observed through comparison of the current and cash ratios that B&N trailing behind Borders in their ability to cover short term debts. We also examine Barnes and Noble Education, a spin-off of the parent company, and a potentially strategic misstep in spinning off a growing and profitable business segment. The pattern in the data suggests that uncertainty in B&N's going concern may soon become a topic of discussion.

Graduate

IS ALL PUBLICITY ACTUALLY GOOD PUBLICITY IN A VIRAL ERA?

Primary Author: Jackson Redditt, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Coleman Oyster

Advisor(s): Sid C. Bundy

In a time when a racist comment becomes viral in seconds, John Schnatter (founder and former CEO of Papa John's) created a crisis for his brand that changed the outlook of Papa John's forever. In 2017, Papa John's stock price decreased by roughly 34% as a direct result of two comments made by Schnatter: (1) a racist comment via a conference call with a marketing agency and (2) a comment during the company's earnings conference call blaming the NFL for decreased pizza sales on their handling of their players' National Anthem protests. John Schnatter's lack of discernment and rash speech demonstrates that one moment can erode the foundations of a nationwide brand in minutes. As Papa John's fights the backlash from their representative's comments, we need empirical evidence for the extent of the damage. Beyond spending $19.5 million on legal and professional fees, we attempt to quantify loss of company value based on investor reactions to three events to help quantify the extent of financial repercussions. We examined a five-day change in market capitalization when John Schnatter blamed poor sales on NFL, his stepdown as CEO, and his viral comment from 2017. Our research provides evidence

that a single lapse of judgement not only tarnished the reputations of executives but also damaged the overall market value of the company represented.

Graduate

CAN THE FITNESS INDUSTRY SUSTAIN HVLP? PUTTING PLANET FITNESS, TSI TO AN INVESTING LEGEND'S "DURABLE COMPETITIVE ADVANTAGE" TEST

Primary Author: Katie Slizewski, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Erika Dibrell

Advisor(s): Sid C. Bundy

A current boom in the fitness industry shows no signs of slowing down, with consistent growth in facilities, memberships, and revenues logged annually for the past several years. A segment of the industry known as the HVLP ("high value, low price") health club emerged during the boom and continues to contribute significantly to this growth. We apply Warren Buffett's method for analyzing financial statements to test the durable competitive advantage of two large competitors in the fitness industry that have implemented the HVLP model: Planet Fitness (PLNT) and Town Sports International Holdings (CLUB). PLNT's business model targets new and/or occasional club users. At $10 a month for a basic membership, PLNT reduced gym prices in order to compete with bigger gyms. Up until 2015, CLUB operated under a traditional business model that included higher membership fees. In 2015 CLUB converted most of its fitness center brands across the United States and Switzerland to the HVLP model. "Warren Buffett and the Interpretation of Financial Statements: The Search for the Company with a Durable Competitive Advantage" by Mary Buffett and David Clark outlines Warren Buffett's step-by-step technique for analyzing the income statement, balance sheet, and statement of cash flows to determine durability. His method evaluates the historical consistency in key ratios and trends as indicators of sustainable financial success. We analyzed PLNT and CLUB using these methods. The data suggest that neither PLNT nor CLUB pass Buffet's "Durable Competitive Advantage" test.

Graduate

DEATH OF THE DEPARTMENT STORE: CAN TRADITIONAL RETAILERS SURVIVE IN A CHANGING INDUSTRY?

Primary Author: Angie Sturdivant, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): McKenzie Hicks

Advisor(s): Sid C. Bundy

Department stores were once the easiest, most accessible way for consumers to purchase clothing and accessories. Each store carried several brands in varying sizes all under the same roof. However, customers now obtain even more shopping options without ever leaving their living rooms. They compare prices, read customer reviews, and ship products directly to their doorstep with the simple click of a button. Not many miss the presence of poorly-lit dressing rooms, holiday crowds, and overzealous salespeople in their shopping experience. As shopping habits continue to shift towards a more direct-to-consumer based process, can the traditional brick and mortar retailer stay afloat? I attempt to answer this question by analyzing and comparing horizontal sales trends from retailers with various consumer delivery methods. I examine the sales spread between lines of business, inventory turnover, asset turnover, and ROE from Nordstrom, Vince, Inc., and Stitch Fix. Nordstrom represents the traditional major department store retailer with both full-line store presence and e-commerce ventures. Vince, Inc. sells through a standalone web platform and wholesale within department

stores. Stitch Fix is a relatively new subscription-based retailer with an online-only shopping environment designed to cater to each individual customer's needs. This research explores modern purchasing platforms' impact on the traditional retail industry. My findings suggest that as full-line sales decline, retailers must adapt with customer habits and shift focus to e-commerce business.

Graduate

MONEY LENT, MONEY LOST: ACCOUNTS RECEIVABLE MANAGEMENT AND THE BOTTOM LINE

Primary Author: Logan Tackett, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Matthew Bouldin

Advisor(s): Sid C. Bundy

Have you ever lent money to someone, only to find them asking for more before they paid the prior amount? Most people decline a request for additional funds after instances of late or non-payment. However, some businesses allow this situation to occur due to mismanagement of accounts receivable. In some cases, management places too much emphasis on increasing sales volume. In others, management doesn't place enough emphasis on collections. Still others neglect the credit approval process. Regardless of the reason, inefficient accounts receivable management ties up working capital resources. How can we make the value of efficient AR management more salient to our students, accounting and collections staff members, sales team members, and client management?

We analyze the relation between AR efficiency and other financial measures of success by looking for patterns in accounts receivable turnover, days in inventory, accounts payable turnover, the cash conversion cycle, return on equity, return on assets, and profit margin for the 2013-2017 financial statements of six companies. We match these companies by industry and the magnitude of accounts receivable. We calculate the cost of each day of extended collection. We compare profitability indicators with indicators of AR efficiency to gain anecdotal evidence of the impact of AR. Our analysis provides insight about the effectiveness of AR management and the impact of this efficiency on profitability. We plan to use this visual evidence when discussing AR efficiency concepts with students, collection employees, sales staff, and clients.

Graduate

AN APPLE A DAY MAY NOT BE SO HEALTHY FOR ITS COMPETITORS – HOW DID APPLE'S ENTRANCE INTO THE WEARABLES MARKET AFFECT THE PREVIOUS INDUSTRY LEADER, FITBIT?

Primary Author: Christian Webster, Business Administration (M.B.A.)

Advisor(s): Sid C. Bundy

Investors projected great things for Fitbit's IPO in June 2015 given the company's competitive position and fast sales growth in a booming market. The company sold 4.4 million wearable devices in the second quarter of 2015 and stocks traded for over $51 per share. However, stock prices consistently fell to less than $6 per share after Apple Inc. released their wearable devices. The company's survival depends on sustaining market share in the wearable market in spite of Apple's loyal customer base, diversified products, and size.

My analysis includes an examination of their stock prices as well as financial statements. I calculate the change in overall firm value of Fitbit before and after Apple's release of their second Apple watches on September 16th, 2016. In addition, I track the quarterly change in key financial ratios, such as Profit Margin, Financial Leverage, Return on Assets, and Return on Equity, during the period of June

17th, 2015 to December 31st, 2018. I analyze investor's perception of Apple's entrance into the market on Fitbit's firm value by measuring the change in Fitbit Inc. and Apple Inc.'s total market capitalization at key dates. This research provides anecdotal evidence of what can happen to small tech companies when Apple decides to offer their product.

Graduate

R&D SPENDING IN THE NICHE PET MARKET AND HOW IT AFFECTS PROFIT SUSTAINABILITY

Primary Author: Jerri Woodard, Business Administration (M.B.A.)

Co-Author(s)/Collaborator(s): Gustavo Moreno

Advisor(s): Sid C. Bundy

With consumer spending in the pet industry reaching over $72 billion in 2018, opportunity for niche markets and services within the pet industry grows daily. A private animal genomics company (The Private Company) seeks strategies to hold its market share as competitors threaten to enter their niche market. Should they invest more resources toward innovation and/or expansion to discourage competitors from market entry? I compare the audited financial statements of The Private Company to the published annual reports of three publicly traded innovators in other niche markets within the pet industry: (1) Trupanion, provides pet insurance, (2) Heska, provides in-house veterinary diagnostic equipment, and (3) Phibro Animal Health Corporation, produces healthy and sustainable feed for farm animals including cattle and swine. I measure investment in innovation (research and development costs) and expansion (capital assets), financial leverage, and changes in profitability, liquidity, and net working capital. I explore the impact of the rate of investment in innovation and expansion on the sustainability of profit and market share. In addition, I compare the market caps of these public companies to find the potential market cap of The Private Company. The data suggests The Private Company's performance metrics closely follow metrics from other niche pet companies and therefore we expect The Company to see a growing ROI (net income/R&D investment), provided the R&D budget remain conservative in order to curtail potential decreased profit margins.

Undergraduate

CLOUD SERVICES – SILVER LINING

Primary Author: Brandon Cravens, Accounting

Co-Author(s)/Collaborator(s): Sundar Krishnamoorthy

Advisor(s): Sid C. Bundy

In today's environment of digital transformation, industries deal with large volumes of data and uncertainties in data requirements. Companies shift towards shared resources to reduce costs associated with exponential data growth and data volume volatility. Cloud technology services (CTS) offer digital infrastructure and software that multiple businesses share. Companies adopt a rental model for their data storage and processing needs rather than investing in capital infrastructure. CTS companies try to scale operations without accruing large debt. This research explores the relative operating expenses and capital expenditures in the business model of companies that use CTS.

Our research analyzes annual reports for 25 CTS consumers across five sectors. We collected data from the footnotes and management's comments within 10-Ks about operational expenses (opex) and capital expenditures (capex). Analysis of ratios in opex, capex and assets against revenues provides a comparative picture of growth in revenue to operational expenses and assets growth. What-if analysis illustrates potential additional income generated as a result of adopting CTS versus traditional infrastructure. Predictable expenses result from the rental model for data services, which leads to smoother earnings

and a lower variance in management's revenue projections. Our research indicates lower asset growth and higher opex growth for CTS companies.

Undergraduate

LEGALIZED MARIJUANA STOCKS, WHO'S POISED TO HASH IT OUT? A PROFITABILITY ANALYSIS OF NYSE & NASDAQ LISTED MARKET LEADERS

Primary Author: Nicole Patterson, Accounting

Co-Author(s)/Collaborator(s): Tom Stevens

Advisor(s): Sid C Bundy

Industry analysts expect spending on legal cannabis usage worldwide to reach $57 billion by 2027 and the North American market segment to climb from $9.2 billion in 2017 to $47.3 billion a decade later (Forbes 2018). Currently, NYSE & NASDAQ stock exchanges only trade eleven marijuana related companies. As cannabis usage increases in popularity, many investors seek to evaluate the merits of marijuana stocks. Our research analyzes 3-year trends of the ten publicly traded cannabis companies in the food, beverage and pharmaceutical industries by comparing the profit margins of each as well as their respective GIC sub-group averages. We specifically examine return on equity (ROE) and apply DuPont Analysis to disaggregate ROE into return on assets (ROA) and financial leverage (FL). An inspection of these elements yields a clear understanding of profit margin and asset turnover to further explain what makes a successful pot based business. Our preliminary results show Aphria, Inc., (APHA) as the leader in profitability when compared to its competitors. Aphria rises to the top as the only company that maintained a positive profit margin from 2016 to 2018 as well as a positive ROE. Aphria's profit margin increased significantly from 4.72% in 2016 to 20.54% in 2017 and then soared to 79.77% in 2018. Influenced more by profit margin than financial leverage, which remained fairly steady at 1.05 in 2016, 1.14 in 2017 and 1.13 in 2018, Aphria's ROE and ROA increased all three years.

Abstracts

College of Education

Department of Counseling & Psychology

Graduate

COLLEGE STUDENTS' CONTINGENT SELF-ESTEEM: THE EFFECTS OF MENTAL STRESS AND SUBSTANCE ABUSE ON UNDERGRADUATES IN TENNESSEE

Primary Author: Mason Doss, Clinical Mental Health

Advisor(s): Anthony Michael

The purpose of this study was to examine if there is a correlation between contingent self-esteem and whether there were effects on substance abuse. In addition, this research attempted to find whether or not mental stress in conjunction with contingent self-esteem has an influence on substance abuse. Methods: The research was conducted using Qualtrics, and there were 189 undergraduate participants. Results: The findings showed there was not a significant relationship between contingent self-esteem and mental stress on substance abuse. However, the results indicated that males abuse substances more often than females. Further discussions, limitations, and implications for counseling are provided.

Department of Curriculum & Instruction

Graduate

UNDERSTANDING LEARNING ENVIRONMENTS AT THE GRADUATE LEVEL: A QUALITATIVE ANALYSIS OF DOCTORAL ENGINEERING EDUCATION PROGRAMS WITHIN THE UNITED STATES

Primary Author: Bobby Adams, Engineering (Ph.D.)

Co-Author(s)/Collaborator(s): Pedro Arce

Advisor(s): Andrea Arce-Trigatti

The purpose of this contribution is to offer insight on the methods in which current, graduate, engineering education programs incorporate tenets of the four learning environments from the How People Learn framework into their programs of study (Bransford et al., 1999). For over a decade, professional and academic engineering organizations have declared the need for the integration of non-technical competencies (e.g., communication, collaboration, creative thinking, and lifelong learning) into the curriculum of all engineering programs (Grasso & Burkins, 2010; National Academy of Engineering [NAE], 2004). Efforts advancing this initiative to promote holistic-style engineering requires the training of future postsecondary educators that understand and apply the four learning environments (i.e., student-centered, knowledge-centered, assessment-centered, and community-centered), reflected in Bransford and colleague's (1999) How People Learn framework. In this qualitative study, an open coding strategy was applied to public data gathered from nine, select engineering education, graduate programs to

answer the following question: In what ways do current U.S., graduate engineering education programs incorporate elements of the four learning environments of the How People Learn framework into their programs of study? Based on the analysis presented, the strengths associated with each program - as related to the development of holistic engineers - can be identified. These findings provide implications for the design of graduate, engineering education programs as well as conclusions useful to prospective students interested in pursuing programs that align with their personal goals to become the next generation of holistic, engineering education leaders.

Graduate

BLENDING AS A TREATMENT FOR FEEDING DISORDERS: A REVIEW OF THE LITERATURE

Primary Author: Taneal Burch, Exceptional Learning (Ph.D.)

Co-Author(s)/Collaborator(s): Seth King

Advisor(s): Seth King

Due to the increase in feeding disorder diagnoses, there is a growing need for interventions specific to children who have a feeding disorder. Research indicates that up to 26% of children exhibit some form of a feeding disorder. Blending, sometimes called stimulus or texture fading, is frequently employed as a means of increasing the acceptance of novel foods among children with feeding disorders. Described as the combination of two or more food items in a way that prevents separation, blending is recommended when the child avoids novel textures or flavors. The present study reviewed research published from 1998 to 2018 that treated feeding disorders using blending in a single case design with children. In addition to study quality, methods, and effects, procedures used to progressively introduce novel textures were of particular interest. Identified studies (n = 9), though they provide insight into practical considerations, are not sufficiently rigorous to support the use of the procedure. Implications for practice follow a description of findings.

Graduate

MEDIATION AND MODERATION AMONG STUDENT VOICE, SCHOOL ENGAGEMENT, AND BEHAVIOR IN SCHOOLS

Primary Author: Krista Davis, Exceptional Learning (Ph.D.)

Advisor(s): George Chitiyo

School engagement research often overlooks student voice as a critical component (Yonezawa, Jones, & Joselowsky, 2009) and researchers commonly find that students feel like their voices do not matter (Levin, 2000; Mitra, 2004). It follows logically that this would impact how students feel and behave toward the educators and adults in the school. The present quantitative study tested this hypothesis by investigating underlying relationships among (1) how students perceive their voice is heard and valued at school, (2) how engaged they feel in their classes and school activities, and (3) how both of these constructs might impact behavior incidents throughout the school. Furthermore, the analysis examined if the relationship differed by grade tier (elementary, middle, and high). The dataset used for this study was a school level file (127 schools) with aggregated student responses to a school climate survey, specifically the categories called “Student Voice” and “School Engagement.” School behavior rate (percentage of students who were in-school-suspended, out-of-school-suspended, or expelled) was then mapped onto the survey data. Mediation analysis was applied using Baron and Kenny’s method (1986) through a series of regressions with the three variables—Student Voice (predictor), Student Engagement (mediator), and School Behavior Rate (outcome)—and indicated that a mediating effect occurred. Additionally, moderation analysis was

conducted with the fourth variable (Grade Tier) and found no interaction effects. These findings indicate that the relationship between Student Voice and School Behavior Rate is mediated by School Engagement, and that this relationship remains consistent across all grade tiers.

Graduate

THE EFFECTIVENESS OF ACTIVITY SCHEDULES IN TEACHING INDIVIDUALS WITH DISABILITIES TO ENGAGE IN LEISURE ACTIVITIES: A REVIEW OF LITERATURE

Primary Author: Chaidamoyo Dzenga, Applied Behavioral Analysis

Advisor(s): Seth King

Leisure activities are the voluntary use of free time outside of daily routines for purposes other than work. Leisure activities are essential for the successful inclusion of individuals with disabilities in their communities. Such activities provide an opportunity to gain positive self-consciousness, build relationships, and acquire new skills and knowledge. For leisure activities to be meaningful, they should be socially important, fulfilling, and age appropriate to the individual. Leisure activities for individuals with disabilities, however, are often selected by their caretakers. This study reviewed studies that used activity schedules—a nonintrusive antecedent behavioral intervention to help individuals with autism and intellectual disabilities independently complete leisure activities. Studies published from 1998 to 2018 (n = 9) were identified and evaluated using the standards of the What Works Clearinghouse. Findings of the studies indicated that using an activity schedule is an effective intervention in teaching individuals with disabilities to independently complete leisure activities. Implications on the use of activity schedules in teaching leisure activities are discussed.

