2021 RESEARCH & CREATIVE INQUIRY DAY

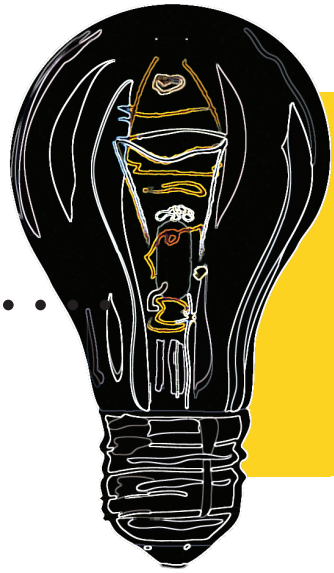
April 2021

16TH ANNUAL EVENT

Tennessee TECH

Proceedings

tntech.edu/research/research-day



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Tennessee TECH

tntech.edu/research/research-day

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;

NOW, THEREFORE, I, Bill Lee, Governor of the State of Tennessee, do hereby proclaim April 6 – April 10, 2021 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 seventeenth day of February, 2021.

Bill Lee

Governor

Tre Hargett

Secretary of State

Foreword

The Office of Research and Economic Development welcomes you to the 16th Annual Research and Creative Inquiry Day. This event provides an opportunity to showcase student research and creative inquiry projects from colleges and 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.

Due to the ongoing pandemic, the 2021 Research and Creative Inquiry event utilized a joint virtual and digital format. Digital files of the posters and papers were submitted and provided to judges and also to the campus community for general viewing. Interactions between judges and students occurred via video conferencing, and the event culminated in a virtual award ceremony.

In recognition of the contributions made by 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 April 6-10 as "Graduate Education Week."

This year's event features posters and papers generated from 220 submitted abstracts on topics as varied as the 22 fields of study from which they originate.

Congratulations to the students and faculty advisors who have worked hard to prepare 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

Information Technology Services, Library Services, Office of Communications and Marketing, Office of Creative Inquiry/QEP, Printing Services, Student Services

We would like to extend a special thanks to Kristen Deiter, associate professor of English, for coordinating the paper portion of the event and to Holly Mills assistant professor in the Volpe Library, for providing poster-design resources.

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

In conjunction with this year's event, you are invited to view three creative media inquiry projects that are available on the event web page at tntech.edu/research/research-day/index.php. These videos were developed in the Social Problems (SOC 1650) class taught by Ada Haynes, professor of sociology, during the fall 2020 semester. During this course, students explored a social problem through research with a creative inquiry and sociological lens and as part of the QEP-sponsored redesign of the course, developed creative projects displaying an effective media campaign that promoted awareness and/or offered an innovative solution to the social problem studied. Three videos were selected for inclusion in this event. Abstracts for the three video projects can be seen on page 57.

We are excited to have two posters from the Women and Gender Studies program as a new feature of this year's event.

#researchday2021

Schedule of Events

The 16th Annual Research and Creative Inquiry Day

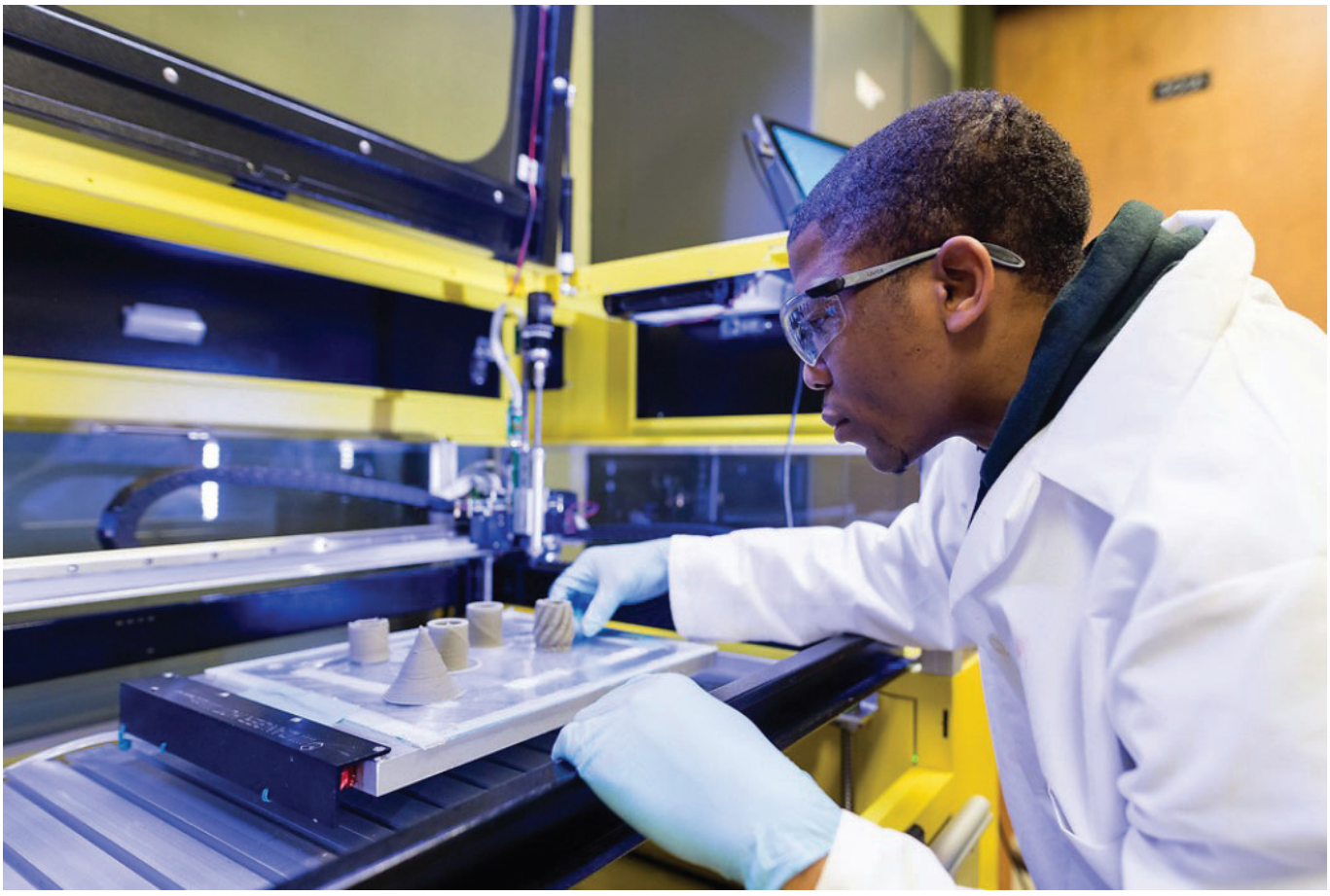
Due to the developments regarding the Novel Coronavirus (COVID-19), the 2021 Research and Creative Inquiry event will be held in a digital format. The following is the event timeline based on that platform:

Monday, April 12: Deadline for participants to submit a PDF file of their poster/paper.

April 13-16: Judges evaluated posters/papers based on evaluation forms posted on the event website.

11 a.m. to noon, Tuesday, April 20: Virtual award ceremony

A SharePoint site will be set up for all posters (for students who opt in during registration), so that the campus community can view them until the end of the semester. This availability will be advertised in *Tech Times* and via the student and faculty listservs.



2021 Judges

Melinda Anderson – Human Ecology
Holly Anthony – Curriculum and Instruction
Steve Anton – Mechanical Engineering
Joseph Asante – Earth Sciences
Megan Atkinson – University Archives
Jeremy Blair – Art, Craft, and Design
Wayne Blaylock – Tennessee Tech Alum (Dow Chemical)
Dolores Bowman – Nursing
Chris Brown – Biology
Nathan Bryant – Tennessee Tech Alum
Sid Bundy – Accounting
Derek Cashman – Chemistry
Rufaro Chitiyo – Human Ecology
Scott Christen – Communication
Oana Cojocaru – Chemistry
Janet Coonce – Chemistry
Kristen Deiter – English
Steve Desirey – Tennessee Tech Alum (DuPont Company - retired)
Dennis Duncan – Agriculture
William Eberle – Computer Science
Robert Engelhardt – Physics
Ismail Fidan – Manufacturing and Engineering Technology
Julia Gruber – Foreign Languages
Ann Hellman – Nursing
Nicole Henniger – Counseling and Psychology
MacKenzie Hodge – Tennessee Tech Alum
Adam Holley – Physics
Hope Holt – Tennessee Tech Alum (University of South Carolina)
Maria-Cristina Humita – Foreign Languages
Samantha Hutson – Human Ecology
Muhammad Ismail – Computer Science
Stephanie Jorgensen – Chemical Engineering
Elena Kazakova – Foreign Languages
Stephanie Kazanas – Counseling and Psychology
Mary Kidd – Physics
Duckbong Kim – Manufacturing and Engineering Technology
Ethan Languri – Mechanical Engineering
Leora Loftis – Pace Analytical
Parker Lusk – Tennessee Tech Alum (Nashville Chemical)
Allen MacKenzie – Electrical and Computer Engineering
Satish Mahajan – Center for Energy Systems Research
Colleen Mestayer – Communication
Lauren Michel – Earth Sciences
Robin Mickelson – Nursing
Holly Mills – Volpe Library
Ben Mohr – Civil and Environmental Engineering
Jonathan Moldenhauer – Chemistry
Gene Mullins – Chemistry
Justin Murdock – Biology
Nikki Panter – Biology
Avinash Paruchuri – Manufacturing and Engineering Technology
Richard Pirkle – Biology
Mustafa Rajabali – Physics
Chad Rezsnyak – Chemistry
Susmit Shannigrahi – Computer Science
Martin Sheehan – Foreign Languages
Cara Sisk – Human Ecology
David Smith – Mathematics
Doug Talbert – Computer Science
Sandra Terneus – Counseling and Psychology
Denis Ulybyshev – Computer Science
Hannah Upole – Human Ecology
Daniel VandenBerge – Civil and Environmental Engineering
Charles VanNeste, Electrical and Computer Engineering
Ahmad Vasel – Mechanical Engineering
Robert Wilbanks – Accounting
Dewayne Wright – Communications and Marketing
Matthew Younglove – Music

Abstracts

College of Agriculture & Human Ecology

School of Agriculture

Undergraduate

THE IMPACT SOCIAL CAPITAL HAS ON COMMUNICATION WITHIN EXTENSION EDUCATION

Primary Author: Lisa Ellis, Agriculture

Advisor(s): Dennis Duncan

Social capital is important within all communities – rural and urban, and especially important in Extension education. Social capital is defined as the network among people within a given community/society that work together for the common good. Extension personnel serve communities/societies through educational programming and support networks. More specifically, Extension education is an outreach program that provides non-formal education and learning activities to homeowners, youth, and agriculture producers. Therefore, strong communication; informed educational programming will be more impactful in communities/societies where social capital is increased. Social capital is important in rural areas – it has the potential to create opportunities within smaller communities that would not be as likely. With strong social capital, education and communication will be increased between the local Extension office and the community. This may lead to enhanced 4-H youth development, improved agriculture and natural resource practices, and more impactful and effective family and consumer sciences programming. Through a met-analysis of the literature published the past 20 years on the effects of social capital on rural communities/societies shows that there will be more community involvement associated with church groups, 4-H, county fairs, county events, and extension education courses. According to research, without the trust and communication between community leaders and the citizens of the community: there will not be an increase in social capital and the community will work against one another. Results can include lack of community support and involvement through expenses, volunteerism, and education.

School of Human Ecology

Undergraduate

HIGHER EDUCATION READINESS AFTER PUBLIC OR PRIVATE SCHOOL

Primary Author: Morgan Agee, Human Ecology

Advisor(s): Rufaro Chitiyo

To what extent does private schools prepare you for higher education? The two main ways to obtain grade school education is through public or private schools. Anyone can go to a public school zoned for you. Private schools you have to pay and get accepted for, like colleges. Private schools hold a higher standard and have a very stereotypical opinion about them. Studies show that this might not always be the case. Private school often push their "better preparing" agenda, but how much better does it really prepare students for college/higher education? In this research paper, I will be sharing studies done that look into how students perform after different types of grade school education. We will also be looking into what extent it betters students, if any. Include studies as to prepared they are for life in general after grade school. As well as if private schools do better prepare, then why? This paper will overall show to the extent to which private school prepares students for higher education.

Undergraduate

CORRELATION BETWEEN SCHOOL GARDENS AND NUTRITION EDUCATION FOR MIDDLE SCHOOL STUDENTS

Primary Author: Loren Alcorn, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a correlation between school gardens and nutrition education for middle school students? Many students rely on school lunches to avoid going hungry throughout the day. There are specific standards that schools must meet when providing lunch to students, but are these students actually benefitting from these regulations? By implementing a school garden, students would learn how to grow their own foods and vegetables, be introduced to new foods, and learn the benefits of different foods on their body and health in an interactive way. The schools could then incorporate the foods grown in the garden into the lunches that are prepared for the students in the cafeteria. Evidence shows that having more access to fruits and vegetables increases the amount consumed. It may also improve better eating habits and may change the way students feel about healthy foods. Research also shows that there is a lot of waste from school lunches. This waste could be from students not liking the food provided but are required to get, depending on the program they are enrolled in. The different programs, free or reduced price lunch, require students to get certain foods and students may not normally eat those foods at home or may have never been introduced to those foods before, thus creating a lot of wasted food. This waste could possibly be reduced by providing students with proper nutrition education and by interacting with new foods through a school garden.

Undergraduate

OBESITY INTERVENTIONS AMONG ADOLESCENTS AND CHILDREN

Primary Author: Hailey Angel, Human Ecology

Advisor(s): Samantha Hutson

The purpose of this review of literature was to examine the effectiveness of both school and home-based interventions in preventing obesity among the children and adolescent population. Childhood obesity has become a serious health concern in this population. In the United States, the percentage of children and adolescents who have been affected by obesity has more than tripled since the 1970's. Many children and adolescents are at risk for poor health

throughout their lifetime, due to developing obesity at a young age. The research examined in this literature review focused on the effectiveness of interventions that took place in the home and school settings. It has been shown that including parents in an intervention is vital for childhood obesity treatment because parental obesity has been linked to adolescent obesity. While interventions that take place in the home are important, it is may also be beneficial for children and adolescents to receive proper interventions at school. It is vitally important for children and adolescents to receive the appropriate intervention for obesity at this time in their lives. Whether it be in the child's home, if the resources are available to them, or if the individual lacks proper assistance from the home, being able to receive the intervention in a school setting can help prevent adult obesity-related morbidity and decrease the risk of future chronic health conditions.

Undergraduate

THE CORRELATION BETWEEN MENTAL ILLNESSES AND EATING DISORDERS

Primary Author: Reagan Baker, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a correlation between mental illnesses and eating disorders? Eating disorders are not a topic a lot of people talk about. Usually, if it is talked about it is short and not a lot of information is given. With anorexia, bulimia, and binge eating goes into the clinical description, theories of etiology, diagnostic signs, and treatment. For example, antidepressants, antipsychotics, and appetite stimulants are all medications that can help the treatment strategy (Williamson et al., 2004). Eating disorders treatments undergo psychotherapy, biological, and cognitive-behavioral therapy (Williamson et al., 2004). Psychotherapy is where the problems are addressed, and helped identified . Biological therapy is where the genetics are examined to contributing the development of eating disorders. Cognitive-behavioral therapy is where the actual fear of the patient's body image is challenged into a rational mind set to eating and weight (William et al., 2004). The model used for the initial assessment was inpatient where the BMI is measured below 17, medical problems, failure of treatments; partial hospitalization, where BMI is between 17-19, no medical or psychiatric issues, rapid weight lost; intensive outpatient, where BMI is lower than 19, motivation for treatment, and social support; and outpatient treatment, where there is motivation to prevent relapse, and BMI is above 19 (Williamson et al., 2004). Anorexia nervosa is best treated with medical stabilization, bulimia nervosa is best treated with outpatient therapy, and binge eating disorder is best treated by pharmacotherapy and psychotherapy treatments (William et al., 2004).

Undergraduate

FOOD INSECURITY ON ADOLESCENT DEVELOPMENT

Primary Author: Ashton Brown, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a correlation between food insecurity and adolescent development? Food insecurity can have a negative impact on the health of many children across the United States as well as our world. Food insecurity exists when people don't have access to safe and nutritious foods to meet nutrient needs and maintain a healthy lifestyle. The research I reviewed for this project defines the food insecure as people who are not able to meet their nutrient needs because of the circumstances they are under and it also shows existing correlations between food insecurities and adolescent development. This review will explore the correlations between food insecurity and the physical, social, emotional, and cognitive development in adolescents. Searching using key terms like 'Food insecurity', 'Food insecurity and health outcomes', and 'Food insecurity and development' led to articles that provide supporting evidence of this correlation. If there is a correlation between food insecurity and developing

adolescents then further research can examine how to reduce food insecurity in order to have more positive developmental outcomes for developing adolescents. In conclusion, this review will explore a possible relationship between food insecurity and adolescent development in order to lay a foundation for future research aimed at improving the lives of growing children in the adolescent phase of development.

Undergraduate

DIY PROJECTS WITHIN THE HOME TO HELP THE ENVIRONMENT

Primary Author: Morgen Burris, Human Ecology

Co-Author(s)/Collaborators: Kendall Brantley

Advisor(s): Hannah Upole

During the current pandemic there is a growing need for DIY projects while people are confined at home. This research is an examination of the likelihood that consumers will DIY their homes instead of buying everything new. Upcycling in a sustainable way is definitely achievable if done properly. Jane Milburn states, “Slow clothing is about thoughtful, ethical, creative, and sustainable ways to enjoy clothes while minimizing our material footprint. Slow clothing manifests through ten simple actions—be thoughtful, treasure natural, buy quality, support local, have few, care, make, revive, adapt, and salvage” (Milburn, 2017, p. 2). A case study done by The Design Society also proved that it is possible to use upcycled materials in the home in a functional way (Ali et al., 2013, p. 4). For example, a consumer can turn old wooden pallets into a bed frame or wall art. Most often consumers DIY or upcycle to show creativity or individualism. Another willingness to upcycle is to seek savings (Wolf, 2011, p. 5). For example if a consumer can not find the specific product they are looking for then they will DIY it. This research explores new options for utilizing textile waste within the industry to create new and recycled home decor products.

Undergraduate

THE BENEFITS OF INCREASED FUNDING FOR THE NATIONAL SCHOOL LUNCH PROGRAM IN ELEMENTARY SCHOOLS

Primary Author: Kaylee Case, Human Ecology

Advisor(s): Rufaro Chitiyo

The National School Lunch Program (NSLP) in the United States exists to provide lunches to students in both public and private schools. Funding is dispersed among participating school systems. However, there is not enough funding given to schools, so schools are not able to provide a variety of nutrient-dense lunches, which then leads to lunches not being filling enough for students. The studies used for reference in this essay describe the benefits the NSLP has on student health, and support the claim that increasing funding for the NSLP will have a positive outcome on student health. Searching the keywords “NSLP funding”, “NSLP benefits”, “food insecurity”, and “NSLP nutritional standards” led to research articles that measured and assessed the benefits of the NSLP. This leads to the hypothesis that increasing funding for the NSLP will continue to result in beneficial outcomes for students; the research indicates that students will lead healthier lives with a lowered risk of disease. In conclusion, this essay will explore the data and will further support the needs and benefits of increasing the funding for the National School Lunch Program.

Undergraduate

PARENTING STYLES AND THE ASSOCIATED HEALTH OUTCOMES IN CHILDREN

Primary Author: Alyssa Colson, Human Ecology

Advisor(s): Samantha Hutson

Several studies over the last decade have provided data

linking child health outcomes and eating behaviors to parenting styles. Because childhood obesity continues to be an issue in the United States, and obesity is a major contributor to the development of comorbidities, many researchers have conducted studies that aim to identify environmental variables that may impact health outcomes in children. The purpose of this review of literature was to identify which parenting styles were associated with positive or negative child health outcomes, and which behaviors exhibited by these parenting styles affect health outcomes. The four parenting styles: authoritative, permissive, authoritarian, and uninvolved, can be distinguished by the amount of nurturing and demandingness each display. Studies that examined parenting styles, specific parental behaviors, food restrictions, and eating patterns in relation to child health outcomes were utilized to determine outcomes. The review of data concluded that parenting styles, and more specifically, specific parenting behaviors shared a strong relationship with child health outcomes. Permissive parenting was found to be associated with higher body mass index (BMI) in children when compared to other parenting styles. Authoritative and authoritarian parenting resulted in higher Dietary Approaches to Stop Hypertension (DASH) scores. Positive food modeling, avoiding pressuring children to eat, preparing home cooked meals, and restricting the over consumption of calorie-dense foods or foods that could be considered unhealthy when over consumed are all specific behaviors that need more research to determine the correlation with child health outcomes.
Undergraduate

THE RELATIONSHIP BETWEEN SOCIAL MEDIA AND TEENS' EATING HABITS

Primary Author: Tyler Dill, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a relationship between social media and teens' eating habits? The goal for this research is to help teens be able to discern reality from fake on social media and stay safe from harmful eating habits that can be promoted by social media. Methods for this research include writing down my own questions and then searching for reputable articles and studies based on my questions. It is arguable that social media impacts our decisions and social norms whether it be for a teenager or an adult. Magner (2018) discussed the shift in the way kids socialize because of social media. Is this all bad? that is what I will be delving into in my research. So, it is clear that social media is impacting the upcoming generation and their eating habits. Many social media posts contain fancy filters and have been edited to make someone look more desirable; this results in younger people with brains that are not fully developed disliking the way they look. If a teenager is in this situation and does not like their body because of how social media makes them perceive themselves, then it can force them into doing extreme things with their diet such as cutting calories to harmfully low levels. Sometimes even developing eating disorders that can cause deficiencies in their diet that may be irreversible.

Undergraduate

PHYSICAL ACTIVITY'S IMPACT ON ACADEMIC ACHIEVEMENT IN SCHOOL-AGED CHILDREN

Primary Author: Chase Eldridge

Advisor(s): Samantha Hutson

Physical activity is an integral part of wellness, but does it have an impact on academic outcomes? The purpose of this review of literature was to examine the relationship between physical activity and academic outcomes in school aged children. School has become a propagator of sedentary life-style de-emphasizing the importance of physical activity. The current recommendations from physical activity are one hour per day. A literature review was conducted in order to gain understanding of the relationship between physical activity and academic

outcomes. Search terms used included: physical activity and academic performance, physical activity and its impact on academic achievement, and physical activity and its impact on academic outcomes for school aged children. Physical activity was positively impactful on the academic outcomes of the school aged children who took part in it.There has yet to be a study to identify the mechanism of this phenomenon or determine if this is nothing more than a casual relationship between physical activity and academic outcomes. However, there is strong evidence that aerobic fitness improved the function and structure of the brain as well as improving academic performance and cognitive control. Physical activity is an integral part of wellness, but does it have an impact on academic outcomes? The purpose of this review of literature was to examine the relationship between physical activity and academic outcomes in school aged children. School has become a propagator of sedentary life-style de-emphasizing the importance of physical activity. The current recommendations from physical activity are one hour per day. Physical activity was positively impactful on the academic outcomes of the school aged children who took part in it.There has yet to be a study to identify the mechanism of this phenomenon or determine if this is nothing more than a casual relationship between physical activity and academic outcomes. However, there is strong evidence that aerobic fitness improved the function and structure of the brain as well as improving academic performance and cognitive control.
Undergraduate

HOW IS THE UNITED STATES ADDRESSING FURNITURE INDUSTRY WASTE?

Primary Author: Brianna Felts, Human Ecology

Co-Author(s)/Collaborators: Erin Simmons

Advisor(s): Hannah Upole

The textile industry continues to pose a growing concern in today's world as the second most polluting industry. However, it is not just the textile creation process that is harmful to the environment. Furniture items are some of the least recycled products in the world. The EPA estimates 19.6 trillion pounds of furniture is buried in landfills each year (EPA, 2018). This literature review examines the data collected by the EPA and explores the current programs with the specific mission to combat furniture waste. The gap in knowledge exists between the American consumer and landfill waste management. During the 1970s in the United Kingdom, the reuse rate grew from 2-3% to approximately 40% after the installation of 400 third sector organizations that enhanced the partnership between landfills and recycling centers (Curran & Williams, 2010). Sweden currently offers a tax break for all recycled furniture to provide an incentive for larger corporations, such as hotels and corporate offices. This research explores whether existing programs and procedures being implemented in other countries, specifically targeted towards reducing furniture industry waste, would be accepted by the American consumer. It is imperative that action take place toward reducing the amount of furniture waste in landfills, and the data suggests moving toward a more circular design process, as well as a circular mindset.

Undergraduate

TEXTILE WASTE AND ITS EFFECTS ON THE ENVIRONMENT

Primary Author: Taylor Frost, Human Ecology

Co-Author(s)/Collaborators: Katie Holmes

Advisor(s): Hannah Upole

Textile waste is one of the leading contributors in worldwide pollution. This research is an examination of the current disposal methods for clothing items and how those practices affect the environment. In North America alone, every consumer throws out an average of eighty-one pounds of textiles each year, which totals more than twenty-six billion pounds of textiles in landfills (Hirschlag,

2019). Adding to that astounding statistic, is the fact there is little awareness of the environmental impact of fashion. In Joung's (2013) survey, the researcher questioned 335 college students, mainly female, on whether they were hoarding clothes. The results determined that 20-29% hoard them, but they dispose of 10-14 items a year (Joung 2013). When it comes to fast-fashion, consumers frequently are buying the latest trends that seem to come out quicker than the average seasonal line comes out. Whether it is through donation or throwing away, consumers are disposing of their clothing at a higher rate each year. This research explores the question of if people will continue to throw out clothing if they are presented with the negative effects it has on the environment.

Undergraduate

EXPLORING THE SUSTAINABILITY IN THE TEXTILE INDUSTRY

Primary Author: Allison Gilbert, Human Ecology

Co-Author(s)/Collaborators: Rylin Dunlap

Advisor(s): Hannah Upole

There is a growing concern about sustainability in the textile industry, which is causing companies to make drastic changes. This research is the examination of the harm that the textile industry can cause to the environment and how society will respond to the textile industry changing their environmental policies. The development of the sustainability issue essentially surrounds the many damages it causes to the environment. The earth's natural resources are being used at a rate that the natural ecosystem cannot handle (Carp, 2020). This information lead us further into the consumer end of the textile industry. A study that recruited 593 responses from women living in the USA showed results that environmentally friendly companies are more appealing than not (Moon, H. & Lee, H.H. 2018). We know that environmental policies are possible because one source revealed their exact statistics on how they have reduced chemical waste (Roy et al., 2020). Also, it has been found that recycling the fabric waste to make products like insulation is entirely possible (Briga-S, A., et al.). Furthermore, there are known specific companies that have utilized the findings on how to reduce environmental destruction. Zara and H&M are two companies that are open about their ongoing transition to environmentally friendly products and how they support sustainability (Moon, H. & Lee, H.H. 2018). This research explores the possible repercussions that companies experience based on if they support the elimination of environmental harm or if they let the damage pass by.

Undergraduate

THE ROLE OF LEGACY BUILDING IN CHRONICALLY ILL CHILDREN'S OVERALL WELL-BEING

Primary Author: Jaymee Gouge, Human Ecology

Advisor(s): Rufaro Chitiyo

What is the link between legacy building and chronically ill children's overall wellbeing? Legacy building refers to interventions that are focused on helping children and families create lasting memories during extended, significantly stressful, or end-of-life healthcare experiences. In this review, the role of legacy building in chronically ill children's overall wellbeing will be discussed. To gather sources, 10 different databases were searched to provide a variety for the project. Key terms used for identifying articles included legacy building, child life, children, legacy activities and end-of-life intervention. Research suggests a need for child life specialists to provide psychosocial support at the end of life, mainly through legacy building. Throughout the literature there was a common finding, children and families use legacy building to cope with the death and dying process. Children who are faced with end-of-life scenarios can benefit from legacy building. Legacy building improves families' overall coping abilities, adjustment to death, and

provides them with keepsakes of the deceased.

Undergraduate

THE LINK BETWEEN A BAD DIET AND NUTRITION

Primary Author: Savannah Gunter, Human Ecology

Advisor(s): Rufaro Chitiyo

What is the link between a bad diet and nutrition? There is a constant struggle between proper nutrition and diets. Many people cannot find a diet that supplies all of their nutrition needs as well as helps them to reach their goal of weight loss. This is due to misinformation as well as a misconception of the proper way to lose weight. Most people think that they have to give up certain foods like carbohydrates or fat to achieve their goals. This very well may work for them in the short term, but long term it is not possible. The human body requires things like carbohydrates and fats to survive. Creating a deficit in any one of these areas or in multiple areas can create problems in the future. It also can have a very negative impact on the overall health and well being of the individual. Fad diets, unfortunately, sometimes create a bad relationship between the participant and food. They can cause the person to develop unhealthy eating habits that potentially lead to bigger problems such as development of an eating disorder. It is important to know that if you are going to go on a diet it needs to incorporate all of the food groups in a moderate amount, and if possible always consult a doctor or a nutritionist for proper nutrition advice.

Undergraduate

THRIFTING: SUSTAINABLE OR JUST A TREND?

Primary Author: Samantha Hall, Human Ecology

Co-Author(s)/Collaborators: Anna-Becca Chester

Advisor(s): Hannah Upole

Thrifting: Is it the answer to textile waste or just another trend? This research is an examination of how today's generation uses the practice of thrifting versus the environmentally beneficial origins of second-hand clothing. In recent years, teens and young adults have been making a profit through purchasing low-cost items from thrift stores and reselling them on popular websites at a much higher cost. This brings up the potential issue of gentrification wherein the thrifting experience has become something of privilege (Abdellatif et al., 2020 p. 51), rather than just an eco-friendly or low-budget approach to shopping. At the basis of it all is whether or not these consumers care about the environmental impact of their habits or if it is all about staying trendy. Results from the research explore the psychology behind this trend-driven consumerism, sustainable shopping habits, and how this idea of reselling thrifted items will impact sustainability in the future.

Undergraduate

ADVERSE EFFECTS OF THE WORLD'S COTTON INDUSTRY

Primary Author: Madison Harris, Human Ecology

Co-Author(s)/Collaborators: Laurabeth Ray; Madison Qualls

Advisor(s): Hannah Upole

It takes 1,800 gallons of water to create a pair of cotton jeans, a fact that only further solidifies the textile industry as the second largest polluter in the world. This research is an examination of the alterations needed to transition the cotton industry to be more sustainable. There are many labels misleading society's philosophy of sustainability, however, a precise definition of sustainability lacks credibility. Advocates have created educational resources to cultivate the industry for further understanding of the harmful practices of conventional cotton (Better

Cotton Initiative, nd). Sustainable cotton lacks the use of manmade chemicals which leave a harmful footprint on the environment. The harmful practices of the conventional industry are long-lasting for the environment, while sustainable cotton promotes the future integrity of the land. This research explores the options for challenging the textiles industry to acknowledge the detrimental effects on our environment from the lack of sustainability, as well as develop sustainable practices within the cotton market.

Undergraduate

THE CORRELATION BETWEEN HOMELESSNESS AND CHILD DEVELOPMENT

Primary Author: Hanna Haston, Human Ecology

Advisor(s): Rufaro Chitiyo

Although the United States is a first world country, there is still a concern about homelessness among today's youth and the consequences that may come from it. The most prevalent group of those that are homeless continues to be families with children, and it is still growing. Is there a correlation between child development and child homelessness? This adverse experience affects all areas of children's development including physical, cognitive, and psychosocial, and those consequences are likely to follow them through life. The goal of this research is to explore the different developmental delays a child who is homeless may have and the different adverse experiences that might be a risk factor for it. Using keywords like child development and homelessness in different databases, a literature search was conducted to identify the research already available about child development and homelessness. Research has shown that children who are homeless are more likely to have a physical disability of some kind, as well as test academically below their peers who are not homeless. Some research has focused on the psychosocial domain which has shown children who are homeless may lack that social connection because of instability, and in turn alienates them from the rest of their peers. This has been a trend amongst most research with some not acknowledging the room for resilience which is prevalent in children. However, children who experience homelessness are more likely to have a delay in one or more developmental domains.

Undergraduate

THE RELATIONSHIP BETWEEN FAMILY STRUCTURE AND CHILD DEVELOPMENT

Primary Author: Laura Lynn Hughes, Human Ecology

Advisor(s): Rufaro Chitiyo

Research suggests that family types can have positive and negative effects on children. Research also shows relationships between family types and cognitive development, and family types and socioemotional development. This project intends to examine the relationship between family structure and child development. For this literature synthesis I reviewed existing research articles that provided evidence of this relationship. I looked for articles that included outside factors that could influence the development. This includes topics such as race, gender, ethnicity, age, religion, culture, and economic status/social class. I focused on connecting the similarities and differences between the results. The outside factors listed above provide opportunities for gaps in the research. A question that arose from the research is, what role does the environment play on this relationship? Another was, how does society speed up or slow down the cognitive and socioemotional development? I found that different family types affect different areas of development. Going from a two-parent household to a one-parent household has a bigger influence on a child's behavior. Starting with only one parent and gaining another influences a child's achievements. Reviewed articles expressed that the type of family experiencing a change determines the developmental results. What is the relationship between family structure and child development? Through reviewing the literature, I found

there is a relationship and there are many other factors that play a role in the relationship.

Undergraduate

IS THERE A RELATIONSHIP BETWEEN CHILD ABUSE AND CHILD DEVELOPMENT?

Primary Author: Marielena Juan, Human Ecology

Advisor(s): Rufaro Chitiyo

Child abuse is a problem that is still going on in society. Many children suffer from child abuse which has consequences that can be drastic to their development. Is there a relationship between child abuse and child development? In this project I will explore the types of child abuse. This should give an understanding of the consequences that it can have on child's mental, emotional, and social development. There is need to raise awareness about it. Since some parents might not know the difference between a punishment and when it becomes abuse. The aim is to bring awareness to the effects of child abuse on a child's development. One group uses logistic regression to find the relationship of child abuse and adult health risk behaviors. The other group compares eighty-seven abused children to eighty-seven non-maltreated classmates. One study collected saliva samples from school age maltreated and non-maltreated children. Some of the research was also conducted in classrooms. In other instance, children and mothers were interviewed. The information gathered in the classroom was to investigate behavioral problems witnessed by teachers. Research shows that family violence can have an effect on social development for children especially when it comes to peers. Also, that child abuse can have an effect on a child's behavior and mental health. The awareness of child abuse to parents and the community can help in reducing the risks that it has on a child's development. This can improve the health of many children in the long term.

Undergraduate

MISCONCEPTIONS OF SUSTAINABILITY WITHIN THE LUXURY FASHION INDUSTRY

Primary Author: Chloe Land, Human Ecology

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Cassie Bonamie

Advisor(s): Hannah Upole

There is an extreme contrast between fast fashion and designer fashion, but ironically they are both leaders in the fashion industry. This research is an examination of how fast fashion brands and designer brands are integrating sustainable and ethical practices into their designs within the industry. Fast fashion is the reinvention of slow fashion that encourages disposability and thrives on fast cycles constantly bringing in the newest trends, where luxury fashion is a much slower form of design, centered around three main themes: dreams, exclusivity, and beauty/art (Joy, Sherry, Venkatesh, Wang, & Chan, 2012). One of the biggest differences between fast fashion and slow fashion is that creating luxury products takes time, limiting availability, and not mass-producing. In return, this actually slows the fashion cycle, reducing the amount of waste associated with creating fashion products. However, without a clear understanding of what consumers should look for when shopping for more sustainable fashion brands, this all can become overwhelming. This research will explore the disconnect in consumers' knowledge regarding the sustainability within the luxury fashion industry.