Graduate

DEFYING GRAVITY: HOW MOTHERS NAVIGATE THE ACADEMIC JOURNEY

Primary Author: Nécole Elizer, Exceptional Learning (Ph.D.)

Advisor(s): Janet Isbell

This critical feminist study uses qualitative methods of inquiry to better understand how mothers navigate the academic journey while balancing child rearing, partnership, household, and doctoral coursework. The study focuses on how mothers experience the intersection of higher education institutions and family structures as well as, the ways in which they enact agency over their time, relationships and academic career. This study challenges patriarchal tones, power structures, and biases about gender roles that permeate the lives of women.

Graduate

RURAL HIGH SCHOOL TEACHERS' PERCEPTIONS OF TEACHING AND LEARNING WHEN USING AN INTEGRATED MATHEMATICS CURRICULUM

Primary Author: Meghan England, Exceptional Learning (Ph.D.)

Advisor(s): Holly Anthony

The primary goal of this interpretive study was to add more teachers' perspectives, specifically from rural high schools in Tennessee, to the sparse research focused on transitioning and teaching integrated high school mathematics. This study was prompted by a recent change in the teaching of mathematics from a traditional curriculum to an integrated curriculum in the middle Tennessee area. Previous research has focused on teacher perceptions, student perceptions, and student achievement

scores when using an integrated mathematics curriculum. Bowzer (2008) found several factors both negatively and positively affected the transition to integrated mathematics including testing pressures and limited preparation time. The research question in this study was: What were rural high school Tennessee mathematics teachers' perspectives regarding integrated mathematics and how it had impacted teaching and learning in their classroom? The researcher interviewed 3 teachers individually, conducted a focus group interview, and analyzed lesson plans they shared. Preliminary analysis shows a need for more professional development focused on specific teaching strategies for integrated mathematics as well as better aligned textbooks and resources to meet the needs of integrated mathematics teaching.

Reference:
Bowzer, A. D. (2008). Professional identity and curricular construction: A study of teacher interaction with mathematics curricula of two types. (Doctoral dissertation). Retrieved from http://hdl.handle.net/10355/5610

Graduate

SCHOLASTIC CHESS-BASED INSTRUCTION: STUDENT PERCEPTIONS OF THE COGNITIVE AND NON-COGNITIVE BENEFITS OF CHESS

Primary Author: Michael Littrell, Exceptional Learning (Ph.D.)

Advisor(s): George Chitiyo

This study is part of an evaluation of a Chess in Schools Initiative (CIS) which was a program implemented in 2017-2018 by a State Department of Education in the southeastern United States. The aim of the program was to introduce chess instruction in the classroom in order to impact the areas of curriculum standards, critical thinking, and 21st Century Skills. Teachers were trained in the use of chess in education, how to both play chess, and to use the game during lesson time in different subject areas. This presentation focuses on students' perceptions of the benefits of chess in several areas; cognitive, academic, and social. The data were obtained from a cross-sectional survey administered at the end of the academic year after a year-long exposure to chess. The findings showed that the majority of the 1,286 students who were surveyed across all grade levels felt they had experienced a variety of positive outcomes as a result of their exposure to chess-based instruction. Large percentages (Grades 1-4: 65.8%; Grades 5-12: 43.6%) of students had an increased enjoyment of math and felt an overall increase in their ability to work harder on their school assignments (Grades 1-4: 82.7%; Grades 5-12: 65.7%) after participating in chess-based instruction. Also, students (Grades 1-4: 80.6%; Grades 5-12: 65.7%) felt better able to work on difficult assignments. These perceived increases could prove beneficial in understanding chess-based learning as they provide insight beyond only measuring students on metrics such as test scores.

Graduate

ANALYZING OBSERVATIONAL STRATEGIES USING THE KIRKPATRICK MODEL: INSIGHT FROM A CURRICULAR REDESIGN EARMARKED TO PROMOTE STUDENT-CENTERED LEARNING IN POSTSECONDARY EDUCATION

Primary Author: Allen Mathende, Exceptional Learning (Ph.D.)

Co-Author(s)/Collaborator(s): Stephanie Jorgensen, J. Robby Sanders, Pedro E. Arce

Advisor(s): Andrea Arce-Trigatti

The purpose of this contribution is to provide insight into the role that observational strategies and models play in conducting program evaluations for student-centered STEM curricular redesigns at the postsecondary level. Since the start of the century, there has been a shift in STEM pedagogy that has emphasized a student-centered

rather than teacher-centered approach. STEM fields have embraced these changes in order to offer more holistic and experiential-based learning practices to undergraduate students (Carlisle & Weaver, 2018; Felder & Brent, 2015). Within this context, the Chemical Engineering department at a four-year, public, Southeastern University implemented a three-course curricular redesign to try to enhance student-centered practices anchored in the Renaissance Foundry pedagogical platform via immersion experiences (Arce et al., 2015). These immersion experiences included guest speakers, simulations, training sessions, among others (Jorgensen, Arce-Trigatti, Sanders, Arce, 2019). The Kirkpatrick model is used analyze various aspects of student-centered learning within these curricular enhancements on observational data that was collected throughout the course of one semester of this redesign. Two different approaches to conducting observations were taken: one unstructured but guided by literature, the other structured via five observational models from scholarship. Both approaches (structured and unstructured) and the observational models utilized provided vastly different elements within the data collection that were insightful for evaluation purposes. Analysis of these approaches, implications for the use of these observational techniques for student-centered learning practices, and a discussion of these processes are provided as part of this contribution.

Graduate

TENNESSEE HIGH SCHOOL TEACHERS' EXPERIENCES WITH STUDENTS WITH DISABILITIES IN THE INTEGRATED MATHEMATICS CURRICULUM

Primary Author: Miguel Perez, Exceptional Learning (Ph.D.)

Advisor(s): Holly Anthony

Since national standards for mathematics education are pushing the implementation of concept-based, integrated curricula without setting any guidelines or expectations for the special education (SPED) community, this study sought to understand high school teachers' experiences with students with learning disabilities after changing from a traditional mathematics curriculum to an integrated one. An interpretive approach was adopted in order to make sense of the data collected from three secondary school mathematics teachers through structured interviews, a focus group, and relevant documents (e.g. lesson plans) with the goal of understanding the educational reform from the teachers' perspectives with special emphasis on their beliefs about students with learning disabilities. Data analysis showed an overall agreement on the appropriateness of integrated mathematics (IM) curricula in special education classrooms since they seem to offer students more accessible, richer experiences which promote a feeling of ownership of the material.

Graduate

FLIPPED VERSUS FACE-TO-FACE CLASSROOMS AND SCIENCE ACHIEVEMENT IN MIDDLE SCHOOL

Primary Author: Erin Stratton, Curriculum & Instruction (M.A.)

Co-Author(s)/Collaborator(s): Allen Mathende

Advisor(s): George Chitiyo

The purposes of this study were to compare student achievement between seventh grade students receiving instruction in a face-to-face versus a flipped classroom as well as to gauge how those who were in the flipped classroom felt about their experiences. During spring 2018, three classes received face-to-face instruction (85 students: 54 boys and 31 girls) and three other classes received instruction in a flipped classroom (72 students: 32 boys and 40 girls). The study design was the matching-only pretest-posttest control group design. In addition to pre and post assessments, students who experienced the flipped classroom completed a survey at the end to provide perceptions of their experiences with the flipped model.

A three-way analysis of variance (ANOVA) showed that the main effect of method was not significant F(1,124) =.000, p > .05. While slight differences were observed, with females faring slightly better than males in the flipped classroom, there was no statistically significant interaction between the two gender and method F(1,124) = 1.443, p > .05. The interaction between method and student aptitude (low, middle, and high) was also not significant F(1,124) = 2.589, p > 085. Overall, student feedback on the survey administered to students who experienced the flipped classroom was found to be very positive. The vast majority of students preferred flipped instruction to face-to-face instruction.

Undergraduate

SOCIAL JUSTICE IN CONTEMPORARY YOUNG ADULT LITERATURE

Primary Author: Haley Vandergriff, Secondary Education

Advisor(s): Julie Stepp

In order to approach the difficult topic of social justice within young adult literature (YAL), especially concerning those who have been neglected in the literature, we read and analyzed nine young adult novels published within the past three years. We used a new perspective defined by Linda Ragsdale as a path to peace, created to set peace as the default response to any life challenge (personal communication). Through thematic analysis, we explored patterned responses through view: how protagonists view themselves and others view them; voice: how the protagonists learn to use their voice to change insights of themselves or perspectives of others; and choice: how protagonists choose their current/future path or react to the choices others have made that affect their lives. Following the expectation of many young adult social (aka problem) novels, the stories explored personal situations. However, these contemporary novels better represented a greater number of critical social justice issues for populations who have been previously stereotyped or overlooked. Through our reading, many novels included high support systems from family, another change in the field of YAL. The benefits of novels such as these include readers seeing themselves in novels, helping other readers to overcome their biases, and better representation of previously disregarded populations.

Undergraduate

WILLIAM BLAKE'S "THE SCHOOL BOY": BRITISH ROMANTIC VIEWS ON CHILDHOOD AND EDUCATION

Primary Author: Hannah Webster, English

Co-Author(s)/Collaborator(s): Jackson Williams

Advisor(s): James Akenson

William Blake, both an author and an illustrator, lived from 1757-1827. He created "illuminated books" -- hand printed works combining image and text. Dover published two volumes of Blake's poems, entitled Songs of Innocence (1789) and Songs of Experience (1794); Blake's poem, "The School Boy" is in both. This presents a conundrum, as the volumes are polar opposites of one another. Blake's reasoning for moving "The School Boy" to his later work, Songs of Experience when he finally published the combined version of Songs of Innocence and of Experience lies at the heart of his developing philosophy. By analyzing the verbal elements of the poem, and the illustration that accompanies it, "The School Boy" may seem to fit in both volumes in that the illustrations, colors, and overall tone of the poem are light but the message of the poem covers darker subject matter, such as a child's loss of innocence and the flaws of children's schools in 18th century England. Blake did not have much of a formal education, but if he had problems with the authoritarian education of his day, we can imagine he would have trouble with our own formal system of education – and that is why the poem is finally assigned to the very dark volume of Experience. Blake and other Romantics believed children should have

a childhood. It is easy to see why the British Romanticism movement valued childhood so much, as the environment for children in 18th century England was toxic.

Undergraduate

EFFECTS OF STEM GUEST SPEAKER SESSIONS ON STUDENT INTEREST IN STEM

Primary Author: Kaley White, Computer Science

Advisor(s): Jennifer Meadows

This is a case study in a rural Southeastern school district of the effectiveness of STEM guest speaker sessions at increasing pre-K–12 student interest in STEM and STEM careers, which traditional STEM education fails to adequately do. I attempt to determine whether STEM guest speaker sessions improve student attitudes; whether they empower teachers and speakers; and whether the results depend on teacher, speaker, or student/school demographics. Voluntary response samples of public school teachers and area STEM professionals (employees and university students) filled out pre-session and post-session surveys. Pre-session surveys consisted of demographic questions as well as Likert questions about students' attitudes toward STEM and the participant's attitude toward his or her role in STEM education. After a session, teacher and speaker answered the same attitude questions as well as some Likert questions about how the speaking session went. I find statistically significant ($\alpha = 0.05$) changes in several mean ratings for the Likert attitude questions, suggesting that speaking sessions are effective at improving student attitudes and that they do empower teachers in STEM education. Responses to the pre-session speaker survey suggest little room for speaker attitude improvement. However, a small sample size and homogeneity of the teacher sample prevents analysis based on demographics. Likewise, results cannot be safely generalized beyond grades 2–4 at high-poverty rural schools with few STEM opportunities. The promising results suggest similar studies with different demographics or more diverse samples.

Keywords: STEM education, guest speakers

Department of Exercise Science, Physical Education & Wellness

Undergraduate

CORRELATION BETWEEN RESTING HEART RATE AND BODY FAT PERCENTAGE

Primary Author: Andrew Bumpas, Exercise Science, Physical Education and Wellness

Co-Author(s)/Collaborator(s): Emma Claire Garrard, Karley Clabo

Advisor(s): Michael Phillips

According to the World Heart Federation (2017), there are 400 million adults, worldwide, who are considered obese and 17.6 million children who are overweight. Obesity has become a pandemic. With obesity being a key risk factor for cardiovascular disease, finding a correlation with another variable, such as resting heart rate, could help identify cardiovascular disease (CVD) early on so that preventative measures can be taken. Therefore, the purpose of the study was to determine if there was a relationship between an individual's resting heart rate (RHR) and body fat percentage. The researchers tested 27 (N = 27) college-aged individuals consisting of athletes (N = 6) and non-athletes (N = 15). Blood pressure was measured using an aneroid blood pressure cuff monitor. Body fat was calculated using a bioelectrical impedance (BIA) monitor. The results of our research revealed a weak, positive relationship between body fat percentage and resting heart rate (r = .36).

Undergraduate

THE EFFECT OF STATIC VS. DYNAMIC WARM-UP ON FLEXIBILITY

Primary Author: Carly Payne, Exercise Science, Physical Education and Wellness

Co-Author(s)/Collaborator(s): Kayla Langford, Kylee Parrott

Advisor(s): Michael Phillips

The purpose of the study was to determine if there was a significant difference between the effect of static warm-up versus dynamic warm-up on an individual's flexibility. Flexibility can be beneficial to one's health in many ways like reducing daily pain and discomfort and increasing vascular health. This study will help trainers and those who exercise, both athletes and non athletes, to understand which is the best warm-up to complete in order to achieve optimal results for flexibility. The participants in the study consisted of thirty traditional college-aged students. There were fifteen males and fifteen females, eight of which were athletes. The students performed three static stretches on the first day then measured their flexibility using the sit-and-reach test. The second day followed the same routine but instead with dynamic stretches. Overall, the results of the study showed that dynamic warm-up produced slightly greater results. However, after performing a statistical analysis, there was no significant difference between the two group means. Therefore, this study shows that both static and dynamic stretches are effective at improving flexibility for athletes and non athletes.

Abstracts

College of Engineering

Department of Chemical Engineering

Graduate

MATHEMATICS-ASSISTED MEDICINE (MAM) VIA INTEGRAL-SPECTRAL METHODS: APPLICATION TO CANCEROUS TUMOR UNDERGOING HYPERTHERMIA TREATMENT

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

Co-Author(s)/Collaborator(s): Yung-Way Liu, J. Robby Sanders

Advisor(s): Pedro Arce

Hyperthermia treatment is a non-invasive procedure that uses high-temperatures (41-45°C) in order to damage/kill cancer cells. This work presents a model that describes the temperature profile in a cancerous tumor undergoing hyperthermia treatment and analyzes the different heat transfer mechanisms present in the system. The transient model has complexities due to the combination of linear and non-linear aspects. The linear aspects result from the less complex terms found in thermal energy conservation such as conduction and accumulation, but the more complex terms result from the heat source term due to the applied hyperthermia treatment. Due to the presence of linear and non-linear terms, an approach with higher mathematical sophistication is required; and thus, Integral-Spectral Methods (ISM) is introduced. ISM is unique in that it uses a Green's function approach to decouple the linear and nonlinear aspects of the model and the solution is obtained through the use of integral equations and associated eigenvalue problems. This approach also allows for a certain "flexibility" through which the generation function can be manipulated without altering the Green's function, thus allowing for multiple scenarios to be modeled efficiently. Once the temperature profile for the system is obtained, this information is used to calculate the "Arrhenius Thermal Damage" which is a result that uses transient temperature history to provide the total estimated injury to the tissue exposed to the high temperatures of the treatment. These results be communicated to medical physicians in order to provide a more effective treatment to patients undergoing hyperthermia treatment.

Graduate

ASSESSING THE EFFECTIVENESS OF DRUG DELIVERY TO STAGE III PANCREATIC CANCER DOMAIN

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

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

Advisor(s): Pedro Arce

Currently, pancreatic cancer is the third most prevalent malignancy of the gastrointestinal (GI) tract. The only true "cure" is surgical resection at the early stages. For patients that cannot undergo surgery, or their surgery was not successful in achieving negative tumor margins, the main option for treatment is traditional chemotherapy and occasionally radiation. This research is aimed at understanding and quantifying the effectiveness of the delivery of current chemotherapeutics in use. This

work proposes to bring together two fields that have previously not been linked, heterogeneous catalysis and pharmacology. The effectiveness of catalytic materials is evaluated in industrial applications using what is known as the “catalytic effectiveness factor”. This effectiveness factor is the ratio of the reaction rate influenced by diffusion to the rate which is diffusion-free. As drugs in cancer treatment ultimately work by a reaction and (most likely) their transport will be opposed by diffusion, the situation parallels traditional catalysis well.

Therefore, this presentation will revolve around the derivation of an effectiveness factor for drug delivery to a specific solid tumor domain. The domain chosen for this analysis is that of a small cylindrical portion (1-10 mm) of tumor tissue leftover post-operatively that is wrapped around a cylindrical artery with a radius of 2-4 mm. This type of domain is characteristic of some cases of stage III pancreatic cancer. The goal of this work is that by utilizing a mathematically assisted medicine technique, a patient specific treatment protocol could be developed or, current treatments improved.

Graduate

MOLECULAR TRANSITIONS OF POLYMERS AT CRYOGENIC TEMPERATURES: A LITERATURE REVIEW

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

Advisor(s): Holly Stretz

Polymer materials are used in a wide array of applications. Due to their versatility, we are constantly synthesizing new polymer materials to optimize their role in the specific applications. The applications focused on in this review all deal with cryogenic temperatures, and more specifically extreme cryogenic temperatures approaching 0 K. With new materials, comes new testing to fully understand the properties of the materials in question. This can be difficult for materials with molecular transitions. Transition here is referring to a thermally-induced rearrangement of the material structure at the molecular or nanometer scale. These rearrangements, if they exist, can lead to changes in properties which would be difficult to predict. The goal of this review is to summarize the different transitions that have been shown or predicted in literature for different polymer materials at these low temperatures.