Undergraduate

HOW ARE MICRONUTRIENT DEFICIENCIES ASSOCIATED WITH OUTCOMES OF POSTPARTUM ANXIETY AND DEPRESSION IN WOMEN?

Primary Author: Destiny Lee, Human Ecology

Advisor(s): Samantha Hutson

Women who are pregnant or nursing have an increased risk of malnutrition as well as depression. The objective of this review of literature was to determine whether there was a direct correlation between the two diagnoses. Individuals with either antepartum or postpartum depression experience symptoms detrimental to the well-being of both themselves and their child. Common characteristics associated with this form of depression include lower levels of functioning in household care, financial instability leading to homelessness, and low birth weight for the infant due to lack of feeding. There is no exact panacea to maternal depression, however, research has found a potential link between diet and mental health. Certain neurotransmitters from the central nervous system like dopamine and glutamate play a role in digestive processes. Pregnant women experience a depletion of certain nutrients more rapidly than most individuals. These pregnancy-specific nutrients include but are not limited to folate, iron, zinc, and have shown to have a relationship with the regulation of mood. In conclusion, studies have shown a small yet promising correlation between neurological function and nutrient intake. However, an expansion of research on this topic is needed because most studies focused on the effects of overall diet quality on depression rather than specific nutrients. In addition, there has not yet been a cure confirmed for maternal depression.

Undergraduate

ANIMAL RIGHTS WITHIN THE TEXTILE INDUSTRY

Primary Author: Bailey Madewell, Human Ecology

Co-Author(s)/Collaborators: Lauren Smith

Advisor(s): Hannah Upole

Why do the majority of consumers have little to no issues with wearing leather but cannot fathom the thought of wearing fur? This research is an examination of how consumers' perceptions change their decision making with respect to animal cruelty in the fabric production process. It is common knowledge that cows, pigs and sheep are used for leather, however, looking further into which animal made the most luxurious fabrics, we found that most designer brands use other exotic animals, such as crocodiles for their products (PETA, 2020). There is a wide variety of facts and opinions with reference to the fur and leather industry, by both global animals rights activists and consumers. Peta explains that, "after a lifetime of torment, [animals are] violently slaughtered via the cheapest means possible, including bludgeoning, anal electrocution, and gassing" (PETA, 2020). Rules and regulations were made for fur years ago, however, animals are still being gruesomely abused for their skin. Given that the apparel industry is growing, many companies want the cheapest process that does the most or they want the most expensive process that sells the best, often disregarding the animals rights in the production process. This research further invests consumer's perceptions of animal rights in the textile industry and how it affects their decision making in regards to buying products made of animal by-product.

Undergraduate

THE RELATIONSHIP BETWEEN THE CONSUMPTION OF DIETARY SUGARS AND HEALTH OUTCOMES

Primary Author: Olivia Moore, Human Ecology

Advisor(s): Rufaro Chitiyo

What is the relationship between the consumption of dietary sugars and heath outcomes? Dietary sugars are

found in many foods and can be classified as total, added, and naturally occurring sugars. Naturally occurring sugars include lactose, which is milk sugar, and fructose, which is fruit sugar. Many types of dairy and fruit products contain these natural sugars. Added sugars include high-fructose corn syrup (HFCS), which is an artificial sugar sweetener made from corn syrup. Added sugars are the ones you want to avoid or limit in your diet. These types of sugars are linked to many health issues, like diabetes, obesity, and cardiovascular disease. The purpose of this review was to examine the relationship between the consumption of dietary sugars and health outcomes. Research collected focused mainly on dietary sugar effects on obesity, diabetes, and cardiovascular disease health outcomes. All the literature collectively found a correlation between dietary sugar intake, among other things, held a connection to many chronic diseases. According to the research, more than one-quarter of the calories children consume every day comes from sugars. These controlled dietary habits can be linked to chronic diseases later in life. The research also stated that education was key to controlling these dietary habits and the consumption of dietary sugars. These sugars can be found in many forms including soft drinks, candies, etc. Evidence from this review has also shown that a diet high in fiber and vegetables will help lower these risks of chronic diseases.

Undergraduate

MALADAPTIVE EATING AMONG FEMALE ADOLESCENTS AND YOUNG ADULTS WITH CELIAC DISEASE

Primary Author: Olivia Moore, Human Ecology

Advisor(s): Samantha Hutson

Celiac disease is an autoimmune disorder that can cause damage to the lining of the small intestine when gluten is consumed. Gluten is a protein found in wheat, barley, and rye. This protein is prevalent in many foods commonly cooked with and consumed. Individual who are diagnosed with celiac disease must be sure to take special care when consuming, cooking, and purchasing food products. Maladaptive eating behaviors can be found in individuals exhibiting an excessive avoidance and preoccupation with maintaining a special diet, such as gluten-free diet. The purpose of this review of literature was to examine the prevalence of maladaptive eating behaviors among female adolescents/young adults who were diagnosed with celiac disease. Research used in the literature review was conducted through surveying and interviewing adolescents and young adults. Many young adults who were surveyed were on college campuses. A higher prevalence maladaptive eating behaviors were found in adolescents and young adults following a gluten-free diet. A lack of nutrition education regarding a gluten-free diet was prevalent among this population. It was also found that a diagnosis of celiac disease can greatly affect an individual's social life. Participants had a fear of eating out and ingesting gluten-contaminated foods, then experiencing celiac disease symptoms. Much research still needs to be conducted about this topic overall and its effects on this population as a whole.

Undergraduate

DIETARY INTAKE AND COGNITION AND EMOTIONAL HEALTH IN OLDER ADULTS

Primary Author: Caraline Partin, Human Ecology

Advisor(s): Samantha Hutson

The purpose of this review of literature was to explore the relationship between food and nutrient intake and cognition and emotional health in older adults. Nutrition is a key factor in successful aging, and a healthy diet is crucial to the psychological quality of life. Healthy lifestyles have been shown to help improve longevity and overall health in older adults. The prevalence of older adults in the United States, and the world, is growing

rapidly, as is the prevalence of older adults showing signs of cognitive decline, dementia, or depression. Prevention practices help decrease the risk of developing diseases and have the most impact if they are implemented before individuals reach 65 years old. Mental and emotional health disorders, such as cognitive decline and depression, are not always preventable, which is why there is a need for more evidence- based research that can be implemented into practice to help manage certain health conditions. Several studies found that the increased consumption of fruit and vegetables was linked to a reduced risk of cognitive impairment and dementia, and other research found that B vitamins are especially important in reducing the risk for negative neurological situations. Although there is no research that can definitively prove that a specific dietary intake will prevent or help manage cognitive impairment, dementia, or depression, all of the studies in this review provided data that did support a significant relationship between food intake (fruits and vegetables) and cognitive and emotional health in older adults.

Undergraduate

EFFECTS OF FRUITS & VEGETABLES ON SELF & CLINICALLY-DIAGNOSED DEPRESSION

Primary Author: Bethany Petty, Nutrition/Dietetics

Advisor(s): Samantha Hutson

Research regarding the effects of fruits and vegetables in depression has been growing recently. However, there is still a great deal of research that needs to be done over this topic. The purpose of writing this thesis paper was to review the impact that fruits and vegetables have on those who are diagnosed and self-diagnosed with depression. A large amount of research has shown the general health benefits of consuming fruits and vegetables, but the research regarding the effect it has on those who are clinically diagnosed and self-diagnosed with depression is lacking. Research concluded that the quality of someone's diet, was inversely and significantly related with the reported symptoms of depression. Research showed participants who had depression consumed less fruits and vegetables, and consumed more processed foods and sweets than mentally healthier participants. It has been shown that several psychological benefits come out from consuming fruits and vegetables such as greater happiness, lower rates of developing depression and anxiety, as well as a higher life satisfaction. Researchers found that those who consumed a higher 'whole food' diet, were least likely to report as CES-D depressed after adjusting for age, gender and energy intake, and those who consumed a higher 'processed food' were most likely to report as CES-D depressed. Many of these studies have shown that fruits and vegetables have lowered the symptoms of depression as well as increase quality of life.

Undergraduate

THE EFFECTS OF DOMESTIC VIOLENCE ON CHILDREN

Primary Author: Kortney Robbins, Human Ecology

Advisor(s): Rufaro Chitiyo

What is the correlation between domestic violence and children's development? Witnessing domestic violence leads children to have a variety of age-dependent negative effects. The objective of this research is to determine the negative effects of domestic violence on children. Case studies would be the most beneficial method of research. Most studies that have been conducted on domestic violence do not consider the effects on secondary victims, such as children, this project explores the effects on secondary victims. Researchers looked at a range of age groups, to gain an accurate representation of the developmental effects on each age group. The findings showed us that children who witness domestic violence in the home are more likely to exhibit similar psychological effects. Children who experience domestic violence are at a greater risk for negative internalized and externalized behaviors. Research also revealed that there are several variables that can provide some prevention

strategies in order to try to minimize the negative effects that come along with witnessing domestic violence. In this presentation, I will be sharing information on the differences between the age groups, and providing examples of some possible regressions that are associated with each age group. I will also be sharing information on the resilience in children, to discuss the possible positive outcomes that can occur if the proper help is given to the child. This synthesis clearly indicates that the research that was conducted proves that there are developmental issues that can be directly related to witnessing domestic violence.

Undergraduate

THE EFFECTS OF DOG OWNERSHIP ON COPING SKILLS IN CHILDREN WITH CHRONIC ILLNESS

Primary Author: Tatera Roe, Human Ecology

Advisor(s): Rufaro Chitiyo

Can pet ownership have effects on coping skills in a child who has a chronic illness? Pet therapy in a children's hospital is one aspect of the services provided to help children who have chronic illness increase their coping skills. The Stress and Coping Theory explains how humans cope with the stress and sets the foundation for a Certified Child Life Specialist (CCLS). CCLS enhance children's psychosocial development and coping ability when hospitalized, including transitioning back home, and to the new normal. When children leave the hospital, they are left without their pet that has helped them cope with the trauma of their critical illness while being hospitalized. The aim of this literature synthesis is to find effects of pet ownership on coping skills once they return home from the hospital. The key terms used include, coping abilities in children, chronic illness, and pet ownership. Results showed that there are significant positive, and negative effects that owning pets can have on coping skills in chronically ill children. Owning a pet can help coping skills in children with chronic illness, but the negative effects of dog ownership, such as asthma, can cause negative coping abilities by stressing the child out. Trends observed were positive effects such as increase in positivity, companionship, and joy, while negative effects were mostly allergies and asthma related conditions. In conclusion, pet ownership can have positive and negative effects on coping skills in children who have chronic illness.

Undergraduate

REDUCING TEXTILE WATER WASTE

Primary Author: Lydia Smith, Human Ecology

Co-Author(s)/Collaborators: Emily Price

Advisor(s): Hannah Upole

There is a growing concern for the abundance of water waste produced by the textile industry. This research explains how the industry generates pollution, destroys water ecosystems, and how to diminish the waste caused by the textile industry as a whole. With the rise in human civilization, a rapid increase in population, the industrial revolution, rapid urbanization, and oceans being used as a dumping ground for industrial waste, there is a major concern regarding the availability of freshwater sources. There is no denying that nature has the ability to tackle small amounts of water pollution, however, it would be catastrophic if a large amount of untreated wastewater was to be discharged into these natural bodies of water. (Bhatia, Sharma, Kanwar, & Singh, 2018, pg. 1) If this were to occur, the receiving bodies of water would carry precarious industrial pollutants, which affect the quality of water, into other more fragile aquatic ecosystems. This could cause irreversible damage to the water systems humans rely on for survival. This research explores the different ways to reduce water waste in the industry and whether or not it's possible to use household water saving techniques on a mass industrial scale to effectively cut back on water usage and waste.

Undergraduate

COMPARING INTUITIVE EATING TO TRADITIONAL WEIGHT LOSS APPROACHES

Primary Author: Wyneshia Spears, Human Ecology

Advisor(s): Samantha Hutson

The majority of the U.S. population experiences a weight-related issue, from overweight and obesity to disordered eating. These weight related issues are commonly addressed by traditional diets in the U.S., but the traditional approaches to these weight related concerns have inconsistent results. This purpose of this review of literature was to explore how an intuitive eating approach may promote psychological health, weight loss, and maintenance compared to traditional weight loss approaches. By exploring different studies data was collected to determine the effectiveness of intuitive eating approaches. One study examined a "health at every size", non-diet, body acceptance model in which participants utilized an intuitive eating approach. When compared to traditional diet group, the intuitive eating group had more success with attrition rates, maintaining weight, increasing physical activity, and disinhibition. Weight- related psychological flexibility interventions like acceptance commitment therapy helped increase reliance on hunger and satiety cues and eating for physical rather than emotional reasons. An intuitive eating approach can have positive effects on individuals' weight related issues, psychological flexibility and maintenance of weight over time. The intuitive eating lifestyle may help promote self-esteem and help clients to feel better about themselves.

Undergraduate

NEW SUSTAINABILITY METHODS FOR DENIM

Primary Author: Kayla Stafford, Merchandising and Design

Co-Author(s)/Collaborators: Mallory Christian

Advisor(s): Hannah Upole

The production of denim is an enormous issue in today's textile industry, as thousands of liters of water, massive amounts of energy, and an excessive use of chemicals are necessary to create just one pair of jeans. This research is an examination of new methods that manufacturers can use to produce denim in a more sustainable way, as to lower environmental impact. One of the major negative impacts on the environment from the creation of denim is the water pollution from the dyes that are used to create denim products (Radocchia, 2018). A second major issue with the production of denim is the fact that each manufacturer has their own individual standards for sustainability, creating many differing cycles of production, some of which are less sustainable than others. Until all of the manufacturers are using approved sustainable methods to produce denim, new methods and technologies in terms of upcycling denim will need to be explored to help counteract the negative impacts of denim production (Chua, 2020). This research explores new innovative ways to make denim more sustainable through various ways, such as upcycling, recycling, and overall reconstruction for consumer use.

Undergraduate

CHILD LIFE SPECIALISTS PROVIDE EFFECTIVE INTERVENTIONS THROUGHOUT A CHILD'S HOSPITAL STAY

Primary Author: Abigail Staley, Human Ecology

Advisor(s): Rufaro Chitiyo

Can working with a Certified Child Life Specialist help a child throughout their hospital stay? Certified Child Life Specialists (CCLS) are healthcare workers who provide developmentally appropriate interventions such as play, procedural preparation, and effective teaching that help children to reduce the fears and anxieties that the hospital may bring. Many children will experience a hospital visit

at least once throughout their lifetime. Often a child will need medical attention for chronic illnesses, acute injuries, broken bones, etc. When a child is admitted into the hospital for any reason they may find themselves working with a CCLS. Children may view the hospital as a scary, unfamiliar place which can cause them to be overcome by anxiety. However, CCLS can provide specific resources such as play, education techniques, games, and more to help patients and their families cope with their hospitalization. The goal of this literature synthesis is to examine how CCLS helps children and families overcome their hospital stay by providing age-appropriate interventions to help minimize the negative effects of hospitalization. Reviewing existing research articles will provide an understanding of what services Certified Child Life Specialists provide along with an understanding of the effectiveness of having a CCLS present throughout the child and family's hospital stay. Throughout literature, there is evidence of positive effects a child life specialist can have on a child's hospitalization. Research trends indicate that CCLS can help families' satisfaction throughout their hospital stay and provide effective interventions such as procedure preparation and medical play.

Undergraduate

THE FAST FASHION INDUSTRY AND CONSUMER RESPONSES TO ALTERNATIVES

Primary Author: Hannah Steger, Human Ecology

Co-Author(s)/Collaborators: Allison Day

Advisor(s): Hannah Upole

The fast fashion industry has been a subject of controversy for some time, dividing consumers over their opinions and shopping habits, between the positives and the negatives of the industry. This research is an examination of whether or not consumers would continue to shop fast fashion after being presented with alternatives. Fast fashion is an industry described as producing affordable clothing that copies the latest styles and markets them as fast as possible, without making the consumer pay full price. Though the prices are often very cheap, so is the quality of the clothing. Companies in the fast fashion industry are known for their rapid production of the latest trends to get them out on the floor as soon as possible, sometimes before the average consumer is aware of the trend. This high-speed process is certain to cause harm along the way. Many fast fashion companies have received allegations of unfair treatment of labor, sexual misconduct, and paying below the minimum wage (Crespo, 2019). There are major environmental and social injustice concerns with the industry, spanning from the contamination of local water sources caused by textile dyes to underpaying factory workers and subjecting them to harsh, inhumane working conditions. This research explores consumer perceptions of sustainable, ethical alternatives to fast fashion shopping in an effort to impact the future shopping choices of consumers in the fashion industry.

Undergraduate

EMERGENT LITERACY FOR SCHOOL READINESS

Primary Author: Delenn Strong, Human Ecology

Advisor(s): Rufaro Chitiyo

What role does emergent literacy play in a child's school readiness? This budding skill is essential for children before starting school. Children need a foundation of different learning techniques to learn the materials they will experience in the school setting. School readiness is key to a child's learning while in education. The goal of this research is to explore the benefits of starting learning early in the home. Interaction with reading and writing prior to the start of school is achieved by learning through researching literature. Research shows that age matters when emergent literacy is most helpful and agrees that the learning should take place in the home. The research also has gaps on topics, such as age, and gender. Research also

has gaps on who is the most helpful in teaching emergent literacy in the home. Developing emergent literacy is essential for a child to succeed in school readiness.

Undergraduate

THE CORRELATION OF FAD DIETS AND EATING DISORDERS

Primary Author: Lorena Wance, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a correlation between fad diets and eating disorders? Fad diets are popular societal trends that promote eating styles that promise results in weight loss at an expedited rate and extraordinary health benefits through dietary and lifestyle changes via various methods. Eating disorders are commonly known for their association with unhealthy eating habits due to psychological aspects. Due to the nature of fad diets being unsustainable, strict, and limiting in certain facets, the aim of this project is to explore literature that opposes or supports whether fad diets and eating disorders are related. The method being utilized is a literature synthesis. The search strategies included words like “correlation”, “linked”, “associated with”, “and”, and “related” within the Volpe library search engine, Google scholar and Google search engine. Research acknowledges that there is a correlation between certain fad diets and eating disorders, but the limiting factors include the type of fad diet, the diagnosis of which eating disorder, and whether these variables affect individuals positively or negatively for long-term. The correlation seems to favor the idea that certain risks associated with fad dieting can impact individuals who might already have precursors for negative eating behaviors and habits. Future research should address a direct correlation of all fad diets and all eating disorders. In conclusion, fad diets and eating disorders may be correlated but may not be heavily supported due to gaps in research and limited information available on the direct correlation of the factors.

Undergraduate

THE LINK BETWEEN DEPRESSION AND HEALTH OUTCOMES

Primary Author: Kaylee Whitefield, Human Ecology

Advisor(s): Rufaro Chitiyo

Is there a link between depression and health outcomes? Our health is sensitive and can be affected by so many things. With the use of the Hospital Anxiety and Depression Scale, we can determine how our health is affected by our mental health, specifically anxiety and depression. By discovering the effect our mental health has on our overall health, diseases and pain can be managed better due to a more complete understanding of the internal and external connections of the body. I aim to find the link, or links, discussing the effects that depression can have on our health and the outcomes of diseases. I will use a literature synthesis to dissect research articles to gain a better understanding of how easily our mental health can influence our physical health. Researchers have administered surveys within the hospital and outpatient setting as well as over the phone interviews pertaining to the effects of depression on participants’ health. Research shows that after using these forms of assessment, most people who had a terminal, or chronic, illness had higher scores showing anxiety and depression. The research findings also reveal that those who struggle with lifelong issues have higher rates of mental illness and a lack of wanting to continue their care. Finally, through exploring previously published studies, we understand the link between our mental health and our overall health and willingness to continue taking care of ourselves.

College of Arts & Sciences

Department of Biology

Graduate

STREAM WATER QUALITY RESPONSES IN A TORNADO DAMAGED RESIDENTIAL WATERSHED

Primary Author: Peter Blum, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Samantha Allen; Brittany Bajo; Robert Brown; Frederick Hoogakker; Ashley Padgett, Victor Wesley, F. Hoogakker, B. Bajo, and Tyler Wright; Justin Murdock, Tennessee Technological University; Joseph Asante, Tennessee Technological University

Advisor(s): Justin Murdock

Tornado damage has the potential to impact stream water quality from seeping anthropogenic compounds and scattered debris in affected areas. On 3 March 2020, an EF4 tornado (~282 km h-1 winds) hit Putnam County, Tennessee, destroying structures, trees, and removing vegetation across the area. This study assessed the influence of tornado damage on the water quality of streams draining the damaged area. We compared physiochemical conditions, fecal contamination, and chemical water quality measures for affected and unaffected watersheds over three months. We found differences between stormflow and baseflow conditions between watersheds, with elevated nutrients, dissolved metals, and fecal coliform bacteria after rain events. However, there were no significant differences between affected and unaffected watersheds for any parameter. Similarly, there were no relationships among nutrients or contaminants and distance to, or density of tornado wreckage. This study provides evidence that unlike other natural disasters, such as earthquakes and hurricanes, tornados may have minimal effects on water quality when residential areas are hit, possibly due to the localized area of destruction that tornados leave. However, tornado influence may still be event-specific and depend on the type of structures damaged.

Graduate

DOES DENITRIFICATION DRIVE NITROGEN REMOVAL ACROSS RESTORED FLOODPLAIN WETLANDS?

Primary Author: Robert Brown, Biology

Advisor(s): Justin Murdock

Wetland restoration projects commonly seek to promote denitrification, which permanently removes NO3 from ecosystems by stepwise conversion to N2 gas. Anammox (N2 production from NH4 and NO2) and dissimilatory nitrate reduction to ammonium (NH4 production from NO3) are assumed to be less common than denitrification in freshwater systems. However, the relative importance of these processes may not be consistent across wetlands subject to different vegetation and hydrologic restoration practices. We measured NO3, NH4, NO2, and N2 flux in 18 restored floodplain wetlands across west Tennessee and Kentucky, USA, in summer 2019 and 2020 using flow-through soil core incubations ($n > 500$). We predict N2 production will be positively correlated with NO3 uptake and sediment oxygen demand if denitrification is the dominant N removal process across our sites. A weak relationship between N2 production and NO3 uptake

would indicate that other N cycling processes contribute significantly to NO3 uptake or N2 production. We will use mixed effects models to explore potentially dominant N cycling pathways while accounting for effects of restoration practices. Results will inform future isotopic labeling experiments designed to trace sources and fates of excess N in restored floodplains.

Graduate

THE RELATION OF MICROBIAL BIOMASS CARBON WITH DENITRIFICATION AND NUTRIENT RETENTION IN RESTORED FLOODPLAIN WETLANDS

Primary Author: Shrijana Duwadi, Biology

Co-Author(s)/Collaborators: Spencer Womble; Robert Brown; Justin Murdock, Tennessee Technological University

Advisor(s): Justin Murdock

Restoration activities have been implemented in the lower Mississippi River basin through the Wetlands Reserve Program (WRP) to enhance essential functions by restoring wetlands. Soil can be a zone of significant nutrient retention in wetlands by providing an environment for microbial development and nutrient processing. The objective of this study was to assess soil microbe-based ecosystem function in three restored riparian wetlands in Western Kentucky, focusing on the relationship between microbial biomass and nutrient removal. We hypothesized that nutrient retention, and specifically denitrification is directly related to microbial biomass carbon (MBC). At each easement, thirty sediment cores were collected and used to measure a suite of soil processes and properties, including soil nitrogen (N) and phosphorus (P) uptake rates, denitrification potential, soil moisture, and MBC. MBC was significantly higher in undisturbed older habitat, followed by remnant forest, and lowest in the shallow water areas. Denitrification potential, and N and P uptake were strongly correlated with MBC and soil moisture. Our results suggest that increasing total soil microorganism biomass is an indicator for monitoring improvements in ecological functions in restored wetlands, with potentially important long-term consequences for denitrification and nutrient retention.

Graduate

SPATIAL VARIATION OF NUTRIENT UPTAKE IN A RESTORED AGRICULTURAL WETLAND

Primary Author: Morgan Michael, Biology (M.S.)

Co-Author(s)/Collaborators: Justin Murdock, Tennesee Tech University

Advisor(s): Justin Murdock

The USDA Wetlands Reserve Program (WRP) was originally established to restore wildlife habitat in converted and degraded riparian wetlands, but an increased emphasis has also been put on restoring their ability to reduce nutrient runoff. We analyzed nutrient uptake rates and their variability across WRP restoration practices to evaluate nutrient retention rates in four main restoration habitat types; shallow water areas (SWA), remnant forests (RF), tree planting areas (TP), and natural regeneration areas (NR) in a west Tennessee wetland. We collected 30 soil/sediment cores from each habitat; and measured nitrate and phosphate uptake and denitrification potential in continuous-flow incubations for 72 hours, simulating a flood. Preliminary analyses show that nitrate uptake was highest in the SWA (207% more than other habitats), and phosphate uptake was highest in RF (159% more than others). Soil denitrification was similar among SWA, RP, and NR habitats, but was 176% lower in RF. We also found significant spatial variability in uptake across all habitats. These results suggest that no, one habitat provides optimum nitrogen and phosphorus removal, and a multihabitat approach may provide the best overall nutrient removal capacity.

Graduate

DEVELOPMENT OF AN ENVIRONMENTAL DNA (EDNA) ASSAY TO DELINEATE THE DISTRIBUTION OF THE IMPERILED STRIATED DARTER (ETHEOSTOMA STRIATULUM, PAGE AND BRAASCH 1977) IN THE DUCK RIVER, TENNESSEE

Primary Author: Adam Walker, Biology (M.S.)

Co-Author(s)/Collaborators: Emma Barnett; Connor Lee; Kit Wheeler, TTU Stream Fish Ecology Lab

Advisor(s): Carla Hurt

Striated Darters (Etheostoma striatulum) are small, uncommon darters endemic to the Middle-to-Upper regions of the Duck River, Tennessee. Since their description, they have become increasingly rare within their range. Historically, Striated Darters occupied 16 tributaries of the Duck River; as of 2011, their known distribution has declined to nine tributaries. Due to this documented decline, Striated Darters are currently under review for federal listing under the Endangered Species Act. Effective management and conservation of this species will also require information about their distribution. This study aims to delineate the present-day distribution of the Striated Darter through a species-specific environmental DNA (eDNA) assay. Aquatic species discard DNA fragments in many ways (e.g., urination and reproduction) into the water column which can then be identified using well-established molecular techniques. Due to the Striated Darter's reclusive and cryptic behavior, conventional techniques are ineffective for detection, requiring the use of much more efficient and sensitive eDNA monitoring techniques. At 30 historical sites in the Duck River, three water samples will be taken and then filtered for molecular analyses. A qPCR assay will be designed to detect Striated Darters across all sites and conclusions will be run through a hierarchical occupancy model to test for the probability of detection at the qPCR replicate, sample replicate, and site levels. Another project investigating the population status of the Striated Darter will be running similar occupancy models using conventional techniques, which will allow for comparison between traditional and molecular approaches.

Graduate

SOIL NUTRIENT RETENTION ACROSS RESTORED FLOOPLAIN WETLAND HABITATS

Primary Author: Spencer Womble, Environmental Sciences Biology (Ph.D.)

Co-Author(s)/Collaborators: Robert Brown; Shrijana Duwadi; Justin Murdock, Tennessee Technological University - Biology

Advisor(s): Justin Murdock

Floodplain wetlands have been historically degraded by agricultural practices. The U.S. Department of Agriculture's Wetlands Reserve Program (WRP) transitions cropland back to wetlands to restore ecosystem structure and function. We evaluated how WRP restoration practices influence nutrient retention on 14 restored wetlands in western Tennessee and Kentucky during the summers of 2019 and 2020. Thirty soil cores were collected from dominant habitat types and inundated with elevated nitrogen and phosphorus water using a flow-through system to estimate maximum uptake potentials. Nitrogen and phosphorus uptake, and denitrification rates were measured over 48-h. A linear mixed effects model was used to compare nutrient removal rates with habitat type and soil properties. Preliminary data suggest that soil oxygen demand, soil moisture, and soil organic matter have the strongest influence on nutrient uptake and denitrification potential. Natural regeneration habitats had greater phosphate retention and denitrification potential relative to shallow water and tree planting habitats. Phosphate uptake and denitrification rates appear to be highest after 24 h and

48 h of inundation, respectively. These preliminary results suggest that prolonging inundation and allowing for natural succession to occur may maximize nutrient retention in these wetlands.

Undergraduate

WHITE-TAILED DEER SITE USE AFFECTS VEGETATION STRUCTURE, COMPOSITION, AND BIODIVERSITY IN UPPER CUMBERLAND REGION OF TENNESSEE

Primary Author: Cassandra Fink, Wildlife and Fisheries Science

Co-Author(s)/Collaborators: Stefan Nelson; Shawn Krosnick, Tennessee Technological University; Bradley Cohen, Tennessee Technological University

Advisor(s): Bradley Cohen

Herbivores have been known to exert powerful forces on vegetation structures in many plant communities. In particular, selective herbivores, those who choose specific plants to forage on, can greatly impact community structure by inhibiting the growth of species that contribute to the diversity within plant communities. Primarily, studies in the northeastern United States have shown the cascading effects white-tailed deer have in regions that have slow growing climatic conditions. The question remains of how white-tailed deer herbivory might affect vegetation structure and diversity in the southeastern United States, where the climate allows for faster growth of vegetation. Therefore, our research focused on delineating how white-tailed deer affect the plant community and diversity at Chestnut Mountain in Sparta, Tennessee. We measured vegetation abundance, visual obstruction, and diversity at six 50-meter plots throughout Chestnut Mountain and correlated daily numbers of deer photographed in the area by remote cameras. Deer herbivory did not inhibit vegetation growth of unpreferred grass or fern species, but preferred shrubs and vining species had decreased in relation to deer presence. Our study demonstrates that white-tailed deer might not have as powerful as an effect in the southeast as they do in the northeast except when in relation with shrub and vining species. Our results are preliminary but suggest that more extensive examination of deer herbivory and its affect on vegetation communities in warmer climates may be warranted.

Undergraduate

GENETIC VARIATION IN CAPTIVE POPULATIONS OF BARRENS TOPMINNOW

Primary Author: Holly Palk, Biology

Co-Author(s)/Collaborators: Morgan Dearnbarger

Advisor(s): Carla Hurt

The Barrens topminnow (Fundulus julisia), a freshwater killifish native to the Barrens Plateau in Tennessee, has suffered continual population declines since the 1980's. These declines can be attributed to multiple factors including droughts, habitat loss, and harassment by the invasive Western Mosquitofish (Gambusia affinis) which have been widely introduced across the Southeastern United States. As of 2019, this species was federally listed under the Endangered Species Act. In an effort to mitigate further population declines, a number of captive refuge populations were established in the early 2000s as a source for future introductions. These captive populations were initiated from brood stocks from three natural populations (Pond Spring in the Elk River drainage, and Hickory and McMahan Creek in the Caney Fork Drainage) and have been used as a source for establishing new population in the wild. There is concern about the adaptive potential and genetic health of these newly established populations as loss of genetic diversity and inbreeding can accumulate rapidly in captivity. Here we used genotype data from 14

microsatellite loci to investigate genetic variation in captive stock populations of the Barrens Topminnow and compare measures of genetic variation to estimates from native source populations. Results from these genetic surveys will be used to inform captive breeding strategies that will best preserve the long-term persistence and adaptive potential of this species.

Undergraduate

THE EFFECTS OF CORN EAR DECLINATION ON WATERFOWL FORAGE AVAILABILITY IN UNHARVESTED FLOODED CORN FIELDS

Primary Author: Jenna Smith, Wildlife and Fisheries Science

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Cory Highway

Advisor(s): Bradley Cohen

Managing for non-breeding waterfowl throughout the winter requires managers to provide enough forage resources to meet the energetic demands of waterfowl recovering from autumn migration, maintaining body condition during winter, and preparing for spring migration. During the winter months (November to March), waterfowl species, such as the mallard (Anas Platyhrynchos), rely on calorie-dense food sources to meet their energetic demands. Many waterfowl species readily consume agricultural seeds, such as corn (Zea mays), grain sorghum (Sorghum bicolor), millet (Echinochloa spp), soybeans (Glycine max), and rice (Oryza spp), to fulfill their energetic requirements. In western Tennessee, public and private land managers often flood unharvested corn fields to provide forage for wintering waterfowl. The availability of forage within unharvested flooded corn fields is affected by several factors including distance of corn ear to water and ear declination. We measure foraging intensity, ear distance to water and ear declination by repeatedly surveying 30 unharvested, flooded corn fields in western Tennessee at two-week intervals throughout the winter (October-March). The analysis is ongoing and will be done before poster presentations. We hope that by determining the factors influencing forage availability we will allow wetland managers to improve forage availability for wintering waterfowl.

Undergraduate

THE IMPACT OF A LARGE SURFACE ROCK ON TEMPERATURE AND DECAY RATE

Primary Author: Salem Sullivan, Biology

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: David Beck; Lauren Michel

Advisor(s): David Beck

Purpose:
Do cadavers on rocks decay more quickly? How do rocks affect insect succession and ground level temperature? Is this effect more dramatic on small or large carcasses?
Background:

Assuming an organism is not consumed by scavengers, it goes through five stages in the process of decay– fresh, bloat, active decay, advanced decay, and putrid dry remains– which are distinguished through physical observation. Larger masses decay at slower rates, and hotter temperatures tend to expedite decay.

Methods:
Four rabbit carcasses were placed out to decay. One small carcass and one large carcass were placed out in the sun

on soil or on exposed rock. The mass, carcass dimensions, and ground level temperatures were monitored. This experiment was repeated three times over the summer. Insects were captured by hand and pitfall traps.
In the fall and winter, temperature probes were placed at varying heights and lengths from a rocky surface and a non-rocky surface. Temperature was recorded every half hour from September to January.

Results:
The effect of the rock on decay rate varied, so this experiment would need to be repeated. Ground level temperatures tended to be higher at the rock sites, and insect colonization was more abundant at the rock sites. Temperature changed more as height from the rock increased compared to length. The difference in temperature between rock and soil site was minimized when ground level temperatures reached 20C, as well as when it rained.

Significance:
Cadavers next to rocks may decay more quickly in summer months.

Undergraduate

PAIR MOVEMENTS IN CANADA GEESE

Primary Author: Kathryn Wilkins, Wildlife and Fisheries Science

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Nikki Panter

Canada geese (Branta canadensis) are a staple of most parks, neighborhoods, and even shopping centers (Conover 1998) – wherever there is a body of water with subsequent aquatic vegetation, you will most likely find Canada geese. This is especially true during their annual molting period from mid-June to late July, in which they shed and regrow their flight feathers. It is generally accepted that geese with broods prefer to molt and rear the brood near to or at their own birthplaces- this concept is known as philopatry. Over the summer of 2020, I observed the Canada goose flock of Cookeville, Tennessee to discern whether this philopatric trend can be observed within the flock. Geese with broods and those without were examined and analyzed separately to accommodate for the heightened philopatry that is commonly seen in geese that are rearing broods. Results showed that local males, those first captured in the Cookeville flock as hatch years, did indeed travel farther on average than local females. It was also found that individuals were philopatric to their natal sight whether or not they had had a brood that season. Such results raise questions regarding the following, or lack thereof, of seen trends within the study: (1) If the trends followed are seen in the Cookeville flock, are they followed by other resident flocks? and (2) Are the common trends that are not being followed due to the flock being a resident flock, or is it due to other variables?