Graduate

RHEOLOGICAL PROPERTIES OF BLOOD FLOW IN ARTERIAL STENOSIS

Primary Author: Kurt Dunham, Engineering (Ph.D.) (Chemical Engineering)

Advisor(s): Pedro Arce

One of the leading causes of death worldwide is heart disease. Heart disease is a collective term used to describe several conditions, many of which are related to the buildup of plaque in the walls of blood vessels. Blood is a bodily fluid that circulates to locations near all of the cells that make up the organs and tissues of the human body where oxygen and nutrients exchange with cellular waste products. Plaque is made up of mostly fat, cholesterol, and other substances found in the blood. An arterial stenosis occurs when the buildup of plaque narrows the lumen of the artery, making it more difficult for blood to flow.
In order to better understand the blood flow in an arterial stenosis, it is important to investigate the rheological properties of blood. Blood is often classified as a non-Newtonian fluid due to the behavior of red blood cells and the nonlinear relationship observed between blood viscosity and shear rate. The rheological characteristics of blood, such as shear thinning, yield stress, and viscoelasticity, are described using one of several mathematical expressions. These rheological equations

are applied to the conservation of linear momentum for a cylindrical tube system, resembling an artery, with and without stenosis formation. Velocity profiles for blood flow are developed for the Newtonian, Power law, and Casson fluid models. These velocity profiles are compared numerically using blood viscosity parameters found in the literature to determine the impact of the stenosis formation on blood flow.

Graduate

ROLE OF PRE-ELECTROPHORESIS IN TAILORING HYDROGEL STRUCTURE FOR HEALTH CARE APPLICATIONS-RESULTS AND FURTHER RESEARCH

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

Co-Author(s)/Collaborator(s): J. Robby Sanders

Advisor(s): Pedro Arce

Hydrogels are three-dimensional, hydrophilic, polymeric networks, with a substantial amount of water. Their biocompatible properties make them suitable materials for various biomedical-based technologies, including tissue engineering, pharmaceutical compounds, bio-separation, wound healing and clinical diagnostics. In tissue engineering, for example, they can mimic the extracellular matrix (ECM) environment due to their flexible structure that is very similar to a natural tissue. The large amounts of water retained in their polymeric structure makes them attractive for providing suitable environments in wound dressings and healing applications. Recently, smart hydrogels have gained relevance for cancer therapy and drug delivery processes, as these hydrogels exhibit changes in response to their environmental stimuli such as pH, light, temperature, or ionic strength. In clinical diagnostics, controlling porosity of hydrogels is a key factor in enhancing bio-separation and selectivity of macromolecules. Researchers have developed different techniques for modifying the porosity of hydrogels to improve separation including but not limited to using templating agents and introducing nanoparticles as “fillers”. Transport of molecules through the separation media (i.e., the hydrogel) depends mainly on the hydrogel internal porous structure coupled with “external factors” such as electrolyte strength and applied electrical field strength. Therefore, the main objective of this project is to assess the role of applied electrical fields, i.e. “pre-electrophoresis”, in modifying the structure of polyacrylamide hydrogels to improve protein separation by electrophoresis. Further research to foster additional understanding of the key factors will also be outlined.

Graduate

ROLE OF NANOPARTICLES IN NANOCOMPOSITE HYDROGELS TO IMPROVE PROTEIN SEPARATION

Primary Author: Mackenzie Hodge, Engineering (Ph.D.)

Advisor(s): Pedro Arce

Hydrogels are composed of an entangled polymeric network swollen with water to produce a three-dimensional matrix. Hydrogels are a highly versatile material due to their unique properties such as high-water content, softness, flexibility and bio-compatibility. This versatility makes hydrogels very attractive for research in areas such as tissue engineering, clinical diagnostics, bio-separations, and drug delivery. However, hydrogels exhibit weak mechanical strength and, therefore, improvement in the durability of the gel is of high interest. Furthermore, the understanding of the role of internal structure (of the hydrogel) in electrophoresis of, for example, proteins and how to tailor such structure to enhance the separation of macromolecules is highly desirable. To aid with this goal, the role of embedded particles on the structure of hydrogels and how these particles might affect hydrogel strength and the electrophoretic separation of protein standards is proposed as key objectives. In addition, the

change in rheological characteristics of the gel will be studied by using oscillatory deformation tests. Through the research, the investigators will quantify changes in protein separation and changes in the hydrogel rheology based on the size, shape, concentration, and other characteristics of the embedded particles. A complementary objective is to outline further research goals related to these changes.

Graduate

ADVANCED OXIDATION APPLIED TO WATER CONTAMINANT DEGRADATION AND ENERGY RECOVERY

Primary Author: Sabrina Hurlock, Environmental Sciences Integrated Research (Ph.D.)

Co-Author(s)/Collaborator(s): Sunil Rawal, Helen Okoye, Pedro Arce

Advisor(s): Pedro Arce

With the continued increase of human and industrial waste in our society, the treatment of wastewater is becoming a challenging task as the demand for more effective treatment methods and efficient technologies for water recycling is higher than ever before. The number and flexibility of current water treatment practices have been found to be not sufficient against a growing number of contaminants of concern, including pharmaceuticals and other industrial chemicals. Coupled with the need for cleaner water, the need for affordable, clean, and easily-produced energy is an ever-growing cause for concern. As a result of these health and environmental interests, the need for technology to not only rid water of contaminants, but to produce is energy is evolving. In this work, we investigate a method for using photocatalysis to recover hydrogen gas (H2) as an energy source from the treatment of wastewater via the use of titanium dioxide (TiO2) thin films. Some preliminary results will be presented and an outline for a mathematical-computational model for reactor-cell scale up will be outlined in this contribution. Finally, further research efforts will also be aligned.

Graduate

WARM MIX ASPHALT

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

Advisor(s): Liqun Zhang

Asphalt is a complicated mixture of millions of compounds. It is originally from crude oil distillation and is widely applied on road pavement and roof patching. One of the new developments in the asphalt technology is Warm Mix Asphalt (WMA), an environmentally benign and energy efficient technology compared with the state of practice of Hot Mix Asphalt (HMA). In WMA process, water was spread to improve the efficiency of mixing between asphalt and aggregate, and the effect is affected by the dynamics and properties of water/air-asphalt interface. Thus, in this project, we investigated the relationships among the chemical composition of asphalt and major physical properties of the interface between asphalt and air/water at different temperatures. The result will help to improve the warm-mix asphalt technology in the long term.

Graduate

STRUCTURAL AND THERMO-MECHANICAL PROPERTIES OF POLYMER NANOCOMPOSITES

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

Advisor(s): Venkat Padmanabhan

The enhancement of structural and thermo-mechanical properties of polymer nanocomposites(PNCs) that has been

observed is not only due to the addition of nanoparticles but also due to the role of the interface between polymer chains and nanoparticles. The thermo-mechanical and flow properties are investigated as a function of type, shape, non-uniformity, and size distribution of nanoparticles and compared with the pure polymer melt. Firstly, the diffusivity of PGNPs in the homopolymer matrix is investigated as a function of graft length and grafting density, and it is compared to that of bare nanoparticles with comparable effective size. Our results indicate that, in addition to the increase in the effective size of PGNPs due to grafting, the interpenetration of matrix polymers into the grafted layer also plays an important role in the mobility of PGNPs. In systems consisting of both PGNPs and bare particles, the spatial arrangement of the bare particles was found to be having a significant influence on the mobility of PGNPs. At low graft length and high grafting density, the matrix chains dewets the grafted layer, due to autophobic dewetting, creating a sharper interface between the matrix and the grafted layer. The bare particles then migrate to the interface creating a barrier around the PGNPs that hinders the matrix-graft interpenetration and results in the higher mobility of PGNPs. Our results emphasize the importance of the polymer-particle interface on the dynamic properties of polymer nanocomposites. Currently, we are investigating the nanoparticle size-distribution and interactions on the viscoelastic properties of PNCs

Graduate

COMPUTATIONAL PRINTING OF CEMENT-BASED PASTES IN 2D AND 3D GEOMETRY – A FLUID DYNAMICS STUDY

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

Advisor(s): Joseph Biernacki

Additive manufacturing (AM or 3D printing) offers the cement-based construction industry new opportunities to reduce labor costs and waste, and to increase the reliability of concrete infrastructure. The 3D printing of cement-based materials involves extrusion of cementitious mixtures through a nozzle to layer-by-layer build structural components. Designing cement pastes for 3D printing is related to the rheological (flow) characteristics of the material, e.g. yield stress, plastic viscosity and thixotropy, and design strategies and data correlating rheological properties to printability are among the existing research gaps. In an effort to close these gaps, fluid dynamic (CFD) simulations using COMSOL Multiphysics are being developed for computational printing of fresh cement paste in 2D and 3D geometries. A mini conical slum flow test was used to experimentally establish the fluid properties and to calibrate rheological models prior to conducting computational experiments. Deformations and rates of deformation for the free-surface flow of spherical, cylindrical, and rectangular gobs of material were simulated in 3D and 2D geometries respectively. The relative importance of yield stress, plastic viscosity and structuration rates were quantified. The model was then used at scale to simulate rheological “printability” of benchmark geometries, which were also printed. The objective of this study was to link relevant experimentally determined rheological measures of printing pastes to computer generated 3D printed constructs in an effort to correlate properties to printability metrics and to target optimal paste design parameters.

Graduate

ADVANCING 3D PRINTING CONSTRUCTION THROUGH THE DEVELOPMENT OF NEW CEMENT-BASED MATERIALS

Primary Author: Babajide Onanuga, Engineering (Ph.D.)

Advisor(s): Joseph Biernacki

Concrete is the most widely used material on earth, second only to water. Due to its high consumption, over 10 billion metric tonnes of concrete is produced annually to provide roadways, housing, foundations, dams, hospitals, schools, power plants and so on. Concrete is made up of water, aggregates and cement. Since portland cement is the strength bearing component of concrete, its annual global production is likewise very high. This high production of cement leads to the generation of huge amounts of CO2 with potential danger to the environment. In addition, current construction practices generate large amounts of concrete waste. Embracing 3D printing in construction promises reduced construction waste, thus reducing the demand for portland cement and benefiting the earth and its inhabitants.

Researchers around the world are currently pushing to demonstrate the printability of large-scale structural components. To ensure sustained gains from 3D printing in construction, issues regarding printability and structural integrity of printed infrastructure materials must be addressed. This research seeks to develop well-formulated additive systems aimed at enhancing cement-based pastes for effective printing. Various combinations of polymers including specialty polymers, viscosity modifying admixtures, superplasticizers and mineral-based additives were explored as printing aids. Various time-domain rheology experiments were performed to explore the flow properties, i.e. the yield stress and plastic viscosity, of select pastes were measured using oscillatory and flow rheometry. Pastes were also printed in different geometries to explore the effect of process operating variables including extrusion speed, layer thickness and print rate.

Graduate

MOLECULAR DYNAMICS SIMULATION ON HUMAN BETA DEFENSIN TYPE 3 BINDING WITH CXCR4 RECEPTOR

Primary Author: Jackson Penfield, Chemical Engineering (M.S.)

Advisor(s): Liqun Zhang

The protein human beta-defensin type 3 (hBD-3) is a component of the human innate immune system, mainly secreted from human epithelial tissues and mucosa. It is known to have multiple roles, including bactericide, binding with chemokine receptors (including CXCR4), and is notably involved in the inhibition of HIV-1 replication. Six cysteine residues on hBD-3 are capable of forming three pairs of disulfide bonds. Those bonds break in a specific order under reducing conditions, which can modify the chemotactic activities of hBD-3. The molecular detail of hBD-3's diverse chemotactic function is not yet known. All-atom molecular dynamics simulations using NAMD software were performed on hBD-3 analogs, which have different disulfide bonding states interacting with the CXCR4 receptor embedded inside lipid bilayers. The binding structure and dynamics of hBD-3 with the CXCR4 receptor will be studied, and the result may aid in understanding the relationship between hBD-3's structure and its diverse chemotactic functions.

Graduate

ADVANCED OXIDATION OF BIOPHARMACEUTICALS FOR WASTEWATER TREATMENT: TESTING ACETAMINOPHEN DEGRADATION BY PHOTOCATALYTIC METHODS – PRELIMINARY RESULTS

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

Co-Author(s)/Collaborator(s): Sabrina Hurlock

Advisor(s): Pedro Arce

Traditional waste water treatment plants have not been

designed to handle degradation of pharmaceutical-based contaminants and cannot completely eliminate drugs residues; therefore, their metabolites can be seen in ground water, surface water and even in drinking water in low concentration. These residues must be eliminated by, for example, an advanced oxidation process to avoid the contamination of the land and aquifers. The research described here is focused on the use of advanced oxidation techniques, especially the use of photo-catalytic degradation processes via TiO2 nanoparticles-assisted by UV radiation-to degrade a pharmaceutical compound (Acetaminophen), in city water treatment plants similar to the Cookeville Water Treatment Plant. The reactor equipped with UV-lamp and the TiO2 nanoparticles has been applied to the degradation of the model contaminant with different concentrations of catalyst and Acetaminophen concentrations. Favorable conditions for contaminant degradation (~34%) were identified at low concentration of contaminants with low concentration of titanium dioxide at 90 minutes of treatment. In addition, a successful comparison was conducted to test the degradation of Acetaminophen with different advanced oxidation process e.g. UV(alone), UV/H2O2, UV/H2O2/TiO2 and H2O2 alone. The contribution will illustrate details of the treatment technique and will discuss the results obtained. Suggestions for further research will also be included.

Graduate

MOLECULAR DYNAMICS SIMULATIONS ON BIOMASS-MODIFIED MODEL ASPHALT

Primary Author: Kolawole Sonibare, Chemical Engineering (M.S.)

Co-Author(s)/Collaborator(s): Loukas Petridis, Center for Molecular Biophysics, Oak Ridge National Laboratory

Advisor(s): 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 conditions.

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 chemical composition, microstructure, and major physical properties of lignin-modified asphalt is important. In this project, molecular dynamics simulations on the lignin and model asphalt mixtures was carried out. The asphalt model consists of three components: the asphaltene, aromatic, and saturate. The lignin model consists of long-chain guaiacyl and syringyl units. Major physical properties such as density, viscosity, thermal conductivity, expansion coefficient, and microstructure such as the radial distribution function was 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

A MOLECULAR STUDY OF GEL-FORMING POLYMERS FOR 3D PRINTING OF CEMENT PASTES

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

Co-Author(s)/Collaborator(s): Joseph Biernaci, Venkat Padmanabahan

Advisor(s): Joseph Biernacki

3D printing (also called Additive Manufacturing) is widely used in food preparation, healthcare, and polymer and metal component manufacturing. More recently, 3D printing has been introduced to the construction industry. 3D printing is expected to enable construction of cementitious structures without need for formwork and with freedom of shape and design. To make the cement paste printable, however, additives, possibly including polymeric hydrogels, are needed to produce printable cement-based pastes. Unfortunately, not all gel-forming polymers appear to provide the properties necessary for printing. What molecular features are critical? What forms of water-polymer-particle interactions are desirable? These questions and others are being addressed using a combination of molecular simulations, thermo-porosimetry, and rheological metrics and printing outcomes. It appears that even small changes in molecular structure affect extrudability and thus printability of the cement paste.

Graduate

CHARACTERIZATION TECHNIQUES FOR CONTAMINATED SITES IN ENVIRONMENTAL FORENSICS

Primary Author: Dipendra Wagle, Engineering (Ph.D.) (Chemical Engineering)

Advisor(s): J. Robby Sanders

Environmental forensics combines scientific disciplines and historical research methods to reconstruct past contaminating events, For example, when and how contamination at various locations occurred. Site investigation, characterization of the contaminants, and monitoring of the cleanup progress are the key topics while dealing with environmental issues. Many techniques has been mentioned in the literature to accomplish these purposes. Conducting a cost effective and innovative practices for site investigation and cleanup, needs systematic project planning, dynamic work strategies and the real-time measurement techniques. A successful site characterization projects rely on environmental data that accurately represent actual site conditions. Field based methods are the useful tools that assists in making a timely decisions rather than waiting for laboratory results. Chlorinated solvents are one of the widespread volatile organic compounds detected in soil and groundwater. Given their frequency of detection in environmental investigations, techniques to age date and identify the origin of chlorinated solvent releases are of great interest in environmental forensic investigations.

Graduate

USE OF DESALINATION BRINE FOR LOW-ENERGY CONCENTRATION OF ORANGE JUICE VIA FORWARD OSMOSIS

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

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

Advisor(s): Laura Arias Chavez

Membrane technologies have the potential to enhance sustainability at the food-energy-water nexus by reclaiming energy from ‘waste’ streams. Forward osmosis (FO) is a selective membrane process that could facilitate such reclamation. FO is driven by an osmotic pressure gradient between a highly concentrated draw solution and more dilute feed solution, and is energy efficient until draw solution regeneration is considered. To avoid regeneration, concentrated waste streams can act as single-use draw solutions in certain applications. We investigated a possible implementation of this strategy: concentrating liquid commodities using seawater desalination brine as a draw solution. Orange juice was selected as a model commodity due to the proximity of citrus production to seawater desalination in Florida. Juice concentration was conducted in a bench-scale FO system using commercial

membranes and NaCl draw solutions simulating seawater desalination brine. Juice recovery reached 55% with water flux maintained at 5 to 8 L m-2 h-1. Fouling was reversible, with up to 98% of initial water flux regained after physical cleaning. From these data, we predict that modest fluxes can be maintained up to 80% recovery, with desalination brine as the only significant source of energy. Juice concentrates met quality standards for recoveries of up to 32%. At higher recoveries, sugar levels declined, likely due to fermentation during long experiment times. Transport of draw solutes and juice components through the membrane increased over time, perhaps due to stretching of the unsupported membranes. Despite bench-scale limitations, this study shows the potential for 'waste' streams to power relevant separations.