Department of Chemistry

Graduate

METAL-FREE, MICROWAVE-ASSISTED OXIDATIVE CYCLIZATION OF 2-PYRIDYL N-TOSYLHYDRAZONES TOWARD UNSYMMETRIC 1,2,3-TRIAZOLE COMPLEXANTS

Primary Author: Zachary Gulledge, Chemistry

Advisor(s): Jesse Carrick

In this lab's quest towards the synthesis of novel N-donor ligands for selective minor actinide separations from spent nuclear fuel, the construction of unsymmetric tridentate ligands containing a 1,2,3-triazole is explored. In contrast to azide-alkyne cycloaddition chemistry more commonly utilized for the synthesis of 1,2,3-triazoles, microwave-assisted cyclization of N-tosylhydrazone derivatives and anilines offers short reaction times and forgoes the use of both transition metal catalysts and potentially unstable azides without sacrificing potential substrate scope. This class of unsymmetric ligand is unknown in the primary literature and could offer improvements in both solubility within process-relevant organic diluents and extraction chemoselectivity in comparison to more commonly studied symmetric ligands. The current synthetic progress of N-substituted 1,2,3-triazole complexants and relevant derivatives will be discussed.

Graduate

A STUDY ON THE SPECTROPHOTOMETRIC ANALYSIS OF HG(II) USING DITHIZONE UNDER CONDITIONS PERTINENT TO HG(II) REDUCTION IN AQUATIC SYSTEMS

Primary Author: Lesta Kocher, Environmental Sciences Chemistry (Ph.D.)

Co-Author(s)/Collaborators: Stephen Okine; Hong Zhang, Tennessee Tech University

Advisor(s): Hong Zhang

The reduction of mercuric mercury (Hg(II)) in aquatic systems contributes to the transformation, transportation, and fate of mercury in the environment. Solar radiation has been identified as the driving force of Hg(II) reduction to volatile dissolved gaseous mercury (DGM) in aquatic bodies and is hypothesized to be linked to processes mediated by dissolved organic carbon (DOC). Superoxide has also been hypothesized to mediate Hg(II) photoreduction in aquatic systems but the proposed mechanism has recently been rejected in literature. We investigated the applicability of the dithizone method for spectrophotometric analysis of Hg(II) under different environmental conditions pertinent to the study on aquatic Hg(II) reduction, particularly superoxide-mediated Hg(II) reduction. We studied the effects of organic acids (e.g., citrate, cysteine), pH, and reagents used to generate superoxide (e.g., xanthine, xanthine oxidase). Our study showed that some organic acids lowered the sensitivity of the method but the calibration curves in all scenarios retained good linearity. We concluded that the mercury-dithizone method was valid for the study of superoxide mediated Hg(II) reduction. Our preliminary study of this reduction was performed in the absence of light and under controlled conditions (e.g., pH 7.2, 25°C, and 5 μM initial Hg(II) concentration). We observed a decrease of the absorbance at 496 nm (i.e. reduction of Hg(II)) with various rates of superoxide production and various concentrations of organic acids. This preliminary research suggests that superoxide could be an important intermediate for Hg(II) reduction even in the absence of sunlight.

Graduate

SYNTHESIS AND TRANSDERMAL DELIVERY OF DUAL FUNCTIONAL PHENOTHIAZINE IONIC LIQUIDS

Primary Author: Lillian Pipkin, Chemistry (M.S.)

Advisor(s): O. Andreea Cojocaru

Many pharmaceuticals presently available on the market have disadvantages associated with the solid state (i.e., multiple crystalline states, decreased bioavailability/ aqueous solubility, etc.). Prior research has proven that conversion of active pharmaceutical ingredients (APIs) in the solid state to a liquid form (i.e., ionic liquid or IL) is highly advantageous, in that the drug has increased solubility in water or simulated body fluids, improved bioavailability/dissolution, and increased delivery through a skin-mimicking membrane. These liquid state APIs (API-ILs) can also be dual functional, where both drugs forming the IL retain their functionality as well as have synergistic effects.

Phenothiazine drugs (PHZ) are good candidates for liquid conversion as they 1.) have disadvantages associated with the solid form, and 2.) have no analgesic effect. Conversion to a liquid form and combination with an NSAID can rectify both of these issues. Here, we synthesized API-ILs of various combinations, with PHZs acting as cations and NSAIDs as anions. Each new API-IL was then purified and analyzed with NMR and IR spectroscopic methods. A select cation and anion were then tested against their respective API-IL combinations via transdermal delivery experiments in order to determine if conversion to a liquid form improved upon the drugs' delivery through a skin-mimicking membrane.

Graduate

TRANSITION METAL-FREE OXIDATION OF METHYL HETEROARENES VIA MICROWAVE-ASSISTED KORNBLUM OXIDATION TO AFFORD FORMYL DERIVATIVES

Primary Author: Mariah Tedder, Chemistry (M.S.)

Advisor(s): Jesse Carrick

Ongoing efforts seek to expand the scope of potential complexants available for screening for minor actinide separations of spent nuclear fuel (SNF). Prior efforts have focused on accessing symmetric complexants including bis-[1,2,4]-triazinylpyridines (BTPs) which have proved chemoselective for trivalent minor actinides over trivalent lanthanides in the post-PUREX raffinate. Efforts to improve the solubility of these chemoselective complexants are ongoing. One potential avenue to explore are unsymmetrical complexants with varying heterocycles attached to the mono-[1,2,4]-triazinylpyridine (MTP) core. One of the primary avenues to access these unsymmetrical complexants is predicated on accessing the formyl derivative of MTP, followed by subsequent chemistry to afford varied cyclization products.

Our group has leveraged a microwave-assisted Kornblum oxidation to access formyl derivatives of MTP complexants, as well as diversified heteroarenes, in an efficient, chemoselective strategy which eliminates the need to utilize traditional methods with toxic selenium dioxide reagents. The synthetic pathway proceeds quickly with reactions taking place in under one hour, as well as with minimal formation of unwanted side products. Reaction optimization, present substrate scope, and future directions will be disclosed.

Graduate

TRANSDERMAL DELIVERY OF HEPATOPROTECTIVE DRUGS IN LIQUID STATE

Primary Author: Jacob Thorn, Chemistry (M.S.)

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Thomas Robertson, O. Andreea Cojocaru

Advisor(s): O. Andreea Cojocaru

In an emerging field of research, active pharmaceutical ingredients (APIs) in liquid state (ionic liquids or double salt ionic liquids) have been shown to overcome the various drawbacks of their solid state counterparts. Liquid state APIs were shown to add enhanced drug properties such as increased solubility or an increase in a drug‘s affinity to be applied transdermally. Ionic liquids (ILs) are low melting ionic salts comprised of a cation and an anion in a 1:1 molar ratio. ILs containing three or more types of ions in varying molar ratios are classified as double salt ionic liquids (DSILs). Varying the molar ratio of consitiuents in a task specific pharmaceutical DSIL will contribute to the variety of chemical and physical properties of that DSIL.
By applying the IL strategy to a hepatoprotective medication such as N-acetyl-L-cysteine (NALC) and hepatotoxic drugs such as quinidine/quinine hydrochloride, the new hepatoprotective drugs would curtail drug induced liver injury (DILI). Moreover, combining these drugs with a penetration enhancer precursor (sodium docusate) will allow one to synthesize the corresponding DSILs as a hepatoprotective medication that can be delivered transdermally. The research presented here focuses on investigating the transdermal delivery of several new quinidine and quinine ILs and DSILs.

Undergraduate

COMPUTATIONAL DESIGN OF NOVEL INHIBITORS OF DIHYDROFOLATE REDUCTASE IN THREE BACTERIAL SPECIES

Primary Author: Allison Adams, Chemistry

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

Advisor(s): Derek Cashman

This project aims to design high affinity small molecule inhibitors of bacterial dihydrofolate reductase (DHFR) for the purpose of obtaining broad-spectrum antibiotics against multiple bacteria, including Bacillus anthracis (anthrax), Staphylococcus aureus, and Mycobacterium tuberculosis. Inhibitors were designed using MOE 2020 (Chemical Computing, Ltd., Montreal, Quebec, Canada) based on a previous ZINC Database search to target the active site of DHFR based on computational analysis of the energetic frustration and evolutionary importance of amino acid residues present. This analysis was conducted using the Protein Frustratometer (http://frustratometer.qb.fcen.uba.ar/; EMBNet Aargentina, Buenos Aires, Argentina) and Evolutionary Trace (http://lichtargelab.org/software/ETserver; Baylor College of Medicine, Baylor University, Houston, Texas USA). Evolutionary trace and frustration define the active site, by determining binding sites, and areas of the molecule in high energetic states, respectively. Designed inhibitors were docked into each protein using the Docking module of MOE 2020, and the binding residues were then compared to the areas of evolutionary trace and frustration to help determine if the molecules had favorable binding scores. 189 small molecules were designed to interact with these amino acid functional groups based on complementary, non-covalent functional group interactions. The ligand interactions for the top compounds in each bacteria were examined and these compounds were examined according to Lipinski’s Rule of Five, which helps to determine potential druggability. One compound was found to have favorable bonding

across all three bacterial DHFR, and fourteen compounds were recognized as having favorable bonding across two bacterial DHFR.

Undergraduate

DEVELOPMENT OF A NEW GREEN REACTION SYNTHESIS USING DESIGN OF EXPERIMENT (DOE)

Primary Author: Sydney Asmus, Chemistry

Co-Author(s)/Collaborators: Taylor Fletcher

Advisor(s): William Carroll

The use of certain solvents in chemical reactions can cause negative environmental impacts. The goal of this work is to optimize a novel synthesis for both yield and environmental impact. The reactions will be analyzed by a green scoring software, DOZN, that provides a quantitative scoring of its impact. This research optimized a green reaction on the microliter scale using design of experiment (DOE) procedures with nuclear magnetic resonance (NMR). This is conducive to many of the green chemistry tenants as it limits the waste volumes, allows for the use of green solvents, and continuously monitors the progress of the reaction. A standard procedure that optimizes multiple reactions while also remaining fiscally competitive with non-green alternatives was developed.

Undergraduate

SYNTHESIS AND SOLUBILITY STUDIES OF DUAL ACTIVE ASTHMA DRUGS IN LIQUID STATE

Primary Author: Devon Cotter, Chemical Engineering

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

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Jacob Thorn

Advisor(s): O. Andreea Cojocaru

Patients suffering from asthma receive treatment in the form of solid-state ingestible tablets or inhalants. Such forms of treatment are not a pervasive solution to those suffering from long term asthma due to the delivery effectiveness of most beta-agonists and corticosteroids such as albuterol and fluticasone (common drugs prescribed for dealing with asthma exacerbation with worsening conditions). Effectiveness of delivery derives from administration (i.e. inhaled medications hardly reach below the larynx of the human body). Thus, the intended effect of the drug is lost amid delivery complications. An alternative method to inhalants that contiguously resolves complications with delivery and effect while mitigating the use of corticosteroids is to administer these drugs in an ionic liquid form. An ionic liquid approach would be especially useful against standard dry powder inhalants (DPIs) as these solid state drugs can exist in multiple crystalline forms (i.e., polymorphism). Polymorphism declines the drug solvation ultimately decimating its bioavailability while converting the drug to less or nonactive forms. Ionic liquids with multiple cations and anions of varying molar ratios balanced by a neutral charge are known as double salt ionic liquids (DSILs). When applied to pharmaceuticals, the DSIL approach should increase drug bioavailability, remove the existence of polymorphic forms, and add multifunctionality to the final drugs. This study investigates the DSIL forming properties of albuterol when combined with ionic forms of over-the-counter non-steroidal anti-inflammatory drugs (NSAIDs) and docusate anion (a known penetration enhancer), as well as the aqueous solubility of the synthesized compounds.
Undergraduate

CREATING COLOR FLAME CANDLES AS AN

ALTERNATIVE TO THE RAINBOW FLAME TEST

Primary Author: Shawna Grey Coulter, Chemistry

Advisor(s): Amanda Carroll

The rainbow flame test is a visually appealing chemical demonstration that showcases atomic emission spectra, but it can be very dangerous and has caused injuries due to accidents. Recently updates have been made to increase the safety of the demonstration, but it can still prove to be inaccessible to groups without access to proper safety training, certain scientific equipment, and supplies. The purpose of this research is to create easy to make candles that produce colored flames which can be used over long periods of time in a safe manner in classroom and educational settings. Cotton and wood candle wicks are soaked in salt solutions containing different metal cations that are known to produce colored flames and then sealed with wax prior to making the candles. Some wicks are sealed with wax and others are not to determine the effectiveness of sealing the salts into the wicks prior to making the candles. A portion of the sealed candles are coated with a wax containing the salt to allow the salts to soak into the wick as they burn. Other wicks are prepared by spraying the solution on the wicks and allowing them to dry between applications to build up the amount of the salt on the wicks. If successful, this work would allow a new way for the rainbow flame test to be conducted in a safe and accessible manner for a variety of audiences in scientific and non-scientific settings.

Undergraduate

IMPROVEMENTS TO THE BRADFORD PROTEIN ASSAY

Primary Author: Hunter Davis, Chemistry

Co-Author(s)/Collaborators: Jeffrey Boles, Tennessee Tech University

Advisor(s): Jeffrey Boles

The ability to measure protein concentration in solution is widely used in research and the ability to measure the concentrations accurately is of great importance. The measured absorbance of the Bradford assay is slightly linear up to 2000 µg/mL of protein, and linearity is decreased at lower concentrations. An increase in linearity would allow for more accurate estimations of the amount of protein in an unknown solution. This work is investigating the use of alternative alcohols and acids to determine protein concentration in the range up to 20 µg/mL, which demonstrates the most deviations from linearity. Various short-chain alcohols and citric and ascorbic acids will be studied instead of the ethanol and phosphoric acid traditionally used. The results will either reinforce the standard protocol, or introduce an improved method for the preparation of the Bradford reagent.

Undergraduate

VIRTUAL SCREENING OF HAMIGOMYCIN B NATURAL PRODUCT DERIVATIVES IN 26 KINASE PROTEINS

Primary Author: Meagan Edmonds, Chemistry

Co-Author(s)/Collaborators: Derek Cashman, Tennessee Technological University; Jesse Carrick, Tennessee Technological University

Advisor(s): Derek Cashman

Hamigeromycin B and its analogs are synthetic natural product derivatives that may be useful at mediating signal transduction activity in human kinases. To study this potential activity, 11 Hamigomycin analogs were constructed using MOE 2019 and subjected to energy minimization using the AMBER14:EHT force field. Each analog was also compared against the parameters of Lipinski's Rules of Five to determine druggability. The

compounds were docked into twenty-six human kinase structures obtained from the Protein Data Bank (www.rcsb.org) to obtain relative binding free energy scores using the Docking module of MOE 2019. The binding sites for these kinase proteins were analyzed using the Evolutionary Trace server (http://lichtargelab.org/software/ETserver; Lichtarge Laboratory; Baylor University; Houston, TX USA) and the Protein Frustratometer (http://frustratometer.qb.fcen.uba.ar/; EMBNet Argentina; Buenos Aires, Argentina) to characterize the energetics and evolutionary information of the amino acid residues for likely contributions to binding. The lowest docking scores were used to determine the best binding and orientation of each analog to each protein. Docking data suggest good binding of these analogs with five out of twenty-six human kinase proteins. Functional group modifications were done to the original compounds in an effort to enhance binding to these five kinases. Future in vitro studies are being planned to confirm the computational docking results. Preliminary computational results will be disseminated.

Undergraduate

POLYAROMATIC RADICAL ANIONS: UTILIZATION OF A HARMONIC MODEL IN SIMULATING RADICAL VIBRATIONAL STRUCTURE AND GAS-PHASE ACIDITY DETERMINATION

Primary Author: Benjamin Headrick, Chemical Engineering

Co-Author(s)/Collaborators: Taylor Dimino; Rebecca Firth

Advisor(s): Wilson Gihchuhi

Through their diverse molecular structure, charge and protonation states, polyaromatic hydrocarbons (PAHs) play a central role in the field of Biochemistry, combustion chemistry, and Astrochemistry. In this poster, a harmonic model was utilized in the Franck–Condon (FC) analysis of the vibrational structure of negative radical anions of PAHs such as naphthalene and anthracene, following the ultra violet (UV) photodetachment of the initially prepared deprotonated anionic species. The two PAHs are utilized as a prototype for the vibronic analysis of the ground-state and lowest lying excited states of similar gas-phase isomers that contain a rigid, ring structure. The spectra are interpreted based on the comparison with quantum-mechanical data obtained from ab initio calculations as well as the Franck-Condon (FC) calculations. The geometric and frequency of the optimized structures of the anion and the neutral radical are calculated using the GAUSSIAN 09 software package. The FC factors of the anion PES are simulated using the PESCAL program. PESCAL obtains the FC factors using molecular geometry, normal mode vectors, and normal mode harmonic vibrational frequencies of the anion and neutral states. These FC simulations are based on a harmonic oscillator approximation model that utilizes the Duschinsky rotation between the normal mode vectors of the anion and neutral radical species. The calculated adiabatic electron affinity is utilized in the negative ion thermochemical cycle to determine gas-phase acidity values of neutral PAH molecules.

Undergraduate

LIQUID STATE PHARMACEUTICALS BASED ON ALIPHATIC DICARBOXYLIC ACIDS

Primary Author: Caroline Hunter, Biology

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

Advisor(s): O. Andreea Cojocaru

Pharmaceuticals are necessary aspects of everyday life for many people. Unfortunately, pharmaceuticals can also pose dangerous health risks for individuals, as well as side effects, mostly provided by their inherent solid state (e.g., limited bioavailability and aqueous solubility;

change in their activity due to polymorphic changes). These issues can be addressed by converting solid-state pharmaceuticals into liquid-state compounds with melting points below body temperature, such as ionic liquids (ILs) and double salt ionic liquids (DSILs). These strategies allow the development of liquid-state pharmaceuticals that will potentially avoid harmful side effects that the solid-state poses while adding dual functionality. Furthermore, a liquid state would provide additional methods of drug delivery, making it beneficial for individuals that are unable to ingest drugs in tablet form. To form liquid state compounds, cation and anion precursors are combined either in a 1:1 ratio (when ILs with two ions of different biological activity are obtained) or in different molar ratios (when DSILs that can contain three or more ions of different biological activity are obtained). Amines or ammonium salts are used as cation precursors while carboxylic acids or metal carboxylates are used as anion precursors.

This presentation focuses on the synthesis and spectroscopic characterization of new liquid state compounds obtained by combining various pharmaceuticals (e.g., thioridazine, lidocaine, promazine) as cation precursors with aliphatic dicarboxylic acids as anion precursors in different molar ratios.

Undergraduate

UPPER CUMBERLAND HEALTH EDUCATION

Primary Author: Samuel LeFave, Chemistry

Advisor(s): Janet Coonce

The Upper Cumberland Community Host Group has shown the need for rural health innovation through gathering data from Remote Area Medical (RAM) clinics. Seeing the needs in dental and medical health continue to go unmet, there must be another way to treat the patient. This research shows how focused Health Education in the rural areas of the Upper Cumberland may provide a hope for patients and a relief for the healthcare system.

Undergraduate

DEVELOPMENT OF A TERNARY MOBILE PHASE IN THIN LAYER CHROMATOGRAPHY TESTING FOR DISTINCTIONS BETWEEN HEMP AND MARIJUANA

Primary Author: Kaitlyn Lovell, Chemistry

Co-Author(s)/Collaborators: Sara Selvidge; Courtney Lapointe

Advisor(s): Jeffery Boles

The illegal use of recreational drugs has led to an increase of presumptive drug testing in the law enforcement field. These tests can be faulty, and there is a need for improved testing methods. The enhanced ability to distinguish Cannabis from other related substances through presumptive testing would allow officers to have better information regarding making arrests. This project involves the use of thin layer chromatography (TLC) to create a new presumptive test that is more effective. Different compounds will be added to the current mobile phase to decrease the acid appearance on the TLC plates which is visualized by streaking. The ideal ternary mobile phase will be able to maintain successful extraction of the Cannabinoids and reduce the appearance of acid streaking on the TLC plates. The reduction of the streaking effect will give clearer results, this will allow officers to make better decisions based on the test kit. The test kit will show different colors in the presence of Cannabis compared to other similar substances making a clear indication for the presence of THC. If successful, this project holds the potential to provide officers with a safe and effective field testing kit.

Undergraduate

LEACHING OF JUGLONE FROM HYDROPHOBIC SILICA AND ZNO SOLID SUPPORTS

Primary Author: Rachel Paris, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

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

Advisor(s): Twanelle Majors

Juglone is a naphthoquinone present in the hulls and other parts of the walnut tree. Juglone is also characterized by its toxicity to many plant species (i.e herbicide properties) and has numerous useful medicinal properties. The selective toxicity of juglone can be utilized to control undesired competitive plant and microbial species. Due to its low water solubility and high volatility, a controlled mechanism is needed to reduce drift into non-target areas.
A controlled leaching of the compound can be attained by its adsorption on mesoporous hydrophobic silica material and zinc oxide material. This presentation focuses on loading juglone on these solid supports in three wt/wt% loadings (10%, 20%, and 50%) and on its leaching from the new materials into a buffer of pH=5 and a 1/1 (v/v) pH=5 buffer/ethanol mixture.

Undergraduate

CHEMOSELECTIVE GREEN OXIDATION OF HETEROARYL ISOPRENES TOWARD FUNCTIONALIZED METHYL KETONES

Primary Author: Connor Pinson, Mathematics

Advisor(s): Jesse Carrick

Nuclear power plants produce heat through fission of enriched materials. The resulting heat is what drives the rest of energy producing processes. Once the enriched fuel has been depleted to the point of no longer self-sustaining a nuclear reaction, it is not able to be utilized by the nuclear power plants. The remaining fuel is called spent nuclear fuel, or SNF. With the goal of separating specific daughter nuclides from the SNF, our group is seeking to find complexants that are able to selectively bind the minor actinides. Prior work focused on symmetrical examples, bis-[1,2,4]-triazinylpyridines (BTPs), that are chemoselective for actinides over lanthanides in post-PUREX raffinate. Solubility is an area of focus, and our group is working to see how different functional groups added to a core, mono-[1,2,4]-triazinylpyridine (MTP), will influence downstream behavior of the complexants.
In order to examine options of unsymmetrical complexants, an efficient pathway for acylation of pyridines to synthesize hydrazones was needed. However, acylation of pyridines has very few current regioselective synthesis options. Many notable reactions for arene acylation, such as the Friedel-Crafts acylation, do not operate the same when pyridine is involved. Our group leveraged a Suzuki-Miyaura cross-coupling for the addition of an isoprenyl group to starting compounds. Then, we proceed with a quick and efficient green oxidation that chemoselectivly affords the ketone over the carboxylic acid. Using this method, complexants can be synthesized to investigate the effects of their unsymmetrical nature. Reaction optimization, substrate scope, and application to other heteroarenes are disclosed.

Undergraduate

TOWARDS USING MESOPOROUS SILICA AS A DRUG DELIVERY SYSTEM FOR CHLORPROMAZINE IBUPROFENATE IONIC LIQUID

Primary Author: Abigail Pipkin, Chemistry

Advisor(s): O. Andreea Cojocaru

In pharmacies around the world, solid-state pharmaceuticals sit on shelves changing their crystalline structures day by day through polymorphic transformations (polymorphism is the event of a substance

crystallizing into more than two crystalline forms). As a result, a drug's effectiveness may change during shelf life due to a decrease in aqueous solubility which may lead to a limited bioavailability. These disadvantages can be resolved through the conversion of solid-state drugs into a liquid state compound (ionic liquid, IL) with a greater therapeutic effect on users. ILs can be synthesized by combining two different pharmaceuticals into one single compound to create ILs with dual functionality, in that both parent drugs retain their functions.

The IL of interest for this project is chlorpromazine ibuprofenate which is synthesized through the metathesis reaction between chlorpromazine hydrochloride and sodium ibuprofenate. Spectroscopic methods (Nuclear Magnetic Resonance and Infrared Spectroscopy) are employed to determine the purity and structure of the synthesized IL while the supported ionic liquid phase (SILP) methodology is used as a potential delivery strategy. This procedure is favorable for a highly viscous liquid drug. Its adsorption onto solid supports (e.g., mesoporous silica) consolidates the benefits of the liquid state compound with the ease of transfer and handling. Investigating the leaching of the IL from the solid support into simulated body fluids (e.g., simulated gastric fluid) will test the potential for this drug's delivery mechanism.

Undergraduate

CONSTRUCTION OF POTENTIOSTAT FOR EDUCATIONAL LAB USE

Primary Author: Kami Pullum, Chemistry

Advisor(s): Jonathan Moldenhauer

Analytical equipment for electrochemistry is extremely expensive and not always accessible, to not only higher education campuses, but especially secondary education. In order to make electrochemistry education more available at all levels, a homemade potentiostat has been developed to accomplish this. Literature shows that construction of a DStat potentiostat by undergraduates can be accomplished for under $100. The goal of this research is test if this procedure is achievable in an undergraduate setting. Individual parts for the circuit board were obtained and used for construction. The containment area for the board was 3D printed using CAD schematics. The Dstat was designed to be computer compatible via USB. The benefits of a project like this can be a deeper understanding of electrochemistry instrumentation and principles in basic electrochemistry. It can also broaden student knowledge in circuit boards, schematics, and other construction techniques. Once construction is completed, a sample experiment will be run comparing the professionally constructed equipment to the DStat. The sample experiment will determine the amount of acetaminophen in children's medicine. A calibration curve will be constructed from known amounts of stock solution to compare against an unknown. The accuracy and precision from both procedures on each respective instrument can be compared.

Undergraduate

SOLUBILITY OF THIORIDAZINE DOUBLE SALT IONIC LIQUIDS IN PHOSPHATE BUFFER SALINE

Primary Author: Claire Rust

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Oana Cojocaru

Thioridazine, a member of the phenothiazine drug class, is used as a treatment for the symptoms of schizophrenia and other psychotic conditions. However, this drug has reportedly caused many life-threatening issues including cardiac arrythmia. This drug is currently manufactured as a solid state drug and its crystalline structure inhibits its ability to function as expected due to lower aqueous solubility as well as its existence in different polymorphic

structures. By converting this drug into a liquid form, an ionic liquid (IL) or a double salt ionic liquid (DSIL), new, highly viscous liquid state drugs with new, more desirable properties (e.g., increased aqueous solubility and retained activity) will be obtained.

This presentation focuses on combining various molar ratios of thioridazine, as a cation precursor, with lidocaine cation and docusate anion to create multifunctional DSILs. The two ionic components, lidocaine cation and docusate anion, are added to combat thioridazineâ??s negative side effect of cardiac arrythmia and to provide the drug with extra delivery options (i.e., transdermal delivery). Three new DSILs were synthesized using the strategies reported in the literature and their aqueous solubility in phosphate buffer saline (pH = 7.4) was investigated.

Undergraduate

SYNTHESIS OF INAP-ETSC AND INAP-TBUTYL

Primary Author: Bailey Talent, Chemistry

Advisor(s): Edward Lisic

Thiosemicarbazenes are a class of organic compounds that function extremely well as ligands that bind to transition metals to form metal complexes with interesting biological properties. This presentation focuses on synthesis and characterization of a new series of monoxime thiosemicarbozone. Two new compounds, namely α-isonitrosacetophenone ethyl thiosemicarbozone (INAP-ETSC) and α-isonitrosacetophenone tert-butyl thiosemicarbozone (INAP-tButyl), are synthesized and characterized by Nuclear Magnetic Resonance Spectroscopy (NMR). The synthesized compounds are further used to create the palladium-ligand complexes that can be tested for their anticancer properties by studying the inhibition of topo-isomerase 2α.

Undergraduate

LIQUID-LIQUID EXTRACTION AND SPECTROSCOPIC METHODS FOR DISTINGUISHING BETWEEN HEMP AND MARIJUANA

Primary Author: Brooke Underwood, Chemistry

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Courtney LaPointe; Jeffrey Boles, Tennessee Tech University

Advisor(s): Jeffrey Boles

Passage of the Farm Bill in December 2018 legalized cannabis containing less than 0.3% tetrahydrocannabinol (THC), otherwise known as hemp (1). This creates problems for law enforcement since current presumptive test kits either 1) don't work at all or 2) work somewhat in differentiating between legal and illegal hemp crops. This problem exists because most hemp crops and hemp products contain low levels of THC and the carboxylated form, THCA. Our approach involves the advancement of an efficient, mobile, liquid-liquid extraction (LLE) that provides presumptive, qualitative forensic evidence of the chemical extract of a bud or other plant material. This research is focused on developing a kit that functions in a similar manner to NIK kits, commonly used by law enforcement, where all components of the kit are contained within a bag. The current NIK kit for Marijuana provides a false positive when Hemp is placed in the bag, thus creating the need for a more reliable test (2). The evidence would later be sent to a crime lab for definitive analysis and quantitation of THC by ultraviolet- visible spectroscopy (UV-vis). This research has focused on the utilization of liquid-liquid extraction techniques and commercially available stains. The methods presented are rapid (requiring no more than five to six minutes to complete). The differentiation between two lots of commercially available hemp and seven lots of marijuana obtained from the Cookeville City Police will be presented.

Undergraduate

ADVANCED ACCESS TO UNSYMMETRIC TRIDENTATE COMPLEXANTS FOR UTILIZATION IN SPENT NUCLEAR FUEL REMEDIATION

Primary Author: Gabrielle Waters, Chemical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Jesse Carrick

Radioactive waste mitigation is a critical component of the nuclear fuel cycle, but largely remains inefficient and expensive. To combat this reality, developments in separations techniques that decrease the amount and toxicity of generated waste are highly sought after. Contemporary techniques are rooted in liquid-liquid extractions via a chelating agent and a radioactive ion such as Americium. This lab focuses on synthesizing nitrogen-containing, Lewis-basic, chelating scaffolds for use in separation processes. Such compounds need to be resistant to acidic environments and soluble in nonpolar organic solvents. Previous synthons in the lab have consisted of durable pyridine and triazine derivatives, but solubility assays in process relevant solvents highlight the need for additional exploration. Current strategies focus on improving solubility through unsymmetric functionalization that leads to topographical changes of the ligand and solvent interaction, in situ. One avenue for investigation involves Kornblum type oxidation of an MTP derivative followed by oxime formation, tosylation and elimination to afford a carbonitrile that can then form a 1,2,4-triazine through previously established methods. An alternative route for exploration involves oxidative cyclization with benzamidines to afford terpy-like complexants which offer another type of bonding array for ions not previously explored. Preliminary optimization and substrate screening for these reaction pathways towards unsymmetric compounds, or previously unreported compounds will be presented.

Department of Earth Sciences

Undergraduate

SURVEY AND ANALYSIS OF ARCTIC FANS IN SVALBARD, NORWAY AS AN ANALOG FOR MARS

Primary Author: Sydney Beltran, Geosciences

Advisor(s): Jeannette Luna

The islands of Svalbard, Norway are located between Scandinavia and the North Pole (78°50'50.36"N 18°19'00.95"E). This region is known for its glacier-filled frozen tundra environment. Along the coastline of Svalbard are fan shaped deposits of unconsolidated sediment that are frozen during winter months (mean low temperature -17°C in January) and fluidized during summer months (mean high temperature 5°C in July). These conditions make Svalbard a good terrestrial analog for Mars, where fan-shaped features suggest evidence of liquid water on the ancient surface. Comparing alluvial fans and fan-deltas on Earth to those on Mars, we can draw conclusions about the paleoclimate and geologic history of each planet.
In this study, 302 arctic fans were identified and measured on the islands of Svalbard using high-resolution satellite data (< 5 m/pixel). Images were acquired by NASA Landsat satellites and Digital Globe commercial satellites. With using the historic imaging provided, some remote sections of the islands only had older images available while the majority was more recent, higher quality images. Each fan was marked and measured at its widest diameter and all data and coordinates recorded in Google Earth and Excel. Fans range in size from less than a kilometer to over five kilometers in diameter, and some fans display asymmetrical geometries consistent with alongshore transport. Preliminary results show that fans in Svalbard record interactions between snow, ice, and overland water flow, similar to what climate models predict for fan-shaped features formed early in Mars' history.

Undergraduate

FLASH FLOODING PREDICTION OF CUMMINS FALLS STATE PARK.

Primary Author: Jason Gentry, Geosciences

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Evan Hart

Cummins Falls State Park has become a popular attraction since being named as one of America's Secret Swimming Holes by the Travel Channel. Located in southern Jackson County, the park is visited by thousands of people each year. While a beautiful place, the falls also are subject to flash flooding like the arroyo flash floods of the western U.S. In response, the state has installed gauging and rainfall monitoring in the watershed. Our research focuses on comparing observed data with model output using the USACE's Hydraulic Engineering Center River Analysis System (HEC-RAS). The objective is to determine how much rainfall can cause dangerous increases in stream level, and how much time elapses between a rainfall and the increased stream level. Observations from the rain gauges indicate that rainfall amounts over 0.04 inches in 5 minutes can cause unsafe rises in the stream depth. The time from rainfall at the far reach of the watershed to the Cummins Bridge Road station appears to range from 2-3 hours. The time between the stream rising at the West Fork gauge and the East Fork Gauge to reach the bridge is about 45 minutes. Further modeling of the watershed may provide more details of stream behavior and answers to questions of rainfall and timing.

Undergraduate

ORIGIN OF LINEAR DEFORMATION PATTERNS IN THE FORTUNA AND ITZPAPALOTL TESSERAE, VENUS

Primary Author: Riley Grecol, Geosciences

Advisor(s): Jeannette Luna

Tesserae are unique surface features identified by linear deformation in multiple crossing directions. They are found on Venus and are assumed to comprise the oldest known crust of the planet. This study focuses on tessera lineations in order to identify similarities regarding their formation. Two tesserae, the Fortuna Tessera and Itzpapalotl Tessera, located in the northern polar region (V1), are compared. The goal of this work is to determine if tesserae formed in isolated events or if they were formed by the same or similar events. This could help understandings in the processes that form tesserae and how they relate to each other. This study tests the hypothesis that lineations within the tesserae will differ enough in orientation to conclude that individual tesserae were formed in unique isolated events.

This study presents bearing measurements taken of the lineations within the chosen tesserae. Each tessera has two distinct sets of linear features which cross at near perpendicular angles. Using GIS, 400 lineations were mapped at a scale of 1:1,000,000 and their bearings calculated. The bearing measurements were then plotted against each other to determine if the sets of lineations had significant similarity in their orientations. Preliminary results show that there is a general northeast and northwest trend for the two sets of lineations, respectively, on each of the observed tesserae. This refutes the hypothesis that individual tessera experienced deformation during unique, local deformation events and instead suggests that tessera may record widespread, global deformation.

Undergraduate

CHANGES IN MONTHLY AVERAGE DISCHARGE FOR RIVERS IN TN, KY, AL, GA, NC, SC, VA, WV OVER THE LAST 100 YEARS

Primary Author: Miguel Holguin, Geosciences

Advisor(s): Evan Hart

Throughout the years, monthly river discharge may increase or decrease depending on climatic conditions. The river discharge is the volume of water flowing in the river, the USGS measures flow in cubic feet per second. For the research 8 states in the southeast US were selected to analyze rivers that contained records of monthly discharge that ranged from 90-100 years of records. Monthly average discharge data were collected from the USGS website https://waterdata.usgs.gov/nwis/rt. The latitude and longitude of each gauging station were also taken to plot the data in ArcGIS. Using MS the mean, maximum, minimum, and the standard deviation were calculated. Each period of record was divided into 2 parts: roughly from 1920 to 1979 and 1971 to present. Statistics for mean monthly flow were compared between these two periods. The percent average for each state showed that there is an increase in discharge around September through December with the exception of South Carolina and Alabama, who have a decrease in discharge. By comparing the two time periods of the individual data for each river in each state, we can see that the two time periods differ and some are similar to each other.