Graduate

TRANSLOCATION FREE ENERGY CALCULATION ON HBD-3 THROUGH DIFFERENT TYPES OF LIPID BILAYERS

Primary Author: Rabeta Yeasmin, Engineering (Ph.D.) (Chemical Engineering)

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

Advisor(s): Liqun Zhang

Human β Defensin type 3 (hBD-3) is a small cationic antimicrobial peptide (AMP). It shows antimicrobial activity against both Gram-positive and Gram-negative bacteria, by disrupting their membrane in a salt-insensitive manner. In an era of antibiotic resistance, this AMP can be a good candidate for therapeutic agent. Therefore, it is very important to know the interaction of hBD-3 with biological membranes to understand its membrane disruption mechanism.

The potential mean force (PMF) on hBD-3 had been calculated during the translocation process through pure POPS (resembles bacterial membrane) lipid bilayer, pure POPC (resembles human red blood cell membrane) lipid bilayer, and combined POPS and POPC lipid bilayer at different oligomerization states of hBD-3 (monomer, dimer, and tetramer); to understand the antimicrobial mechanism of hBD-3. We performed Umbrella Sampling simulations in combination with coarse-grained method to calculate the potential of mean force (PMF) at the physiological condition- temperature 310.15 K and pressure 1 atm. The PMF results revealed that hBD-3 had to overcome a higher energy barrier through neutrally charged POPC lipid bilayer compared to the POPS lipid bilayer in high oligomerization state. In addition, as the oligomerization order increased, the insertion of hBD-3 became more energetically favourable through POPS lipid bilayer, while the PMF decreases inside the POPC lipid bilayer with increase in the hBD-3/lipid ratio. hBD-3 caused membrane thinning in both POPS and POPC lipid bilayer around hBD-3.

Undergraduate

REFINING THE POROSITY OF THE ANODE CATALYST LAYER TO INCREASE THE PERFORMANCE OF A DIRECT FORMIC ACID FUEL CELL

Primary Author: Cody Bowerman, Chemical Engineering

Advisor(s): Cynthia Rice

Batteries have become a vital necessity in an age of portable electronic devices. Direct formic acid fuel cells provide an alternative replacement to traditional batteries which have the capacity to power portable electronic devices for longer periods of time while also taking up less space inside the device as opposed to standard batteries. However, direct acid fuel cells have some short comings such as their power density and durability performance need to be addressed to enable further advances in portable electronic devices. Two-phase flow on the anode limits

mass transport of formic acid to active sites in the ~10 micrometer thick catalyst layer. Formic acid produces carbon dioxide that must be removed from the catalyst layer: HCOOH -->□CO2 + 2H+ +2e-. Previous work by the Rice research group has shown that by increasing the porosity (~10 micrometer pores) of catalyst layer more formic acid reacts. The goal of this research project is to investigate alternative pore forming templates ~100 nm in size to maintain electrical connectivity of the catalyst layer.

Undergraduate

LITHIUM EXTRACTION FROM BRINE USING LI/AL LAYERED DOUBLE HYDROXIDE CHLORIDE

Primary Author: Viviana Cruz, Chemical Engineering

Co-Author(s)/Collaborator(s): Tessa Eskander, Holly Stretz

Advisor(s): Holly Stretz

The demand of lithium batteries is projected to almost double by the year 2025, between big consumers such as Panasonic and Tesla. Most of the lithium produced for batteries is done so through open pit mining and extraction from salt-lake brines. A new method to selectively extract lithium from brines uses sorbents. This project focused on synthesizing high surface area nanoparticle lithium-aluminum layered double hydroxide chloride sorbent using nanoparticle precursors, gibbsite. SEM analysis of the reactants and products provides early evidence that this is a viable synthetic path.

Undergraduate

SYNTHESIS AND ZETA POTENTIAL OF NANO-PARTICLE LITHIUM ALUMINUM LAYERED DOUBLE HYDROXIDE CHLORIDE SORBENT

Primary Author: Sarah Delozier, Chemical Engineering

Co-Author(s)/Collaborator(s): Ryan Phillips, Tessa Eskander

Advisor(s): Holly Stretz

The significance of being able to extract lithium from brine at an efficient rate is critical to the sustainability of production of lithium ion batteries. Enhancing production of such an extraction would be a greener process than the present strip mining process. The approach in this research was to synthesize a sorbent from a nanoparticle precursor that would hypothetically lead to a nanoparticle scale lithium aluminum layered double hydroxide (LDH). This sorbent has been shown to be scalable to production extraction techniques at Oak Ridge National Laboratory, but our approach uses high surface area nanoparticle LDH. Results indicate the synthesis produced meso-scale LDH particles, confirmed by changes in the XRD scan and in SEM images. Zeta potential measurements will also be presented, which are an indicator of ability to disperse the LDH particles in water.

Undergraduate

MODELING HYPERTHERMIA EFFECTS ON SPHERICAL-SHAPED TUMORS

Primary Author: Moamen Elkelany, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborator(s): Nastasia Allred, Pedro Arce

Advisor(s): Pedro Arce

Hyperthermia is a form of cancer therapy in which the

cancer cells are exposed to high temperatures, typically 41-45 degrees C. This treatment produces a reduction in the tumors' dimensions as the cancer cells are killed by the effect of relatively high temperatures. This project is aimed at modeling the heat transfer process for hyperthermia treatment of a spherical-shaped tumor in order to predict both the temperature profiles as well as the rate of cancer cell killing inside the tumor domain. The model will be based upon the conservation equation for heat conduction with "bulk" heat sources. By assuming limiting cases of the heat sources (such as uniform and constant), a solution will be proposed for the model by using a separation of variables approach for differential equations coupled with particular solutions. The primary goal of the research in this project is to outline a systematic and efficient approach to learn about hyperthermia performance in cancer tumor treatment. The results can then be shared with medical doctors so that they can propose a better strategy for a more personalized patient treatment. In addition, the research will establish a model that serves as a basis for other types of heat sources such as oscillatory-time dependent and non-uniform functions. Details about the model formulation, solution approach, and an outline for future research will be discussed.

Undergraduate

MOLECULAR SIMULATION ON HUMAN BETA DEFENSIN INTERACTION WITH LIPID MEMBRANES

Primary Author: Christopher Elson, Chemical Engineering

Advisor(s): 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 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 concentrations. It is known that human β defensins (hBDs) kill bacteria by directly interacting with the cell membrane. But the molecular details are still unknown.
In this study, all-atom molecular dynamics simulations are performed to investigate how hBD type 1 (hBD-1) and hBD type 4 (hBD-4) interact with different lipid membranes. Simulations on hBD-1 monomer, hBD-4 monomer, and hBD-1 dimer were set up using CHARMM-GUI online program and, and all-atom NAMD molecular dynamics simulations were conducted. VMD program will be applied to analyze the simulation trajectories. Up to now, around 60 nanoseconds of simulations have been performed. The results will help in understanding the binding dynamics and selectivity of hBDs' interaction with different kinds of membranes, and will help with designing improved antibiotics in the future.

Undergraduate

hBD-3 PROTEIN INTERACTION WITH LIPID MEMBRANES

Primary Author: Lela Fine, Chemical Engineering

Advisor(s): Liqun Zhang

Human Beta-Defensin Type 3 (hBD-3) is a protein naturally-occurring in the human body which has antimicrobial properties by interaction with bacterial cell membranes directly. In order to understand its functional mechanism, it is important to study and analyze the interaction of hBD-3 with various lipid membranes, especially the gram-positive and gram-negative bacteria membranes. To study its function in molecular detail, doing molecular simulations is the correct method to try.
The hBD-3 binding with different lipid bilayer systems were set up using CHARMM-GUI software, and the simulations were performed using NAMD program. The simulation trajectories will be analyzed using VMD program. The binding structure and dynamics of hBD-3 on

lipid membranes will be analyzed and the result will cast light on novel antibacterial drug development in the long term.

Undergraduate

WHERE DID THE NOTES GO? A LITERATURE REVIEW OF RELEVANT TOPICS FOR NOTETAKING STRATEGIES IN ACTIVE-BASED LEARNING

Primary Author: Katherine Finks, Civil Engineering

Co-Author(s)/Collaborator(s): Andrea Arce-Trigatti, Pedro Arce

Advisor(s): Stephanie Jorgensen

STEM disciplines and higher education are moving towards active learning strategies that require students to engage in knowledge acquisition and knowledge transfer (Arce et al., 2015). Traditional learning environments encourage note taking to document conceptual understanding; however such supporting tools to solidify knowledge acquisition in active based learning are less integrated into higher education (Rawlings, Allen, & Arce, 2005). The purpose of this study is to explore the existing literature to learn about effective notetaking strategies for active learning environments in STEM. The criteria for this literature review include articles that: were published within the last five years, reflect post-secondary context, are peer-reviewed articles, are housed within STEM, education, or psychology, that were deemed accurate, credible, or reliable. Multiple comprehensive searches were conducted using verified databases that contained a combination of the following search terms: student centered, active learning, documentation cycle, note taking, STEM, post-secondary, connections, cognitive growth, and constructivism. After reviewing the results of the searches, twenty-three articles were selected and relevant information analyzed for this study. The analysis of the papers selected resulted in the following categories: 1) notetaking: traditional, virtual, collaborative, and active learning; 2) active learning environments: active description of student teacher roles; 3) learning in active learning environments: knowledge acquisition and knowledge transfer. This literature review identifies potential gaps in the strategies and utilization in notetaking for active learning environments in post-secondary environments. Possible strategies for addressing this gap will be suggested as part of this contribution of this research.

Undergraduate

ACCURATE USE OF FITC AND TRITC FLUOROPHORES FOR TAGGING DEXTRANS

Primary Author: Jacob Green, Chemical Engineering

Advisor(s): J. Robby Sanders

This research is a part of a larger research effort by a team (the “team”) that has the objective of modeling and understanding the process of wound healing for the purpose of speeding up the process and reducing scarring. The team currently models the migration of chemical species in a wound by examining diffusion across a microfluidic gel of dextrans fluorescently tagged with FITC and TRITC fluorophores. There is a two-fold risk to using these tagged dextrans: First, some of the fluorophores may have dissociated from the dextrans, and second, the emission energy of FITC may be high enough to excite TRITC. Both of these issues could lead to false positives. This research seeks to ensure accurate use of the tagged dextrans. This is achieved by separating out dissociated fluorophores via size-exclusion chromatography (SEC), and diluting the dextran solutions so that the FITC emissions are weak enough to not excite TRITC.

Undergraduate

TOWARD CHARACTERIZATION OF RECYCLED POLYETHYLENE TEREPHTHALATE WITH AND WITHOUT EPOXY CHAIN EXTENDER

Primary Author: Ryan Johnson, Chemical Engineering (M.S.)

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

Advisor(s): Holly Stretz

The purpose of this research is to determine if the loss of integrity due to high temperature processing of recycled PET found on campus can be counteracted or overcome by the addition of epoxy chain extender to the melt. Characterizations of the PET with and without the chain extender are to be determined via melt flow index (MFI), tensile testing, and rheometry. Molecular weight distributions are to be determined by dynamic light scattering (DLS) if the polymers can be dispersed in solution. An increase in viscosity, Young's modulus, and storage modulus are expected. As a result, the overall integrity of the PET is expected to be maintained or increased with addition of the chain extender. Further, the process is likely to be viable for upscale to processing using a larger twin screw extruder from which sustainable quantities of filament can be produced supporting the mission of the iMakerSpace on campus.

Undergraduate

APPLICATION OF BLOCKCHAIN TECHNOLOGY IN THE CHEMICAL PROCESS INDUSTRY

Primary Author: Carl Kosut, Chemical Engineering

Co-Author(s)/Collaborator(s): Chris Bartol

Advisor(s): Bahman Ghorashi

The scope of this project is to study the impact of Machine to Machine (M2M) communication on a chemical process operation through implementation of Blockchain technology. The study will encompass the modeling of a chemical process, a distillation column, by using Aspen software in conjunction with, Matlab Simulink, Python and a program created for use on Multichain software. The resulting system should allow for each part of the distillation process to communicate its energy input and output, as well as important physical data, such as: Temperature, Pressure and flowrate. A Programmable Logic Controller (PLC) will be created in Matlab in order to make corrective changes to the dynamic simulation, which those changes will be recorded as well. Reduction of waste and cost savings are the ultimate goals of this project which can be realized via M2M communication.

Undergraduate

INTEGRATION OF VACUUM ON SELECTIVELY GAS PERMEABLE FLOW FIELD DESIGN IN DIRECT FORMIC ACID FUEL CELLS

Primary Author: Steven Lam, Chemical Engineering

Advisor(s): Cynthia Rice

In today's society, as the demand for energy increases with the use of portable electronic devices, so does the need for higher power density energy sources. This problem can be solved with Direct Formic Acid Fuel Cells (DFAFC) which are a continuous energy conversion source. Formic acid is readily available, as it is a common byproduct of many industrial reactions. Formic acid electrooxidation (HCOOH -> CO2 + 2H+ +2e-) produces a gaseous byproduct (carbon dioxide, CO2) that accumulates in the DFAFC liquid serpentine flow fields disrupt the transport of formic acid through the fuel cell. Reductions in CO2 accumulation has previously been demonstrated by the Rice research group with the prototype development of a Selectively Gas Permeable Flow Field (SGPFF). The current research

project proposes to further increase the amount of CO2 removal by the integration of a vacuum on the gas phase side of the permeable flow field.

Undergraduate

IN-DEPTH KINETIC MODELING OF POLY(ACRYLAMIDE-CO-BISACRYLAMIDE) GELS

Primary Author: Casey McCormick, Chemical Engineering

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Co-Author(s)/Collaborator(s): Conner Hintze

Advisor(s): Holly Stretz

The reaction of acrylamide with bisacrylamide to form poly (acrylamide-co-bisacrylamide) is an important research area for optimization of laboratory and industrial processes related to innovative gel designs. Many researchers have expounded on individual aspects of the chemical kinetics involved in the process, but a comprehensive model for solving the dynamic chemical kinetics of a process that has changing flows has not been detailed extensively. The aim of this project has been to conduct several experiments that detail the kinetic-altering factors of the process such that a model can be programmed using multidimensional solvers such as MATLAB. Carefully controlled assays were performed and were fitted using a Chapman-Richardson Equation and a Hill Method equation for sigmoidal regressions. These determinations had a coefficient of determination of 0.95 or better. Domains evaluated were then regressed for linear relationships to write a MATLAB model. Results of these experiments indicate that further work should be done to better define the multi-domains that exist in certain kinetic-altering parameters (e.g. APS/TEMED ratios).

Undergraduate

CONVERSATIONS ON THE ART AND SCIENCE OF ENGINEERING MODELING

Primary Author: Rebekah Preshong, Chemical Engineering

Co-Author(s)/Collaborator(s): Nastasia Allred

Advisor(s): Pedro Arce

Frequently, professors may wish to present advanced engineering concepts to freshman and sophomore engineering students, but their methodologies often seem geared to more experienced learners. Therefore, they focus on traditional lecture/classroom teaching styles, which can be less effective in engaging the students in conversations about the subject. Conversations among the facilitator of learning and the students can be appealing because they allow presentation of different ideas on a given subject and collaborative construction of knowledge based on these ideas. It is believed that lower-division engineering students can become proficient in advanced concepts when they engage in conversations about the subject. To test this hypothesis, a pilot effort was conducted in which conversations among several students (primarily freshmen and sophomores), a doctoral student, and an engineering professor took place weekly. The discussions followed an active-learning, student-based, collaborative approach to various topics related to mass, energy, and momentum conservation. A literature review was also performed to determine the extent of the implementation of these active approaches in engineering classes for upper (and sometimes lower) division students. This contribution will highlight aspects of these conversations and offer selected illustrations. The students' overall view seems to indicate that conversations, conducted as previously discussed, provide beneficial exposure to key engineering concepts before they are encountered in a formal class, help develop a mathematical framework, encourage analytical skills,

simulate the real world, and familiarize students with searching for information on their own, thus preparing them to be more engaged, informed, and competent students and engineers.

Undergraduate

PARTITION FACTOR FOR A DRUG IN PNIPAM HYDROGEL AND WATER

Primary Author: Rylee Smith, Chemical Engineering

Advisor(s): Holly Stretz

Taking medication often comes with side effects which range in severity which may even deter people from seeking treatment. Accordingly, there is a need for improved efficiency in drug delivery which can be achieved with the use of a nanoparticle drug delivery system. In order to manufacture drug delivery hydrogel particles at a nanoscale, the behavior of the system must first be understood fundamentally. This study focused on quantifying the amount of a drug, chosen to be DL-propranolol hydrochloride, that diffuses into a poly(n-isopropylacrylamide) (PNIPAm) hydrogel at equilibrium. Three gels were synthesized and soaked in a solution containing DL-propranolol hydrochloride for 14 days, which was found to be the amount of time needed for the drug to reach equilibrium (complete diffusion). After this time period, the gels were then sliced into disks in order for the drug to be extracted. Using UV-visible spectroscopy, the concentration of drug in each disk was analyzed. This data, along with the concentration of the drug in the solution, gave an average partition coefficient for DL-propranolol hydrochloride in a poly(n-isopropylacrylamide) hydrogel as 0.5861. This number is indicative of one aspect of the behavior of a nanoparticle drug delivery system that will be produced in future work.