Undergraduate

DIAGENETIC ASSESSMENT OF THE MISSISSIPPIAN MACCRADY FORMATION, WEST VIRGINIA USING CLAY MINERALOGY

Primary Author: Ben Holladay, Geosciences

Co-Author(s)/Collaborators: Wayne Leimer

Advisor(s): Lauren Michel

As CO2 levels increase with concomitant temperature advances and glacial retreat there has been a push to better understand past climate change. The one of the best studied icehouse conditions was during the Carboniferous (Mississippian and Pennsylvanian) through Early Permian, (358.9 Mya to 272.95 Mya) when CO2 levels fluctuated between 300 ppm and 1000ppm. The Maccrady Formation in West Virginia, was deposited in the Mississippian period of the Carboniferous on the equator, and is comprised primarily of siltstone, mudstone, and sandstone. Field observations show soil-forming vertic features including slickensides and wedge-shaped peds, and pedogenic carbonate. The carbonate and vertic features represent calcic Vertisols; today Vertisols form in locations with discrete periods of water-budget surplus and deficit. X-ray diffraction analysis of the <2 μm fraction from oriented aggregates reveals a mineralogy primarily comprised of illite, hydroxy-interlayered minerals, and chlorite. The vertic features seen in modern Vertisols are usually attributed to the presence of the mineral smectite and not the mineral suite observed. The presence of illite, hydroxy-interlayered clay and chlorite and the absence of smectite is attributed to clay mineral transformation as a result of diagenesis. In particular, the conversation of smectite to illite is attributed to the illitization processes. Chlorite present within these sample is shown by a lack of peak collapse on XRD spectra after heating. The degree of diagenetic alteration means that while qualitative assessment of paleoclimate is possible, quantitative assessment of paleoclimate is not possible.

Undergraduate

GLOBAL SURVEY AND DISTRIBUTION OF PENNSYLVANIAN AND MISSISSIPPIAN MICROBIAL MOUNDS

Primary Author: Clarice Kiser, Biology

Advisor(s): Jeanette Luna

Microbial mounds, including Waulsortian and Waulsortian-like mounds, are lithified structures composed of carbonate compounds and ancient microbes that aided in the production of those compounds. They commonly developed in shallow sea environments of the Pennsylvanian (323 to 299 Ma) and Mississippian (359 to 323 Ma) era strata due to the photosynthetic tendencies of cyanobacteria and its environmental symbionts that require marine environments (i.e.: phylloid algae). The lithification of these microbes can give insight to biosignatures left by this process and can therefore inform our understanding of microbial mounds on Earth and, potentially, on other planets.

This study serves to build a global database of microbial mounds from these geologic eras, which span 60 million years. This database will include geographic data from scientific studies of microbial mound structures from the last 31 years (1990-2021). We sift through these studies to find the specific locality of when and where the specimens are found and then pinpoint the location on Google Earth. With these locations pinpointed, we can construct paleogeographic maps and compare the ecology, location, and sedimentary character of each mound. This is done in order to find similarities in conditions on ancient shallow marine slopes and determine the fundamental controls on mound formation. Understanding the conditions necessary for microbial mound growth is a first step toward predicting where mounds may have developed elsewhere in the Solar System.

Undergraduate

SEDIMENTOLOGIC AND PETROLOGIC ANALYSIS OF THE CHINLE FORMATION IN COLORADO

Primary Author: Dillon Preston, Geosciences

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Lauren Michel; Julia McIntosh, Southern Methodist University

Advisor(s): Lauren Michel

The Permian-Triassic boundary denotes the largest mass extinction event on record, as well as a time with concurrent rises in temperatures and CO2 levels. This is similar to what the Earth is experiencing today. Outcrops located at South Canyon Creek near Glenwood Springs, Colorado, are part of the Eagle Basin, and are currently being researched with the intent of discovering conclusive information that can be utilized to infer about past environmental conditions during the Permian-Triassic extinction event. This area is home to a variety of rock formations, including the State Bridge and Chinle Formations. The State Bridge and Chinle Formations were likely deposited during and after the extinction event, respectively. Therefore, they offer an opportunity to study how climate changed during and after the largest mass extinction on record. Particular areas of these formations are home to fossilized soils, or paleosols, which serve as a proxy for past climate data. Field observations include vertic features such as wedge-shaped peds and slickensides, as well as carbonate and iron/manganese nodules, root traces, and burrow structures. Micromorphological investigation indicates differences in the style of root traces and burrow structures. The calcic and vertic features along with the nodules are interpreted for form as a result of seasonality. The occurrence of root traces and burrows likely indicates the presence of an abundance in early soil colonizers after the extinction evident. Further analysis of this information will lend to a greater understanding of modern-day climatic processes and events in analogous conditions.

Undergraduate

SUITABILITY OF PALEOSOLS FROM THE EARLY MIOCENE KIAHERA FORMATION, RUSINGA ISLAND, KENYA FOR STABLE ISOTOPIC ANALYSIS

Primary Author: Heather Vineyard, Geosciences

Co-Author(s)/Collaborators: Lauren Michel, Tennessee Technological University; Wayne Leimer, Tennessee Technological University

Advisor(s): Lauren Michel

Climate change and concurrent environmental changes play an important role in understanding biological evolution through time, because climate change may be a stressor that promotes flora and fauna adaptations. Nearly a century of geological and paleontological study on Rusinga Island, Lake Victoria, Kenya, has made it a touchstone for understanding early Neogene floral and faunal evolution. This is because sediments that were deposited between ca. 20-17 Ma, during the early Miocene, are famous for the presence of the early ape, Ekembo, as well as more than 100 species of mammals. The basal Kiahera Formation has largely been understudied, but recent preliminary work suggests it contains an abundance of fossil soils (paleosols), as well as uniquely preserved fossils. Here we report on the clay mineralogy of four different paleosols within the Kiahera Formation using x-ray diffraction (XRD) analysis. Preliminary XRD analysis reveals samples dominated by illite, kaolinite, and mixed layer clay minerals. In particular, sample LM17KF contained an abundance of clay minerals, no evidence of diagenetic alteration, and the desired two clay mineral suite of illite and kaolinite. This sample was determined to be the most robust candidate for future stable isotopic analysis. These results advance our ability to quantitively assess climate on the island, particularly in a formation that is important for its small mammal communities. Furthermore, this work, suggests

there are phyllosilicates that are appropriate for □18O analysis which may result in our better understanding the role the East African monsoon played in the environment during this time.

Undergraduate

TROG SINK AND ITS HYDROLOGIC EFFECTS ON HEAD WATERS OF THE EAST BLACKBURN FORK RIVER

Primary Author: Todd Wisor, Geosciences

Co-Author(s)/Collaborators: Evan Hart

Advisor(s): Evan Hart

A hydrologic model was developed to predict runoff in an urban watershed in Cookeville, TN. In the research area there resides a massive sinkhole responsible for storing and transmitting storm water to the East Blackburn Fork River. The sinkhole is hypothesized to store excess rain water, and release it at a steady rate. Maintaining a higher baseflow discharge well after storms have passed over the watershed. A rain gauge and two stream gauges were deployed to record water level in the sinkhole and at a spring known to be its outlet. ArcGIS Pro software was used to calculate the watershed area and interpret the terrain of the watershed. The hydrologic model HEC-HMS (Army Corps of Engineers) was used to model runoff from a rain event that happened on December 5, 2020. Results showed a normal hydrograph with peak rainfall and a fairly quick return to baseflow estimated at hours compared to the time recorded in field data. Field data showed Trog sink retaining a large volume of water about 8.5ft in height at its maximum, and not allowing the spring to return to base flow for roughly thirteen days. Further research and modeling are hypothesized to display Trog sinks actual retention pattern in a hydrograph and become more synonymous with the field data during the rain events.

Department of English

MARRYING FOR AUTONOMY: A FEMINIST ANALYSIS OF ROMEO AND JULIET

Primary Author: Abbigail Jackson, English (M.A.)

Advisor(s): Kristen Deiter

Several Shakespeare scholars focus on the oppression of women in Shakespeare's time, and maintain that stance when analyzing Romeo and Juliet. Some scholars argue that both Romeo and Juliet, but especially Juliet, are oppressed and passive in the events of the play. This paper argues that not only do both characters actively participate in their lives, but Juliet in particular determines her own fate. Juliet chooses not to abide by her parents' wish that she marry Paris, and instead chases Romeo, despite knowing her parents' expectations of her to marry the man they chose for her. This paper claims that, with the help of her nurse, Juliet makes rational decisions, showing that she does not have a history of impulsive actions. While Romeo may make impulsive decisions, those are a result of a lack of mature guidance, not a result of his own immaturity. The difference in their support systems shows how Juliet has the capability to make well-informed, reasonable decisions, and therefore chooses to commit suicide on her own accord. She determines her own fate, knows she would not live the life she wants if she lives, and chooses death over living an unhappy life. The paper uses feminist criticism and close reading to arrive at this conclusion. I wrote this paper for my English 6000 Intro to Graduate Studies course in the Fall 2020 semester.

Graduate

THE MIRRORED SELF: FRAGMENTED NARRATIVE IN TIM O'BRIEN'S IN THE LAKE OF THE WOODS

Primary Author: Lalonie McCarter, English (M.A.)

Advisor(s): Brian Williams

My paper explores Tim O'Brien's In the Lake of the Woods as a text that divulges the effects of trauma on personal narratives. Rather than simply telling the story of a man broken by the tragedy of the Vietnam war, O'Brien crafts a text that reveals one man's creation of self and how various traumas work to untether him from that self and reality at large. O'Brien employees the use of mirrors and narrativization to underscore the importance of narrative in creating our identities. I argue that O'Brien shows how such narration, made unstable by trauma, can collapse and leave a traumatized individual with no way to discern between fiction and reality. Furthermore, I explore how the failure to integrate stories of trauma into an individual's narrative creates fractures in their identity and stunts recovery. This type of reading envisions a new way of interpreting the impact of trauma on affected individuals by offering a fresh perspective on how the self is created and maintained through narrative.

I wrote this paper for my undergraduate Topics in American Literature: Trauma and the Nation class. I presented this paper at the 30th Annual Mardi Gras Conference at Louisiana State University in February 2020. I received a CAS Graduate Student Travel Fund grant to attend this conference.

Graduate

BIAS, POLITICS, AND IDENTITY IN THE NEWS AND YOUTUBE

Primary Author: Sarah Rutledge, English (M.A.)

Advisor(s): Kristen Pickering

Recently, with the rise of technology, there has been a generational shift regarding where people get their news, from television to social media. The implications of this shift are relevant to the fields of Rhetoric, Communication, and Media Studies and have impacts on even broader audiences. This research paper focuses on how political media bias, the shift of television news media to social media, and YouTube, specifically, have impacted or could impact audience identity, power relations, and the genre of news itself. Drawing upon the theoretical lenses of genre theory, political communication, naïve realism and the analytical frameworks of power and identity, this study analyzes four news channels, two television stations and two YouTube channels, to determine ways that they portray their bias. Following this analysis, the paper concludes with a discussion of the ethics of polarization and social media and how the shift of television to social media relates to political identities and what that means, ethically, for the future of the news genre, communication, and polarization.

Undergraduate

"THOU GAUDY GOLD": WEALTH IN THE MERCHANT OF VENICE

Primary Author: Christopher Fairchild, English

Advisor(s): Kristen Deiter

A great deal of scholarship on the Merchant of Venice analyzes the play's romantic themes and Jewish stereotypes. However, the play's main theme is wealth. The lack of scholarship on wealth in this play is surprising, especially given that the title indicates the importance of economics. Wealth is central to the characterization, and the historic, and economic contexts presented in the play. This paper analyses the play in these contexts.

Wealth is the most important theme of the play since it is connected to most, if not all, of the critical parts within it. The context of Shylock's wealth should be explained to a modern audience. As such, I explain the modern monetary value of Shylock's 3000 Ducat loan and his fortune rather than an estimation of the raw gold value of Ducat coins. Shakespeare uses many Greek mythological references, here the golden fleece and King Mydas are used. It is no coincidence that gold is the central object in these myths. Even in the play's romantic scenes, wealth is still tied to love and is often the motivating factor for the characters. Sometimes love is betrayed for economic power. The paper also includes the historic economic importance of marriage and its pressures on men and women. And lastly Shakespeare often used other settings to comment on England. As such, I analyze the English view of other countries' wealth under the guise an Italian setting.

Undergraduate

SHARING STORIES: RECORDING STORIES THAT CHANGE IN TRACKS

Primary Author: Linda Stegall, English

Advisor(s): Brian Williams

Native American cultures thrives in the cyclical nature and continual existence of change in the world. However, with white culture oppressing and destroying their natural world, Native culture had to adapt to survive. One of the adaptations included the recording of Native stories and later the publication of said stories. Many Native Americans resent this new tradition, as it preserves a single version of the story instead of allowing for the adaptations that comes with storytelling.

My paper focuses on Louise Erdrich's novel Tracks, a single book in a collection of novels focusing on the same characters experiencing Native life in a more modern world. Erdrich uses Tracks to tell the story of the character Fleur; however, much like Native storytelling, many narrators tell her tale in different, sometimes contradictory ways, providing a customizable story that changes depending on the narrator. I argue that Erdrich's novel proves that the recording of Native American tales can reflect the original intent—to share ever-changing and growing stories. Contradicting the issue that recording stories is only preserving a corpse of the original intent provides an opportunity for Native Americans to share their stories without the threat of losing them entirely as their culture continues to assimilate into modern American culture. Additionally, novels create an avenue by which the stories can be spread and told to multiple people, including people of different cultures, therein allowing more people to both understand and accurately participate in Native American traditions.

Department of Foreign Languages

Undergraduate

COMMUNICATING CORONA: HOW SCIENCE CAN HARNESS NEW MEDIA DURING A PANDEMIC

Primary Author: Lena Albro, English

Advisor(s): Martin Sheehan

The COVID-19 pandemic has presented a major challenge to public health and the field of technical communication across the globe: how can medical experts quickly and effectively convey their highly specialized knowledge in ways that instruct, inform, and persuade non-specialists when infection rates are rising?

In Germany, two instances of new media—a podcast series titled “Das Coronavirus-Update” and the YouTube channel “maiLab”—demonstrate how scientists can quickly engage audiences and thereby have a major impact on public health. Informed by central principles of technical communication, such as purpose, audience, and situation, this project investigates the ways in which this podcast and YouTube channel successfully build trust and rapport while still managing to impart scientific knowledge in a professional, impactful, yet accessible manner. Although each genre features scientists sharing their hyper-specialized knowledge, these modern forms of communication manage to effectively instruct and inform their audience by considering the audience’s needs and the special circumstances surrounding the production of the medium.

This project was created for a Directed Studies in German course with a focus on Technical Communication in the age of COVID, where I use my Technical and Professional Communication skills to explore how Germany handled the pandemic.

Undergraduate

CULTURAL VARIATIONS OF CINDERELLA

Primary Author: Sydney Edwards, Mechanical Engineering

Co-Author(s)/Collaborators: Prinya Tep; Jake Jeffers

Advisor(s): Julia Gruber

Fairy tales are popular and highly adaptable ways to convey life lessons in a way that is easy for one to consume. Different cultures throughout the ages heave produced their own unique versions of the same story. Our poster will explore three interpretations of Cinderella as told in Germany, Ireland, and Russia. These stories are Aschenputtel, Billy Beg and the Bull, and Vasilia the Brave, respectively. We will explore how these different settings influenced the variances in the stories, as well as how each story conveys overarching lessons to those that read them.

Lessons that will be expanded upon include not letting others control your life, efforts are rewarded, and benevolence in all situations.

Undergraduate

COVID-19 IN A GLOBAL, ECONOMIC PERSPECTIVE

Primary Author: Rachel Everett, International Business and Cultures

Advisor(s): Martin Sheehan

While the emergence of the Corona Virus in humans is considered a novelty, historically speaking, it has

a precedent in the “Spanish Flu” and the worldwide pandemic it caused in 1918. This project seeks to understand what lessons the prior pandemic has for the current world, especially when it comes to the economy on a national and global scale. After providing the major historical details of the 1918 pandemic and its cultural impact, this project will focus on the differences in how each pandemic was handled, how they impacted the world’s GDP, and how some countries recovered economically faster than others. Ultimately, the 1918 pandemic has much to teach us about how humans and their institutions react to a global challenge like a pandemic.

Undergraduate

ANIMALS VERSUS HUMANS IN DER STRUWWELPETER AND OTHER CHILDREN'S LITERATURE

Primary Author: Rebekah Garber, Secondary Education

Co-Author(s)/Collaborators: Taylor Liggett

Advisor(s): Julia Gruber

Der Struwwelpeter is a classic children’s German book that attempts to teach about behavior by exaggerated punishments. In many of the stories in Der Struwwelpeter, it is clear that animals have a significant purpose. The animals are portrayed as powerful and dominant against the protagonists, adding a statement on the effects of misbehavior. However, compared to animals in other children’s literature, animals in Der Struwwelpeter serve quite different roles. In this poster, we will take a closer look at the differences between the animals in Der Struwwelpeter and C. S. Lewis’ The Chronicles of Narnia. The animals in Der Struwwelpeter take control over the humans whereas the animals in The Chronicles of Narnia are friendly and welcoming towards the humans. This poster will aim to compare the relationship between animals and human characters in Hoffman’s Der Struwwelpeter and C. S. Lewis’ The Chronicles of Narnia.

Undergraduate

"HANSEL & GRETEL" AND "GRETEL & HANSEL": A COMPARISON OF THE BROTHERS GRIMM FAIRYTALE AND OZ PERKINS MOVIE

Primary Author: Lena Hildebrand, Multidisciplinary Studies

Advisor(s): Julia Gruber

The classic German fairytale ‘Hansel and Gretel’, written by the Brothers Grimm, confronts the reader with the issues such as famine, cannibalism, and abandonment. These are topics that also appeared in a lot of other fairytales around that time. Based on this observation this poster evaluates what influenced ‘Hansel and Gretel’ (1857) and how it may influence the same fairytale, told by Oz Perkins almost 200 years later. The movie ‘Gretel and Hansel’ came out in January 2020. Oz Perkins directed the movie and used the Brothers Grimm fairytale as the baseline for his story/movie. Perkins movie is one out of many adaptations of the Brothers Grimm fairytale.
Does society play a big role in changing the tale and does famine still exist in today’s fairytales? Does the moral of the story stay the same? These are some points the poster will touch on.

Undergraduate

CLOUDED AMBITIONS

Primary Author: Conor Jones, International Business and Cultures

Co-Author(s)/Collaborators: Jake Jeffers

Advisor(s): Julia Gruber

Heinrich Hoffman's der Struwwelpeter contains a series of short stories that could be accurately interpreted as parables. The question arises however, what is the lesson of these parables, and what is the intention? Parables and other stories that we tell ourselves are critical to the way that we learn to access the world around us. These parables can also contain numerous different lessons when analyzed using different lenses. This poster aims to uncover the different lenses that can be placed over Struwwelpeter, what they can extract as useful information from it, and whether the meaning we draw the today is a fair interpretation of how Hoffman may have perceived the world over 100 years ago.

Undergraduate

SEEING THE VALUE IN DER STREWWELPETER

Primary Author: Michael Lewis, English

Co-Author(s)/Collaborators: Peyton Gilmore

Advisor(s): Julia Gruber

Der Struwwelpeter is a staple of German children's literature written by Dr. Heinrich Hoffman in the mid 19th century. The book contains ten illustrated stories written in verse meant to teach children moral lessons, often ending with them suffering for their indiscretions. In the stories, children burn to death, waste away from malnutrition, and, most infamously, have their thumbs cut off by a tailor because of bad or unacceptable behavior. Regardless of the book's enduring popularity, the question of whether it succeeds as a pedagogical narrative continues to be asked due to the graphic content described within. While Der Struwwelpeter itself is not appropriate for the 21st century, its structure as a narrative can be valuable in the modern day. Despite the controversy surrounding it, Der Struwwelpeter served as a successful and effective educational text in its time, and it still has something to offer now.

Undergraduate

COMPARING DER STRUWWELPETER: ENGLISH VS GERMAN

Primary Author: Ian Sweetin, Foreign Languages

Co-Author(s)/Collaborators: Patrick Howard; Christopher Fairchild

Advisor(s): Julia Gruber

Der Struwwelpeter is a culturally significant children's book in Germany. Written by Dr. Heinrich Hoffman, a children's psychologist, in 1845, the book warns young children of the dangers of cruelty and disobedience. While the book is intended for children, many of the illustrations are graphic depictions of the consequences of misbehavior. These stories often feature the great injury or death of several children. This has led many English scholars to label Der Struwwelpeter as barbaric and unfit for children. However, many German speakers reflect on the book fondly. This poster seeks to explore the difference in interpretation of Der Struwwelpeter between cultures.

Undergraduate

FREEDOM OF THE PRESS IN GERMANY 2020

Primary Author: Prinya Tep, Foreign Languages

Advisor(s): Martin Sheehan

Freedom of the press (Pressefreiheit) has always been a controversial topic and Germany is one of the places where the issue comes up. This idea is stressed even further in the year of 2020 due to the worldwide Covid-19 pandemic. Due to the pandemic, many countries including Germany agreed to guarantee freedom of the press. Despite this agreement, German reporters have their ability to publish the facts restricted. While reporters are

mostly free to travel, the ones that cover crucial matters receive suppression from local and political groups. The reason behind these actions, are groups that believe the press is creating fake news and attempting to subvert their positions. This poster is an overview that covers how freedom of the press is treated in Germany during 2020 through Covid-19.

Undergraduate

FAIRY TALES: A LOOK INTO ITS IMPACT ON THE CHILD PSYCHE

Primary Author: Nancy Webb, Foreign Languages

Co-Author(s)/Collaborators: Jordan Wright

Advisor(s): Julia Gruber

Fairy tales have been around in all cultures since before we can record, starting as only oral traditions then progressing into written literature. For generations, families used these stories as one of the many ways to teach their young children the life lessons and societal norms surrounding them. Now modern-day individuals are looking into the effects these tales have on children. Children use these fairy tales as a way for them to make sense of the world around them and to understand the implications of their actions on those near them. So, what are the actual impacts on children's early development when we tell them these stories? Are stories like the Grimms' too gruesome on their impressionable minds? Or, are they a crucial part of their development into adulthood? This poster will illustrate the different effects that fairy tales have on the child's psyche and development.

Undergraduate

PUBLIC HEALTH, PRIVATE DATA, AND THE INTERNATIONAL ECONOMY: A GERMAN PERSPECTIVE

Primary Author: Jordan Wright, Foreign Languages

Advisor(s): Martin Sheehan

Since COVID-19 first appeared in December of 2019, businesses around the world have been forced to adapt to a new, pandemic reality. While international responses to the virus differ from country to country, the stricter, swifter approach that Germany took as a nation seems to have minimized the potentially devastating impact COVID-19 could have had on the country's economy. With its high standards of workman's rights and rights to privacy, Germany's financial sector appears to have found a balance between preventing the spread of the virus, maintaining a normalcy in German office life, and protecting the personal data of its workers. This project explores what German businesses can tell us about what happens to private data during a public health crisis. As the research suggests, the responses of certain, leading businesses in Germany offer an effective model to follow when it comes to the rapid generation and secure storage of personal information in the workplace during a global pandemic.

Undergraduate

STRUWWELPETER STILL HAS VALUE FOR MODERN DAY SOCIETY WITH CHILDREN'S EATING HABITS AND DISTRACTIONS FROM LIFE

Primary Author: Landon York, History (B.A.)

Advisor(s): Julia Gruber

In Heinrich Hoffmann's Der Struwwelpeter, Hoffmann attempts at illustrating lessons to children. These lesson are on how to behave and avoid the development of terrible behaviors and habits. In two of the ten stories that are within Der Struwwelpeter, Hoffmann protrays the terrible conqueneces of being a picky eater, unhealthy eating habits, and not paying attention to the real world and being

distracted. These lessons are still valuable for modern day children and parents. Especially with the growing of modern day problems of child obesity, laziness, addiction to various media forms such as video games, movies, and social media. Also, comparing the methods of teaching and helping children to not develop these bad behaviors or habits with modern day parenting to parenting durning the nineteenth century.

Department of Physics

Undergraduate

BETA DECAY OF 35MG

Primary Author: Rachel Cullison, Physics

Advisor(s): Mustafa Rajabali

The beta decay of a very exotic isotope - 35Mg was studied over the summer. A c++ macro was prepared to analyze events where beta particles were detected in the experiment. The goal of this analysis was to identify true beta particle events from background events. The code allowed beta vs. photon timing spectra of all events to be made to characterize the photon energies. The photon spectra [RM1] were beta-gated to reduce noise, so that it is very clear where these changes in energy occur. The analysis done and results obtained will be presented in this poster.

Undergraduate

CONSTRUCTION OF A PERISCOPIC LENS SYSTEM TO ACHIEVE REMOTE POSITION-SENSITIVE DETECTION OF UCN

Primary Author: Darsh Dinger, Physics

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

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

Advisor(s): Adam Holley

In trapping experiments such as the ultracold neutron lifetime experiment (UCNτ), Position-Sensitive Detection (PSD) of UCNs can be useful in characterizing the spatial distribution of detected particles. In particular, this detection method can aid in understanding systematic effects such as depolarization and phase space evolution. We have demonstrated that this can be accomplished using a cost-effective “scientific” complementary-symmetry metal-oxide-semiconductor (sCMOS) camera to image a Zinc Sulfide scintillator. The challenge of building a practical detector is the development of a lens system that allows sufficient signal to be collected from distances of over a meter. A test stand was constructed which allows the evaluation and calibration of detectors using various lens systems. The performance of a periscopic lens system designed using this apparatus for imaging at a distance of 1.1m will be discussed.

Undergraduate

MOTOR CONTROLLER FOR 98RUBIDIUM DECAY SPECTROSCOPY STATION

Primary Author: Sean Jones, Electrical Engineering

Advisor(s): Mustafa Rajabali

Two auxiliary systems for a 98Rb beta-decay experiment were prepared. A motor controller to rotate the implant wheel behind a thick steel barrier to help shield the beta-tagging scintillators from the undesired daughter decays. The aluminum wheel will need to be controlled precisely and be able to rotate rapidly as to ensure proper measurements can be made. The second system is a beam monitoring detector to measure the spread of the ion beam after it comes across an electromagnetic bend at the target site. A four-quadrant ringed Si detector will be placed at the target to allow the beam to pass through the center and any spread from the ion beam will be measured. Work done on both developments will be presented.

Undergraduate

NEUTRON DETECTOR WITH XN TRACKING (NEXT)

Primary Author: Aaron Kindred, Physics

Advisor(s): Mustafa Rajabali

The neutron detector NEXT will allow higher accuracy studies for beta-delayed neutron emission, while maintaining neutron-gamma discrimination. NEXT utilizes thin, segmented, inorganic scintillators which are paired with photosensitive devices to increase detection efficiency for energy measurement and tracking capabilities. NEXT is currently in a prototype phase and is continuously being modeled with GEANT4 based simulation software, NEXTSim. Neutrons and gamma-rays with energies ranging from 100 keV to 10 MeV have been simulated and show consistent results in regards to scattering patterns and energy resolution within NEXT. Sample simulation outputs will be shown and described in this work. This work is funded by NSF grant NSF-1919735, sub-grant A20-0254-S001.

Undergraduate

TTU ION GENERATOR DEVELOPMENT

Primary Author: Austin Marler, Mechanical Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Mustafa Rajabali

A new laser ablation ion source has been designed to replace TTU's existing cesium ion source for over 5 times less power drawn during operation. The design is near completion and will allow for large or multiple samples to be tested with minimal down time by moving samples into the path of the laser. This source is simulated using an open source ion beam extraction simulation named IBSimu. Preliminary results for this ion beam will be presented in this work.
DOE grant: DE-SC0016988

Undergraduate

INTEGRAL METHOD FOR FITTING NUCLEAR DECAY CHAINS

Primary Author: Richard Mitchell, Physics

Co-Author(s)/Collaborators: Charlie Rasco, Oak Ridge National Lab

Advisor(s): Mustafa Rajabai

The conventional method for determining unknown half-lives of isotopes in data that have many decay chains is by fitting radioactive decay curves using the Bateman equations. The fit gets difficult in cases with very low statistics on the fast-decaying components. To compensate for the low statistics, we propose a new method for fitting and extracting these half-lives. The new method consists of making an integral histogram of all the counts recorded from the radioactive isotope, then fitting the histogram with an integral of the Bateman method. In this work we show results from the new algorithm which was used to test the integral method. The validity of the integral method will also be disused. The result of the study will be shown in the presentation.

Undergraduate

ASTROMETRIC MEASUREMENTS OF DOUBLE STAR WDS 06047-4505

Primary Author: Luke Parsons, Physics

Co-Author(s)/Collaborators: Kaitlyn Kidwell; David Pham,

Crean Lutheran High School; Kyra Bettwy, Marymount School of New York

Advisor(s): Mary Kidd

Measurements of the position angle and separation of the double star system WDS 06047-4505 were made on images taken by telescopes from the Las Cumbres Observatory (LCO) equipped with CCD cameras. The position angle was measured to be 5.77″ and the separation to be 213.52°. Analysis of the data when compared to previous measurements as well as parallax and proper motion data from Gaia strongly suggests this is a binary star. More observations are required in order to confirm the true nature of the double star.

Undergraduate

ASSESSMENT OF AN NV MAGNETOMETER FOR USE IN PRECISION ULTRACOLD NEUTRON EXPERIMENTS

Primary Author: Cameron Shepherd, Physics

Advisor(s): Adam Holley

The UCNτ experiment aims to improve current measurements of the mean free neutron lifetime. One innovation of UCNτ is that a large-volume magneto-gravitational trap is used to prevent polarized ultracold neutrons (UCN) from interacting with the walls of the trap, which prevents them from being lost to material interactions. Thus, the UCNτ experiment can more accurately count neutrons lost specifically to beta decay. Small defects in the magnetic field can still cause losses of UCN stored in the trap, so it is important to be able to detect these defects and account for them. The automated Hall probe currently in use has limited resolution and requires long periods of time to measure magnetic field gradients in the large area of the trap. A possible improvement would be a Nitrogen-Vacancy (NV) fluorescence microscopy setup which could increase the spatial resolution at which field data can be collected and increase the speed of data collection. Potential spatial resolution and design requirements of such a device were investigated using a typical NV magnetometry setup. Results of this work will be discussed in this presentation.

Undergraduate

FURTHER OPTIMIZATION OF AN ULTRACOLD NEUTRON SPIN DYNAMICS SIMULATION CODE

Primary Author: Chris Swindell, Computer Science

Advisor(s): Adam Holley

The UCNτ experiment is designed to measure an ultracold neutron's (UCN's) mean lifetime when trapped by a magnetic field before undergoing beta-decay. One value needed to determine this lifetime to high precision is a UCN's depolarization rate. This value is difficult to measure empirically because it's very small, but simulations may be used to estimate it. One simulation we are developing can be validated by comparing to actual trap lifetimes measured at different holding fields. Due to the amount of required computation, on a 10-core computer running Ubuntu 16.04 this code initially took about 36 hours to simulate 100 disjoint UCNs; but we really want to simulate in batches of millions of UCNs to get good statistics, which would take over 40 years to complete on the same hardware when scaled up. Optimization of the simulation code was required for better time efficiency. This code was fully converted to C++ from Python after trying optimization methods in

Python and before using basic parallel programming methods, resulting in code 169 times faster than its Python equivalent. Interesting issues encountered during the conversion process, optimization methods used, and some parallel programming methods used to further enhance efficiency will be presented.

Department of Sociology and Political Science

Undergraduate

EXAMINATION OF A BOTTLE BILL IN TENNESSEE

Primary Author: Grady Hicks, Environmental and Sustainability Studies

Advisor(s): Lachelle Norris

Pollution is a major component to the degradation of our planet's biosphere, and effective recycling policies may be needed to halt the process. Some areas in the United States, such as California and New York, have implemented a "bottle bill", or a piece of legislation that incentivizes the recycling of certain beverage containers by providing monetary resources to consumers who participate. In the state of Tennessee, a similar bill has attempted ratification in recent years, but to no avail. The effects of such legislation in states that have adopted "bottle bill" regulations have been investigated when questioning whether to implement such laws in Tennessee. California, a state with active bottle bill programs, Delaware, a state with a recently decommissioned bottle bill program, and Tennessee, a state with no bottle bill, will be studied to determine the effects such legislation has on the amount of waste collected. The results were clear; in areas that incentivized recycling through monetary gain, more physical waste was collected. However, it is important to recognize that such legislation is not the final solution; it must be supplemented by further recycling initiatives.

Creative Media Inquiry Projects Developed by Students in the SOC 1650 Social Problems Course (Project Advisor: Ada Haynes)

Undergraduate

DISPROPORTIONATE SUICIDE RATE OF MALES IN THE UNITED STATES

Primary Author: Benjamin McCrea, Scoiology

Suicide is the 10th leading cause of death in the United States. Men died by suicide over 3.5 times the rate of women in 2018. This showcases the disproportionality of suicide occuring between males and females. The problem of suicide impacts society as one population is shown to be suffering at an abnormal rate, and it could likely be addressed. This project aims to further understand and examine why males may be more vulnerable to suicide, and risks associated with the act. Researchers found that in a study of 1388 children ages 10 through 18, 85% were male that committed suicide. This further displays that an extreme disproportion exists in which males are taking their life, and it likely begins at a young age. The goal of this video is to increase awareness about the disproportionate loss of life with men committing suicide. This video gives ideas of ways to increase education, lower access to lethal means, and raise general awareness of the societal problem. Ideally one day with increased awareness this problem can be solved or greatly reduced in our society.

Undergraduate

THE SCHOOL TO PRISON PIPELINE

Primary Author: Haley Reagan, Sociology

The School to Prison Pipeline is an imaginary pipeline that connects students from disadvantaged backgrounds to entering into the prison system during or after their time in school. This line usually involves youth of color and children who have different abilities. This pipeline is still in use today without a lot of people realizing it because of zero tolerance policies. These policies are in place to stop misbehavior after one incident. When really that can be more detrimental than dealing with it on a basis of case. This project is to bring light to the School to Prison Pipeline because most people do not know what it is, or how it came to be. It presents solutions for how to stop the School to Prison Pipeline. It also gives outlets for educators to seek different ways of noticing the pipeline and how it can be stopped in the classroom so it doesn't go any further. The hope for this media project is to bring awareness to the problem that is so large in today's educational system. It gives possible strategies and the outcomes of how these could play out. It also brings in professional opinions from people who have studied the School to Prison Pipeline to great lengths.

Undergraduate

AVAILABILITY OF CONTRACEPTIVES AND PROPER SEXUAL EDUCATION AMONG WOMEN

Primary Author: Emily Buckner, Business Administration

The lack of contraceptive availability and sexual health information are problems for young girls and women across the United States. The lack of contraceptive availability presents many challenges to women who are vulnerable, whether that be from living in poverty or the basic need for proper sexual education. This project presents research that brings awareness to the lack of accessible contraceptives and information for women across the United States. This project is an awareness campaign that highlights some of the specific challenges' women in poverty and young women have to face. In addition, it presents possible solutions to solving this major social issue that is not always recognized and compares the impact of solutions that have previously been implemented. It also presents ways for people on a community level to come together and try and make a change for the better. The hope of this video is to bring awareness to the lack of accessibility to contraceptives and sexual health information to women across the United States. It gives ideas for communities to try and implement for the women in their community. It also gives hope that maybe one day with enough awareness that this social issue can be solved or at least help as many women as possible.