Undergraduate

UNDERSTANDING THE NANO AGGREGATION OF ASPHALTENES THROUGH MOLECULAR SIMULATIONS

Primary Author: Andrew Whittenbarger, Chemical Engineering

Advisor(s): Venkat Padmanabhan

Asphaltenes, widely known as the “cholesterol of petroleum”, are the heaviest and most polarizable components of crude oil. They are known to be one of the largest causes for fouling in pipe walls, valves and other equipment resulting in the requirement of down-time and cleaning, that cost the petroleum industry billions of dollars in maintenance every year. Understanding the behavior of asphaltenes in crude oil is particularly important in locations where enhanced oil recovery (EOR) strategies are required. Despite the enormous amount of experimental and modeling efforts devoted to the characterization of asphaltene structure and behavior, there is still a lack of understanding of the aggregation mechanism at a molecular level. Molecular simulations, that incorporate atomistic details of asphaltenes, can fill this gap by giving insight into the mechanism of aggregation. They can be used to understand how aliphatic chains, heteroatoms, and asphaltene geometry affect aggregation.

Department of Civil & Environmental Engineering

Graduate

DEVELOPMENT OF HEC-HMS MODEL FOR THE CANE CREEK WATERSHED

Primary Author: Godson Ebenezer Adjovu, Civil Engineering (M.S.)

Co-Author(s)/Collaborator(s): Rex Gamble

Advisor(s): Alfred Kalyanapu

Cane Creek Watershed project was aimed at developing a Hydrologic Engineering Center Hydrologic Modeling System (HEC-HMS) model for the Cane Creek Watershed to understand its hydrological characteristics and then to simulate 10-yr, 50-yr, 100-yr, and 500-yr storm events. Discharges from past events were converted from depth gauge data and used as observed flow to calibrate the model. Flows used include that of October 23rd, 2017, May 31st, 2018, June 26th, 2018, and July 21st, 2018, since these events represented different flow regimes between 2017 and 2018. Data used in constructing the HEC-HMS model including land-use/land-cover data (LULC), digital elevation models (DEM), and precipitation depth data. Once the model was calibrated and validated Soil Conservation Service (SCS) design storms were simulated and their peak flows were obtained. The performance of the model was evaluated using the statistical techniques Nash–Sutcliffe Efficiency (NSE), Root Mean Square Error (RMSE), Percent Bias (PBIAS), Coefficient of determination (R2), and Ratio of the RMSE to Standard Deviation (RSR). When run with 10-yr, 50-yr, 100-yr, and 500-yr storm events the calibrated and validated model yielded a discharge of 2538-cfs, 3942-cfs, 4744-cfs, and 6285-cfs respectively. While plausible, these discharges' reliability are called into question by statistical analyses, which were mixed in affirming the model's accuracy. This may be as a result of the model's exclusion of the Cane Creek Reservoir and the changing geomorphology of creek crossing 1 (where the observed flow data was collected).

Graduate

EFFECT OF SOIL-STRUCTURE INTERACTION ON THE SEISMIC PERFORMANCE OF STRUCTURES DESIGNED BY ASCE7-16

Primary Author: Moatez Alhassan, Engineering (Ph.D.) (Civil Engineering)

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

Advisor(s): Daniel VandenBerge

Performance-seismic design of structures aims to control earthquake damage through energy dissipation and the inelastic behavior of some structural elements based on the type of the structure. The current seismic design codes generally design for seismic effects by applying lateral static forces distributed over the height of the structure. The effect of soil structure interaction (SSI) is neglected in these codes. While not required, ASCE 7-16 does provide guidance on optional SSI as applied to equivalent lateral force, linear dynamic, and nonlinear dynamic procedures. Therefore, the current study investigated the seismic performance of a mid-rise multistory moment resisting frame (MRF) structure designed according ASCE 7-16. The effects of SSI have been examined where the structures designed with the classical way of fixed base for site condition class D and seismic hazard building risk category D. The models were analysed with a shallow foundation resting on soil with a shear wave velocity of Vs =250 m/sec and subjected to different seismic excitation. Fully nonlinear analysis was conducted using FLAC2D software with two different cases of fixed-base and flexible

base. SSI effect were investigated in terms of the elastic displacements which were observed to increase in general compared to the fixed base but that increase does not affect the life safety and does not lead to the collapse in terms of drift.

Graduate

PERFORMANCE EVALUATION OF VEGETATED SWALES FOR HIGHWAY RUNOFF REDUCTION BASED ON SITE CHARACTERISTICS AND METEOROLOGICAL INFLUENCES

Primary Author: Joseph Brockwell, Civil Engineering (M.S.)

Advisor(s): Tania Datta

Vegetated swales are stormwater control structures designed to reduce peak runoff flow volumes, and promote infiltration and evapotranspiration. Their historical use in highways was solely to convey runoff into a downstream outlet in an inexpensive way. In recent years, due to new stormwater regulations, the use of vegetated swales in highway systems has shifted from just flow conveyance to the reduction of total flows. This transition, however, is inhibited due to the lack of knowledge on the actual performance of existing swale structures within highway systems. Therefore, this project aims to evaluate the stormwater reduction potential of two existing vegetated swales located on State Route 111 and Interstate 40, in Putnam County, Tennessee, based on their individual site characteristics, and meteorological influences. The site characteristics selected for the study include the soil infiltration rates, initial soil moisture content, site geometry, and the land cover. As for the meteorological factors, rainfall intensity, rainfall volume, antecedent dry period, and evapotranspiration rates were selected to gauge the performance of the reduction potential of these two swales. Preliminary data from the site located on State Route 111 has exhibited reduction potentials of up to 75% for small rain events (< 0.35 in), but only after long dry periods (> 6 days). When there is little to no dry period (< 1 day), the reduction potential of the swale is minimal.

Graduate

CHARACTERIZATION OF HIGHWAY STORMWATER RUNOFF FROM VARIOUS LAND-USE IN TENNESSEE

Primary Author: Alisa Danielle Kirkpatrick, Civil Engineering (M.S.)

Co-Author(s)/Collaborator(s): Tania Datta

Advisor(s): Tania Datta

This study aimed to characterize highway stormwater runoff in Tennessee, and to understand possible sources of ammonia and nitrates in the runoff across three sites with varying land-use. Influences from atmospheric deposition were determined using statistical correlations and possible sources were tracked using dual stable isotopic (δ18O and δ15N) analysis. The contribution of vegetation as a source or sink was analyzed by preventing mowing of the sites for a duration of one year, after which mowing continued as scheduled. Statistical significance testing was also performed to determine significant differences in stormwater characteristics between seasons and land-use. Preliminary results show that stormwater quality from highways is more complex than previously hypothesized. A significant difference in chlorides and ammonia was observed during winter months, which could be contributed to the use of road salts, and decaying vegetation releasing stored nutrients, respectively. From dual stable isotopic analysis, atmospheric deposition was observed as a source of nitrate at all study sites; however soil and fertilizers were also identified as a source, especially for areas with adjoining agricultural practices. Further analysis is being conducted to determine their relative contributions to nitrogen pollution. These results,

along with comprehensive characterization of Tennessee's highway runoff will be presented.

Graduate

MICROBIAL COMMUNITY STRUCTURE AND STABILITY DURING OPTIMIZATION OF A FULL-SCALE BIOLOGICAL NUTRIENT REMOVAL PROCESS

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

Advisor(s): Tania Datta

As regulatory limits on nutrient discharge from wastewater treatment facilities (WWTF) become more stringent, optimizing the secondary treatment process, rather than building new infrastructure, has been gaining popularity. Biological nutrient removal (BNR) is commonly the focus of such optimizations, where typically a reactor is modified to create a dissolved oxygen gradient enabling simultaneous nitrification and denitrification (SND), and enhanced biological phosphorus removal (EBPR). This study aims to elucidate how functionally relevant microbial communities adapt to such optimizations, and whether the community and the process stabilize over time. The WWTF of Cookeville, Tennessee, began optimizing its secondary treatment process in 2015 to accommodate SND. By altering the brush aeration patterns of the oxidation ditches, a dissolved oxygen gradient was generated both laterally and vertically, resulting in anaerobic, anoxic, and oxic environments within a single ditch. For three years, we investigated the stability of this process optimization, by monitoring the microbial community and wastewater characteristics. The denitrifiers showed a significant increase in diversity over time, suggesting optimization resulted in a more resilient denitrifying community. Apart from SND, Cookeville also observed some EBPR. Interestingly, polyphosphate accumulating organisms were ranked among the top ten genera of the activated sludge community. The microbial community composition between sampling events was distinct. However, shifts in composition showed trends that may indicate stabilization of community structure, supporting optimization to possibly be a reliable practice. Two other WWTFs in Tennessee that did not undergo optimization were also investigated for comparison. Results comparing all three WWTFs will be presented.

Graduate

MICROBIAL COMMUNITY STRUCTURE DYNAMICS IN RESPONSE TO ANAEROBIC CO-DIGESTION OF WASTE ACTIVATED SLUDGE WITH FOOD WASTE AND FATS, OILS AND GREASE

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

Advisor(s): Tania Datta

The study explored microbial community structure dynamics during anaerobic co-digestion of waste activated sludge (WAS) with food waste (FW) and fats, oils and grease (FOG) at 25%, 50% and 75% (vs basis) using biomethane potential tests. Additionally, the study assessed if prior exposure of the inoculum to stepwise increment of the co-substrate induces some form of microbial acclimation for enhanced methane yield. Mono digestion of WAS yielded the lowest methane yield of 83.9 mL CH4/gVS. The co-digestion of both FW and FOG significantly increased methane yield with 75% FOG (vs basis) co-digestion yielding the highest methane yield of 1087.2 mL CH4/gVS. Prior exposure of inoculum to the co-substrates enhanced methane production. Generally, the microbial community displayed some form of resistance to the different substrates and co-substrate mixes and hydrogenotrophic methanogensis was the predominant methane formation pathway observed in all the tests.

Graduate

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

Primary Author: Prince Turkson, Engineering (Ph.D.) (Civil Engineering)

Advisor(s): Daniel VandenBerge

As part of a broader research initiative exploring the extent of the saturation zone in levees due to flooding, this study investigates the effects of foundation properties on levee through-seepage. The coefficient of consolidation, cv dictates the response of levee and foundation soils to transient flow conditions and subsequently the extent of saturation in levees. Uncoupled transient seepage analysis from finite element methods was used to estimate parametrically the position of the phreatic surface in levees considering soil coefficient of consolidation, levee geometry and flood hydrograph. The results showed that the extent of the saturated zone for an impervious foundation was similar to that found for levees with cv higher than the foundation cv. The saturated zone tends to have an L-shape when a more pervious foundation is considered. Seepage from the retained water (Zone A) is not significantly affected by the presence of a pervious foundation. On the other hand, Zone B is influenced by the rate of seepage within the foundation and the levee properties. The results indicate that levee foundation conditions have the largest impact on levee through-seepage when the foundation has a higher cv than that of the levee itself. The study develops equations and chart which can be used to make appropriately conservative assumptions about the saturation zone within levees on pervious foundation prior to rapid drawdown. Cases where the levee has a higher cv than the foundation may be analyzed for RDD by assuming an impervious foundation.

Undergraduate

DEVELOPMENT OF A SOIL COMPACTION METHOD FOR NON-STANDARDIZED ENERGY LEVELS

Primary Author: Alec Brenner, Civil Engineering

Co-Author(s)/Collaborator(s): Jacob Thompson

Advisor(s): Daniel VandenBerge

Since its creation in 1933, the Proctor compaction test has been a prominent means to analyze the relationship between a soil's water content and dry unit weight when compacted with a particular compaction energy. The test is typically conducted at the two energy levels, Standard and Modified, specified by ASTM. When compaction to a particular dry unit weight and water content is necessary, no method currently exists to estimate the corresponding compaction energy. This project aims to identify trends in soil properties that can be used to predict compaction behavior at other energy levels. Original data was gathered by performing the Proctor test on two materials, a clay-based soil and a limestone sand. Compaction results from other sources were also gathered to test the method on additional types of soils. From the data, the relative compaction and relative energy were calculated based on the peak of the standard Proctor curve. A linear trend is observed in the data when plotted on logarithmic axes. This approach will lead to a method to predict compaction behavior and dry unit weight for conditions outside of energy levels specified by ASTM.

Department of Computer Science

Graduate

SOLVING MULTIMODAL PROBLEM USING DEEP LEARNING: SPEAKER IDENTIFICATION

Primary Author: Farzana Ahamed Bhuiyan, Engineering (Ph.D.) (Computer Science)

Co-Author(s)/Collaborator(s): Md Bulbul Sharif

Advisor(s): Douglas Talbert

Speaker identification refers to the task of locating the face of a person with the same identity as the voice in a video. Speaker identification is a challenging perception task integrating both visual and auditory signals. Long Short Time Memory (LSTM) is a natural choice for solving such multimodal learning task of sequence data in a unified model. One of the most straightforward methods to deal with data from different domains is to integrate them into a single network by directly concatenating the data to produce a larger input sequence. However, in this case, the multimodal property of the inputs is completely ignored. Another solution is to treat data from different domains completely independently. We can use multiple LSTMs in parallel and then use a voting mechanism to merge the output labels at the highest layer. The advantage of this approach is that the two separate memory units can be trained explicitly for each domain to store useful information. But the weakness is that the interaction between modalities occurs only at the highest level during the labeling process. A better solution might be a multimodal LSTM architecture that unifies both visual and auditory modalities from the beginning of each sequence input and then extend the conventional LSTM not only by sharing weights across time steps but also by sharing weights across modalities. We are comparing each of these models and the assumptions behind them and trying to find out the best model for solving multimodal problems like speaker identification.

Graduate

NELMA: NEVER-ENDING LEARNER FOR MALWARE ANALYSIS

Primary Author: Joe Bivens, Computer Science (M.S.)

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

Advisor(s): Douglas Talbert

The availability of potentially malicious software continues to outpace the security industry's capacity for manual analysis. Machine learning models can provide highly accurate malware classification, but often rely on small datasets labelled by humans. Additionally, obfuscation techniques widely employed by malware authors may conceal some malicious attributes from analysis. Inspired by NELL (Never-Ending Language Learner), NELMA: Never-Ending Learner for Malware Analysis — aims to provide a continually learning system that is primarily self-sufficient (requiring little human interaction) and integrates knowledge from multiple learning agents that utilize different feature representations. NELMA is implemented as a flexible, modular, and extensible testbed for use by researchers, supporting future work in machine learning, malware analysis, data visualization, and software engineering. In its reference configuration, NELMA processes potentially malicious Android applications (APKs), is primarily implemented in Python (supporting popular libraries such as androguard and scikit-learn), and uses Elasticsearch as a backend database.

Graduate

ESTIMATING UNCERTAINTY IN DEEP IMAGE CLASSIFICATION

Primary Author: Katherine Brown, Engineering (Ph.D.)

Advisor(s): Douglas Talbert

The application of deep learning to the medical diagnosis process has been an active area of research in recent years. Convolutional neural networks (CNNs) have made the computational processing of medical images realizable. CNNs automatically extract important features from images to be processed by an Artificial Neural Network to produce a final classification or regression result. Despite their high performance, CNNs are a “black-box”. Thus, deploying CNNs in a clinical setting requires a measure of the uncertainty of its prediction. A theoretically grounded approach to determining uncertainty is to utilize dropout layers during training and testing and computing the standard deviation of a sample of predictions. A naïve approach to uncertainty quantification is to use the difference of the absolute value of the predicted probabilities of binary classes from a standard CNN. The first network is fine-tuning a VGG-16 CNN with ImageNet weights. Our second model is a VGG-16 model augmented to measure Bayesian uncertainty. We evaluate our models on a dataset of 85,000 images to determine the presence or absence of Tumor-Infiltrating Lymphocytes which are the infiltration of the immune system into a cancerous tumor. We evaluate the effectiveness of these uncertainty measures with two experiments. The first experiment evaluates classification accuracy when removing the most uncertain images from evaluation. The second experiment replaces the most uncertain labels with the correct labels to simulate a clinical setting with a pathologist. From our analysis, the best increase in accuracy occurs when uncertainty is measured from the model performing the predictions.

Graduate

SEMI-SUPERVISED AUTOENCODERS FOR SPECTRAL UNMIXING

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

Advisor(s): William Eberle

In imaging spectroscopy, special hardware is used to capture hundreds of wavelength bands across the electromagnetic spectrum for every pixel in an image. These spatially coregistered images can be used to identify objects or materials. Despite having a high spectral resolution, many spectral images have a low spatial resolution. This, along with the effects of multiple scattering, can make it difficult to analyze the composition of a spectral image. Spectral unmixing is the problem of extracting components (endmembers) and their associated spatial locations (abundance maps) from an image using the observed spectra at every pixel. Autoencoders, a type of artificial neural network trained to reconstruct their inputs, have been applied to the problem of blind-source spectral unmixing with relatively good success. However, it is not uncommon for an autoencoder to produce redundant endmembers, uninterruptible abundance maps, and results that do meet physical constraints. To address these issues, we explore the use of semi-supervised autoencoders for spectral unmixing. For many unmixing problems, a domain expert can often provide guidance as to the material most likely present in a scene. Given a collection of reference spectra, we can train an autoencoder to simultaneously learn the provided endmembers and reconstruct the given image. This enables us to guide the model towards producing physically meaningful endmembers while still allowing the autoencoder to capture nonlinearies in the data and produce unsupervised abundance maps. We have explored the use of autoencoders with semi-supervised training on datasets obtained using electron microscopy as well as satellite imagery.