Women's and Gender Studies

Undergraduate

REPRESENTATION OF PLUS-SIZE WOMEN AND GIRLS IN MEDIA AND POP-CULTURE

Primary Author: Savannah Hunter, Sociology

Advisor(s): Nicole Cook

The representation of plus-size women and girls has never been an important issue to talk about. The media only shows a specific ideal beauty and what the media perceives as the "perfect body". Therefore, this problem affects the self-esteem of plus-size women and girls.

The importance of this topic is to learn and understand the problems with media and how they represent plus-size women. How using stereotypes in movies and in ads is a problem and should be changed. To bring awareness on how the media blindsides plus-size women and girls. The representation is shown in these forms of media and how they affect plus-size women and girl's mental and physical health.

The goal is to change how the media represents plus-size women and girls and to erase the "perfect body" or "ideal body" ideology that controls how we look at ourselves. Having a certain type of body should not dictate our self-worth.

Every body is a perfect body.

Undergraduate

SAINT RADEGUND: THE PORTRAYAL OF A FEMALE SAINT'S BODY

Primary Author: Katrina Mauk, English

Advisor(s): Nicole Cook

Hagiographies have been an important part of story telling and also providing historical context in the Merovingian Kingdom. In the two hagiographies of Radegund's life by Fortunatus and Baudonivia, both begin by giving summaries of Radegund's early life. Fortunatus focuses on the connection between Radegund's body and how the torture she causes to it makes her the exception compared to the rest of her weaker sex. Fortunatus uses the torture of Radegund's body to hide her feminity and relate her pain to the pain of Christ, also adding to Radegund being the exception. Baudonivia focuses on Radegund's ability to teach and produce miracles. While some torture is mentioned, the torture of Radegund's body builds a connection with Christ giving her the ability to proform miracles. Baudonivia also demonstrates how Radegund is able to create a court society in her convent through her leadership and teachings to the other girls. Through these two hagiographies, the depiction of Radegund's body and femininity changes, demonstrating the difference between a male writer and a female writer at this time.

College of Business

Department of Accounting

Graduate

IMPACT OF STIMULUS ON BANK LIQUIDITY

Primary Author: Jake Farley, Business Administration (MBA)

Co-Author(s)/Collaborators: Connor Adams

Advisor(s): Sid Bundy

Economic uncertainty leads consumers to save and stockpile money (Ghosh and Ostry,1997). The U.S. Department of Commerce reports the percentage of savings to income has increased from 7.6% in January 2020 to 13.4% in December 2020 (Bureau of Economic Analysis, 2021). This led to significant rises in deposit accounts of banks across the country. At the same time, many companies facing uncertainty made cost-cutting measures, focusing on short-term liquidity. Delays on expansion and capital purchases reduced demand for commercial loans. Newly released data estimates 5.2 million businesses sought forgivable loans, like the PPP loans, to address their needs rather than using traditional commercial lending (New York Times).

Some financial institutions found themselves with large supplies of cash but diminishing demands for loans. How did banks respond and how did their actions affect their financials?

We examined the connections between ROA changes, bank size, provisions for loan losses changes, and the ratio of loans to deposits through careful regression analysis. We found that ROA was negatively correlated with bank size and the ratio of loans to deposits. The evidence implies that not all banks should follow similar tactics. They should always consider their own relative financial position before making these decisions. Our evidence suggests that small banks might benefit from finding any rare and/or little opportunity possible to loan more in a period of high liquidity but low loan demand while larger banks might benefit from finding ways to lower their loan portfolio in similar situations.

Graduate

EXPLORING GOODWILL IMPAIRMENT IN RELATION TO COVID-19 AND CRITICAL AUDIT MATTERS

Primary Author: Linda Johnson, Accountancy (M. Acc.)

Advisor(s): Steve Garner

In 2019, Auditing Standard 3101 began requiring Critical Audit Matters (CAM) to be included in Auditors Reports. A CAM is any matter arising from the audit of the financial statements that has been communicated or is required to be communicated to the audit committee, and that relates to accounts or disclosures that are material to the financial statements, and that involves especially challenging, subjective, or complex auditor judgments. Goodwill impairment was identified as a CAM for many companies in 2019 and 2020. I examined the auditor's reports for 36 public companies that reported goodwill impairment for the period impacted by the Covid-19 pandemic, from March 2020 to December 2020. Within this sample, Auditors issued 45 CAMs total, including 19 CAMs for goodwill. I examined the footnotes to determine whether restrictions and/or lockdowns imposed due to the pandemic were mentioned as causes of the impairment. A majority of them cited a decline in demand for their products/services and/or a decline in market capitalization as factors that

led to testing goodwill for impairment. I examined the determining factors for inclusion in the Auditor's Report as a CAM. My analysis suggests that a CAM for goodwill impairment is more likely when the size of the impairment relative to goodwill is large and when the company is audited by a Big 4 accounting firm. Regression analysis indicates that CAMs are less likely for companies with international segments.

Graduate

EVIDENCE OF EARNINGS SMOOTHING IN THE OUTDOOR RECREATION INDUSTRY

Primary Author: Cody Littlejohn, Business Administration (M.B.A.)

Co-Author(s)/Collaborators: Matthew Gravitte; Matthew Alley

Advisor(s): Sid Bundy

The Covid-19 pandemic response had detrimental economic repercussions. Research is pursuing evidence of companies taking a "big bath" during this economic downturn. However, the negative repercussions devastated industries; some saw positive financial results. As gyms and arenas closed, individuals found fewer travel opportunities; many consumers turned toward outdoor recreation. M. Kirschenheiter and N. Melumad (2002) suggest that companies may choose a "big bath" and earnings smoothing as an equilibrium strategy to create confidence in their projected earnings. Did these companies smooth earnings downward during this period? We examined 11 companies in the outdoor recreation industry for evidence of earnings smoothing. Initial analysis suggests companies in the boat manufacturing, camping, and golfing industry saw a drop in net income in Q3 and Q4 of 2020. A general increase in sales in Q1 and Q2 of 2021, but the boating industry saw a sharp increase in CAPEX, suggesting it expects a quick recovery. Reported EPS for boating and golf companies slightly increase in Q1 of 2021, but the camping industry sharply increased. A possible indication of earnings smoothing in the boating and golf industry. Following Lim and Lustgarten (2002), we constructed a way to measure this by Std(CFO)/Std(NIBE). Companies with the highest sales increase have the most significant increase in this measure, suggesting that they may be smoothing earnings downward. We found companies specializing in camping equipment had the highest sales increase and the largest increase in this measure. This evidence supports our prediction that the outdoor recreation industry had earnings smoothing.

Graduate

PPP LOANS - SMALL BUSINESS VACCINE AND CORPORATE STING

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

Co-Author(s)/Collaborators: Timothy Williams; Spencer Gooch

Advisor(s): Sid Bundy

As a result of the COVID-19 Pandemic, the U.S. Government passed the CARES Act. One key aspect of the Act was the Paycheck Protection Program (PPP), whose primary purpose was to provide relief to struggling small businesses and retain employment levels through the use of forgivable loans. According to the U.S. Small Business Administration, in 2020, over 383,000 PPP loans totaling just under $42.5 Million went to the Accommodation and Food Services industry. As intended, most loans went to small businesses; however, a few large public corporations faced severe public backlash after applying to and accepting PPP loans. A legislative loophole allowed individual restaurants to qualify, even if their parent corporation did not. We analyzed quarterly financial

statements from March 2019 through December 2020 of 23 public companies in the restaurant industry, including eight that accepted PPP payments. We noted whether any subsidiary or franchisee applied for, received, or returned a PPP loan. We present an analysis of key metrics from the quarterly financial statements.

Graduate

IS THE WORK-FROM-HOME CONCEPT HERE TO STAY? STUDY OF CHANGES IN RENTAL INCOME FROM COMMERCIAL REAL ESTATE FIRMS

Primary Author: Andrea Spencer, Business Administration (M.B.A.)

Co-Author(s)/Collaborators: Michael Ashburn

Advisor(s): Sid Bundy

In March of 2020, the COVID-19 pandemic caused a sudden influx of employees working from home full-time. A study of 100,000 tweets in spring 2020 showed a 73% positive sentiment toward working from home (Dubey & Tripathi, 2020). In October 2020, Rutgers reported between 14 and 203 million Americans plan to relocate in response to the availability of work-from-home assignments. That might signal a shift in demand for companies connected to residential real estate; however, one industry is positioned to lose big if Americans don't return to office buildings: commercial real estate.

We analyzed the 2019 and 2020 quarterly financial statements of seven commercial real estate firms that specialize in renting office space and found evidence of changes in revenue and net property, plant, & equipment. Q2 2020 quickly showed an average decrease in rental income by more than 12% from Q1. The decrease suggests that while many companies are closing brick-and-mortar locations and workers anticipate a permanent work-from-home status, their landlords are not yet experiencing a significant change in their rental income or PPE. The average long-term lease for office space is around 3-5 years (Smith, 2021), so it may take years to see an impact as clients decide now to renew leases in the future and management completes existing projects.

Graduate

CAR CRASH: THE EFFECT OF COVID-19 ON SUPPLY AND DEMAND IN THE AUTOMOTIVE INDUSTRY

Primary Author: McKenzie Viau, Business Administration (M.B.A.)

Co-Author(s)/Collaborators: Neal Reagor; Ting Lu

Advisor(s): Sid Bundy

The global response to the Covid-19 pandemic had a substantial impact on supply in the auto manufacturing sector as governmental responses caused rolling halts in automotive production. At the same time, the surge to 14% unemployment coupled with the economic uncertainty changed consumer spending habits impacting demand. We analyzed the quarterly financial statements of five companies from three different stops on the supply chain: Tier 1 automotive suppliers, automotive retailers, and automotive aftermarket retailers from Q2, 2017 to Q4, 2020. We hypothesized that (1) disruptions in the supply chain would impact Tier 1 automotive suppliers as their production and revenue are directly tied to the automotive OEMs and (2) automotive retailers and the aftermarket industry would be affected by the inconsistent demand caused by the pandemic. We found that revenue and profit margin decreased for Tier 1 Suppliers in the quarters following governmental regulations on COVID-19, as Tier 1 and OEM plants began to slow production. In the same period, automotive retailers saw a significant decline in revenue and profit margin, while the aftermarket industry saw unprecedented demand for their products.

Unemployment and economic uncertainty may reveal why consumers decided to stray away from new vehicle purchases, and instead spent money in the aftermarket industry to repair vehicles they already own. As the country began to open and consumers became more secure, the data suggests that supply and demand increased for both Tier 1 Suppliers and Automotive Retailers, while the Aftermarket industry slowed to pre-pandemic levels.

Graduate

THE IMPACT OF AS 3101 AND CAMS ON AUDIT FEES

Primary Author: Heather Wall, Business Administration (M.B.A.)

Co-Author(s)/Collaborators: Andrea Ayala

Advisor(s): Sid Bundy

Auditor's Reports have often been perceived as a necessity of compliance with little intrinsic value to a company. Beginning in 2019, the goal of Auditing Standard 3101 includes enhancing transparency about the audit process by including the disclosure of Critical Audit Matters (CAMs) in the Auditor's Report. Billed as one of the biggest changes to hit the Auditor's Report in over seventy years, CAMs are explanatory paragraphs about the audit process that relates to accounts or disclosures that are 1) material to the financial statements and 2) involved especially challenging, subjective, or complex auditor judgment. The hope is that CAM disclosure will provide clarity and powerful signals of the financial performance of companies. Does it come at an additional cost? We examine the cost of providing this information. Using established models, we investigate the impact of five categories of CAMs (Revenue Recognition, Allowance for Credit Accounts, Acquisitions, Liabilities & Goodwill) on Audit Fees. We find evidence that the number of CAMs included in an Audit Report is significantly associated with a higher Audit Fee. Throughout this process, we use several dependent variables to test the impact on the Audit Fees. Some of these variables were: Auditor size, Auditor Tenure, Revenue Size, and Assets. Multiple regression analyses were run to test if the CAM had an impact on the Audit Fee. Furthermore, we found these variables to be individually significant with the Audit Fee Model.

Undergraduate

THE ECONOMIC EFFECTS OF COVID-19 ON MEDICAL RESEARCH

Primary Author: Kassaundra Copas, Accounting

Co-Author(s)/Collaborators: Jeel Patel

Advisor(s): Sid Bundy

During 2020, much of the medical research community focused on developing treatments and preventative measures for COVID-19 to save lives, end suffering, and lift restrictions around the world. However, this focus may have pulled economic resources away from other fields of medical research, causing negative effects for thousands of patients around the world. To study this, we compared the quarterly financial statements of pharmaceutical companies that specialize in oncology (4) and gastroenterology (3) to companies researching COVID-19 (7). We analyzed Research and Development expenditures and revenues between 2019 and 2020. Oncology and gastroenterology companies reported average revenue decreased by 9% and average research and development expenses decreased by 12% from 2019 to 2020. Covid-related companies reported revenue growth of 842% and research and development expenses growth of 93%.

Our findings suggest that a concentration of research funding in one field comes at the expense of other fields. These trends which we discovered may not continue as vaccines and treatments for COVID-19 are being

distributed. However, if further research is required as new variants and long-term health complications are discovered, we could see these economic impacts well into the future. Patients suffering from non-viral conditions, such as cancer and gastrointestinal disease, would suffer if more focus remained on the ongoing pandemic rather than these other major medical fields.

Undergraduate

HOW A NIMBLE COMPANY CAN OUTRUN ITS COMPETITION IN TENSE SITUATIONS

Primary Author: Austin White, Accounting

Co-Author(s)/Collaborators: Brenden Stoops

Advisor(s): Sid Bundy

During the Covid-19 pandemic, supply and demand for most products dramatically shifted. Although this sudden change was a hurdle for most industries, it was an unforeseen boon for others. One industry that benefitted was manufacturers of personal protection equipment. Makers of dust, surgical, and N-95 masks entered the spotlight. Homemakers sought out fabric and elastic to produce homemade masks. A few companies were uniquely positioned to meet this spike in demand. We analyzed the quarterly financial statements of two companies from 2019 through 2020: Ambu A/S (AMBBY) and Alpha Pro Tech (APT) During 2020, AMBBY's ROE decreased by 5.016% while APT's ROE grew by 48.98%. We conducted horizontal and vertical analysis of the drivers for each company's change in ROE using DuPont Decomposition along with a disaggregation of RNOA for the quarters ended January 2019 through December 2020. We read the Management Discussion and Analysis (MD&A) section of both company's 2020 form 10-k. Our findings suggest that a company's size, relative sales revenue, profit margin, and asset turnover can reduce a company's flexibility, making them less likely to capitalize on unpredictable spikes in demand. APT adapted more quickly than AMBBY, because of its more compact size and favorable metrics. This enabled them to expand and accelerate their profits at a greater rate.

College of Education

Department of Counseling and Psychology

Graduate

COMPLEX TRAUMA AND ATTACHMENT: PATTERNS ASSOCIATED WITH MALADAPTIVE DEVELOPMENT IN ADULTHOOD

Primary Author: Corrin Brown, Counseling and Supervision (Ph.D.)

Advisor(s): Tony Michael

Complex trauma is a fundamental concept in understanding the perspectives responsible in advocating for increased specificity in diagnosis and treatment of individuals with extensive, developmental trauma. Chronic, prolonged trauma is often associated with interpersonal victimization to the extent that individuals are subjected to various forms of child maltreatment perpetrated by primary caregivers over a long period of time. Within the context of this review, representations of complex trauma and research regarding adverse childhood experiences (ACEs) will be addressed to further explain variances in complex traumatic exposure and its impact on attachment. Furthermore, complex trauma histories and insecure attachment patterns will be evaluated as they relate to various domains of maladaptive development in adulthood (i.e. mental health, personality, and suicidality). Implications for mental health professionals will be discussed regarding diagnostic considerations, effective treatment, and clinical application to general populations with special acknowledgement given to trauma-informed care and attachment-based interventions.

Graduate

INTEGRATION OF SPIRITUALITY AND RELIGION IN THERAPEUTIC INTERVENTIONS AND EFFECTUAL FACTORS ON SANISM IN AMERICA: A HISTORICAL CASE STUDY

Primary Author: Christina Dukes, Counseling and Supervision/Doctor of Philosophy

Advisor(s): Tony Michael

This literature review will focus on the importance of integrating religious and spiritual paradigms into therapeutic interventions to meet cultural demands in rural America. The tension lies in the scarcity of training provided to counseling professionals in this area which has resulted in a hesitancy to integrate faith-based interventions into treatment plans. With an added layer of complexity, sanism magnifies the necessity of decreasing discrimination and intolerance starting with the counseling session in hopes of building advocacy outward to challenge and change systemic and societal misperceptions. The reviewer will evaluate articles investigating the impact of faith-based integration and synthesize findings to explore the mechanics of counselor action and advocacy. Gaps will be noted in areas of counselor education to increase competency in spiritual and religious integration as well as the potential negative outcomes of integration. Proposals will be explored for future studies to measure client treatment outcomes with faith-based integration as well as to consider how diverse cultural variables might affect societal perceptions of mental illness or religion and spirituality.

Graduate

THE ROLE OF ATTACHMENT IN FAMILIES AFFECTED BY SUBSTANCE ABUSE AND VICARIOUS TRAUMA

Primary Author: Stephanie Karlosky, Counseling and Supervision (Ph.D.)

Advisor(s): Tony Michael

Many studies have evaluated the role of attachment as it relates to substance abuse, mental health, trauma, and psychosocial functioning. Vicarious trauma, also known as secondary trauma, refers to alterations in perspectives resulting from prolonged engagement in another individual's traumatic material. Research on vicarious trauma has focused on those in helping professions rather than the general population. The present paper will focus on the general population, specifically family system members over the age of 18, whom have been exposed to substance abuse by a separate family member. Research articles on substance abuse exposure, attachment, and vicarious trauma are briefly explained. To conclude, articles are explored and synthesized collectively, as studies have not focused on the correlation between these variables. The goal of this paper is to instigate research aimed at evaluating the family system's experience of vicarious trauma stemming from substance abuse exposure, through the lens of Attachment Theory.

Graduate

A REVIEW OF ADOLESCENT IDENTITY FORMATION: MISSING LINKS IN ASSESSMENT, TRAUMA AND FAITH

Primary Author: Brittney Phillips, Counseling and Supervision

Advisor(s): Tony Michael

Erikson's theory of psychosocial development is foundational to current research regarding identity development (1950, 1968). After examination of several instrument measures related to identity formation, a gap in the literature was apparent. The purpose of the current investigation is to examine the relevant literature on identity formation for adolescents pertaining to relevant assessment measures for counselors. While there are implications for all professionals in the counseling field, special attention has been given to counselors who are assisting adolescent clients in the identity development process. Assessment measures available to explore identity development in adolescents have evolved over the past several decades. Throughout this investigation, it became evident that key variables such as spirituality and trauma have been ignored in the literature. Identification of appropriate treatment modalities is more likely when appropriate assessment is enacted. This investigation offers the opportunity to advance counselors capabilities of appropriately assessing identity formation in the lives of adolescent clients.

Graduate

COHESION IN BLENDED FAMILIES WITH A BLENDED CONCEPT FOR CLINICAL PRACTICE

Primary Author: Tabitha Schlatter, Counseling and Supervision (Ph.D.)

Advisor(s): Tony Michael

The blended family has become increasingly prevalent in our society. It has transitioned from an alternative family type to one of common occurrence. A review of pertinent literature has been assembled to examine the conditions that are conducive to the cohesion of blended families. Two types of models for understanding blended family formation are considered as a prelude to a discussion of the various trajectories blended family formation can take. The review is synthesized by combining a research methodology with counseling theory for a conceptualized clinical practice approach. The fusion of ethnographic interviewing with structural family therapy represents a means of integrating research and theory into clinical practice. The result allows for the application of two

approaches simultaneously for support of clinical work with blended families or other populations as well.
KEYWORDS: blended families, trajectories of blended family development, ethnography, structural family therapy

Undergraduate

STRESS RESISTANCE AS A POTENTIAL MEDIATOR FOR THE EFFECT OF SELF-EFFICACY ON DEPRESSION

Primary Author: Nooshin Younesi, Psychology

Co-Author(s)/Collaborators: Nicole Henniger, Tennessee Tech University

Advisor(s): Nicole Henniger

Individuals with higher self-efficacy and greater stress resistance have lower depression. (Ehrenberg et al., 1991; Bergeman & Deboeck, 2014). Self-efficacy is an individual's belief and confidence regarding their abilities to achieve a goal (Bandura, 1977). When subjects consider themselves not capable of doing a task, they are more likely to experience fear and give up (Bandura, 1982). When people see themselves capable of handling a situation, they show better persistence in the face of an obstacle (Bandura, 1997). We hypothesized that increasing people's self-efficacy would lead to an increase in their stress resistance, which we predicted would mediate a decrease in depression. 150 students participated in the study through Qualtrics. The results were analyzed. Independent samples t-tests indicated that the manipulation increased Social Self-Efficacy by a slightly significant margin ($p = 0.04$) but did not significantly increase the targeted variable General Self-Efficacy ($p = 0.53$). The conditions also did not produce differences in Perceived Stress or Depression (p's $> .05$). Therefore, we analyzed the data collapsed across condition to test if the predicted correlational associations were found. General Self-Efficacy was negatively correlated with Perceived Stress and Depression, which were positively correlated with each other (p's $< .05$). Following the Barron and Kenny (1986) method, we tested for mediation using a linear regression and Sobel test; the results supported Perceived Stress as a mediator of the association between General Self-Efficacy and Depression. Although our manipulation was not successful, the correlational analysis supported further investigation into this model.

Department of Curriculum and Instruction

Graduate

SPECIAL EDUCATION TEACHERS' PERSPECTIVES ON LEISURE ACTIVITIES PARTICIPATION BY ADULTS WITH DEVELOPMENTAL DISABILITIES

Primary Author: Goodson Dzenga, Curriculum and Instruction (M.A.)

Advisor(s): Holly Anthony

Leisure activities refer to the voluntary use of one's free time to participate in desired activities during an individuals' unobligated time. Such activities provide an opportunity for individuals with developmental disabilities to build relationships, gain skills, and develop competencies that are prerequisites for successful integration into the general public. Current literature shows that individuals with developmental disabilities have limited access to leisure activity participation. The purpose of the study is to understand from the perceptions and experiences of special education teachers how forces influence participation by adults with developmental disabilities in leisure activities. Identifying these forces could help policymakers to provide appropriate

interventions to enable individuals with developmental disabilities to participate in leisure activities.

Graduate

WRITING ABILITY AND GENDER AS MODERATORS OF THE RELATIONSHIP BETWEEN INSTRUMENTAL MOTIVATION AND ACADEMIC SELF-EFFICACY

Primary Author: Kinsey Potter, Exceptional Learning (Ph.D.)

Co-Author(s)/Collaborators: Kathryn Lawrence; Allen Mathende; George Chitiyo

Advisor(s): George Chitiyo

Studies have shown that students with high academic self-efficacy are more likely to perform better in the classroom and other environments. In addition to presumably directly influencing achievement, students' self-efficacy beliefs can indirectly influence their achievement through affecting their willingness to learn and their approach towards challenges (Mahyuddin et al., 2006; Zimmerman, 1995). The purpose of this descriptive correlational study was to test the moderating effect of home literacy resources, student writing ability, and gender on the relationship between instrumental motivation and English self-efficacy, controlling for the reading interests and habits of high school students. This study utilized secondary data from a sample of about 11,000 students who participated in the Education Longitudinal Study of 2002. Reading habits and self-efficacy beliefs were measured using questionnaires given to students in their sophomore year in high school. Using Hayes's PROCESS tool, the results of the moderation analysis showed that (i) differences in self-efficacy between students of different writing levels decrease as instrumental motivation increases, (ii) the amount of home literacy resources did not significantly moderate the relationship between instrumental motivation and self-efficacy, and (iii) as instrumental motivation increases, the difference in self-efficacy between males and females increases, with females having higher mean values than males across the whole range of the predictor variable.

Graduate

EXPERIENCES AND PERSPECTIVES OF HIGH SCHOOL FOOTBALL COACHES IN MANAGING ATHLETIC INJURIES AND MEDICAL CONDITIONS IN A RURAL SETTING

Primary Author: Bobbi Severt, Exceptional Learning (Ph.D.)

Advisor(s): Holly Anthony

Rural high schools are less likely than urban or suburban high schools to employ an athletic trainer, and this places the responsibility for injury evaluation and management on the coaches. This interpretive case study included interviews and observations of two football coaches from rural Tennessee high schools—one coach who had an athletic trainer and the other who did not have an athletic trainer prior to the fall of 2020. This study aimed to provide an understanding of the coaches' experiences and perspectives in managing football players' medical emergencies, acute and chronic injuries, and illnesses. Preliminary study findings will be discussed.

Graduate

THE RELATIONSHIP BETWEEN PHYSICAL ABUSE AND CHILDHOOD PROBLEM BEHAVIORS, MODERATED BY GENDER AND ETHNICITY

Primary Author: Marlana Smith, Exceptional Learning (Ph.D.)

Advisor(s): George Chitiyo

This study explored the relationship between physical abuse and problem behaviors among schoolchildren using the Achenbach Child Behavior Checklist (Achenbach & Ruffle, 2000) while controlling for age, and moderating for ethnicity and gender. Data for this study were obtained from the National Data Archive of Child Abuse and Neglect (NDACAN). Participants for this study were between the ages of nine and twelve years old. Participants consisted of 100 physically abused and 100 non-abused children matched based on demographic factors. A multivariate analysis of covariance (MANCOVA) was used for the analysis, with the dependent variables (defined using the Achenbach Child Behavior Checklist) of: total scores withdrawn, total scores somatic, total scores anxiety/depression, total scores social problems, total scores thought problems, total scores attention problems, total scores delinquent behavior, and total scores aggressive behavior. Age was used as a covariate. The results of the MANCOVA showed that there were significant differences in each of the Child Behavior Checklist total scores based on the main effect of abuse status. From the univariate test of between subjects effects, (i) abused Hispanic children tended to have higher total scores of delinquent behavior than abused Black children; (ii) abused Hispanic children tended to have higher total scores of aggressive behavior than abused Black children, and (iii) abused males tended to have higher total scores of aggressive behavior than abused females. Based on these findings, improvements can be made to better identify and support adolescents who have experienced childhood physical abuse.

Graduate

PRESERVICE MATHEMATICS TEACHERS' PERSPECTIVES OF MATHEMATICS DURING A MATHEMATICAL LETTER WRITING EXCHANGE

Primary Author: Carey Wilson, Secondary Education

Advisor(s): Holly Anthony

The author interviewed participants individually and conducted a focus group interview with three preservice mathematics teachers (PSMTs) attending a southern university in this interpretive case study. The researcher also gathered the preservice teachers' final reflection papers related to a mathematical letter writing exchange (MLWE) in which they participated. The two research questions guiding this study were: 1. What were the PSMTs' perceptions of value after participating in a MLWE with high school students? 2. How did PSMTs' thinking about the qualities of a good mathematical task evolve as they participated in a MLWE? For this study, the author used open coding and inductively analyzed the interviews. In comparison, directed content analysis guided analysis of the reflection papers to determine the PSMTs' perceived value of the mathematical letter writing exchange experience. Findings suggested that PSMTs should form strong relationships with students to help students become more confident in doing mathematics and, as a result, be more successful in fully engaging with mathematics. Also, explicit and implicit structures existed in the descriptions of a good mathematical task. For example, the participants reported that they needed to find or create mathematical tasks that matched their penpals' interests. Additionally, one intrinsic theme indicated that preservice teachers should consistently prioritize mathematics in their feedback and discussions with students. Finally, this study's findings aligned with and built off of prior literature surrounding MLWEs to help future PSMTs become more successful in their teaching practices and selecting and presenting mathematical tasks to future students.

Department of Exercise Science, Physical Education and Wellness

Undergraduate

WHAT IS THE RELATIONSHIP BETWEEN BALANCE AND CORE STRENGTH?

Primary Author: Mikayla Lovin, Pre-Professional

Co-Author(s)/Collaborators: Molly Topping; Katelyn Lancaster

Advisor(s): Michael Phillips

Balance is a key factor in sports rehabilitation, training, and performance. It has been suggested that strengthening the core muscles may improve balance. Studies have reported (Ambegaonkar et al., 2014; Kahle & Gribble, 2009) that core strength may be related to balance; however, other studies (Gordon et al., 2013; Ozmen, 2016) have stated that further research is needed to determine the correlation. The purpose of the study was to determine if there was a relationship between balance and core strength. Twenty-one Tennessee Tech Exercise Science students were selected to participate, with ages ranging from 20 to 25 years old; additionally, seven Division 1 athletes were included in our sample. All participants performed a modified version of the Star Excursion Balance Test (SEBT), a functional screening tool to assess balance, in addition to the McGill's Lateral Musculature Plank Test, which evaluates the strength of the core muscles essential to stabilizing the back. The authors hypothesized that there would be a positive correlation between balance and core strength, and our results justified that by showing an r-value of 0.33, which was positive and weak. The r-value of 0.33 was not significant at alpha = .05. While further research should be conducted with a larger sample size to determine what other factor(s) provide a higher degree of explanatory value, our findings will benefit individuals or sports professionals, such as coaches or rehabilitation therapists, who are looking for more information about how balance relates to core strength.

College of Engineering

Department of Chemical Engineering

Graduate

CORRELATING THE DEPENDABILITY OF NANOPARTICLE DISPERSION WITH THE PRESENCE OF MATRIX POLYMER IN NANOPARTICLE COMPOSITES GR

Primary Author: Abayomi Adeleke, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Venkat Padmanabhan

Advisor(s): Venkat Padmanabhan

Grafting of polymers on the surface of nanoparticles (NPs) instead of surface coating of nanoparticle with polymers have been shown to lead to better dispersion of nanoparticles is the polymer nanocomposites (PNC). This is due to better steric effect induced by the grafted polymer chains which enhances the dispersion of the nanoparticles in the system. However, although there is a better dispersion of the nanoparticles in the PNCs, which leads enhanced mechanical strength of the PNC material, the presence of the free polymer chains reduces the dispersibility of the NPs due to the entanglements that occurs between the free polymer chains (matrix polymers) and the grafted polymer chains. Thus, some form of aggregation is still experienced by the NPs in the PNCs. We seek to show that by systematically reducing the concentration of the matrix polymers in the system, more dispersion of the nanoparticle can be achieved. Coarse-grained molecular dynamics simulations using LAMMPS parallel MD packages is used in simulating a system which includes solvents, matrix homopolymer chains and nanoparticles grafted with linear polymer chains (PGNPs). Three systems were developed with different but related compositions namely: (1) Solvent, matrix polymers and PGNPs, (2) Solvent and PGNPs, (3) Solvent and PGNPs with longer PGNPs than the previous two systems. The mean displacement of the nano-particles in the systems will be calculated to understand the diffusivity of the nano-particles. This will be done to shed light on some dynamic properties of the nano-particles in the system.

Graduate

ON FLOW VISUALIZATION EXPERIMENTS IN A MASSIVELY ARRAYED MICROFLUIDIC PRODUCTION SYSTEM

Primary Author: Oluwaseyi Ayeni, Engineering (Ph.D.)

Advisor(s): Holly Stretz

The pharmaceutical industry is challenged with continuous production of nanomedicines with high throughput. Well controlled production can be accomplished in a microfluidic channel, but scale-up to massively arrayed microfluidics remains problematic. In case of a fiber-embedded reactor where the fibers define the microfluidic channels, flow visualization can be used to understand the pattern and path that growing particles trace out as they develop. Flow visualization techniques might include commonly used methods such as optical, non-optical and indirect. These techniques are reviewed with critical comparison to the fiber film reactor constraints. With a better understanding of the flow pattern via flow visualization, new models can be developed to better simulate two phase flows, mixing and precipitation within the reactor with special attention to the development of a narrow particle size distribution of nanoparticles.

Graduate

MODELING THE REMOVAL OF COSMETIC DYES BY USING HYDROGEL MATERIALS IN A CSTR

Primary Author: Varsha Balram, Chemical Engineering (M.S.)

Advisor(s): Pedro Arce

Dyes, or their degradation products in water, can cause various human health disorders including but not limited to hemorrhage, ulceration of skin and mucous membranes, and severe damage to the kidney. Even trace amounts of dye in effluent is highly undesirable due to its pollutive effects. Treatment methods for wastewater that are currently pursued include biological treatments, coagulation, ion exchange, and membrane filtration. While there is a considerable amount of research for textile dye effluent wastewater treatment, toxic dyes produced by cosmetic and personal care industries remain yet to be investigated.

The current state of knowledge about treatment of wastewater from the cosmetics industry is poor, which is evidenced by the number of publications on the subject. A number of adverse health effects from cosmetic dyes have been reported, such as birth defects, brain damage, and environmental pollution. Therefore, it is important to address this growing concern within the cosmetic industry. It has been widely hypothesized that adsorption is an efficient method for dye removal in wastewater, and hydrogel beads are efficient adsorbents for this purpose. In this research project, a liquid-solid phase, continuous-stirring tank reactor (CSTR) is modeled via volumetric and area-averaging approaches to derive the up-scaled reactor equation. The model applies for the case of treating wastewater with cosmetic dyes, where adsorption takes place on the surface of the hydrogel beads, extracting these toxic dyes. Key aspects of the upscaling process with illustrative results will be presented and future work outlined.

Graduate

ADSORPTION ISOTHERMS OF CARBON-FRAMED MAGNETIC IRON OXIDE PARTICLE ADSORBENTS IN SELENIUM CONTAMINATED WATER

Primary Author: Iulia Coultis, Chemical Engineering (M.S.)

Advisor(s): Holly Stretz

Demand for potable and irrigation water is increasing as the world population grows, however, contaminants present in water pose a risk to safety. Selenium is naturally present in bodies of water but is highly toxic if concentrations exceed regulatory guidelines. Removal of selenium can be done through the use of adsorbents like C-MNA, magnetic iron oxide particle adsorbents suspended within a tire-derived carbon framework. Two sets of adsorption tests are performed at 25 ˚C and 40 ˚C. A linearized Langmuir fit is performed on both.

Graduate

DETERMINATION OF FIBRIN FIBER DIAMETER USING SCANNING ELECTRON MICROSCOPY AND IMAGE PROCESSING SOFTWARE

Primary Author: Jonathan Garvin, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Dennis Piercy; Stephanie Jorgensen, Tennessee Tech University

Advisor(s): Robby Sanders

Injectable, biodegradable scaffolds that mimic local tissue properties have great potential for aiding and accelerating the natural wound healing process. Ideally, scaffolds will have physical properties e.g., stiffness and microstructures, that are comparable to the tissue in which they will be applied. Fibrin is an insoluble protein that is formed in vivo during hemostasis via action of the enzyme thrombin on the soluble protein fibrinogen. It acts as a glue that holds together a loose platelet plug - a blood clot - that is degraded as wound healing progresses. The stiffness of this material can be easily tuned by adjusting its composition, as has been previously shown. These combined factors make fibrin a suitable scaffolding candidate for promoting cell delivery to wound sites, cell growth, and proliferation which are important parameters influencing the healing process. Scanning electron microscopy as well as other techniques are currently being leveraged in order to better understand fibrin's microstructure. Fibrin hydrogels are prepared in vitro by mixing fibrinogen, thrombin, and CaCl2 at various compositions. After additional processing, samples are then dried using either critical point drying or freeze-drying techniques to retain structure, and are subsequently sputter coated with gold/palladium, and imaged using a Hitachi SU7000. A MATLAB script was created that allows for the random selection and analysis of fibers. The resulting image is transferred into ImageJ where fiber sizes are measured. Average fiber diameter for fibrin gels prepared using fibrinogen at 6mg/ml and thrombin at 1U/ml is estimated to be 77nm.