Graduate

SMART FRAUD DETECTION IN SMART METERING SYSTEM OF AMI NETWORKS

Primary Author: A H M Jakaria, Engineering (Ph.D.) (Computer Science)

Co-Author(s)/Collaborator(s): Md Golam Moula, Mehedi Hasan

Advisor(s): Douglas Talbert

Advanced metering infrastructure (AMI) is a critical part of modern smart grids. It performs the delivery of sensitive power information such as smart metering data of power consumption. While smart meter data helps to improve the overall performance of the grid in terms of efficient energy management, it has also made the AMI an attractive target of cyberattackers with a goal of stealing energy. This is performed through the physical or cyber tampering of the meters, as well as by manipulating the network infrastructure to alter collected data. Proper technology is required for the identification of energy fraud. We propose a Machine Learning based technique to detect fraudulent data from smart meters based on energy consumption patterns of the consumers by utilizing both supervised and unsupervised techniques. We analyze the performance of our proposed technique and show the correctness of the models in identifying the suspicious smart meter data.

Graduate

NODE SIMILARITY FOR ANOMALY DETECTION IN ATTRIBUTED GRAPHS

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

Advisor(s): William Eberle

Most graph-based anomaly detection work uses structural graph connectivity or node information for discovering anomalies in a graph. Approaches relying on solely node information for detecting anomalies do not exploit the structural information, and approaches relying on just the structural connectivity information do not exploit node label values, or attribute information. Little research has been done that uses both structural connectivity as well as node attributes for finding anomalies in data represented as a graph. In this work, we attempt to use both the node attribute information together with the structural connectivity in order to discover anomalies in graph. While existing approaches treat all the attribute values as discrete, when the attributes are numeric values, they lose their measure of similarity - or closeness of information. In this work, in order to preserve the closeness information, we consider the similarities in node values using not only single attributes, but also multiple attributes. In order to discover the similarity between the attribute values, we use discretization, distance-based similarity measures, and a k-means clustering approach. After discovering nodes with similar label values, we use revised labels together with structural properties for discovering anomalies in a graph. Our hypothesis is that if we use node label similarity information together with structural properties of the graph, we can detect anomalies which would be missed by approaches only relying on either structural connectivity or node attribute information.

Graduate

CONTINUOUS SURVEILLANCE DESIGN FOR SMART GRID USING UNMANNED AERIAL VEHICLE (UAV)

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

Advisor(s): Mohammad Ashiqur Rahman

A smart grid is a widely distributed engineering system with overhead transmission lines. Physical damage to those power lines, from natural calamities or technical failures,

will disrupt the functional integrity of the grid. To ensure system recovery, the grid operator must immediately take steps to nullify the impacts. Emerging unmanned aerial vehicles (UAVs) show great potential to replace traditional human patrols for regularly monitoring critical situations involving the safety of the grid. The critical lines can be monitored by a fleet of UAVs to ensure a continuous resilient surveillance system. The proposed approach first considers the n-1 contingency analysis to find the criticality of a transmission line from its performance index, which is calculated using linear sensitivity factors. We divide a line into smaller segments forming multiple inspection points on the line. Then, we propose a formal framework that verifies whether a given set of UAVs can perform continuous surveillance of the grid satisfying various requirements, particularly the monitoring and resiliency specifications. The verification process ultimately provides a trajectory plan for the UAVs, including the refueling schedules. The resiliency requirement of inspecting a point is expressed in terms of a k-property specifying that if k UAVs fail or compromised still there is a UAV to collect the data at the point within a threshold time, while the points that are under resilient surveillance cover a required percentage of the grid's overall criticality. We evaluate the proposed framework on synthetic data based on various IEEE test bus systems.

Graduate

MACHINE LEARNING FOR MULTIPLE DOMAINS

Primary Author: Justin Medley, Engineering (Ph.D.) (Computer Science)

Co-Author(s)/Collaborator(s): Madison Dittner

Advisor(s): Douglas Talbert

Machine Learning has many tools, techniques, and algorithms for data science. In this project, machine learning is applied to the Wind and Solar Power Forecasting and Foreign Exchange Markets. We use feature engineering to find correlations between the two domains. These are then applied to representative data, which is used with classification schemes, such as linear regression, and artificial neural networks. The focus is Wind and Solar power prediction in the context of international economics. The research goal is to find the best combination of features and classifier for an interdisciplinary model.

Graduate

AN APPROACH FOR CONCEPT DRIFT DETECTION IN A GRAPH STREAM USING DISCRIMINATIVE SUBGRAPHS

Primary Author: Ramesh Paudel, Engineering (Ph.D.)

Co-Author(s)/Collaborator(s): William Eberle

Advisor(s): William Eberle

Graph mining has attracted considerable research interest recently with the emergence of complex networks like social media, sensor networks, and the world wide web. In a streaming scenario, the concept to be learned might change over time. While there has been considerable research done for detecting concept drift in traditional data streams, little work has been done on addressing concept drift in data represented as a graph. We propose a novel unsupervised concept-drift detection method on graph streams. The methodology starts by discovering discriminative subgraphs for each graph in the stream. We then compute the entropy of the window based on the distribution of discriminative subgraphs with respect to the graphs and then use the direct density-ratio estimation approach for detecting concept drift in the series of entropy values obtained by moving one step forward in the sliding window. The usefulness of the proposed method is demonstrated through experiments using artificial and real-world datasets and its performance is evaluated by comparing against related baseline methods.

Graduate

AUTOMATED MACHINE LEARNING FOR SHORT-ESSAY ANSWER GRADING

Primary Author: Paul Tinker, Computer Science (M.S.)

Advisor(s): Douglas Talbert

Natural language processing coupled with machine learning has been employed to great effect in the realm of essay and short-answer essay scoring. However, these models typically require a strong understanding of machine learning concepts along with domain knowledge specific to the dataset in order to achieve optimal results. An emerging trend in machine learning is that of automated machine learning. Our project seeks to demonstrate the effectiveness of an automated machine learning system designed to score a critical thinking assessment with no machine learning experience or domain knowledge required. We will show that an ensemble of deep and non-deep machine learners, designed and tuned automatically, can outperform human scorers on this task.

Department of Electrical & Computer Engineering

Graduate

BLOCKCHAIN-BASED PRIVACY-PRESERVING AND SECURE SMART PARKING SYSTEM

Primary Author: Wesam Al Amiri, Electrical and Computer Engineering (M.S.)

Advisor(s): Mohamed Mahmoud

Finding free parking spaces is a major problem for drivers in big cities. Drivers in the U.S. spend 17 hours on average per year searching for available parking spaces, which causes more traffic congestion and air pollution, and increases gas consumption and wastes drivers' time. Recently, Smart Parking system has improved the efficiency of parking operations by providing online parking reservation services to drivers. The idea is that parking owners provide information about the availability of parking spaces online. However, these systems raise significant privacy concerns in which drivers are required to disclose sensitive information, such as real identities, destinations, and reservation times. Also, these centralized systems are vulnerable to single point of failure due to denial of service attacks. In this work, we propose a privacy-preserving parking management system based on Blockchain Technology. The scheme uses two techniques: 1) anonymity technique to hide users' identities, and 2) Private Information Retrieval (PIR) technique to preserve drivers' desired destinations. In our scheme, parking owners make offers on a consortium blockchain to drivers who will retrieve the appropriate offers in terms of proximity or price for reservation. To prevent parking owners from increasing rates during the times of low parking availability (monopolism), we use a commitment scheme where the offers are committed for a specific period of time. Also, to discourage a malicious driver from reserving several parking spaces at one time, he/she should make down payment before reservation. We will implement our scheme using Raspberry-Pi for evaluation.

Graduate

HIGH ENERGY DENSITY COBALT FREE CATHODE FOR NA-ION BATTERY

Primary Author: Devendrasinh Darbar, Engineering (Ph.D.)

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

Advisor(s): Indranil Bhattacharya

There is a high demand for the Li ion battery and due to expensive technology for the extraction of lithium from resources and time consuming, researcher are looking for the alternative to fulfil the needs of the society. Sodium ion battery technology shows a prominent storage system because of low cost and abundance in nature. Further, mining of the Cobalt facing a human right violation, toxic, expensive and availability issue, scientist are trying to use less cobalt in the energy storage devices. Therefore, this work shows a cobalt free cathode can achieve high structure stability and shows good reversible capacity.P2-type cathode Na2/3[Fe1/2Mn1/2]O2 have shown a capacity of 192 mAh/g in the voltage range of 1.5-4.2V, however it gets faded after 30 cycle. By changing the morphology of the material in the form nanostructure, cycling stability of the material can be increase. However, during cycling there is constant transition of structure form P2 to O2 type which results into deterioration of the crystal structure. In this work, doping the Na2/3[Fe1/2Mn1/2]O2 by Zn+2 having greater ionic radius which results in increase of c lattice parameter and d-spacing between the transition metal layers thus promote better sodium ion diffusion and higher cycling stability.Zn+2 shows higher ionic radius. Na2/3[Fe1/2Mn1/2-x Mx]O2 (M=Zn,x=1,2,3,5,10%) nanoparticles will be synthesized by sol-gel technique.

Various characterization technique will be performed such as Scanning electron microscopy, Raman spectroscopy, cyclic voltammetry, galvanostatic studies to understand the electrochemical performances and physical structure.

Graduate

HARDWARE SOFTWARE CO-VERIFICATION OF DNN ON PYNQ-Z1 FPGA

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

Advisor(s): Syed Hasan

Deep neural networks (DNN) is one of the emerging types of machine learning that is being used to solve problems that are too complex to be solved by humans. However, with the growing complexity of the problems in practical applications today, there are more computations and a need for portability for these DNN. With the utilization of graphics processing units (GPUs) to perform the computations required by DNN now deep learning is becoming ubiquitous. However, the downside is that GPUs are not portable to deploy inference on non-specialized general purpose embedded system designs or internet of things (IoT) applications. An alternative is to use a Field Programmable Gate Arrays (FPGAs) which is an embedded system designed for data-intensive processing and can even be used in low-power battery operated devices. FPGAs can achieve a high level of performance at a lower cost of power. In this work, a complete methodology is shown to deploy inference phase of DNN. One of the most popular DNN architecture known as Convolutional Neural Network (CNN) has been implemented on a FPGA board known at PYNQ-Z1 using the PYNQ platform to execute the CNN. Our methodology takes the advantage of Python overlay provided for PYNQ-Z1 to easily debug and verify the CNN-IP generated by regular syntheses tools such as Xilinx's Vivado.

Graduate

INTRODUCING SELF-LEARNING INTO ROBOTIC ARM USING DEEP REINFORCEMENT LEARNING

Primary Author: Ogheneuriri Oderhohwo, Electrical and Computer Engineering (M.S.)

Advisor(s): Syed Hasan

With the growing trend of autonomous machines, the combination of supervised and unsupervised machine learning techniques has been explored in providing optimal solutions for self-learning. In robotics, the curse of dimensionality makes convergence of machine learning difficult, no matter whether it is supervised or unsupervised. Therefore, reinforcement learning, which often requires a large number of trials for effective learning experience similar to unsupervised learning, suffers serious challenges in robotic applications. Consequently, choosing an appropriate algorithm that would perform optimally is of utmost importance. In this work, a robotic arm having 6 degrees of freedom combines supervised and unsupervised learning techniques by using a concept called Deep Reinforcement Learning, this helps the robot in becoming autonomous. It uses a camera image as an input to generate states through observation of the image, and distance for the reward system. It learns the optimum policy for action selection given a particular state observation that would achieve the maximum reward. The off-policy Deep Q Network (DQN) algorithm is to be implemented in this design and will be deployed on the robotic arm for independently learning the optimum movement towards achieving a certain task in a controlled environment.

Undergraduate

CYBERSECURITY IMPLICATIONS OF MODERN AUTOMOBILES

Primary Author: Samuel Hollifield, Computer Engineering

Co-Author(s)/Collaborator(s): Miki Verma, Oak Ridge National Laboratory

Advisor(s): Stacy Prowell

Modern vehicles operate through a complex exchange of data between multiple computers, sensors, and human inputs. Largely, this data is transferred through a combination of networks which are not intended for consumer access. In particular, a Controller Area Network (CAN) is mandated for use in vehicles manufactured after 2008. CAN is designed to be a fault-tolerant system that preserves critical vehicular functions, but lacks basic security such as authentication, encryption, and proper node identification. While this has not been a major concern in the past, the popularity of low-cost consumer electronics, such as Raspberry Pi and Arduino boards, have allowed unprecedented access to these previously obfuscated networks. Hackers have established remote code execution, denial of service attacks, and private data collection from a variety of vehicles. Thus, it becomes important to understand the potential side-effects of both malicious code execution and amateur implementation of programs on vehicles. This presentation will detail our ongoing research, which aims to identify automotive vulnerabilities as well as determine a method to properly model automotive systems. By using both consumer-electronics (e.g., Raspberry Pi and Arduino boards) and manufacturer-grade solutions, we analyze the inherent properties of automotive data and the interactions which take place throughout automotive networks in an effort to detect anomalous malicious data.

Department of Manufacturing & Engineering Technology

Graduate

MICROSTRUCTURE AND MECHANICAL PROPERTIES OF BIMETALLIC ADDITIVELY MANUFACTURED STRUCTURE (BAMS) FABRICATED WITH LOW CARBON STEEL AND AUSTENITIC STAINLESS STEEL USING WIRE+ARC ADDITIVE MANUFACTURING (WAAM)

Primary Author: Md Rumman Ul Ahsan, Engineering (Ph.D.)

Co-Author(s)/Collaborator(s): ANM Tanvir, Kevin Goodwin, Taylor Ross, Brian Bates, Duckbong Kim

Advisor(s): Duckbong Kim

Wire+arc additive manufacturing (WAAM) utilizes existing welding equipment and consumables for fabricating near net shape parts with low to medium geometric complexity. WAAM process inherent the flexibility to use multiple materials successively or simultaneously during the manufacturing of a single component. In this work, a gas metal arc welding (GMAW) based wire+arc additive manufacturing (WAAM) system has been developed to use two material successively and fabricate bimetallic additively manufactured structure (BAMS) of low carbon steel and AISI 316L stainless steel. The microstructural features and mechanical properties of as-deposited parts are studied in-depth with emphasis at the bimetallic interface. In the as-deposited part, two distinctive zones of low carbon steel and stainless steel deposits without any weld defects are observed with higher hardness at the interface. Under tensile loading, the as-deposited samples failed in the low carbon steel side, as it is the weaker one among the constituent material. However, significantly less ductility is found compared to weld joints or rolled plate of either material. Later, the WAAMed part is heat treated over a range of temperature for a different duration to improve strength and ductility. Based on the microstructure analysis and mechanical testing, an optimum heat treatment parameter is obtained for BAMS of low carbon steel and austenitic stainless steel, which has led to an approximate 100Mpa increase in the tensile strength and 100% increase in the ductility.

Graduate

THERMOMECHANICAL INVESTIGATION OF CONTINUOUS FIBER REINFORCED ADDITIVELY MANUFACTURED COMPONENTS

Primary Author: Mahdi Mohammadizadeh, Engineering (Ph.D.) (Mechanical Engineering)

Co-Author(s)/Collaborator(s): Ismail Fidan

Advisor(s): Ismail Fidan

In this research, thermal and mechanical properties of continuous fiber reinforced additively manufactured (CFRAM) composite components were studied. CFRAM is a five years old technology provided by Markforged company. Nylon as a thermoplastic polymer was used as matrix and carbon fiber, Kevlar, and fiberglass were included to improve the properties. Fibers were included under controlled printing situation. Final composite has the properties in the range of conventional composites with all the benefits that 3D printing provides including low cost manufacturing, notable flexibility in design and exemption from sophisticated equipment. Studying thermomechanical properties of CFRAM is important due to their potential applications. CFRAM components can replace metals in applications such as car industry, aerospace and sport good. In this work thermal, mechanical, statistical and microscopical analysis of CFRAM components were

conducted. Creep analysis was conducted at different temperatures, and the effect of fiber type and temperature on creep behavior was studied. The statistical analyses were conducted to analyze the experimental data using mathematical models. The microstructural analysis was performed to further investigate void presence, 3D printing quality, and fracture mechanisms. Stiffness measurement of CFRAM components was also conducted at different temperatures. TGA test was conducted to study thermal stability, humidity absorption, degradation behavior, and flame retardancy. Overall, this paper presents quantitative results demonstrating the capabilities of CFRAM technology. In all cases results showed fiber inclusion improves thermal and mechanical properties.

Graduate

PREDICTION OF MECHANICAL PROPERTIES OF FUSED DEPOSITION MODELING MADE PARTS USING COMPUTATIONAL TOOLS

Primary Author: Aslan Nasirov, Mechanical Engineering (M.S.)

Advisor(s): Ismail Fidan

Fused deposition modeling (FDM) is one of the most popular additive manufacturing (AM) processes that are working based on the layer-by-layer buildup of a 3D modeled part from plastic or fiber-reinforced plastic materials. Primary advantages of FDM are low lead times, a high degree of freedom in design and product customization. However, like any other manufacturing process, FDM has its own disadvantages such as anisotropy and heterogeneity of printed part, low dimensional accuracy and post-processing requirements of the parts. In recent years, extensive research has been done to characterize the mechanical properties of FDM produced parts using classical laminate theory (CLT). However, considering limitations of CLT and micromechanics approach like prediction of mechanical properties, perfect bonding assumption and simple unit cells (UC), there is a need to explore different techniques to alleviate those limitations. Taking into account the periodicity and multiscale nature of FDM infill patterns, one such technique is asymptotic homogenization (AH). AH is a mathematical tool implemented to find effective or homogenized mechanical properties of FDM made part by solving partial differential equation over the UC domain. Another advantage of AH is the ability to post-process deformation, strain and stress values over the UC domain in the post-processing stage. In order to check the validity of this technique, mechanical properties are found experimentally and compared with theoretical results.