Graduate

SYNTHESIS AND CHARACTERIZATION OF HYDROGELS FOR HEALTHCARE AND REGENERATIVE MEDICINE APPLICATIONS

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

Co-Author(s)/Collaborators: Pedro Arce

Advisor(s): Robby Sanders

Hydrogels are cross-linked polymeric materials that can retain a large amount of water within its hydrophilic porous structure. Due to their appealing properties, hydrogels have been considered as a perfect candidate for wide range of applications in healthcare and regenerative medicine. With the rapid evolution of this biomedical field, the demand for new and advanced materials has increased. Thus, the design of hydrogel materials with tunable porous structure and advanced mechanical properties is necessary. Developing methods and techniques that can enhance transport and mechanical properties of hydrogels will improve thier performance and functionality.

This research, overall, will focus on selected preparation methods of polyacrylamide hydrogels and characterization of their porous structure and rheological properties. This will involve understanding the relationship between hydrogel internal morphology and stiffness. The pores size, shape, and distribution of polyacrylamide influence the transport properties. Scanning electron microscopy (SEM) is used to study the porous structure of these hydrogels. Still, it is difficult to compare the obtained results with previous studies due to the lack of an accurate protocol and missing information in sample preparation for imaging the materials with SEM. Here, we will outline a detailed protocol to guide the sample preparation and treatments required in imaging hydrogel samples using SEM, including drying techniques. The results will highlight the role of sample preparation on its properties.

Graduate

SYNTHESIS OF EGYPTIAN BLUE AND MECHANISMS

Primary Author: Agoston Kiss, Engineering (Ph.D.)

Advisor(s): Holly Stretz

Calcium copper silicate ($CaCuSi_4O_{10}$), known as Egyptian Blue (EB), is a pigment that exhibits a strong near-infrared (NIR) (910 nm) fluorescent emission when exposed to a strong visible light source. This property makes it a novel candidate for use as a basis for nanomaterial-based sensors in surface water, as its IR signal is very strong in comparison with current commonly used IR reporters. Also, IR signals penetrate biological samples better, and are scattered less than visible range signals. Since the goal of the research is to produce a uniform coating of Egyptian Blue nanoparticles, first the synthesis must be controlled to obtain the right material. The reaction conditions for Egyptian Blue synthesis were explored with thermogravimetric analysis coupled with mass spectrometry (TGA-MS) and high temperature X-ray diffraction (HT-XRD) measurements in order to better understand the reaction mechanism. Here we report the reaction conditions, the yields, and the photoluminescence characterization of the synthesized EB samples.

Graduate

OPTIMIZATION OF MASS TRANSPORT WITHIN DIRECT FORMIC ACID FUEL CELL ANODE CATALYST VIA PORE FORMERS

Primary Author: Steven Lam, Chemical Engineering (M.S.)

Advisor(s): Cynthia Rice

Batteries have become a necessity for today's ever-increasing demand in portable power, but lengthy recharging times, degradation, and limited charge capacity hinder the batteries' efficiency. Direct formic acid fuel cells are a sustainable alternative to batteries due to their high efficiency, instantaneous fueling times, and 24/7 operating time capabilities. However, mass transport limitations due to two-phase flow (gaseous carbon dioxide product and liquid formic acid reactant) plague the fuel cell's efficiency due to the anode catalyst layer's small pore size (~20 nm). This two-phase flow must be optimized to reach peak cell performance. This research aims to optimize the two-phase flow by incorporating a magnesium oxide pore-former at varying wt% (0-30 wt%), increasing the pore size from ~20 nm to ~50 nm, and creating a porous templated anode catalyst layer. This porous anode catalyst layer will optimize the two-phase flow of the reactant and product while maintaining the proton conduction, mass transport, and electron conduction. These porous templated anode catalyst layers have showed increased electrochemical surface areas and improved cell performances compared to non-templated anode catalyst layers.

Graduate

COMPUTATIONAL PRINTING OF RHEOLOGICAL CHANGES WITH SETTING TIME OF CEMENT-BASED PASTES IN 2D GEOMETRY

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

Advisor(s): Joseph Biernacki

3D printing of cement-based materials requires two primary paste characteristics: (1) extrudability, (2) resistance to deformation under layering load. To study the range of properties that effect printing outcomes, a computational strategy has been developed that captures the dynamics of 2D slices at a stationary location along the print path, i.e. 2-D stationary computation printing (2D-SCP). It is well known that the rheology of cement paste is time-dependent and coupled to both the physical and chemical (hydration) behavior of cement particles. Thus, 3D printing of cement pastes is related to rheological (flow) characteristics of the material, e.g. yield stress, plastic viscosity, and time-dependent effects. Flow rheometry was used to experimentally establish fluid properties of cement pastes with various water contents, isothermal calorimetry was used to verify hydration rates and vicat-needle penetration tests were

done to measure the initial setting times. Benchmark hollow cylinders were printed. Mini conical slump flow tests were used to calibrate rheological models prior to conducting computational experiments. Deformations and rates of deformation for the free-surface flow of the benchmark shape were simulated in 2-D geometries. The relative importance of yield stress, plastic viscosity and structuration rates were quantified by comparing the 2D-SCP model outcomes with cut cross-sections of the 3-D printed cylinders. Good agreement between printed objects and model outcomes were found in all cases. These results pave the way for optimization of mix formulations and development of scaling rules.

Graduate

ADVANCING 3D CONSTRUCTION THROUGH UNDERSTANDING THE TIME-DEPENDENT RHEOLOGY OF CEMENT-BASED PASTES

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

Co-Author(s)/Collaborators: Edward Garboczi, National Institute of Standards and Technology, Boulder, Colorado

Advisor(s): Joseph Biernacki

Developing new cement-based materials and understanding their rheology is gaining momentum as recent advances in 3D additive-manufacturing in construction applications are beginning to be realized. The rheology, i.e. the flow properties, of cement-based printing pastes depends on a number of physical and chemical properties of the particles and solution phase. Critically important is the need to separate the effects of these factors on the rheology of cement-paste, which has been shown to depend not only on the shear-history of the paste, but also on the age of the paste i.e., time, thus exhibiting time-dependent flow behavior. The ability to control the rheological evolution of cement-paste is crucial to achieving structurally sound materials in scale-relevant 3D printing applications. This work aims to separate the contribution of one of the contributing chemical factors, hydration, from the overall evolution of time-dependent rheological behaviors in cement-based systems. The effect of shear history and apparent particle size distribution on the rheology of a Type I-II hydraulic portland-cement paste and two non-hydraulic silicon-carbide surrogate pastes, was studied using cyclical flow curve measurements. The rheological behavior of pastes in deionized-water, 0.15% polycarboxylate-(superplasticizer) solution, and 0.15% ammonium-polymethacrylate solution was observed. Results showed that although certain additives appear to disperse cement in dilute systems, and therefore significantly alter the apparent particle-size-distribution in suspension, that observation does not necessarily translate to intuitive changes in rheological behavior. Inferences from these experiments were also supported by surface particle charge experiments (zeta-potential measurements) and cement hydration datasets.

Graduate

BINDING STRUCTURE AND DYNAMICS OF CHEMOKINE RECEPTOR CXCR4 INTERACTING WITH DIFFERENT LIGANDS

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

Advisor(s): Liqun Zhang

Chemokine receptor CXCR4 is a membrane-bound G-protein coupled receptor (GPCR) involved with chemotaxis in lymphocytes. Because CXCR4 is involved in inflammatory diseases, cancers, and in the replication of HIV-1, it has become a target of interest for therapeutic control. CXCR4 is exclusively activated by its natural ligand CXCL12, and it also can bind with antagonist human β defensin type 3 (hBD-3), which is a cysteine-rich cationic peptide. hBD-3 belongs to the human innate immune system, and is mainly secreted from human

epithelial tissues and mucosa. It has a broad spectrum of bactericidal abilities, but also modulates adaptive immune response by interacting with chemokine receptors including CCR2, CCR6, and CXCR4. hBD-3 has three disulfide bonds, and the disulfide bonding status of hBD-3 has been shown to influence its chemotactic activity. In order to understand the structure and dynamics of CXCR4 binding with agonist CXCL12 and antagonist hBD-3, all-atom molecular dynamics simulations using NAMD and ANTON programs have been performed on CXCL12, hBD-3 wildtype, and hBD-3 linear analog interacting with the CXCR4 receptor embedded inside POPC lipid bilayer. The binding structure and dynamics of hBD-3 with the CXCR4 receptor were studied. Residue pair distance maps, free energy calculation, and hydrogen bonding calculations elucidate the molecular interactions involved in the binding process and suggest a preferred binding site for hBD-3 and CXCL12. The structural dynamics of CXCR4 are also studied to connect binding phenomena to receptor activity and ligand bias.

Graduate

PHOTOCATALYTIC DEGRADATION OF ACETAMINOPHEN IN WATER VIA ULTRAVIOLET RADIATION AND TITANIUM DIOXIDE THIN FILMS

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

Co-Author(s)/Collaborators: Sabrina H. Buer; Robby Sanders, Tennessee Tech University, Chemical Engineering Department; Wayne Hawkins, Center for manufacturing Research, Material Science lab

Advisor(s): Pedro Arce

Traditional Waste Water Treatment Plants (WWTP) have not been designed to handle pharmaceutical-based contaminants and, therefore, cannot completely eliminate drugs residues. As a result, pharmaceutical metabolites can be found in ground water, surface water and in drinking water in low concentrations. The application of titanium dioxide (TiO2) photocatalysis, for water purification, is widespread technique due to it is chemically inert, cost-effective, non-toxic, and environmentally friendly. In this contribution, transparent, anatase-form TiO2 thin films were prepared via the sol-gel method and deposited onto glass microscope slides, using a novel spraying technique, with coatings ranging from one to ten. Furthermore, characterization of the coated TiO2 thin film slides was performed by using scanning electron microscopy (SEM) and x-ray diffraction (XRD). The slides were used to determine the photocatalytic degradation rate of acetaminophen with different pH ranges (acidic, basic and neutral), different contaminant concentration, and different slides conditions. It was observed that over a period of 90-minute intervals the increase in number of thin film slides displayed a considerable increase in the degradation rate due to the increase in surface area, that helps to form more active sites. However, these results are sensitivity to the pH of the media with the neutral one being the most favorable for the degradation. The global reaction rate constants for both four and six thin film glass slides increase with the increases in the coating layers. Key results with systematic statistically analysis and concluding remarks will be presented. Finally, suggestions for future work will be offered.

Graduate

MOLECULAR DYNAMICS SIMULATIONS ON POLYMER MODIFIED ASPHALT MIXTURES

Primary Author: George Rucker, Chemical Engineering (M.S.)

Co-Author(s)/Collaborators: Liqun Zhang, Tennessee Technological University

Advisor(s): Liqun Zhang

Asphalt is a complicated viscous liquid which is the trash part from crude oil distillation. It is mainly applied on road pavement and roof patching. Engineers have tried to modify road pavement's chemical composition by adding polymers to improve performance. This study is aimed to study the mechanism and polymer modification effects on asphalt mixtures by predicting the major physical properties of the polymers and the polymer modified asphalt systems. In total four kinds of polymers were chosen including polyethylene, polystyrene, Styrene-butadiene, and Poly(styrene-butadiene-styrene). Both the pure polymer and polymer modified asphalt systems were built and modelled from the room temperature to the hot-mix asphalt temperature running all-atom LAMMPS molecular dynamic simulations. Different physical properties including: diffusion coefficients, isothermal compressibility, viscosity, density, and the radial distribution function were calculated from the simulation trajectories. It was found that the diffusion coefficients of components in the asphalt systems showed similar temperature dependence for all the systems, and the molecule packing did change with the addition of the polymers. The density of the asphalt systems increased with the addition of all polymers except polyethylene which decreased. The isothermal compressibility did not change significantly. The viscosity showed an increase at high temperatures while with little change at low temperatures. The result in this project can help to understand both the modification effects of different polymers on asphalt mixtures and the structure and properties of polymers in different media, thus helping to design the optimum asphalt for road pavement in the long-term.

Graduate

PRINTABILITY METRICS FOR ADDITIVE MANUFACTURING OF CEMENT-BASED MATERIALS

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

Co-Author(s)/Collaborators: Edward J. Garboczi; Newell H. Moser; Ebrahim Nasr-Esfahani

Advisor(s): Joseph J. Biernacki

Additive manufacturing (AM) has developed rapidly in many industries and is a promising method for improving construction efficiency. Despite the rapid growth of AM, there are a number of challenges that hinder more –wide-spread application in construction. One of the main challenges is maintaining dimensional accuracy of AM objects. Thus, characterization of the shape fidelity of such manufactured objects is critical to establish and ensure shape-related performance. To address this issue, alternative metrics were used to compare the dimensional accuracy of printed cement paste objects. X-ray computed tomography (XCT) of printed objects was used to compute quantitative printability metrics. A metric involving the external surface dimensions (a boundary-based printability index, PIB) and a metric that reflects deviations in the volume (a volume-based printability index, PIV) were developed and compared. The results show the extent to which different penalty logics provide sensitivity for the detection of specific types of flaws.

Graduate

SYNTHESIS OF TIO2-CDS PHOTOCATALYST FOR PHOTOCATALYTIC DEGRADATION OF CARBAMAZIPINE AND PHOTOCATALYTIC WATER SPLITTING FOR HYDROGEN PRODUCTION IN WASTE WATER USING SOLAR AND ARTIFICIAL-UV RADIATION

Primary Author: Dipendra Wagle, Chemical Engineering

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

Advisor(s): Pedro Arce

Advanced oxidation processes, in particular, semiconductor photocatalysis, are useful methods for contaminants' removal from wastewater including pharmaceuticals, organic chemicals, and microbial disinfection. Furthermore, the technique is beneficial for hydrogen production by photocatalytic splitting of water. The optimization of this technology for simultaneous degradation of carbamazepine, hydrogen production and upscaling for its large-scale implementation is still a big challenge for environmental engineers. This research is focused on fostering understanding and new knowledge of novel photocatalytic materials for the simultaneous elimination of water contaminants and hydrogen production. It is well known that titanium dioxide semiconductor photocatalyst is readily available, environmentally safe, and possesses significant photocatalytic activity for water decontamination. However, it is photo-responsive only in the ultraviolet region (Eg 3.2 eV) that comprises only 4% of the solar spectrum falling on Earth. Therefore, there is a need for the synthesis of a new photocatalyst or, alternatively, the modification of the TiO2 for a cost-efficient visible light responsive photocatalytic material that is suitable for the dual purpose indicated above.

This research focuses on developing a general technique to synthesize three different types of photocatalysts such as titanium dioxide (TiO2), cadmium sulfide (CdS), and cadmium sulfide doped titanium dioxide (TiO2/CdS) for the preliminary testing of the degradation of carbamazepine (CBZ) under visible and UV radiation. For the characterization of the catalyst materials, scanning electron microscopy and X-ray diffraction (XRD) instrumentation will be used. Comparisons with current literature values for results' validation will be included and the steps for future research will be highlighted.

Undergraduate

GENERAL OVERVIEW OF WASTEWATER TREATMENT PROCESS WITH SPECIAL FOCUS ON SECONDARY TREATMETNT METHOD

Primary Author: Krishpa Adhikari, Chemical Engineering

Co-Author(s)/Collaborators: Dipendra Wagale, Pedro Arce, Robby Sanders

Advisor(s): Pedro Arce

Wastewater is used water that comes down the drains from buildings such as household, factory, school, or offices and includes sources like showers, sinks, dishwasher, toilet, etc. It contains substances from various sources including organics, medicine, and several other substances like toilet paper, cleaning & personal products that are harmful to the environment. It also contains diverse trophic level of microorganisms such as protozoans, fungi, and varieties of bacteria (aerobic, anaerobic, and facultative). Therefore, a treatment facility needs to be equipped with several processes and unit operations so that a complete decontamination can take place before water is released to the natural environment. Each unit operation in a wastewater treatment plant (WWTP) is associated with mechanical, physical, biological, and chemical aspects of cleaning.

This contribution is focused on reviewing these general cleaning processes and operations and identifying connections with fundamental principles in engineering. Thus, we are looking for appropriateness of employing more effective and efficient variations associated with the biological processes (activated sludge). The aim is to develop an environment to mimic the naturally occurring microbiology and biochemistry in the human system during the metabolic breakdown of these chemicals and biopharmaceuticals. The secondary treatment is identical to

a metabolic type of biological reactor that can be modelled and optimized. The targeted outcome is to identify the key factors controlling the metabolic degradation and make potential observations helpful to increase the degradation efficiency. Our study could be potentially useful for the design of a more efficient and better maintained treatment.

Undergraduate

A SURVEY OVERVIEWING TECHNOLOGICAL ASPECTS OF WASTEWATER TRETMENT FACILITIES IN THE STATE OF TENNESSEE

Primary Author: Diego Bautista, Chemical Engineering

Co-Author(s)/Collaborators: Claire Myers, Luke Horne, Madeline Kidder, Robby Sanders, Dipendra Wagle

Advisor(s): Pedro Arce

Wastewater is produced from several industrial and anthropogenic activities and includes the sources such as showers, sinks, washing machines, dishwasher, toilet, etc. It contains microbes, pathogens, and several other organic and inorganic substances that are harmful to the environment and that must be removed before the water can safely be returned to natural streams. This sewage is pumped to the cleaning facilities through the drainage system. The treatment facilities called wastewater treatment plants (WWTPs) are operated in the cities at different capacities suitable to handle the water volume. Although all these facilities display a basically similar treatment process, there exists a few variations depending upon the capacities, location, cost of operation, population it serves, and type of contaminants required to remove. In this research, a comprehensive report illustrating the different aspects of WWTPs in the State of Tennessee will be drafted. This will include evaluating and summarizing the similarities and variations among the different WWTPs: For example, some facilities implement chlorination methods in tertiary treatment unit; others, UV-based methods, and more advanced cases use UV photocatalysis, etc. The research will also include a general discussion about the pros and cons of these similarities and differences and recommend some potentially novel technologies. These may be susceptible of upscaling and adaptable to treat sewage more effectively and less costly.

We believe that the outcome of this research will be a useful information for potentially improving sewage treatment across the State of Tennessee of the current scenarios and provides a future direction.

Undergraduate

DEVELOPING SYNTHETIC MATERIALS FOR PERCUSSION INSTRUMENTS

Primary Author: Sarena Bemis, Chemical Engineering

Co-Author(s)/Collaborators: Steven Anton, Tennessee Technological University Department of Mechanical Engineering; Holly Stretz, Tennessee Technological University Department of Chemical Engineering; Mohammad Albakri, Tennessee Technological University Department of Mechanical Engineering

Advisor(s): Joseph Biernacki

There is a need for new, sustainable materials to make wooden percussion instruments. Many of the woods used in producing these instruments are exotic or endangered woods. Some companies have switched to fiber-reinforced (glass or carbon) plastics or polymers, but these instruments do not always have the desired sound. Without the necessary desired sound and an increasing need to replace wood, attention must be given to studying and experimenting with other materials. Research shows that the properties of different woods are critical when selecting which materials to use in which instruments. The

Young's Modulus, hardness, density, grain direction, and adaptability to moisture are the properties that determine the speed and color/tone of the sound of the instrument. Data was collected to determine what types of sounds and responses musicians favor in percussion instruments. With that in mind, analyzing the frequency response of different materials are key. Vibrational analysis of soundwaves using a vibrometer, to study the frequency difference between a reference laser and a beam testing a surface, was performed to quantify the difference in the sound of traditional wood instruments along-side synthetic material made instruments. Such information reveals the properties desired and responses that must be replicated when designing new synthetic materials for instrument making. Using the data collected, production of a sustainable prototype materials can begin.

Undergraduate

FREE ENERGY CALCULATION OF HUMAN BETA DEFENSIN TRANSLOCATION THROUGH RED BLOOD CELL LIPID MEMBRANE

Primary Author: Ann Brewer, Chemical Engineering

Co-Author(s)/Collaborators: Liqun Zhang

Advisor(s): Liqun Zhang

Human beta defensins (hBD) present an effective therapeutic approach to combat bacterial infections in the human body. hBDs are a family of peptides consisting of six different types with similar structures. Each type of hBD exhibits a unique antimicrobial activity as a first line of defense to combat infections in the body. For this research, human beta defensin type 1 (hBD-1) and type 3 (hBD-3) are studied in order to understand the dynamics and structure as the proteins translocate through a model red blood cell membrane. Running long-term molecular dynamics simulations, the translocation free energy of hBD-1 dimer and hBD-3 dimer through model red blood cell membrane were calculated. In addition, based on the last structures exported and 5 ns all-atom NAMD simulations, the Root Mean Square Deviation (RMSD) of protein structure change was calculated. The number of hydrogen bonds was calculated between hBD-1 and hBD-3 and the membrane, water, and between the two units in hBD-1 and hBD-3 dimers. In this research, it is found that the RMSD for hBD-3 is greater than the RMSD of hBD-1. It is also seen that hBD-3 experiences more bonding between the protein and the membrane than hBD-1. The results can help to understand the structure and dynamics of human beta defensins as they translocate through the model red blood cell membrane.

Undergraduate

EFFECTS OF SALINITY ON THE RATE OF AGGREGATION OF HUMIC ACIDS AND SUBSTANCES

Primary Author: John Clark, Chemical Engineering

Co-Author(s)/Collaborators: Holly Stretz; Martha Wells

Advisor(s): Holly Stretz

Humic substances comprise a major portion of organic matter found in natural waters, the presence of which poses issues in water treatment, as they react with chemicals used in the chlorination process, forming toxic by-products. Humic acids have the potential to disaggregate and move across a membrane, such as those used for filtration, and proceed to re-aggregate after filtration, though little is known about the process that allows re-aggregation to occur. This study focuses on how the rate of this aggregation could be affected through the variation of salinity in a humic acid-containing water sample. Each of the 15 collected pond water samples were filtered at 0.45 microns, subjected to constant shearing via a rheometer,

and subsequently monitored through Dynamic Light Scattering (DLS) as the humic substances re-aggregated. The aggregation time, defined as the first appearance of a 5-micron particle, was found to have a quadratic dependence on NaCl concentration.

Undergraduate

ELECTROTHERAPEUTIC ASSISTED WOUND HEALING: MODELLING OF THE ELECTROSTATIC FIELD IN A POROUS GEL OR HEALING MEDIA

Primary Author: Phoebe Dawson, Chemical Engineering

Co-Author(s)/Collaborators: Steffano Oyanader, Stephanie Jorgensen, Robby Sanders, Pedro Arce,

Advisor(s): Pedro Arce

Among the many advances in the biomedical sciences in the last decade, the bio-mathematical foundation to homeostatic wound healing deserves further attention in the scientific community. Recent new contributions (Jorgensen, 2017) have made progress experimentally in understanding transport of biomedicines in hydrogels of potential use as an effective scaffolding material to facilitate wound healing. In addition, work has been done (Oyanader et al, 2020) to increase the understanding of the electro-convective-diffusive transport of biomolecules in wound healing in electrotherapeutic assisted wound healing applications, theoretically. This contribution will focus on the modeling of the electrostatic electrical field effects in the wound microenvironment of the scaffolding material by using idealized pore domains to describe pore morphology. The driving interest of our study is to understand the effects of the electrokinetic forces on the diffusion and migration of thrombin to induce the conversion of fibrinogen to fibrin, as this would be one of the initial steps in the early-phases of the wound healing process. Specifically, the electrostatic Laplace equation, in a pore domain of cylindrical geometry, will be solved via the use of area-averaging methods and its solution will be parametrically illustrated for a set of values of the applied voltages. The role of material, scale, and electro-migration on the transport of bio nutrients and medicines via the use of the molar species continuity equation will be discussed. Future steps in the research project will be highlighted.

Undergraduate

DETERPENATION OF BERGAMOT ESSENTIAL OIL VIA LIQUID-LIQUID EXTRACTION

Primary Author: Lauren Ennamorato, Chemical Engineering

Advisor(s): Holly Stretz

Essential oils are intricate mixtures of up to hundreds of hydrocarbon compounds, the majority of these being extremely volatile. These oils have recently become increasingly sought after because of their medical applications and their usage in food industries. To meet this demand, research concerning an acquisition process that is both profitable and efficient is considered. Deterpenation involves the process of removing the terpene functional groups present on many of these hydrocarbon compounds and leaving behind oxygenated species. These terpene hydrocarbons are known to hinder the desired aroma and flavor of essential oils, as well as promote oxidation and resinification. Liquid-liquid extraction (LLE) is rooted on the solubility differences between terpenes and oxygenated compounds in a solvent. Here, the compound linalool is extracted out of an ethanolic phase into an organic phase made up of linalyl acetate and limonene. The motivation behind this extraction is to separate a mixture into an organic (limonene, linalyl acetate, and linalool) and an aqueous phase (ethanol), observe the interface between them, and force the product's concentration gradient forward to be miscible in the desired phase, where it can be isolated and identified. In this project, the liquid-liquid

extraction techniques are going to be employed using the unit operator Hampden Model H-6150.

Undergraduate

DELIVERY OF DRUGS IN CANCER TUMOR TREATMENT: ROLE OF DIFFUSION AND REACTION

Primary Author: Gretchen Karl, Chemical Engineering

Co-Author(s)/Collaborators: Luis Hevia, Pedro Arce, Robby Sanders, Stephanie Jorgensen

Advisor(s): Pedro Arce

For the effectiveness of drug delivery for the treatment of cancer tumors, modeling efforts play an important role in promoting the understanding of fundamental aspects of both the transport to and reaction of drug delivery to the tumor. Both the motion of drugs through the capillary of the microcirculatory system and the reaction, which take place within the tumor domain, must cooperate to eliminate cancer cells for an effective treatment of the tumor over the entire tumor domain. By assuming that this domain is closely described by a medium with a porous-like structure, the biophysical situation is very similar to that encountered in a catalytic pellet found in heterogeneous catalytic reactions. In this contribution, we will apply the fundamental principles of diffusion and reaction to a solid tumor (Arce et al, 2007), typically applied, for example, in the pancreas or other human organs. By following suitable assumptions, we will present a diffusion and reaction microscopic model at the pore level. This model will then be upscaled to a macroscopic domain (i.e., the pore domain) and further to the tumor domain. As part of this process, the effective diffusion coefficient and the effective rate constant of reaction will be identified. Potential solutions for the model and predictive outcomes will be outlined.

Undergraduate

DETERMINATION OF THE RADIUS OF FIBRIN FIBERS FOR WOUND HEALING APPLICATIONS VIA THE CARR-HERMANS METHOD

Primary Author: Lela Manis, Chemical Engineering

Advisor(s): Stephanie Jorgensen

The quantitative description of the structure of the biopolymer fibrin has implications in wound healing. As for any protein, the structure and morphology of fibrin is essential to its function and is conjectured to control specific aspects of the wound healing process. The wound healing process is comprised of four phases. During the initial stages of wound healing, fibrinogen and thrombin are introduced to the wound site to interactively produce fibrin fibers that provide a scaffolded structure for the wound environment [N. Laurens et al.]. As the wound healing process progresses, the fibrin fibers are enzymatically degraded and collagen fibers take the place of fibrin, ultimately resulting in the healed tissue after continued remodeling of the structure [JC Chaplin, KA Hajjar]. This enzymatic degradation of the fibrin fibers is termed fibrinolysis, a process which affects the breakdown of fibrin clots at a wound site and henceforth the healing of the skin and scarring of the tissue surrounding the wound site. The rate of breakdown of fibrin strands is affected by their structure, the thickness of the fibers being one factor affecting this process [DA Gabriel et al.]. This reveals the need for a procedure to determine the radius of the fibrin strands. This contribution will communicate a flowchart that guides one through the steps of acquiring and analyzing data to apply the Carr-Hermans Method, which leads to an estimate of the radius of the fibrin strands.

Undergraduate

BLOCKING CORONAVIRUS 19 INFECTION VIA STRUCTURE AND DYNAMICS OF HUMAN

ALPHA DEFENSIN 5 (HD5) INTERACTION WITH ANGIOTENSIN-CONVERTING ENZYME 2 (ACE2)

Primary Author: Ha Nguyen, Chemical Engineering

Co-Author(s)/Collaborators: Liqun Zhang

Advisor(s): Liqun Zhang

The epidemic caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) is currently a global concern. Viruses enter cells and initiate infection by binding to their cognate cell surface receptors. SARS-CoV-2 is the third human coronavirus known to co-opt the peptidase angiotensin-converting enzyme 2 (ACE2) for cell entry. In this research, the structures and dynamics of human alpha defensin 5 monomer (HD5-monomer) and human alpha defensin 5 dimer (HD5-dimer) are studied in order to unmask the origin of the defense function of HD5 against 2019-nCov. HD5 is a human protein that secreted by Paneth cells in the small intestine and by granules of neutrophils that binds the N-terminal region of the critical red helix. This interaction gives the blocking effect between the receptor ACE2 and SARS-CoV-2, thus, theoretically, this enhances its ability to prevent the virus invasion acting simultaneously on the ligand (S1) and the receptor (ACE2). We first carried out a nanoscale molecular dynamic (NAMD) simulation in which HD5-monomer and HD5-dimer were docked onto the ligan-binding domain (LBD) of ACE2 and ran for 20 ns each. We then calculated the Root Mean Square Deviation (RMSD) in order to compare the docked conformation with the reference conformation. We also calculated the number of hydrogen bonds formed between protein-protein and protein-water in order to find out which protein has more stable binding on the LBD of ACE2. The results can help to explain the activity and ability of HD5 in preventing 2019-nCov when interacting with ACE2.

Undergraduate

MODELING CHEMICAL REACTORS FROM FIRST PRINCIPLES: THE BATCH PHOTOCATALYTIC REACTOR

Primary Author: Isabella Southerland, Chemical Engineering

Co-Author(s)/Collaborators: Sabrina Buer; Sunil Rawal; Pedro Arce; Robby Sanders

Advisor(s): Pedro Arce

In the modeling of isothermal chemical reactors, the specialization of the species continuity equation (for a given reactor domain) is one of the key aspects that the modeler needs to handleaddress. A helpful guidance starting point is the identification of proper simplifying assumptions for the various phenomena involved in the reaction process; these may be related to the type of reactor used, the type of reactant mixture present in the system, and the chemical reactions that taketaking place, among other aspects. In addition, for the case of a photocatalytic reactor, the modeling of the light radiation field must be coupled with the species continuity equation. The reason behind this need is based upon the dependence that of the reaction rate has withon the radiation field intensity. This field can be modelled on the basis of the photon balance equation. In this contribution, we will outline a systematic approach to derive the up-scaled equations for a batch photocatalytic reactor with degradation taking place at the photocatalytic thin film surfaces located at the wall of the reactor. Both, the species continuity equation and the photon conservation equation will be upscaled using a volumetric averaging approach in order to derive the engineering reactor equations. Furthermore, the model solution will be illustrated with conversion results of a biomedical contaminant, i.e., acetaminophen, and comparison with experimental results. Suggestions for

future work will be also highlighted.

Undergraduate

ROLE OF NANOTECHNOLOGY IN ASSISTING HEALTH CARE TREATMENT: A REVIEW OF TECHNOLOGIES

Primary Author: Jennifer Toney, Chemical Engineering

Advisor(s): Pedro Arce

Nanotechnology is known as the science of "tiny" scales and it has very impactful outcomes for applications in materials, the environment, health care, and energy, among other significant fields. In particular, it has a wide range of applications within the healthcare field including diagnosis and treatment of early-stage cancer and other diseases. In addition, nanoparticles offer numerous advantages in drug delivery systems. For example, nanoparticles are used in novel approaches for drug delivery which can achieve better therapeutic action, bioavailability, and reduce toxicity. In this contribution, technologies developed to assist with the treatment of healthcare-related illness will be classified and a brief description of the approach associated with the technology will be presented. Potential research gaps for advancing the technology and/or improving its efficiency will also be highlighted.

Undergraduate

STRUCTURE AND DYNAMICS OF HBD-2 MIMETIC INTERACTION WITH COV-2 RBD

Primary Author: Chase Yancey, Chemical Engineering

Co-Author(s)/Collaborators: Liqun Zhang, Tennessee Technological University

Advisor(s): Liqun Zhang

The coronavirus disease (CoV-2) is a contagious virus that has caused a global pandemic and many deaths. Modeling the receptor-binding domain (RBD) of CoV-2 with a type II human beta defensin (hBD-2) through a molecular dynamics simulation can enhance knowledge and understanding of how hBD-2 prevents the virus from binding to human cell receptors. The first step is to perform protein docking, which computes possible orientations and configurations between molecules. Two docking orientations between hBD-2 and RBD were selected for the second step, which is a molecular dynamics (MD) simulation using the Nanoscale Molecular Dynamics (NAMD) program. Based on NAMD simulation trajectories that ran for 5 nanoseconds, different analyses were performed by comparing the initial and final protein structures, calculating the number of hydrogen bonds formed, and computing the Root Mean Square Deviation (RMSD) of the protein structures. The number of hydrogen bonds formed between hBD-2 and RBD fluctuated rapidly during the simulation and showed a tendency to decrease. The RMSD result indicates that the protein structure deviates from the initially docked protein structure over time. The results establish that hBD-2 can bind with CoV-2 RBD, and thus has the capability to block the virus from binding with the human ACE2 receptor.

Department of Civil and Environmental Engineering

Undergraduate

UL-FGA: EXPANDING THE DATABASE

Primary Author: Dylan Alissandrello, Civil Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Advisor(s): Daniel VandenBerge

For years now, America has been in need of a new type of aggregate that is both lightweight and environmentally friendly, along with encompassing other properties desired by various projects. AeroAggregate, LLC has now released an ultra-lightweight foamed glass aggregate (UL-FGA) in North America that has a low unit weight, a high friction angle, and is highly permeable. The purpose of this research was to expand the current database on this aggregate. During this research, the usage of photogrammetry sieve analysis and one-dimensional compression were used to test the properties of UL-FGA. Since UL-FGA had the property to break into smaller pieces when sieved in a standard sieve shaker, a solution was needed to get grain size analysis properly. This led to the use of photogrammetry sieve analysis. The software used could then accurately estimate the particle size in volume compared to the particle diameter of UL-FGA. This method is still not as accurate as a standard sieve shaker, but it did solve to the solution of getting an estimate of the grain size analysis without rounding the edges of the UL-FGA sample. This research also used the process of one-dimensional tests to get data such as plots of stress vs strain. This research was concluded by comparing the past research to this updated research, which resulted in many similarities and differences that can be used to gain a broader understanding of this aggregate and possible future uses.

Undergraduate

ASSESSING THE IMPACT OF DIFFERENT INOCULUM SOURCES ON SPECIFIC METHANE YIELD OF BIOMETHANE POTENTIAL TESTS

Primary Author: Hugh Harris, Civil Engineering

Creative Inquiry Summer Experience (CISE) Award Recipient

Co-Author(s)/Collaborators: Wright Tyler

Advisor(s): Tania Datta

A Biomethane Potential (BMP) test is a simple and inexpensive technique that determines the biodegradability of a specific substrate, while also evaluating the potential amount of methane that can be produced within the anaerobic system. It is the first fundamental assessment in determining the amount of biogas generated from an anaerobic digestion system. First proposed in 1979 by Owen et al., inoculum from an established anaerobic digester is mixed with a proposed substrate in an oxygen free environment within a batch reactor. The biogas and methane content are then measured over the course of the testing period to determine methane production potential. Although BMP tests have been conducted for years, due to lack of a standardized method there is often inconsistencies in results between similar BMP studies. The source of the inoculum used in BMP tests is one parameter that remains inconsistent among studies. The microbial communities in different inoculum sources can vary. This can greatly affect

the overall methane yield of the BMP test. Therefore, the objective of this study was to evaluate specific methane yield variability in the BMP test using inoculums from wastewater, agricultural, and industrial anaerobic digesters. Results indicated that inoculum source did not have an effect on specific methane yield. However, inoculum sources that had been adapted to similar substrates had a higher rate of reaction. Therefore, if speed of reaction is a necessary requirement during methane production, a well-adapted inoculum source should be considered.

Department of Computer Science

Graduate

UNDERSTANDING RANSOMWARE BEHAVIOR USING TIME SERIES ANALYSIS FOR EARLY DETECTION

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

Advisor(s): Ambareen Siraj

According to the recent cyber threat reports, global damage due to ransomware is expected to reach US$ 20 billion this year, with recovery from these devastating attacks taking an average of 16 days. Our data-driven study investigates early ransomware detection approaches using sequence mining and machine learning techniques due to the severity of these extortion-based cyber-attacks. I/O Request Packet (IRP), a low-level file system log, is used to gain actionable insights into ransomware encryption processes to extract distinguishable sequential operations carried out by ransomware during its execution. We use this insight to predict potential ransomware behavior with multiclass classification by studying a vast number of 383 ransomware samples - belonging to 21 ransomware families. To evaluate the early detection approach, we report all of our empirical findings between 15 and 40 minutes of IRP logs, whereas each sample covers 90 minutes-logs on average. By utilizing one-class classification algorithms, e.g., One-Class SVM, Isolation Forests, and Local Outlier Factor (LOF), we demonstrate that the identified sequences can successfully discover new families of never-before-seen ransomware samples.

Graduate

DYNAMIC ADDRESS VALIDATION ARRAY (DAVA): A MOVING TARGET DEFENSE PROTOCOL FOR CAN BUS

Primary Author: Richard Brown, Computer Science (M.S.)

Co-Author(s)/Collaborators: Alex Marti; Chris Jenkins, Sandia National Labs; Sandia Shannigrahi, Tennessee Tech University

Advisor(s): Susmit Shannigrahi

This paper presents Dynamic Address Validation Array (DAVA), a novel moving target defense protocol for the Controller Area Network Bus (CAN bus). DAVA's primary goal is to mitigate the common CAN bus vulnerability of an unauthorized entity misappropriating components in the vehicle through sniffing and reusing ECU IDs for replaying messages. Using a dynamically allocated array stored in the ECU that is updated and validated frequently, DAVA limits an attacker's ability to reuse ECU IDs for replay attacks. The protocol strives to be minimally invasive and lightweight for application in CAN bus while still being secure. This paper discusses the DAVA protocol, a proof of concept implementation, and initial performance measurements. This paper explains how DAVA is able to provide a robust security framework for CAN bus without the need for a large amount of storage or CAN bus standard modification.

Graduate

COUNTERFACTUAL EXPLANATIONS AND MACHINE LEARNING SECURITY

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

Advisor(s): Doug Talbert

In explainable artificial intelligence (XAI), counterfactual explanations are perturbed instances of a data point that result in an alternate classification than the original data point. This type of XAI is powerful as it provides actionable information to inquirers about how to change to receive the desired classification from a machine learning model. Model extraction attacks are a common technique for an adversary to obtain a highly similar machine learning model to profit or gain an unfair advantage. Recent work has discovered that counterfactual explanation can help adversaries execute high-fidelity model extraction attacks. This study is limited in scope to one counterfactual generation algorithm and one dataset for most scenarios. This work extends previous work to incorporate additional datasets, including real-world datasets, and additional counterfactual generation algorithms

Graduate

DEVELOPMENT OF A HYBRID RESEARCH TESTBED FOR IN-VEHICLE SECURITY RESEARCH

Primary Author: William Lambert, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Haley Burnell

Advisor(s): Sheikh Ghafoor

A modern automotive system consists of up to 100 Electronic Control Units (ECUs) and thousands of communication signals via the Controller Area Network (CAN) protocol, over a bus-based network topology. While the CAN protocol benefits from its low-cost, reliable, and real-time properties, it lacks information security mechanisms such as authentication and encryption, making it susceptible to fabrication, suspension, and masquerade attacks. In a real-world setting, some of these attacks could even cause the endangerment or loss of life. In-vehicle security researchers today use software-based solutions, actual vehicles, or simulated hardware testing to find solutions to these problems. While software-based solutions are often cost-effective and flexible, they do not typically provide realistic results. On the other hand, actual vehicles provide a realistic scenario, however, they can be cost-prohibitive and lack flexibility when modifications need to be made. Simulated hardware is created by simulating ECUs using low-cost equipment, such as Raspberry Pis, however, like the software-based solutions, these simulated ECUs are not accurate representations of realistic ECUs. We have developed a hybrid testbed that incorporate real ECUs as well as simulators. Our testbed provides the real time behavior of actual ECUs as well as the flexibility of simulators. We have also developed an easy-to-use software interface to develop and test in-vehicle communication algorithms on the testbed. The testbed has been validated by testing and experimental secured CAN protocol called SecCAN. The validation indicates that our testbed provides a low cost, very flexible, but realistic environment for in-vehicle network security research.

Graduate

FARM-TO-FORK SUPPLY CHAIN TRACKING USING BLOCKCHAIN

Primary Author: Kendall Land, Computer Science (M.S.)

Advisor(s): Ambareen Siraj

Current systems for tracking agricultural products from their production at a farm to a consumer's possession

are built on top of separate centralized architectures. This makes tracing a specific product back to its source complicated, time consuming, as well as susceptible to potential tampering. Implementing a blockchain to reliably store pertinent information about agricultural products from farm-to-fork in a decentralized manner and using IoT devices to perform the logging of the information, seems to provide a promising solution to this issue.

Graduate

SCHEDULING ELASTIC MESSAGE PASSING PARALLEL APPLICATION IN HPC ENVIRONMENT

Primary Author: Debolina Halder Lina, Computer Science

Advisor(s): Sheikh Ghafoor

An elastic parallel application that can change the number of processors while running, promises improved application and system performance as well as new classes of parallel applications. From the application point of view, users want lower response time and lower turnaround time, on the other hand from the system perspective we want higher utilization and throughput. The elastic application promises both by reducing fragmentation. In addition, elastic applications provide the possibility of predictive proactive fault tolerance via shrinkage in increasingly larger HPC systems where the mean time between component failures is decreasing. The research work for elastic parallel systems is at a very early stage and rudimentary at best. The major challenges for elastic parallel systems to become reality are: 1)lack of programming models for elastic applications, 2) lack of support from message passing libraries and middleware and 3) lack of adequate support from HPC resource management systems. In our research, we are developing a model for elastic parallel applications and a model of their interactions with resource management systems. We are also investigating the impact of different scheduling algorithms for elastic parallel applications on system and application performances.

Graduate

MALWARE CLASSIFICATION USING DEEP LEARNING IN CLOUD ENVIRONMENTS

Primary Author: Andrew McDole, Computer Science (M.S.)

Co-Author(s)/Collaborators: Austin Brown; Phillip Brown; Mahmoud Abdelsalam, Manhattan College, Riverdale, NY, USA

Advisor(s): Maanak Gupta

Cloud infrastructure is vulnerable to malware due to its exposure to external adversaries, making it a lucrative attack vector for malicious actors. A datacenter infected with malware can cause data loss and/or major disruptions to service for its users. This work analyzes and compares various deep learning and machine learning methods within the scope of malware classification. The classification is based on behavioural data using process level performance and system wide performance metrics including cpu usage, memory usage, disk usage etc. These machine learning models are designed to extract features from data gathered from live malware running on a real cloud environment. Experiments are performed on OpenStack (a hypervisor) testbed designed to simulate cloud environment scenarios. Comparative analysis is performed for different machine learning models.

Graduate

A TAXONOMY OF CYBER ATTACKS IN SMART MANUFACTURING SYSTEMS THROUGH THE PERSPECTIVE OF THE NIST CYBERSECURITY FRAMEWORK MANUFACTURING PROFILE

Primary Author: Bethanie Williams, Computer Science (M.S.)

Co-Author(s)/Collaborators: Marena Soulet; Ambareen Siraj

Advisor(s): Ambareen Siraj

A revolution in manufacturing systems is underway with smart manufacturing becoming an integral component of the broader push towards Industry 4.0. As the modern manufacturing industry continues to bridge digital and physical environments through the use of Internet of Things (IoT), cloud systems, data analytics, and machine learning, this integration of physical industrial systems with cyber technology has led to an increase in cyber-physical attacks with ongoing discovery of new security challenges. In this poster submission, we will be discussing a comprehensive study of common security challenges and attacks faced by smart manufacturing systems today and use the NIST Cybersecurity Framework Manufacturing Profile as a guideline to address cyber incidents that have occurred within the manufacturing sector.

Undergraduate

A CASE STUDY IN DIGIT RECOGNITION

Primary Author: Dipayan Banik, Computer Science

Co-Author(s)/Collaborators: Shataydrian Marshall; Tony Tai; Scout Doran

Advisor(s): William Eberle

Digit Recognition is a computer vision technique to predict the numerical value of digits in a dataset. The issue is that handwritten digits are not always the same size and that these digits are not always written the same way from person to person. The goal of this project is to take an image of a handwritten image single digit and determine what it is. The objective is to build an efficient model with an accuracy of at least 90% through testing and training on a Kaggle dataset. We will explore various machine learning algorithms such as SVM and K nearest neighbors as to whether they improve the efficiency of recognizing the hand-drawn digits. We present our findings through various metrics and graphical representations.

Undergraduate

THE EFFECT OF DISASTERS ON HAPPINESS

Primary Author: Tymothy Brandel, Computer Science

Co-Author(s)/Collaborators: Megan Young; Nate Morrow; Mateo Gannod

Advisor(s): William Eberle

We intend to address the issue of how levels of happiness in the United States are influenced by its economy, society, and the impact of natural disasters. We will attempt to make predictions to see how any changes to those factors could have a positive or negative impact on the overall happiness score, and see how varying aspects of a natural disaster may have an influence. We will use the World Happiness Report dataset and the Federal Emergencies and Disasters dataset. The World Happiness Report dataset comes from yearly surveys of people in different countries and has information on the country's happiness score, economy, life expectancy, family contribution, freedom, and individuals' perception of the presence of corruption in their country. We will use this dataset, particularly the United State's data from 2015 to 2017, to determine trends in happiness. The Federal Emergencies and Disasters dataset is provided by the Federal Emergency Management Agency and will be used to evaluate whether the amount, length, and size of a disaster affect the US's happiness score for the years of 2015 to 2017. Our goal is to test if the effect of disasters in the United States between the years of 2015 to 2017 has an effect on the happiness score of the

country. We will measure how successful our analysis is by determining if a relationship exists between disasters and the overall happiness score.

Undergraduate

IOT MACHINE HEALTH MONITORING

Primary Author: Ryan Brewer, Computer Science

Advisor(s): Nan Guo

Although the capabilities and presence of 3D printing is ever-expanding, there are still two principal issue hampering the long-term success of the technology, failure rate, and waste. Failure can come from a multitude of issues from the printing process. Extrusion rate, poor support structures, printer misfunction, environmental changes, and more all can hamper the success of any 3D print. From this failure comes a chance of damage to the 3D printer and a waste of the used material as most failed prints cannot be salvaged. At the makerspace, we often have prints that take 24 or more hours to complete. As we do not staff the Makerspace all day, and the failure of these prints creates a great amount of material waste, a computer detection system is a great option to minimize these issues. The IoT Machine Health Monitoring (MHM) Project aims to detect these failure points and notify staff of potential failures. As this project develops, we plan to further increase the capability and reliability of the detection systems to remotely detect and stop failing prints to prevent increased waste and machine failures.

Undergraduate

PREDICTING THE SPREAD OF DENGUE FEVER IN TROPICAL CITIES USING MACHINE LEARNING METHODS

Primary Author: Matthew Brotherton, Computer Science

Co-Author(s)/Collaborators: Tyler Fulghum

Advisor(s): William Eberle

Predicting the spread of communicable diseases is more important than ever, given the impact of the recent COVID-19 pandemic. Despite all the attention that pandemics get, they are not the only health situations that must be handled. There are ongoing endemics in tropical countries where health services and the standard of living are particularly deficient. These endemics are caused by neglected tropical diseases, or NTD's. Of these, a viral disease called dengue fever is of concern for this project. To combat this debilitating disease, we are predicting future cases and outbreaks in Iquitos, Peru and San Juan, Puerto Rico based on prior dengue statistics in the form of case numbers and the corresponding week of the year. We also have climate variables such as temperature, humidity, precipitation amount, and dew point to draw correlations from. We use machine learning and data science techniques such as value imputation and Random Forest Regression to clean and model the data. The goal is to predict our target variable which corresponds to the number of cases per week, where success is determined by the mean absolute error. By conducting this analysis, drawing conclusions, and evaluating models, we believe we can accurately forecast future outbreaks. Ultimately, our approach would help response teams be assigned more efficiently to the severely affected areas. We validate our approach using DrivenData's DengAI competition data set.

Undergraduate

PERFORMANCE ANALYSIS OF MQTT PROTOCOL ACCESS CONTROL IMPLEMENTATION

Primary Author: Glen Cathey, Computer Science

Advisor(s): Maanak Gupta

As smart cars become more mainstream, they present consumers with a plethora of new features. These features come with a large amount of user convenience at the cost of serving as a new major attack surface. We have implemented an MQTT protocol publish/subscribe model in order to facilitate access control in the form of a many-to-one relationship between virtual devices and physical devices. These virtual devices, or shadows, catalog pieces of the device's state. This separation of data allows us to centralize access control through a mysql database authorization plugin. We explore performance impacts of this authorization, as well as scalability of number of simulated physical devices with a standardized number of shadows per physical device.

Undergraduate

SENTIMENT ANALYSIS USING GOOGLE'S WORD2VEC MACHINE LEARNING METHOD

Primary Author: Maddison Davenport, Computer Science

Co-Author(s)/Collaborators: Kaitlyn Carroll; Alison Rust; Sina Sontowski

Advisor(s): William Eberle

Natural language processing is an important research area of Artificial Intelligence. By competing in the "Bag of Words meets Bag of Popcorn" Kaggle challenge, we plan to produce a machine learning model that has been trained to analyze movie reviews and understand the meaning and semantic relationship among words to determine the sentiment behind the reviews. Our model should be able to distinguish between positive and negative reviews using Google's Word2Vec, a deep-learning inspired method that focuses on the meaning of words. After our model has been trained using two different data sets (one containing reviews with a positive or negative sentiment label, the other containing reviews without sentiment labels), we will be able to test our model and determine its accuracy.

After analyzing our model, we will produce graphical representations of our analysis and collected data. For analysis and goal evaluation, we will be computing a classification accuracy score and plotting an ROC curve. The classification accuracy score should be above 50% and by visually inspecting the ROC curve, the line should be above the line of no-discrimination for the model to be considered successful.

We will also generate a report of outcomes wherein we will assess and evaluate the model's performance and accuracy and provide insight into any changes or improvements that could be made in the future to improve upon the performance of the model.

Undergraduate

PREDICTING DAMAGE BASED ON GORKHA EARTHQUAKE DATASET

Primary Author: Shaun Guyette, Computer Science

Co-Author(s)/Collaborators: William Lewis; Nicholas Stone

Advisor(s): William Eberle

Earthquakes like the 2015 Gorkha earthquake in Nepal can cause massive damage to buildings in immediate and surrounding areas. It is important to people in those areas to be prepared for the possibility of such destruction to their structures. One way for those people to be prepared is to be able to predict the degree that buildings will be affected. We set out to predict the variable damage_grade in the dataset, which represents a level of damage to the building that was hit by the earthquake – low, medium, or complete destruction. Based on aspects of building location and construction, we developed a predictive model based on an initial exploratory analysis using descriptive statistics. We utilized R Studio, Python, and other software to construct our predictive model, create visuals, and

compile a report of our findings.

Undergraduate

ABSENTEEISM AT WORK

Primary Author: Jacob Hill, Computer Science

Co-Author(s)/Collaborators: Brandon Vandergriff; Gabriel Kiprono; Stephen Meshotto

Advisor(s): William Eberle

As the economic side of the world continues to grow, so do the demands associated with it. In lieu of these demands, absenteeism at work can lead to interruptions throughout a company or with a company's workflow. The overarching question is, can these be predicted despite being unintentional or habitual? Excessive absences impact the performance of the company and the individual. One guarantee is these absences can derive from a variety of reasons, whether medical or personal. Another factor in absences require looking into personal lives, work load, distance from work. By using the Absenteeism at Work from UCI Machine Learning Repository, we will attempt to build a machine learning model using Python. From this data set and this research, we demonstrate an ability to predict absentee time based on the reason for the absence, while accounting for the general lifestyle of the employee(s). We intend to evaluate the impacts of the absenteeism on the company and how to bridge the gaps left when a worker is missing. We hypothesize that employees with more severe medical issues will be at the upper range of all absences, and employees with more social occupations are more likely to miss than their less social counterparts. Using R's modeling capabilities, we present various statistical and graphical observations.

Undergraduate

ANALYZING MACHINE LEARNING APPROACHES FOR ONLINE MALWARE DETECTION IN CLOUD

Primary Author: Jeffrey Kimmell, Computer Science

Co-Author(s)/Collaborators: Andrew McDole; Maanak Gupta, Tennessee Tech University; Mahmoud Abdelsalam, Manhattan College

Advisor(s): Maanak Gupta

The number of services being offered by various cloud service providers (CSP) have recently exploded. Utilizing such services has created numerous opportunities for enterprises infrastructure to become cloud-based and, in turn, assisted the enterprises to easily and flexibly offer services to their customers. The practice of renting out access to servers to clients for computing and storage purposes is known as Infrastructure as a Service (IaaS). The popularity of IaaS has led to a serious and critical concern about the security of such services. Particularly, malware is often leveraged by malicious entities against cloud services in order to compromise sensitive data or to obstruct the functionality of these services. In response to this, malware detection for cloud environments has become a widely researched topic with numerous methods being proposed. In this paper, we present an online malware detection method based on performance metrics, and analyze the effectiveness of different baseline machine learning models including, Support Vector Classifier (SVC), Random Forest Classifier (RFC), K-Nearest Neighbor (KNN), Gradient Boosted Classifier (GBC), Gaussian Naive Bayes (GNB) and Convolutional Neural Networks (CNN). Our results conclude that neural network models can accurately detect the affects that malware has on the performance metrics of virtual machines in the cloud, and therefore are better suited to detect malware. Our models were trained, validated, and tested by using

a dataset of 40,680 malicious and benign samples. This dataset was compiled by conducting 113 60-minutes long experiments and collecting the process level features.

Undergraduate

OBSERVING THE TRENDS OF VIDEO GAME SALES

Primary Author: Noah Larson, Computer Science

Co-Author(s)/Collaborators: Noah Geiger; Christopher Jenkins; Patrick Adcox

Advisor(s): William Eberle

A video game is a form of electronic game that is played on a computing device, whether that be a PC, game console, and these days, even on a smartphone. Video games are a relatively new form of entertainment that has grown in interest rapidly, especially over the past couple years. Since the inception of video games the industry has grown exponentially leading to a vast market with many different big players. In this paper we plan on diving into a video game sales dataset obtained from Kaggle in order to understand trends in the video game market. We intend to use this dataset along with RStudio and other tools to find meaningful insights about the nature of the video game market. We would like to distinguish between successful games and non-successful ones, which platform has released the most successful games, which types of games are popular in different parts of the world, and which publisher published the most successful games. We believe this knowledge could be useful in determining what properties make certain games popular as well as what properties could cause a game to sell poorly. It is our hope that knowing what attributes will make for a successful video game could help to create more worthwhile experiences by providing valuable insight to producers about the nature of successful games.

Undergraduate

CHESS OPENINGS AND RATINGS

Primary Author: Lukas Motykowski, Computer Science

Co-Author(s)/Collaborators: Cameron Brandt; Thomas Leisure

Advisor(s): William Eberle

The purpose of our research is to determine what chess opening works best for a given rating, so players can give themselves an edge and win more games. In chess, a person's skill can be quantified in a number called a "rating". Most chess websites use this rating to match players together with similar ratings to create an even match. Based on this skill rating, we want to determine what openings work best for different ranges of ratings. This is important because some openings have a more potent effect in lower ratings, but are not as effective in higher ratings. We compare different openings and their win rate together across different buckets of ratings to find out which opening, or openings are most effective at which rating.

Undergraduate

STOCK TRADING: PREDICTION OF AUCTION VOLUMES

Primary Author: Bailey Schepke, Computer Science

Co-Author(s)/Collaborators: Donovan Pinto; Anthony Ramirez; Emma Fannin

Advisor(s): William Eberle

With data analysis methods comes the ability to make predictions about the future behavior of numerous types

of data. This project seeks to analyze stock market closing auctions. Stock exchanges hold closing auctions at the end of a trading day to determine the closing price for each stock. We analyzed volume, the total value of stock exchanged, during the closing auctions from stock exchanges covering a set of 900 stocks over 800 days. In order to complete this project, we built a model to predict stock trade volumes utilizing data provided on challengedata.ens.fr. A benchmark was created by Capital Fund Management, the providers of the challenge, that utilizes a linear fit method for our model to be compared against. We have interpreted and cleaned the data in order to predict exchanged volume of a given stock during closing auctions.

Undergraduate

EDUCATIONAL MACHINE LEARNING MODULES FOR UNDERGRADUATES IN CYBERSECURITY

Primary Author: Daniel Simpson, Computer Science

Co-Author(s)/Collaborators: Maanak Gupta, Tennessee Technological University; Mahmoud Abdelsalam, Manhattan College

Advisor(s): Maanak Gupta

Machine learning resources have developed by leaps and bounds in recent years and have become pervasive in many fields, including the field of Cybersecurity. As such, it is important that machine learning applications be taught at the undergraduate level in the context of Cybersecurity to provide students with a competitive advantage that will be useful in industry. We are seeking to provide versatile module-based solutions that can either be integrated into existing security courses or stand alone. Several of these modules are currently in development, including a convolutional neural network (CNN) implementation for the classification of malware samples, an adversarial attack on that model in a later module by use of the fast gradient sign method (FGSM), followed by an adversarial training lab in order to harden machine learning models against such adversarial attacks. Students will use virtualization with Oracle's VirtualBox to sandbox their experiments in a Linux environment. They will make use of Python to train and test their models, making use of the Keras, Tensorflow, and Scikit-learn libraries. These modules are intended to make applied machine learning knowledge accessible to undergraduates sooner than grad school, but may be used at higher levels or even by themselves. They are self-contained with the lectures and lab materials required for students to succeed as they gain valuable knowledge for their careers in Cybersecurity.

Undergraduate

FUTURE SALES PREDICTIONS ON RUSSIAN ELECTRONICS SHOPS

Primary Author: Jacob Sweeton, Computer Science

Co-Author(s)/Collaborators: Daniel Simpson; Daniel Roberts; Edward Mantsevich

Advisor(s): William Eberle

Speculations about future sales for a given company or store and for given products in those stores have been critical to successful trade going far back in human history. However, until much more recently this was more art than science as the availability of mass sales data was much more limited. Today, we have access to nearly boundless amounts of relevant data and incredible computational tools with which to work with it and to improve upon these speculations. Given the daily historical sales data provided by the Russian firm 1C used in the Kaggle challenge "Predict Future Sales," we seek to improve on existing sales predictions across items and stores that may or may not be chains. This dataset provides information

about many individual store locations as well as 11 fields for products and sales per shop per day from January 2013 to October 2015. To this end, we will use the statistical software R and possibly machine learning methods to generate a month's worth of sales predictions ahead of store restocking. We will identify common patterns across stores such as sales data for the same or similar product as well as attempting to identify yearly trends in sales. As it is a Russian dataset, we will seek to overcome lingual and cultural barriers faced by international data scientists in industry as we pursue this goal.

Undergraduate

MULTILINGUAL TOXIC COMMENT CLASSIFICATION

Primary Author: Noah Treutel, Computer Science

Co-Author(s)/Collaborators: David Feier; Evan Kelley; Evan Sells

Advisor(s): William Eberle

With the growth of the Internet and data collection in the last twenty years, we have seen a rise with Internet Relay Chats (IRC) as well, especially in 2020 due to COVID. Now more than ever, it is important that we stay connected despite being physically separated and to make sure communications systems are as inclusive as ever. Our goal in this project is to categorize toxic comments used in IRC chat rooms and forum pages via a machine learning model in order to keep communications safe and welcoming to the public. We define toxicity as any message that is rude, disrespectful, or otherwise likely to make someone leave a discussion. If these toxic contributions can be identified, we could have a safer, more collaborative internet. As a result of our models, we will be able to identify a dataset of toxic comments with at least a 70% success rate. Additionally, we want to be able to successfully identify both new and previously existing comments as toxic or non-toxic in multiple languages that others have previously label incorrectly. Using a dataset provided by Kaggle, we demonstrate how we are able to detect if a Wikipedia talk page comment is toxic (scored as a 1) or non-toxic (scored as a 0) by using statistical methods, data analysis, and various data science approaches.

Undergraduate

PERFORMING DATA ANALYSIS TO PREDICT ENGAGEMENT FOR USER GENERATED CONTENT

Primary Author: Dylan Turner-Brinson, Computer Science

Co-Author(s)/Collaborators: Nicholas Vlahakos; Brandon Cuskey

Advisor(s): William Eberle

As social media content creation becomes an increasingly popular form of entertainment, understanding what constitutes as "popular content" has become a field of interest among the commercial and political sectors. With this in mind, there is an interesting opportunity for data scientists- find a dependable formula that can guarantee popularity in generated content.
This team will be attempting to develop a consistent method of predicting user engagement with content on social media websites such as Instagram, Twitter, Reddit, Facebook and 9gag. The metric we will be using to chart engagement is "upvotes"- a form of expressing that you like the post, with each viewer being allowed one upvote per post. Upvotes are publicly available to be seen on all posts, and are an excellent form of measuring which content is most popular. Our plan is to develop software that can accumulate large amounts of data from popular posts on

these websites over a period of time, which we will then organize into categories. As of now, these categories will be- the date and time of posting, the amount of upvotes the post received, the author of the content, and for relevant sites, the title of the content, and a genre the post bests fits into. Once a satisfactory sample size has been produced, we will analyze the data for patterns and present a clear formula that offers consistently high amounts of engagement.

Department of Electrical and Computer Engineering

Graduate

ANOMALY DETECTION FOR INDUSTRIAL CONTROL SYSTEMS BASED ON NEURAL NETWORKS WITH ONE-CLASS OBJECTIVE FUNCTION

Primary Author: Emmanuel Aboah Boateng, Engineering (Ph.D.)

Advisor(s): J.W. Bruce

The advent of Internet of Things (IoT) technologies and the prevalence of networked sensors and actuators in many industrial control systems (ICS) have led to the exposure of critical infrastructure in our society to malicious activities and cyber threats. ICS are used to monitor and control critical infrastructure in our society that provide essential services such as electricity, water supply, among others. Programmable logic controllers (PLCs) are embedded devices that automate the processes of industrial control systems. PLCs which serve as the heart of ICS are vulnerable to attacks just like other embedder devices. Because PLCs are widely used to control the physical processes of ICS, attacks against PLCs can cause irreparable damages to enterprises and even loss of lives. However, due to the unique and proprietary architecture of PLCs, it is not easy to apply traditional tools and techniques for PLC protection. In this work, we present a novel unsupervised learning approach for anomaly detection in ICS based on neural networks with one class objective function. This technique combines the abilities of neural networks to learn complex relationships with a one class objective function for separating normal conditions from anomalous operations. We evaluated our model on a recent dataset collected from a real-world ICS: the Secure Water Treatment (SWaT) dataset. The performance of our proposed technique is compared with previous works, and it shows improvements in terms of scalability and attack detection capability, proving that the proposed technique is suitable for use in real ICS scenario.

Graduate

NOVEL FERRITE-CORE METAMATERIAL AND AI-BASED COIL PARAMETER OPTIMIZATION FOR EFFICIENT WIRELESS POWER TRANSFER

Primary Author: Webster Adepoju, Electrical and Computer Engineering (M.S.)

Co-Author(s)/Collaborators: Indranil Bhattacharya; Muhammad Bima

Advisor(s): Indranil Bhattacharya

The adoption of wireless power transfer (WPT) is affected by limitation in power transfer distance, low transfer power (TP) and power transfer efficiency (PTE). However, the discovery of metamaterials (MTM), has proven a viable solution. The inherent magneto-inductive wave and negative refractive index of MTM engender evanescent wave amplification within its vicinity, creating a high-density magnetic field, high mutual inductance and a convergence of the flux lines at the receiver. To this end, we present a novel WPT model based on a working combination of layered DD coil (LDD) and Ferrite-core based metamaterial (FC). The Ferrite-core comprises an inner and outer radius r_i and R_o respectively. It is situated at the center of the LDD and in between its individual layers. A low frequency simulation of the proposed WPT model based on finite element analysis is carried out in ANSYS Maxwell. Simulation results show the proposed FC generates higher mutual inductance and power received than a conventional WPT design. By increasing the start radius of the LDD coil and maintaining a constant inter-layer distance, an improved performance of the proposed WPT system is achieved. Further, it is

observed that the proposed WPT system realizes higher mutual inductance and TP with a small core radius than large core radii, thus presenting cost saving benefits in material fabrication. Optimization of coil parameters was performed in MATLAB to improve the amount of power received and enhance the PTE. The MATLAB results were cross verified with Lt-spice result, and both show close agreement.

Graduate

MODELING AND IMPLEMENTATION OF LQR CONTROLLER FOR EFFICIENT EV SUSPENSION ENERGY HARVESTING

Primary Author: Deborah Afolayan, Electrical and Computer Engineering (M.S.)

Advisor(s): Satish Mahajan

Over the years, the global interest in the Electric Vehicle (EV) market has grown significantly. These vehicles are powered by electricity from off and on-vehicle sources. However, some of the challenges posed by most of these power sources are limited capacity, charging time constraints, availability of charging infrastructure, charger compatibility, etc. These consequently shortens the driving distance an EV can cover as long-distance trips will lead to more unwanted stops. In a bid to augment these sources, vibration energy from the vehicle suspension is harvested and converted to electricity for charging an onboard battery, consequently improving its mileage. In spite of this, a major issue with these vibration energy harvesters is that the device delivers weak output power when excited at frequencies outside their resonance frequencies. The motivation for this research stems from the need to model a low power consumption energy harvesting device that harvests energy rather wasted in the EV's suspension. Also, to auto-tune its resonance frequency rapidly to coincide with the excitation frequency for maximum energy harvesting. This will be achieved by modeling an electromagnetic transducer which is controlled by a piezoelectric actuator. The spring stiffness will be altered by applying voltage to the piezoelectric actuator which will thereby widen the bandwidth of the energy harvester so as to ensure excitations below and above its natural resonance frequency. It is anticipated that the implementation will be carried out and the expected results should show optimized energy harvesting, improved tuning time and minimal energy consumption.

Graduate

EFFICIENT AND PRIVACY-PRESERVING CONTACT TRACING SYSTEM FOR COVID-19 USING BLOCKCHAIN

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

Co-Author(s)/Collaborators: Seham Alansari; Mohamed Mahmoud; Waleed Alasmary

Advisor(s): Mohamed Mahmoud

COVID-19 has been endangering people's lives and causing a huge burden on the healthcare sector.
To limit the fast spread of the virus, contact tracing systems are currently adopted worldwide to identify the close contacts of positive cases during the incubation period of the virus and notify them to quarantine. However, the existing systems are vulnerable to security and privacy attacks and suffer from large communication and computation overheads. To address these limitations, in this paper, we propose an efficient and privacy-preserving contact tracing system based on a consortium Blockchain. Instead of depending on one entity to run the system, our system is run in a decentralized fashion by multiple health authorities that construct the Blockchain network. The utilization of Blockchain secures our system against the problems of centralized architecture.
Besides, our system is designed to thwart false reporting (panic) attacks, while preserving the privacy of the users

against identification and social graph disclosure attacks. The performance evaluation of our system demonstrates its efficiency in terms of communication and computation.

Graduate

NOVEL P2-TYPE NA0.6FE0.5-2XMN0.5TIXVXO2 CATHODE FOR HIGH-CAPACITY AND STABLE SODIUM-ION BATTERIES

Primary Author: Trapa Banik, Electrical and Computer Engineering (M.S.)

Co-Author(s)/Collaborators: Indranil Bhattacharya

Advisor(s): Indranil Bhattacharya

Necessity of enery storage and battery production is soaring up steadily for the growth of portable electronic devices and surging evolution of electric vehicles and renewables. Lithium-ion battery (LIB) technology has been the primary choice for such applications due to its high-energy-density, high-stability, and longer cycle-life. Albeit with all merits, depletion of lithium reserve has prompted battery researchers to search for new alternatives to LIB. Sodium, in this respect, can be a viable solution as it is the sixth most abundant element and shares the same group with lithium in periodic table, having similar structure and electrochemical working mechanisms. The pivotal factor hindering the deployment of the laboratory-based Sodium-ion battery (SIB) technologies into the commercial battery market is low energy density compared to that of LIB. Improvement of overall electrochemical performance of cathode materials can be a game-changer as it affects energy density, lifespan, and tolerance of batteries. In this research, a novel P2-type transition metal-oxide cathode Na0.6Fe0.5-2xMn0.5TixVxO2 was synthesized by doping NaFeMnO2 (NFM) with vanadium and titanium. A set of physicochemical analyses, including Field-Effect Scanning Electron Microscopy and Energy Dispersive X-ray Spectroscopy analysis, were performed to justify the morphological competence of the pristine NFM and vanadium-titanium doped NFM and crystal structures and lattice parameters were refined through X-ray Diffraction and Rietveld analysis. These exhaustive structural and morphological comparisons provided insights on the effects of vanadium-titanium doping on stabilizing surface structures, reducing Jahn Teller distortion, enhancing stability and capacity retention, and promoting Na+ carrier transport mechanism.

Graduate

AN AI-ENABLED CONTROL FOR DYNAMIC WIRELESS POWER TRANSFER

Primary Author: Muhammad Bima, Engineering (Ph.D.)

Advisor(s): Indranil Bhattacharya

Dynamic wireless power transfer (DWPT) is a nascent technology that brings forth great flexibility for charging electric vehicles (EV). For it to achieve fruition and to avoid power wastage, certain measures need to be in place to improve the power transmission. One of such measures is to use multiple transmitters and make the charging system to be aware of the location of the receiver thereby adapting power transmission to the receiver location. This is because, the change in relative location affects the mutual inductance which in turn, affects the amount of power that gets transmitted. This research presents a scheme where the charging system adapts to EV location and tunes its internal parameters to optimize the transmit power. Maximum power point tracking is employed to ensure optimal power transmission. First, the system uses a trained machine learning neural network to estimate the coupling coefficient between the transmitter and receiver. This parameter is then fed into two optimization algorithms; Jaya and Crow search algorithm. These algorithms along-side some predefined parameters would determine how much tuning certain circuit components need to go through to operate the circuit at the

maximum PowerPoint. Two transmit coils were used and preliminary results show a transmit efficiency of 95% and at a distance of 200 mm. Results were also validated using LTSpice simulation software and they show the prospect of implementation for DWPT.