Graduate

TOWARDS THE DEVELOPMENT OF AN INNOVATIVE 3D PRINTER

Primary Author: Andreas Sauter, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborator(s): Connor Welcome, Aslan Nasirov, Michael Allen

Advisor(s): Ismail Fidan

As the use of Additive Manufacturing (AM) is increasing at a staggering rate, it is necessary to come up with new and improved technologies, materials, and processes of AM. One of these ways is to no longer being confined to a dimensioned box to print within, therefore making AM mobile. The new 3D Printer which is underway to construct a mobile system that moves with the help of 4 omni-directional wheels located at the corners of the frame. The system is designed to use the omni-directional wheels for all X and Y axis movement and is, therefore, able to move infinitely in the direction that is chosen by the user. The Z axis of the system is moved by a lead screw attached to a stepper motor and is limited for now. One key feature of the system is also its ability to dispense multiple paste-

type materials i.e. food, concrete, solder, and more. This is possible through the use of a fully customized syringe press that is capable of carrying 150mL syringes. This presentation will report the current structure of the system and its preliminary findings.

Graduate

INVESTIGATING THE PERFORMANCE OF INCONEL 625 SUPERALLOY FABRICATED BY WIRE-ARC ADDITIVE MANUFACTURING

Primary Author: Ali Newaz Mohammad Tanvir, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborator(s): MD R U Ahsan, Peyton S. Hunt, Ahmed H. Elsawy, Wayne Hawkins

Advisor(s): Duckbong Kim

Wire-Arc Additive Manufacturing (WAAM) is a trending manufacturing process currently attracting researchers and manufacturers due to its extensive advantages regarding simplicity in the process, low material cost, and well-established system setup. WAAM system mainly consists of a welding power supply of any kind for melting metal and a guide system, most commonly a welding robot, to deposit metal additively. This study investigates the performance of a nickel-based superalloy Inconel 625 manufactured additively using a Fronius Cold Metal Transfer (CMT) welding machine coupled with a Fanuc Arc-Mate welding robot. Inconel 625 welding wire was melted and deposited in a square pathway. The manufactured square wall was cut into four separate pieces to be heat treated at 980°C but with different time periods – 30, 60, and 120 minutes. The microstructural samples from a total of four conditions were analyzed under the microscope to study the microstructure of the manufactured sample. The microstructure was correlated with the mechanical properties to examine the effect of different heat-treating conditions and find a suitable heat-treating guideline for WAAMed products. The result suggests the presence of brittle Laves phase in the as-deposited sample. The time-concentrated heat treatment seemed to cause the formation and evolution of Nb and Ti-based MC carbides along with delta particles. Due to increasing heat-treating time, the delta phases seemed to be clustered near enlarged NbCs. However, the gradual evolution of the microstructure seemed to increase the ultimate tensile strength and decrease the total elongation.

Graduate

INNOVATING THE FDM PROCESS - METAL POWDER PLA PRINTING

Primary Author: Shane Terry, Mechanical Engineering (M.S.)

Advisor(s): Ismail Fidan

The process of 3D Printing is a part of the overall fabrication process known as Additive Manufacturing. As opposed to subtractive manufacturing, the 3D printing process produces far less waste with a high degree of customization. Despite the benefits, there have been troubles in widespread adoption for the manufacturing field. Industry leads often ask about mechanical properties and methods in which to additively manufacture strong metallic parts. The area of research presented in this paper is that of low-cost 3D Printing. By printing metal powder PolyLactic Acid (PLA) composite filament with approximately 90% metal concentration, a part can be fabricated on a Fused Deposition Modeling (FDM) printer that costs as little as $200 and sintered in a kiln. The sintering process removed the PLA bonding agent leaving a highly customizable 100% metal part fabricated on a low-cost printer. This current study provides the preliminary findings of the mechanical testing studies of the components fabricated via this method. The results of the analytical results received from this mechanical studies will be benchmarked with the conventionally

prepared PLA and Acrylonitrile Butadiene Styrene (ABS) components. The advantages of the current method will be presented with the currently performed experimental and analytical studies.

Graduate

DETECTION OF THE ADDITIVE MANUFACTURING IN-PROCESS FAILURES VIA DEEP LEARNING

Primary Author: Zhicheng Zhang, Mechanical Engineering (M.S.)

Advisor(s): Ismail Fidan

Today, the utilization of Additive Manufacturing (AM) is growing sharply in almost every field of daily life. And, the focus of the current studies in the field of AM is mainly focused on the development of new machines and materials. There is a limited number of technical studies on the troubleshooting, maintenance and problem solving aspects of the AM processes. Deep Learning (DL) is an emerging machine learning type which is wildly used in several research studies lately. The research team believes that the application of DL could improve the smooth operation of AM processes and help the AM machines to print very accurate objects eventually. In this study the research team proposes a newly developed DL application to avoid the waste of materials generated by the bad printing process. This study will report the nature of this newly developed DL application and how it works in several failure cases.

Undergraduate

RESEARCH IN THE IMAKERSPACE

Primary Author: Josef Bangean, Mechanical Engineering

Co-Author(s)/Collaborator(s): Blake Dempsey, Lizzy Zink

Advisor(s): Ismail Fidan

The iMakerspace helps with innovative and entrepreneurial projects that students and faculty wish to bring into reality. The space is funded by tuition fees and is free to use by any student or faculty, regardless of their major or department. The space has 3D printers, a mill, a CNC machine, and many other tools to help students to create their products. The space is currently home to 7 research projects and a total of 23 employees who either fill a leadership, research assistant, or technical role.
The iMakerspace is used by student organizations and clubs, including SEDS and ARC. SEDS is currently participating in the Intercollegiate Rocket Engineering Competition (IREC), an international competition involving a 12' high powered rocket. ARC (Autonomous Robotics Club) is a club that uses the space for their meetings and projects, one of which is Talus (Totally Autonomous Legless Useful System), which is a 3d printed human torso and will be an interactive greeter for the space that visitors can ask questions and get directions from.
The space is also used for classes, including communications and other class subjects. Pop up informational meetings are also conducted in the space for Eagle Works, a Shark Tank like competition for students to compete for funding for their start up ideas and companies.
The iMakerspace also hosts a holiday design contest to design a holiday ornament for the iMakerspace holiday tree. Many research projects from undergraduates and people outside the university are presented in the space as well.

Undergraduate

PRODUCTION OF BIODIESEL FROM WASTE VEGETABLE OIL AS AN ECONOMICAL AND ENVIRONMENTALLY BENIGN ALTERNATIVE ENERGY SOURCE AND WAY TO REUSE OF WASTE VEGETABLE OIL

Primary Author: Jeffery Bess, Engineering Technology

Co-Author(s)/Collaborator(s): Jacob Griffin, Trevor Hayes, Igbax Saanyol

Advisor(s): Ahmed ElSawy

Production of biodiesel from waste vegetable oil is an economical and environmentally benign option to use as an alternative energy source and reuse of waste vegetable oil. The main objectives of this project are to reduce the processing time, increasing the yield and the decrease the amount of catalyst for the separation of the biodiesel from the glycine. In previous work, it was found that ultrasonic processing used in biodiesel production delivers a biodiesel in excess of 95%. While reducing the amount of catalyst required by more than 50% due to the increased chemical activity in the presence of cavitation. Also, it was found in lab experiments that utilizing high voltage would reduce the biodiesel/glycerin separation time considerably. In order to automate this process, this team is building a small automated biodiesel processing unit equipped with ultrasonic processing unit and high voltage unit. The whole process sequences and minimizing human involvement during the process, a Raspberry Pi 3 because of the relative cheap cost of its automation. The design set up has 4 storage tanks, 4 pumps and sets of four flow regulators. The mix ratio used in this experiment was 4:1 to produce Biodiesel with a density of 1.26 g/cm3 and Glycerin with a density of 0.8746g/ cm3. Reaction test 27/3 and ASTM D6584 standards were the basis for this research. A 93% Yield was achieved which translates to 4.3 gallons of glycerin and 57 gallons of biodiesel.

Undergraduate

NASA HUMAN EXPLORATION ROVER CHALLENGE SENIOR DESIGN TEAM

Primary Author: Kevin Goodwin, Engineering Technology

Co-Author(s)/Collaborator(s): Thomas Houston, Gary Harris, Connor Welcome, Daulton Russell

Advisor(s): Ahmed ElSawy

This competition challenges high school and college students to construct a vehicle designed to traverse the terrain of another planet. This challenge focuses on testing the design and fabrication, and evaluating skills of each team present. This gives each team present an eye-opening experience in a real world critical thinking project. Instead of competitors facing an all-out race across difficult terrain as in the past, the challenge now mimics the opportunities, challenges and decision-making that our future planetary explorers will face in interplanetary travel. There are many rules and design regulations set by NASA, which make the race very challenging and competitive. The goals of this year's project was to create a brand new design that is much lighter, stronger, and more efficient while improving upon the success of the previous year's rovers. The team plans to put TTU on the top of the leaderboard for the 2019 challenge. Furthermore, the team is planning to win the innovation, featherweight and design competitions. Therefore, the team designed and started to fabricate a completely new and innovative rover. To achieve the teams' goals, the chassis was designed entirely of titanium with the suspension composed of aluminum tubing and light weight-more efficient pneumatic shocks. These extreme alloys provide the rover with the entire weight to strength ratio necessary to keep the weight to a minimum while retaining enough strength to withstand the harsh race environment and capability of traversing a challenging exoplanetary-like moon landscape.

Undergraduate

CRITICAL REVIEW: IMPACT OF SMART MANUFACTURING TO ENERGY SAVING

Primary Author: Brandon In, Mechanical Engineering

Co-Author(s)/Collaborator(s): Brenden Ragsdale, Shane Terry

Advisor(s): Ismail Fidan

The goal of Smart Manufacturing is to take advantage of advancements in manufacturing technologies to make manufacturing more cost effective and energy efficient. Smart Manufacturing differs from traditional manufacturing in that smart manufacturing subsystems communicate with each other to allow them to adapt and optimize the manufacturing process. This can lead into improvements in production speed and much more robust and reliable parts. Smart Manufacturing also has the ability for greater customization for parts leading to reduced costs for the consumer and higher profits. A big part of the potential cost savings that come from Smart Manufacturing can be made through adjusting older, already existing, equipment by integrating new technologies into them. This includes things such as installing sensors to get feedback and control conveyor belts, pumps, and a variety of other equipment. Overall, Smart Manufacturing is going to be the next big industrial revolution by modernizing our current manufacturing systems to increase production and bring down costs at the same time. This foundational research study is focused on the collection of the most current studies in the energy efficiency and its impact to overall cost factor in Smart Manufacturing.

Undergraduate

THE DEVELOPMENT OF A TIME AND ENERGY CONSUMPTION KNOWLEDGE BASE OF ADDITIVE MANUFACTURING

Primary Author: Billyvan Lian, Mechanical Engineering

Co-Author(s)/Collaborator(s): Carter Schunk, Shane Terry

Advisor(s): Ismail Fidan

This case study examines the process of 3D Printing and analyzes possible correlations between printing variables, and the economics of printing process. In manufacturing, there are three primary variables: energy, material consumption, and time. In order to quantify energy costs, the power consumption of the printer was measured on a Kill A Watt power logger. To calculate power consumption, initial power readings were compared with the final power readings, and the total power consumed during the printing process was the average of the two values. The parameters that were varied to quantify the material consumption were number of perimeter layers (1, 3, 5), layer height (0.1, 0.2, 0.3), infill percentage (0 25 50 75). Print times were measured outside the slicer software to improve accuracy, and turnover time is one of the most important factors when utilizing Additive Manufacturing (AM). By 3D Printing affords companies the opportunity to rapidly prototype and manufacturing highly customizable parts, this case study aims to quantify some of the most important characteristics attributed to AM.

Undergraduate

INTERNET OF THINGS (IOT) FOR LIVE MONITORING AND ANALYSIS OF 3D PRINTERS

Primary Author: Anthony Palmer, Computer Science

Co-Author(s)/Collaborator(s): Trevin Pointer

Advisor(s): Terry Guo

As the Internet of Things (IoT) continues to evolve, the need arises to keep a constant eye on the integrity of IoT implementations to ensure that everything is running as it should. This is especially true in industrial sector. Machine Health Monitoring (MHM) was created. The primary goal of MHM is to ensure that all devices within an Industrial IoT (IIoT) implementation are functioning as expected at all times. For our specific usage of MHM, we are monitoring various readings from a 3D printer. We have currently implemented an array of sensors, and a live camera feed, with an accelerometer and a power meter soon to come. We have also created a web server running

off of a Raspberry Pi 3 to hold our database and provide accessibility to the data. Through this setup, a user could access our storage and view up to the last 60 readings from the sensors in real time. The user can also view the live camera feed. We plan to use that range to implement fault detection with an alert system. We also look to eventually add predictive AI in an attempt to prevent faults before they occur. We believe our implementation provides a more cost effective and scalable architecture for MHM. It also provides large amounts of customizability and adaptability due to our usage of generalized sensor data inputs and storage. The system is also self-monitoring, providing proper detection of its own internal issues.

Undergraduate

MULTI-INSTITUTIONAL DESIGN AND MANUFACTURING PRACTICE FOR A CUTTING-EDGE BOTTLE CAP OPENER

Primary Author: Connor Welcome, Engineering Technology

Co-Author(s)/Collaborator(s): Joshua Kemper, Sinclair Community College, Dayton, OH; Thomas Singer, Sinclair Community College, Dayton, OH; Eric Wooldridge, Somerset Community College, Somerset, KY

Advisor(s): Ismail Fidan

The Universal Bottle Cap Opener (UBCO) was designed with capability and versatility in mind. This unique project targets to help aid disabled or elderly individuals with the commonly simple task of opening a bottle cap or soda can. UBCO is meant for any additive manufacturing machine to be produced on and is currently the thinnest 3D printable bottle opener with the most versatile uses requiring no support material to be utilized in its fabrication.
UBCO is completely new and different because it is truly universal by definition to every bottle/can that would currently be encountered in the US. No other design is by definition truly universal except to a particular brand name or bottle type. The ergonomic design is meant to reduce fatigue significantly on the hands and wrists of individuals with weaker muscle tissue. UBCU utilizes a single US minted penny, which is installed post printing, as a force absorber to open metal bottle caps without damaging the part or fatigue to the user.

The design, manufacturing and testing stages of this project have been managed by two other institutions other than Tennessee Tech University. Professor Thomas Singer's team at Sinclair Community College and Professor Eric Wooldridge's team at Somerset Community College have collaborated with the Tennessee Tech University team to successfully complete this project. The presentation will report the successful completion of the project with the steps from the start to end.

Department of Mechanical Engineering

Graduate

A STUDY OF HEAT TRANSPORT IN FUNCTIONALIZED NANODIAMOND SUSPENSIONS

Primary Author: Aaron Bain, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborator(s): Farzin Mashali; Ethan Languri; Jim Davidson, International Femtoscience, Inc.; David Kerns, International Femtoscience, Inc.

Advisor(s): Ethan Languri

Nanofluids, with their anomalous thermal conductivity, have attracted attention in research and industry as a novel mode of enhancing the heat transfer medium in closed loop cooling systems. Most studies conducted on nanofluids at present have relied on constitutive relations using properties of the bulk substance of the nanoparticle and the solvent to explain thermal conductivity. To utilize nanofluids in real world applications without redesigning current heat transfer equipment, stable and relatively dilute suspensions must be utilized; the method of accomplishing this is through chemical functionalization of the surface of the nanoparticle. In this study, we have sought to explain the underlying mechanisms of conductivity enhancement taking into consideration the nanoscale effects, such as ballistic transport through the nanoparticle. In tandem with a phonon theory of liquid thermodynamics, a model for explaining the effective thermal properties of the bulk nanofluid was built. The optimization of the bulk nanofluid was accomplished through comparative study of the phonon frequency distribution of the nanoparticle crystal lattice, the surface functional molecules, and liquid solvent, thereby tailoring the functional groups not only for suspension stability but also for minimizing Kapitza resistance at the surface of the nanoparticle. Density functional theory simulations in CASTEP paired with non-equilibrium molecular dynamics were used to verify solutions of the diffuse mismatch model of phonon transport and demonstrate suspension stability of the nanoparticle solution with chosen surface functional groups.

Graduate

COGENERATION FOR MANUFACTURING INDUSTRIES

Primary Author: Divya Jaladi, Engineering (Ph.D.)

Co-Author(s)/Collaborator(s): Aaron Bain

Advisor(s): Ethan Languri

Fossil fuels usage is accelerating the problem of global warming and leading to major climatic changes and utmost usage of these fuel accounts for energy generation. This usage cannot be minimized until a renewable alternative completely replaces their job, but can decreased with necessary techniques. Co-generation by combined heat and power is one such practice making better use of fuel by electricity production and simultaneous use of heat recovering from the process. Conventional power plant or on-site grid with boiler generates less than half of output from the consumed fossil fuel energy input. Whereas, CHP increase the output efficiency on-site by making better use of fuel burnt by enhancing energy resiliency. This work shows, based on what factors CHP can be considered for manufacturing and other facilities, what can be facilities payback period based on their utility charges. And manufacturing entities suitability for converting from the conventional grid or supplementing electricity provided from local utility to more efficient CHP system.

Graduate

VORTEX-INDUCED VIBRATIONS OF FLEXIBLE, BUOYANT, THREE-DIMENSIONAL BLUFF BODIES FOR ENERGY CONVERSION-STORAGE APPLICATIONS

Primary Author: Cody Long, Mechanical Engineering (M.S.)

Advisor(s): Ahmad Vasel-Be-Hagh

While the engineering community is making leaps and bounds in the renewable energy area, several issues remain. Some of the most prevalent issues are intermittence and low efficiencies. To overcome these challenges, one of the solutions used is implementing integrated storage. Several different types of integrated storage technologies have been proposed. These technologies were thoroughly reviewed, and their performance was compared against each other as the first phase of this research. Then, the Storage-integrAted Vortex hydro Energy converteR (SAVER) was introduced.

At the heart of SAVER, flexible, buoyant, finite cylinders, namely accumulator-converters, serve as both energy accumulator and energy converter modules. These cylinders store energy in the form of potential energy of compressed air while extracting kinetic energy of underwater currents via vortex-induced vibrations. These linear vibrations drive a generator through a crank-shaft mechanism. The unit will utilize the generated energy to overcome the losses that occur during the energy conversion processes. SAVER has been mathematically shown to have a round-trip efficiency upwards of at least 80%.

To develop the most effective design for this technology, one needs to have a deep understanding of vortex-induced vibrations of the accumulator-converters, which are flexible, deformable, buoyant, finite (introducing the end effects), and affected by turbulence boundary layers. This very complex and fundamental fluid-structure problem has not been studied yet and the literature is mainly focused on vortex induced vibrations of rigid bluff bodies. The main purpose of this research is addressing this gap using numerical simulations in concert with laboratory experiments.

Graduate

A PARTICULAR NANODIAMOND SUSPENSION FOR THERMAL MANAGEMENT

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

Advisor(s): Ethan Languri

In this study, a particular diamond nanoparticle is examined as a low concentration additive to conventional liquid coolants such as water, ethylene glycol, and mineral oil to enhance their thermal capability while aiming not to cause major disruption in the viscosity or the pressure drop through the heat exchanger in a heat transfer apparatus. The suspensions of de-aggregated and functionalized nanodiamond (nanofluids) are prepared, in such a way that the functional groups on the nanoparticle surface are intended to have their terminal chemical bonding coupled with the base fluid molecules (the host matrix), can be resulting in their operational improvement. The exigency of appropriate de-aggregation and compatible surface chemical modification of the diamond nanoparticles to achieve successful outcomes in heat transfer enhancement, efficient cooling and energy saving is addressed. Microstructural and thermo-electrical characterization, particle size distribution and rheological behavior, as well as, the convective heat transfer performance in an experimental setup destined for electronic cooling are investigated.

Graduate

ELECTROMECHANICAL IMPEDANCE BASED STRUCTURAL HEALTH MONITORING DURING A DYNAMIC EVENT

Primary Author: Eric Nolan, Mechanical Engineering (M.S.)

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

Advisor(s): Steven Anton

Structural health monitoring (SHM) is a relatively new field with many applications in static and dynamic structures. The capability to develop SHM systems to operate in the microsecond timescale during highly dynamic events has been a focus with applications from mining to aerospace industries. One of the potential solutions is creating an impedance measurement system using the electromechanical impedance (EMI) method. EMI measurements have traditionally been performed using an impedance analyzer such as the HP-4194A, however these systems are inadequate due to their slow measuring speeds. Other methods of measuring impedance have been developed which offer a dramatic decrease in the time of measurement and other benefits such as decreased size and cost. In this study, a previously developed test stand at the Dynamic and Smart Systems Laboratory at Tennessee Technological University was utilized to investigate the ability of the EMI method to monitor a dynamic event caused by an impact of a pneumatically actuated striker bar against a beam bonded with a piezoelectric disk. The dynamic response of the beam and impedance during the impact are studied experimentally, and a finite element model of the experiment is studied to better understand the propagation of elastic waves at different impact velocities. Preliminary results indicate a change in impedance at impact , but further research is necessary to determine if this change is due to the change in boundary conditions (added mass of the projectile) or simply a result of the impact waves in the system because of the impact.

Graduate

DETECTION OF ASEPTIC LOOSENING IN TOTAL KNEE REPLACEMENTS USING IMPEDANCE BASED STRUCTURAL HEALTH MONITORING

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

Co-Author(s)/Collaborator(s): R. Michael Meneghini, Indiana University School of Medicine

Advisor(s): Steven Anton

Total knee replacements (TKR) remain an important orthopedic procedure for patients with osteoarthritis. Though TKR can allow these patients to regain their mobility, some will experience failure of their TKR. The most common cause of TKR failure is aseptic loosening. Aseptic loosening usually describes mechanical loosening between the tibial component of the TKR and the underlying tibial bone. Two modes of failure often cited when discussing aseptic loosening include separation between the implant and underlying bone cement as well as separation between the bone cement and underlying bone structure. It is the interest of the medical community that a method be developed for detecting loosening before it becomes a hazard to the patient. Previous efforts at the Dynamic and Smart Systems Lab at Tennessee Technological University have identified the electromechanical impedance (EMI) method as capable of detecting damage in a biomedical environment. The current work builds on previous research in order to determine if loosening, as caused by the two previously mentioned failure modes, can be identified via the EMI method. In this study, geometrically realistic test samples comprised of artificial bone and an actual TKR tibial component are constructed in order to represent healthy, weakened, and failed TKR systems. These test samples are

evaluated using a novel algorithm which quantifies changes in the impedance spectrum. The results of this work are intended to lay a comprehensive foundation for future work in loosening detection using impedance based structural health monitoring.

Graduate

STUDY OF MUSHY ZONE CONSTANT IN SOLIDIFICATION/MELTING MODEL TO DETERMINE THE OPTIMUM VALUE

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

Co-Author(s)/Collaborator(s): Evan Kixmiller

Advisor(s): Ethan Languri

The solidification/melting model is employed in various commercial softwares and applied for different applications which include the solidification or melting. The phase change material (PCM) are used in a variety of heat storage applications and there has been a significant research in the recent years to develop an effective thermal energy storage system. In the numerical analysis, the solidification/melting of PCM is modelled using enthalpy-porosity method in which mushy zone constant is an important factor. The mushy zone constant is varied from 104 to 106 to determine the optimum value for the PCM material in this study. The numerical analysis is performed using ANSYS Fluent 18.1. The PCM used in this study is a paraffin and has a melting point of 48 °C. The melting and solidification of the PCM is studied and compared with the experimental results. This study aims to determine the optimum value of mushy zone constant in the enthalpy-porosity method for PCM.

Graduate

FINITE ELEMENT SIMULATION OF HIGH FREQUENCY ELECTROMECHANICAL IMPEDANCE MEASUREMENTS FOR STRUCTURAL HEALTH MONITORING

Primary Author: Mohsen Safaei, Engineering (Ph.D.) (Mechanical Engineering)

Co-Author(s)/Collaborator(s): Eric Nolan

Advisor(s): Steven Anton

Structural health monitoring (SHM) techniques have been widely used to detect changes in the state of structures to avoid sudden failure in engineering systems. Electromechanical impedance (EMI)-based techniques have shown a promising potential in SHM applications due to active sensing capabilities, which can provide engineers with the ability to detect incidence and existence of flaws, track propagation of damage, and measure the dimension and location of defects. The EMI technique utilizes piezoelectric transducers as the active element to perform simultaneous actuation/sensing on the host structure. While the EMI method presents its best performance in kHz frequencies, the application is limited in MHz frequencies. In this study, using a combined experimental and simulation approach, the sensitivity of an example structure to high frequency, MHz EMI measurements is evaluated. Initially, a test setup including a piezoelectric ceramic bonded on an aluminum cantilever beam is prepared and the impedance is measured using an HP 4194 impedance analyzer. Adding damage to the structure, the impedance measurements are repeated and results are compared to the healthy condition. In addition, a finite element (FE) model is created to obtain a better understanding of the measurements and the effective parameters on the impedance of the piezoelectric element. The FE model is first tuned by characterizing the piezoelectric material properties using a FE-based

optimization process. The final model is compared to the experimental measurement and the findings are discussed in order to develop strategies to extend the application of EMI-based SHM using piezoelectric transducers to MHz frequency ranges.

Undergraduate

EFFECTS OF COATINGS ON SURFACE ROUGHNESS OF NICKEL BASED ALLOYS PRODUCED BY ADDITIVE MANUFACTURING

Primary Author: Will Buida, Mechanical Engineering

Co-Author(s)/Collaborator(s): Giovanni Mainardi Neto, Brian Bates

Advisor(s): Ying Zhang

Alloys that have been produced using additive manufacturing techniques have rougher surfaces compared to samples that were produced by other means. A variety of post-manufacturing processes are being investigated to improve surface roughness. The focus of this research is to investigate the effects of two coating processes on the surface roughness of nickel-based alloys fabricated by electron beam melting. To measure surface roughness of alloys, images are taken of a cross-sectioned sample and processed in ImageJ where a plot of the surface can be produced. This plot can then be used to calculate a roughness value. These values can be compared to a sample that has not been coated.

Undergraduate

INVESTIGATION OF MECHANICAL BOUNDARY CONDITIONS ON IMPEDANCE BASED STRUCTURAL HEALTH MONITORING IN A BIOMEDICAL ENVIRONMENT

Primary Author: Nathan Ghattas, Mechanical Engineering

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

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

Advisor(s): Steven Anton

The purpose of this research is to test the feasibility of the electromechanical impedance (EMI) method, to detect damage under different boundary conditions found inside of a typical total knee replacement (TKR) system. This is achieved by creating a test setup that is able to replicate the basic properties of a typical TKR using materials similar to those in a true system, including simulated bone material, bone cement, and a metallic knee replacement component. In order to determine if the EMI method can be used in an environment that includes the loads present in a knee, two bearings are designed: one that transfers the axial knee load directly to the PZT, and one where the axial knee load bypasses the PZT and flows directly to the underlying sample. The impedance is analyzed at different axial knee loads. Damage is inflicted upon the test setup by removing a portion of the bone cement between the metallic component and synthetic bone, and the same tests are run under the damaged conditions. The impedance is then compared for undamaged and damaged conditions when the load is transferred to the PZT and when the load bypasses the PZT and is transferred to the sample in order to test the validity of the EMI method for damage detection under loaded conditions. Then the impedance is compared between the two load conditions first in the undamaged case then in the damaged case in order to validate static force sensing.

Undergraduate

BIO-INSPIRED THERMAL STORAGE SYSTEM USING PHASE CHANGE MATERIAL

Primary Author: Spencer Hammons, Mechanical Engineering

Co-Author(s)/Collaborator(s): Vinit Prabhu

Advisor(s): Ethan Languri

Significant improvement in the performance of utilities and limiting the use of energy during peak load periods is essential due to the high cost of energy during this time. The thermal energy storage (TES) systems are useful in utilizing the excess thermal energy during non-peak load time by effective storage and supply of 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 phase change materials inherently have low thermal conductivity which reduces the response rate of the system. In order to overcome this, the TES is designed with high aspect ratios i.e. surface area to volume ratio. This TES is inspired from the biological systems found in nature such as elephant ears, venation of leaves etc. The TES system is modeled for numerical analysis using ANSYS Fluent 18.1 and 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.

Undergraduate

FEASIBILITY OF 3D PRINTED FORCE SENSING INSOLES FOR USE IN PLANTAR PRESSURE DETECTION

Primary Author: Samuel Worley, Mechanical Engineering

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

Advisor(s): Steven Anton

Analysis of human locomotion has substantially furthered orthopedic medical knowledge. Measurement of forces in gait analysis has historically been collected via force plates. Recent studies have investigated force sensing insoles as an alternate method that shows potential. There are, however, limitations to current sensing insoles, such as most being “one size fits all” solutions. While many patients can be accurately measured with generalized insoles, some foot shapes, with features like diabetic ulcers, require ergonomically customized insoles for acceptable plantar pressure analysis. 3D printing with flexible materials, e.g. NinjaFlex, shows potential through customizable insoles in which force sensors can be directly embedded during fabrication. This research investigates the development of customizable force sensing insoles by exploring the ability of embedded sensors to detect forces in a simplified setup: a cylindrical disc. Three types of force sensors are investigated, and their resolution and error are compared. A simple analytical model is developed to analyze the system. Prior research in the Dynamic and Smart Systems Laboratory at Tennessee Tech found error under normal walking plantar pressure at undesirable levels for the original design. Therefore, in this work, a harder disc printed with polylactic acid (PLA) is placed on top of the sensor to improve force transmissibility. This study compares the performance of the revised design to the original design, with the overall intention to prove the ability of a custom force sensing insole that can improve research in the field of orthopedics.

Undergraduate Research and Creative Activity (URECA!) Program Award Recipient

Abstracts

College of Interdisciplinary Studies

School of Environmental Studies

Undergraduate

GIS ANALYSIS OF ILLEGAL DUMPING IN THE UPPER CUMBERLAND AND RECOMMENDATIONS FOR ABATEMENT

Primary Author: Melody Culver, Environmental and Sustainability Studies

Co-Author(s)/Collaborator(s): Jordan Durham, Savannah Shanklin, Mike Bolan, Phillip Fox

Advisor(s): Steve Sharp

Students in the Environmental and Sustainability Studies Capstone Experience 1 and 2 courses have prepared recommendations for the Upper Cumberland Development District (UCDD) to address illegal dumping in the 14 counties of the Upper Cumberland. The purpose of this study was to compile the best available information and to characterize dumpsites for analysis and decision making. In Capstone 1, teams conducted literature reviews for the associated sociological, economic, and environmental issues and compiled a white paper discussing the motivations for illegal dumping, benefits and costs of abatement, environmental and health effects of dumping, best practices for educating and motivating children and adults, helpful data management and grant strategies, and best practices for discouraging and preventing dumping. Our Geographic Information System (GIS) team produced an ESRI ArcGIS map and evaluated dumpsites across counties to create a standardized form for collection of characterization data. Using coordinates provided by Chuck Sutherland, Director of Informatics for the UCDD, Capstone 2 traveled to sites to characterize them by content, area, volume, and location. We documented coordinates for additional illegal dumpsites we discovered, and created a more detailed database. We also used GIS capabilities to combine spatial and aspatial information to identify trends and common characteristics of dumpsites. The material will be provided to the UCDD and can be used by government officials, the public, and researchers to develop prediction algorithms and to inform policy decisions. Capstone 2 is also planning a cleanup and researching grant opportunities applicable to illegal dumping in the region.

Abstracts

Whitson-Hester School of Nursing

Undergraduate

WHO IS TALKING TO THE SEDATED PATIENT?

Primary Author: Brooke Powell, Nursing

Advisor(s): Susan Piras

The Society of Critical Care Medicine estimates that 5.7 million people are annually admitted to the Intensive Care Unit (ICU); 20-30% require mechanical ventilation and some level of sedation. The literature strongly supports that sedated patients benefit emotionally and physiologically from verbal communication. Although nurses provide 92% of bedside patient care in the ICU and report that verbal communication with the patient is important, research suggests nurses struggle to communicate with ventilated, sedated patients.
I conducted a literature review to explore the potential gap between nurses' perceptions and practice regarding the phenomenon of speaking to sedated patients in the ICU. Baker and Meley (1996) found that 4 out of 5 critical care nurses considered verbal communication with sedated patients 'very important'. However, observation of these nurses' patient care over 4 hour periods revealed that verbal communication only accounted for 5% of that time. Elliot and Wright (1999) found that a majority of verbal communication consisted of explaining procedural tasks and interventions.

Later findings of Alshraideh and Ahmad (2004) show that lack of consistent verbal communication continues among nurses.

Mona and Sahar's (2015) quasi-experimental study demonstrated a correlation between using a structured communication message and a decrease in length of mechanical ventilation as well as length of stay in the ICU. The literature supports a persistent gap between nurses' beliefs about the need for communication with the sedated patient and nurses' demonstrated clinical practice. Further investigation into the identified barriers and facilitators of talking to sedated patients is warranted.

Undergraduate

WHAT ABOUT THE CHILDREN?

Primary Author: Ashley Stafford, Nursing

Advisor(s): Susan Piras

Since 9/11 and recent major natural disasters, research literature as become abundant in disaster preparedness. Most disaster preparedness research focuses on the general population, but what about the children? This paper is a focused accumulation of the current research in disaster preparedness of children. Most of the articles chosen pay particular attention to the preparedness of emergency responders, nurses, and other healthcare personal to care for the pediatric population during times of emergencies and disasters. While the rest of the articles spotlight the importance of having a pediatric disaster care plan in place. At the end of the review of the literature there is a write up that explores the current pediatric disaster plan in Cookeville, TN and how it compares to the research.

Undergraduate

THE LOST MALE PARTNER IN THE POST ABORTION EXPERIENCE

Primary Author: Taylor Summers, Nursing

Advisor(s): Susan Piras

Approximately one in four women in the US have an abortion (Jones, 2017). Recent studies addressing the post abortion period have documented the involved parties re-experiencing the abortion, avoiding pain caused by the event or developing feelings of guilt or anxiety. These symptoms are termed post abortion syndrome (Speckhard, 1992). There is an abundance of literature surrounding post abortion syndrome experienced by the woman; however, the literature is slowly recognizing the effects of abortion on the male partner. Nearly fifty percent of men in a longitudinal study experienced relief and happiness with their partners' decisions to abort, when surveyed at four and twelve months post abortion (Kero, 2004). In a case study addressing one male's experience after discovering his partner had an elective abortion, the participant voiced feelings of "voicelessness and worthlessness." It was recommended that male partners be offered counseling resources post abortion in addition to the female (Holmes, 2004). A literature review of men's experiences surrounding abortion largely evaluated the subjects during or twelve months after the abortion experience and discovered a spectrum of feelings from relief to grief and sadness (Coyle, 2007).

In addition to the robust data from the literature, I interviewed a local clinical expert in the field, the expert stated that post abortion syndrome signs and symptoms were not commonly observed until five to ten years post abortion. The existing research needs to be further expanded to allow for a post abortion syndrome timeline equivalent to what experts witness in the field.

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Research Day 2018

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 have made substantial contributions to strengthening the nation's technological workforce. By highlighting the national importance of technological innovation, the medal 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."

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