Graduate

UNIPOLAR RESONANT CAPACITIVE POWER TRANSFER FOR SURFACE-POWERED CYBER-PHYSICAL SYSTEMS

Primary Author: Jonathan Dean, Electrical and Computer Engineering (M.S.)

Co-Author(s)/Collaborators: Brandon Nieman; Tyler Marcrum; Michael Coultis, Tennessee Technological University; Matthew Pearce, Tennessee Technological University

Advisor(s): Charles Van Neste

Sensors are a critical part of many Cyber-Physical Systems (CPS), and providing power to them is becoming increasingly challenging due to routing constraints. Wireless Power Transfer (WPT) can offer solutions that reduce the routing constraints, but many wireless power transfer approaches are complex, not scalable, or are not feasible for continuous power delivery to multiple sensors. We propose an efficient, inexpensive, simple, and scalable method for continuously providing power to sensor nodes using Quasi-Wireless Capacitive (QWiC) power transfer. QWiC power transfer allows for power to be transferred capacitively or over a conductive surface, simplifying routing constraints and transmitter complexity by removing the need for a dedicated transmitter. In this experiment, we demonstrate surface powered sensor nodes with a peak efficiency over 68% and multiple sensor nodes being powered over a single surface.

Graduate

SMART MICRO GRID POWER FLOW CONTROL USING SEN TRANSFORMER

Primary Author: Quy Le, Electrical Engineering

Advisor(s): Satish Mahajan

Modern day electric smart grid system has the capability to communicate between the utility and their customers for efficient power management, system integrity and security. In this research a scale model power grid will be used to demonstrate several flow control scenarios. The scale model power grid for this study consists of a 3-bus system with a Supervisory Control and Data Acquisition (SCADA) developed in LabVIEW. The generators utilize a new smart agent and custom hardware for starting each generator, checking voltages, frequencies and phases as well as phase sequence for both the generators and the power grid and then synchronizing them before connecting to the grid. Various alarm conditions can be programmed in to cause it to island from the grid. Once the grid is fully operational, the operator can implement flow control strategies via phase angle changes at each generator. This research further demonstrates an additional element of flow control through a custom designed and operated Flexible AC Transmission System (FACTS) device known as a SEN transformer. The SEN transformer has been modelled and simulated in MATLAB Simulink. This simulation model will be used in the future for implementation of a real-time model to the Smart Micro Grid.

Graduate

AN EFFICIENT DESIGN REPRESENTATION OF CONSERVATIVE REVERSIBLE LOGIC GATES

Primary Author: Tyler McCormick, Electrical and Computer Engineering (M.S.)

Advisor(s): J.W. Bruce

Computers, which have become a ubiquitous staple of modern society, consume nearly 10% of all the energy produced worldwide. While computing implementation technology has been made more energy efficient over the years, the energy required to operate a gate logically has become an increasingly large proportion of the total energy required. A systematic improvement of this power use would result in significant power savings, which would grow even more appreciable as overall efficiency improves. One method for achieving these power savings would be the use of conservative reversible logic (CRL) gates for system design. However, to date, only a few designs using these types of gates have been developed. This sporadic development is primarily due to the lack of a systematic method for representing CRL gates. This work describes an accurate and compact design representation of CRL gates based on a known variation of a zero-suppressed binary decision diagram, called PiDD. Two methods of adapting PiDDs to represent CRL gates of any size are presented, along with examples of design manipulation and analysis.

Graduate

SOWAF: SHUFFLING OF WEIGHTS AND FEATURE MAPS: A NOVEL HARDWARE INTRINSIC ATTACK (HIA) ON CONVOLUTIONAL NEURAL NETWORK (CNN)

Primary Author: Tolulope Odetola, Computer Engineering

Advisor(s): Syed Hasan

Security of inference phase deployment of Convolutional neural network (CNN) into resource-constrained embedded systems (e.g., low-end FPGAs) is a growing research area. Using secure practices, third-party FPGA designers can be provided with no knowledge of initial and final classification layers. In this work, we demonstrate that hardware intrinsic attack (HIA) in such a “secure” design is still possible. Proposed HIA is inserted inside mathematical operations of individual layers of CNN, which propagates erroneous operations in all the subsequent CNN layers that lead to misclassification. The attack is non-periodic and completely random; hence it becomes difficult to detect. Five different attack scenarios with respect to each CNN layer are designed and evaluated based on the overhead resources and the rate of triggering in comparison to the original implementation. Our results for two CNN architectures show that in all the attack scenarios, additional latency is negligible (<0.61%), increment in DSP, LUT, FF is also less than2.36%. Three attack scenarios do not require any additional BRAM resources, while in two scenarios BRAM increases, which compensates with the corresponding decrease in FF and LUTs. To the authors’ best knowledge this work is the first to address the hardware intrinsic CNN attack where the attacker does not have knowledge of the full CNN.

Graduate

TOWARDS A FRAMEWORK TO ASSESS THE PERFORMANCE OF NOVEL CONVOLUTIONAL NEURAL NETWORKS ON FPGAS FOR REAL-TIME VIDEO STREAMS

Primary Author: Travis Sandefur, Computer Engineering

Advisor(s): Syed Hasan

Field Programmable Gate Arrays (FPGAs) can be used to implement Convolutional Neural Network (CNNs) because of their high throughput, low power operations, and portability. Before now, the deployment of CNNs on FPGAs for artificial intelligence (AI) inference was a lengthy process that requires both coding the entire CNN in SW and the knowledge of which HW components the CNN requires to perform inference on the FPGA. Vitis AI is a development stack for AI inference on Xilinx hardware platforms that allow for faster deployment on FPGAs for AI inference. The development stack consists of optimized

IP, tools, libraries, models, and example designs. Vitis AI is designed with high efficiency and ease of use in mind, unleashing the full potential of AI acceleration on Xilinx FPGAs. However, the traditional usage of Vitis-AI leads to loss of information due to the downsizing of images to make them adaptable for state-of-the-art CNN. We plan to apply CNN on multiple segments of the video stream concurrently and integrate the result to achieve higher resolution. In this research, we are investigating how Vitis AI can be used to assess the performance of novel CNN architectures to classify (and integrate) segmented HD video streams in real-time. Our goal is to explore the efficient usage of deep processing units (DPUs) for such segmented classification, to achieve a performance of 30 frames per second on a complete HD video stream.

Undergraduate

OPTIMAL FREDKIN GATE DESIGNS FOR LOGICAL OPERATIONS WITH TWO AND THREE INPUTS

Primary Author: Weston Beebe, Computer Engineering

Co-Author(s)/Collaborators: J.W. Bruce, Department of Electrical and Computer Engineering at Tennessee Technological University

Advisor(s): J.W. Bruce

Conservative and reversible logic gates are widely known to be compatible with and exhibit great efficiency on revolutionary computing paradigms such as low power, optical, and quantum computing. The fundamental conservative reversible logic (CRL) gate is the Fredkin gate. Functionally complete, Fredkin gates can implement any digital logic function, including those commonly used in classical computing. While Fredkin gates have been used by some researchers to build assorted logic functions, a comprehensive study of Fredkin gate implementations for logical operations has never been undertaken. This work describes a systematic study to discover efficient implementations of traditional computing functions using the Fredkin gate. The result of the study has yielded the optimal implementations of all two-input and the most common three-input logic operators.

Undergraduate

ELECTROMAGNETIC CAMOUFLAGE THROUGH A MULTI-LAYER METAMATERIAL STRUCTURE

Primary Author: Jordan Thomas, Electrical Engineering

Advisor(s): Indranil Bhattacharya

Stealth technology plays an important role in the security of our country. In order to gain information on an enemy we must be able to conduct surveillance without being detected. This means that we need to continue to develop stealth technology in order to keep up with the modern devices in object detection and tracking. There are two main methods used for object detection and tracking, which are IR and Radar detection. The IR method detects infrared band frequencies produced by the object and the Radar method relies on microwave band frequencies reflecting off of the object. In order to create stealth against the IR detectors we need to decrease the amount of IR radiation that is emitted from the object. This requires materials that have very low emissivity and therefore high reflectivity. This creates a problem for radar stealth though. For radar stealth the object needs low reflectivity and high absorptivity so that the radar wave is not reflected back. This makes it difficult to create a stealth material that is effective for both IR and Radar detection systems. The solution may be found in the creation of engineered metamaterials, which have a unique property of negative refractive index, unlike materials that are found in nature. My research is related to creating a multi-layer structure comprised of different metamaterials. These meta-structures will act like filters for different frequencies and aid in the creation of IR and Radar stealth structures that are extremely important for electromagnetic camouflage.

Department of Manufacturing and Engineering Technology

***Some graduate students listed in this section are from other departments and are listed here because their faculty advisors are from Manufacturing and Engineering Technology.**

Graduate

EFFICIENCY AND PRINT QUALITY BENCHMARKING BETWEEN FUSED FILAMENT FABRICATION AND STEREOLITHOGRAPHY PROCESSES

Primary Author: Tyler Edwards, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Soraya Olvera; Justin Willingham; Avinash Paruchuri, Tennessee Technological University; Ismail Fidan, Tennessee Technological University

Advisor(s): Ismail Fidan

As additive manufacturing (AM) is becoming ubiquitous, the two most prevalent 3D Printing technologies in almost every sector of life are Fused Filament Fabrication (FFF) and Stereolithography (SLA) resin printing. While FFF printing is considered to be a cheaper, faster process, SLA is considered to have better surface quality and dimensional accuracy.

The objective of this research is to establish a detailed power consumption, process duration, and surface roughness comparison between the two technologies. Using varying infill pattern, infill density, and layer thickness, test specimens (0.5 in. cubes) were printed on SLA and FFF printers, with the power consumption measured using a wattmeter and surface roughness measured using a profilometer. The SLA process is shown to have marked improvements over FFF in power consumption and surface finish, while FFF is faster and less expensive per part. This presentation will report the current findings of the ongoing research study detailing the benchmarking of both processes.

Graduate

PREDICTION OF MECHANICAL PROPERTIES OF SHORT FIBER REINFORCED COMPOSITE FABRICATED BY FUSED FILAMENT FABRICATION (FFF) METHOD USING MACHINE LEARNING

Primary Author: James Femi-Oyetoro, Mechanical Engineering (M.S.)

Advisor(s): Ismail Fidan

The tremendous increase in the application of additive manufacturing (AM) has gained much attention in recent times due to its usability and capacity to ascribe improved mechanical properties on printed parts with no tooling. AM process with the use of FFF is becoming an integral fabrication method for producing the complex geometries and machine components with intricate parts. There is a corresponding increase in dataset derived from AM process which has ushered the use of highly computational models like machine learning (ML) and deep learning for analysis, prediction, classification, dimensional accuracy, and optimization of methods and printing properties of fabricated parts.

This study explores the contribution of printing parameters, e.g., printing speed, layer height and infill density on mechanical properties of short carbon fiber samples produced using FFF technology. ML models will be used for classification of samples built with different print parameters, the models will analyze microstructural images captured under microscope as input dataset and make prediction and classification based on their microstructural attributes (bead shape). In this study, the computation ability of ML models will be used in the predictions for improved mechanical properties based off

results of tensile tests conducted on FFF material samples with various printing parameters. The findings of this study provide evidence and insight that ML can be used to optimize printing performance and its applications.

Graduate

DEVELOPMENT OF THREE DIRECTIONAL THREE-DIMENSIONAL COMPOSITE DENTURES WITH SHORT GLASS FIBER REINFORCED METHYL METHACRYLATE USING FUSED FILAMENT FABRICATION PROCESS

Primary Author: Ankit Gupta, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Ismail Fidan; Frank Alifui-Segbaya, Griffith University

Advisor(s): Ismail Fidan

Fiber reinforced additive manufacturing (FRAM) is becoming a subject of great interest in dentistry as it offers opportunities that could be explored in the dental field concerned with the "design and manufacture" of devices. Herein, we evaluated the practicality of FRAM for constructing patient specific and affordable composite denture bases with improved mechanical and clinical properties: polymethylmethacrylate (PMMA) as matrix was reinforced with short glass fibers (SGFs) using the fused filament fabrication (FFF) process. Representative parts for this study, were built with different layer heights (0.2, 0.1, 0.05 mm) and volume fractions (0%, 2.5%, 5%) in three mutually perpendicular directions (0˚ in X-Y plane, 90˚ in X-Y plane, and 90˚ in Z axis), and analyzed for surface roughness (resolution) and mechanical properties (tensile, flexural, compressive properties). Mechanical properties were influenced significantly by printing direction, layer height, and volume fractions; in general, parts with lower layer heights and higher SGFs reinforcement constructed in 0˚ in X-Y plane showed improved mechanical properties and good surface finish. Additional scanning electron microscopy was performed to study the effect of fiber distribution, fiber breakage, fiber accumulation and the adhesion at the interface of the PMMA/SGFs composite materials. The practical implications of the study at a "proof of concept stage" are low-cost manufacturing of highly accurate, lightweight and affordable medical devices with enhanced patient comfort in the long term and improved clinical properties particularly for geriatric use.
Keywords: Fiber reinforced additive manufacturing, Fused filament fabrication, Denture base, Composite, layer height, surface roughness

Graduate

EXPERIMENTAL AND NUMERICAL CHARACTERIZATION OF FUNCTIONALLY GRADED MATERIALS FABRICATED BY THE FUSED FILAMENT FABRICATION PROCESS

Primary Author: Seymur Hasanov, Engineering (Ph.D.)

Advisor(s): Ismail Fidan

In this research study, mechanical and numerical characterization of functionally graded materials (FGM) fabricated by the multi-material fused filament fabrication (FFF) process have been studied. Design and digital fabrication of tensile, flexural, and compression samples have been performed using the voxelization method. Test samples were mechanically tested, and the results showed that the strength and modulus of ABS material enhanced significantly with the addition of PC material into the ABS matrix. Since the interface of multi-material parts is crucial and needs substantial improvement, different interface patterns were designed and mechanically tested using the tensile test method. Tensile strength of gradient pattern yielded better results than other joint types such as interlock and direct interface. Analysis of variance was also applied to understand the process-property-structure relationships. Microstructural samples showed that there

are periodic voids between adjacent beads and layers of FFF-made parts. Therefore, a numerical homogenization method has been applied to obtain a mesoscale material property using Ansys Material Designer before performing macroscale finite element implementation. The results of numerical methods showed less than 10% error with respect to the experimental test results. Overall, the FFF process with FGM could have potential applications in medical, structural, and automotive industries by locally varying material properties. This study presents a unique method of fabricating FGM structures with a low-cost manufacturing process.

Graduate

INVESTIGATION OF CREEP BEHAVIOR OF BIMETALLIC ADDITIVELY MANUFACTURED STRUCTURE (INCONEL 625 AND SS316L)

Primary Author: Sainand Jadhav, Engineering (Ph.D.)

Co-Author(s)/Collaborators: Md Rumman Ahsan; Duckbong Kim

Advisor(s): Duckbong Kim

A bimetallic additively-manufactured structure (BAMS) is a type of multi-material structure used for achieving different complementary material properties such as thermo-physical, mechanical, electrical, optical, and corrosion/oxidation resistance within the same structure. BAMS locally or selectively improve the thermal, physical, chemical and mechanical properties of parts and enhances functionality of parts. Inconel 625 and SS316L are two widely used materials as bimetallic structures in aerospace, power generation, petrochemical, chemical, and marine applications due to their excellent mechanical and corrosion resistance properties in aggressive environments. The creep of materials is a significant engineering topic in many modern industries including power generation plants, chemical plants and the aerospace industry. Prediction or knowledge of creep life of parts used in such industries is immensely important. The objective of proposed work is to investigate creep behavior of this material. The creep tests will be carried out at different temperatures between 600°C and 750°C and at constant stress conditions according to ASTM E139 standard. After creep test microstructure analysis, creep fracture analysis, and XRD analysis will be done to characterize creep behavior of BAMS. The results facilitate understanding of the creep behavior and performance of this BAMS at elevated temperature, leading to optimal selection of operating temperature and stress level for the creep life.

Graduate

GRAIN STRUCTURE AND TENSILE DEFORMATION BEHAVIOR PREDICTION OF WIRE+ ARC ADDITIVELY MANUFACTURED 316L STAINLESS STEEL

Primary Author: Sumit Paul, Mechanical Engineering

Co-Author(s)/Collaborators: Rumman Ahsan

Advisor(s): Duckbong Kim

The poster aims at incorporating the dynamic kinetic Monte Carlo (KMC) method with the crystal-plasticity finite-element-modelling (CPFEM) for wire + arc additively manufactured (WAAMed) 316L stainless steel (SS316L). The KMC simulation can predict the grain growth behavior based on the thermal data (e.g. temperature profile and thermal history). Whereas, the CPFEM approach can predict the deformation behavior in response to applied stress based on crystallographic data of the material. For the present work, the time-dependent variation in the spatial domain of heat affected zone (HAZ) and melt pool (MP) is attained from the finite-element thermal simulations and high-dynamic-range (HDR) imaging. These thermal data are used as the input for the KMC model. Later, the crystallographic data obtained from

the KMC analysis is used as the input for the CPFEM to predict tensile deformation behavior of the samples. Once validated, the CPFE model as well as this approach will pioneer the combined application of KMC and CPFEM for WAAM and other additive manufacturing methods.

Graduate

USING MACHINE LEARNING TECHNIQUES TO PREDICT THE DIMENSIONAL CHANGES OF LOW-COST METAL MATERIAL EXTRUSION FABRICATED PARTS

Primary Author: Zhicheng Zhang, Engineering (Ph.D.)

Co-Author(s)/Collaborators: James Femi-Oyetoro

Advisor(s): Ismail Fidan

Additive manufacturing (AM) is a widely used layer-by-layer manufacturing process. However, it is limited by material options, different fabrication defects, and inconsistent part quality. Material extrusion (ME) is the most widely used AM technologies. Thus, it is adopted in this research. Low-cost metal ME is a new AM technology used to fabricate metal composite parts using sintering metal infused filament material. Since the materials and the process are relatively new, there is a need to investigate the dimensional accuracy of low-cost metal ME fabricated parts for real-world applications. Each step of the manufacturing process such as 3D printing of the samples and the sintering will affect the dimensional accuracy significantly. By using several machine learning (ML) algorithms, a comprehensive analysis of dimensional changes of metal samples fabricated by low-cost metal ME process is developed in this research. ML methods can assist researchers in sophisticated pre-manufacturing planning and product quality assessment and control. In this study, single linear regression, linear regression with interactions and neural networks were utilized to assess and predict the dimensional changes of components after 3D printing and sintering process. The prediction outcomes using a neural network performed the best with the highest accuracy among the other ML methods. The findings of this study can help researchers and engineers to predict the dimensional variations and optimize the printing and sintering process parameters to obtain high quality metal parts fabricated by the low-cost ME process.

Undergraduate

DECARBONIZATION OF TRANSPORT SECTOR USING HYDROGEN FUEL – AN OVERVIEW

Primary Author: Ethan Guinn, Engineering Technology

Co-Author(s)/Collaborators: Dillon Cranford; Ryan Benton

Advisor(s): Avinash Paruchuri

The rapid depletion of fossil fuels has triggered the energy sector to explore alternative fuels. Another significant problem projected by the extensive usage of fossil fuels is air pollution. Recent studies have provided the proof that the hydrogen fuel is capable of addressing both the problems stated above by reducing the fossil fuel dependency and the carbon emissions. Transport sector is one of the major industries that employ internal combustion engines which contribute significantly towards the pollution. In this paper, recent developments in the hydrogen fuel research area will be reviewed to study the sustainability of hydrogen fuel to replace the fossil fuels. Material properties of hydrogen that aid the combustion in internal combustion engines will be studied and presented. A variety of manufacturing process used to produce hydrogen will be examined. Hydrogen storage is challenging due it's low density. Hydrogen storage technologies can be broadly divided into the physical storage as gas or liquid, the adsorption of hydrogen onto other materials, and the chemical storage as metal

and chemical hydrides. All the above stated storage techniques will be thoroughly reviewed. Performance of the IC engines primarily depend on the fuel combustion. Combustion performance and efficiency of the hydrogen fueled IC engine will be studied. Emissions from hydrogen fuel combustion will be compared with conventional fuel combustion. The environmental benefits projected by the hydrogen fuel effects the transport sector by reducing the carbon-based emissions. This paper will provide the knowledge and awareness of hydrogen fuel research achieved thus far.

Department of Mechanical Engineering

Graduate

THERMAL AND MECHANICAL INTERACTIONS BETWEEN UTILITY SCALE PV PLANTS AND THE ATMOSPHERIC SURFACE LAYER

Primary Author: Daniel Cannon, Engineering (Ph.D.)

Advisor(s): Ahmad Vaselbehagh

Do large-scale PV plants change the near-ground temperature and the mechanics of the surface layer? The literature is divided on this topic, with some studies claiming that photovoltaic power plants adversely affect the local environment, and some argue otherwise. Arguments have been made that PV plants decrease near-surface temperatures. One such argument states that solar panels convert solar power into electrical power, which is then transmitted away from the environment, thereby removing energy. Another supporting argument suggests that solar panels block the ground's direct view of the sun, decreasing the amount of solar radiation absorbed by the earth during the day and lowering ground temperatures. Others conclude that near-surface temperatures would increase in the presence of a PV plant. For instance, one study found that nighttime ground temperatures were on average 4ºC larger at a PV plant than two nearby urban and desert environments. Computational fluid dynamics (CFD) can offer a better understanding of this problem. I am using CFD to develop a deeper understanding of PV plants' impact on heat and temperature fluxes, atmospheric structure and stability, and wind profiles. My research considers variations in PV plant sizes, tilts, and arrangements. I also investigate changes in the background canopies on which the PV plants are built. My research includes limited field data measurements, required to feed the thermal boundary conditions of my simulations to implement realistic time-dependent boundary conditions. With good field and CFD data, one can produce accurate models to understand interactions between PV plants and their surroundings.

Graduate

SUSTAINABLE WATER VAPORIZATION USING SOLAR HEAT LOCALIZATION THROUGH POROUS MEDIA

Primary Author: Divya Jaladi, Mechanical Engineering

Advisor(s): Ethan Languri

Solar energy utilization for water distillation is considered as one of the sustainable ways to deal with water scarcity and efficient and inexpensive way to make use of solar irradiation. Using heat localization technique with interface material heat losses are minimized. Here, we tested different porosities of carbon foam (CF) and combinations of CF as interface media at different sun solar concentrations, in search of a suitable candidate for use with distillation process. We developed an experimental condition to analyze how the heat localization is achieved in each case and investigated vapor temperatures, surface temperatures with single CF as interface. The rate of evaporation, temperature distribution in each combination is studied and suitable combination is selected to use in further testing of desalination model. Then distillation rates are tested with 30 PPI CF as interface media with seawater and tap water.

Graduate

SOLID OXIDE FUEL CELL COMBUSTOR GAS TURBINE HYBRID POWER SYSTEM FOR COMMERCIAL ELECTRIC AIRCRAFT

Primary Author: Trevor Kramer, Mechanical Engineering

Advisor(s): Rory Roberts

Commercial aviation is a vital part of modern society. In 2018, commercial aviation was responsible for 2.4 percent of the total global carbon dioxide emissions and these numbers are expected to triple by 2050. This percentage seems relatively low, but if the commercial aviation industry was considered a country in the national carbon dioxide emission standings, it would rank sixth in the world. The addition of carbon neutral aviation provides a method to lower the carbon dioxide and greenhouse gas emissions caused by current methods of air travel. The proposed solution is to create an electrically powered aircraft that has a net zero carbon emission, and can match the performance of current commercial aviation. A solid oxide fuel cell combustor gas turbine hybrid system (SOFCC-GT) is a viable option to provide an aircraft with enough power for full operation. SOFCs utilize an onboard hydrocarbon fuel and ambient air to produce electricity through electrochemical reactions and typically operate between 650oC – 850oC. The proposed SOFCC-GT will be capable of generating 24 MW of electrical power for the aircraft. The electrical power will be utilized by the propulsion, avionics, and all other electrical systems used in modern commercial aircraft. To validate the SOFCC-GT system, steady state and transient modeling will be used to simulate the system operation under various flight conditions. Pressurized testing of an SOFCC system will be completed and studied to evaluate the power densities generated by the SOFCs and to increase the fidelity of the system models.

Graduate

COMPARISON OF CLASSIFICATION MACHINE LEARNING ALGORITHMS FOR DAMAGE DETECTION IN SIMULATED TOTAL KNEE REPLACEMENTS

Primary Author: Brandon Miller, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Steven Anton

Advisor(s): Steven Anton

Total knee arthroplasty (TKA) is currently one of the most common surgeries in the United States. While the surgery is generally highly successful, revision due to pain and failure is costly and can have adverse impacts on patient outcomes. The possibility exists to reduce rates of catastrophic failure by early detection of damage in total knee replacements (TKR). Previous work has been done to establish the ability of a structural health monitoring (SHM) technique known as the electromechanical impedance (EMI) method to detect certain types of damage prevalent in TKRs. In this work, 19 simulated TKRs were constructed and artificially damaged, impedance spectrum measurements were taken, and healthy and damaged data was compared to determine if significant differences between these impedance responses exist. The work presented here expands upon this work by exploring classification machine learning (ML) algorithms to translate the differences in impedance responses into discrete damage classes. Recent work has been done to make use of various ML algorithms to process EMI-based SHM data to predict existence, location, and severity of damage in various real-world systems. The goal of this work is to determine ideal classification technique(s) for identifying and classifying damage within the aforementioned TKR systems. To this end, several algorithms will be trained on the aforementioned impedance data, and the results of a k-fold cross-validation scheme will be compared for accuracy, among other common ML performance metrics. A 1-dimensional CNN will also be trained and tested, and the results compared to the more classical ML methods.

Graduate

PREDICTING UNKNOWN FACTS ABOUT FLOW EVENTS USING CONVOLUTIONAL NEURAL NETWORK

Primary Author: Reza Nouri, Engineering (Ph.D.)

Advisor(s): Ahmad Vaselbehagh

We investigate the possibility of using artificial intelligence to deduce information about unobserved upstream or past events in fluid dynamics. To test the hypothesis, we applied an existing convolutional neural network (CNN), namely GoogLeNet, to predict an upstream object's geometry. Square and circle-shaped bluff bodies were placed in a two-dimensional turbulent flow. Downstream data was collected and fed to train the CNN model. Then the downstream velocity signals of a flow over an object that was unknown to the model were used to predict the object's shape. The CNN model's input was the absolute values of the continuous wavelet transform (CWT) of velocity signals recorded in far wake regions downstream. CWT transforms velocity signals to functions of time and frequency called scalograms. The contours associated with these scalograms, obtained for square and circle-shaped geometries, were used as the input to the CNN model. The trained model predicted that the unknown geometry was 93% similar to a square which was an optimistic prediction as the unknown geometry was a square with a missing corner. This remarkable achievement led us to move forward and use the model for real-world phenomena (e.g., optimizing power production of a wind farm using AI). Currently, we are researching a wind farm of three turbines using CFD to evaluate whether the model can predict which turbines are not facing the incoming wind using only the downstream wind farm's velocity field where the flow is thoroughly turbulent.

Graduate

IMPEDANCE-BASED NDE THROUGH INSTRUMENTED FIXTURES; EFFECTS OF CLAMPING FORCE ON DEFECT-DETECTION CAPABILITIES

Primary Author: Peter Oyekola, Engineering (Ph.D.)
Co-Author(s)/Collaborators: Mehedi Barkat; Mohammad Albakri

Advisor(s): Mohammad Albakri

Electromechanical impedance measurements allow for a rapid assessment of structural integrity by providing insights into its dynamic response. Several studies, have shown that electromechanical impedance signatures obtained via directly bonded piezoelectric transducers can be used for non-destructive evaluation of manufactured parts. Indirect electromechanical impedance measurements, through an instrumented testbed, have also been introduced as a promising solution for a rapid evaluation of manufactured parts. While such indirect impedance measurements alleviate the need for individual parts to be instrumented, they increase the complexity of the measurement system. Factors such as fixture design, part-fixture interface, and clamping force are found to impact measurement sensitivity to manufacturing defects and anomalies.

In this study, the effect of clamping force between the instrumented fixture and the part under test on indirect electromechanical impedance measurements is investigated. A steel fixture is instrumented with macro-fiber composite piezoelectric transducers for electromechanical impedance measurement. Clamping force is measured using calibrated strain gauges. Defect-free machined steel blocks (controls) and blocks featuring manufacturing defects are selected as the test specimens. Electromechanical impedance signatures of the specimens are measured using Zurich Instruments MFIA impedance

analyzer and then compared with the signature of the control specimens. Finally, the sensitivity of impedance signatures to manufacturing defects is evaluated at various clamping force levels, and recommendations are presented.

Graduate

NATURAL CONVECTION HEAT TRANSFER ENHANCEMENT BY USE OF FUNCTIONALIZED NANO-DIAMOND (F-ND) IN TRANSFORMER OIL

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

Advisor(s): Ethan Languri

Efficient cooling of transformer becomes an important factor in increasing the lifetime of transformer and reducing the associated maintenance costs. It has been reported that 1 °C decrease in the core would amount to 10% increase in life of transformer. The transformer oil which is a type of mineral oil, commonly used in cooling of transformers has a low thermal conductivity which limits the heat transfer from the core of the transformer to the surroundings. This research focusses on improving the thermal conductivity of transformer oil by adding functionalized nano-diamond (f-ND) particles to it. In this study, enhancement in natural convection heat transfer is studied by using two different concentrations i.e., 0.2 wt.% and 0.4 wt.% of f-ND in transformer oil and compared with the base transformer oil. A tall container insulated from all sides and heated from one side is considered. The experimental results are validated with the theoretical model. The enhancement in heat transfer coefficient for 0.2 wt.% sample was 41.7% and for 0.4 wt.% sample was 82.5%.

Graduate

INVESTIGATION OF COINCIDING ORTHOGONAL TWO-DIMENSIONAL STRUCTURE-BORNE TRAVELING WAVES

Primary Author: William Rogers, Mechanical Engineering (M.S.)

Co-Author(s)/Collaborators: Mohammad Albakri, Tennessee Tech University

Advisor(s): Mohammad Albakri

Inspired by serpentine locomotion in animals, structure-borne traveling waves (SBTWs) have been investigated as means of propulsion in fluids and solid-state motion. SBTW are steady-state waves which propagate across a finite structure. One way to generate SBTWs is by using two-mode excitation. With this method, the structure is mechanically coupled with two actuators that are excited at a common frequency but with a phase difference. Two-mode excitation uses the modal properties of the structure to generate such traveling waves. SBTWs generated using two-mode excitation are designed to propagate along a given direction, normally determined by the location of actuator pair.

This paper investigates the superposition of orthogonally propagating SBTWs for general-planar particle motion in directions that are not aligned with the paired actuators. SBTW are excited using two-mode excitation in a thin plate using macro-fiber composite piezoelectric actuators. This approach allows for only two pairs of actuators to propagate waves across the plate in any direction along its surface. Numerical simulations are conduced to investigate the superposition of SBTW using the Finite Element Method. Several combinations of unidirectional traveling waves are investigated and the efficiency of this approach is evaluated.

Graduate

THE AERODYNAMIC EFFECTS OF A BATTLE-DAMAGED WING

Primary Author: Hollee Sadler, Mechanical Engineering (M.S.)

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The aerodynamic effects of battle-damaged wings were investigated using a six-axis torque sensor in a wind tunnel at low Reynolds numbers. Two 3D printed NACA-4409 wings were used for this study. Both wings had a chord length of 8 inches, with the span of the first wing being six times the chord length and the span of the second wing being three times the chord length. The holes used for the study were 16.67 percent (1.34 inches) and 25 percent (2 inches) of the chord length, respectively. The holes were placed along both the leading and trailing edges to investigate the sensitivity of the wing's aerodynamic performance to the chordwise location of the damage.

Undergraduate

FORCE ANALYSIS OF LEG MUSCLES IN GENUS PANTHERA

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Mimicking biology in mechanical systems, while no longer a new solution to design problems, does indeed allow for innovation compared with traditional design. Biological systems are often highly efficient and can offer engineers a blueprint to create from. For example, members of the genus Panthera, (lions, tigers, leopards, jaguars, and snow leopards), defined here as "big cats", are naturally optimized for speed and power in killing prey. They are apex predators yet still maintain balance and stealth as they hunt. The goal of this project is to analyze the muscular structure of the legs in big cats from a mechanical force analysis. The five big cats will be compared graphically based on average size, food consumption, muscle mass, muscle distribution, relative speed, and strength. Computational algorithms describing the mathematical model of motion of each component of the muscle system will be developed. Variables of interest will be identified and tested, hypothesizing to see what combination of graphed characteristics creates the strongest/fastest/lightest/most fuel-efficient system. This information can then be applied to the design of a machine as a mechanical system prototype inspired by the given characteristics and the basic structure of a big cat's leg.

Undergraduate

DYNAMIC CHARACTERIZATION OF FULLY 3D PRINTED CAPACITIVE SENSORS FOR FOOTBED PRESSURE SENSING APPLICATIONS

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Advisor(s): Steven Anton

Currently, the analysis of an individual's gait and foot pressure distribution is a valuable tool in orthopedics to assist in the diagnosis and treatment of gait disorders. Thanks to the development of pressure sensing insoles, gait and foot pressure distribution analysis has become more common in research focused on human locomotion. Typically, however, insoles containing pressure sensor arrays have limited customizability or are expensive to customize. The lack of affordable, patient-specific solutions can be problematic for patients who require insoles for foot deformities. Past work has been done to

mitigate the lack of customizability of pressure sensing insoles through the use of 3D printing to create insoles with embedded commercial capacitive pressure sensors. The use of 3D printing to build insoles gives rise to the potential to create customized insoles rapidly and at low cost. However, at present, there are no wholly developed methods for integrating fully printed embedded capacitive sensors within pressure sensing insoles. This work focuses on the development and dynamic characterization of fully 3D printed capacitive sensors using Ninjatek's NinjaFlex flexible thermoplastic polyurethane filament and Eel conductive flexible filament through cyclic compressive testing, as well as the creation of a simple analytical model based on mechanics of materials principles and capacitive properties of the sensor. In order to capture the range of possible frequencies the sensor might see, the sensors were tested and evaluated at frequencies of approximately 0.5 Hz to 30 Hz to understand their ability to sense expected footbed pressure distribution.

College of Interdisciplinary Studies

School of Environmental Studies

Undergraduate

THE VALUE OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) FOR DIVERSE PROJECTS AT THE NATURE CONSERVANCY'S BRIDGESTONE RESERVE AT CHESTNUT MOUNTAIN

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Co-Author(s)/Collaborators: Fiona Hayward; Shane Stevens

Advisor(s): Steven Sharp

The use of Geographic Information Systems (GIS) for energy and educational outreach projects The Nature Conservancy's (TNC) Bridgestone Reserve at Chestnut Mountain shows the value of this technology for a range of programs. Starting with a carbon neutrality project, the use of GIS led to an accurate evaluation of solar panel and wind turbine placement by using data to account for hill slope angle, hill direction, wind speed, solar exposure, and other components. This use of geospatial analysis allowed for a cost-effective survey of Chestnut Mountain and helped prevent issues in the future with poor turbine or panel placement. Additionally, GIS was beneficial in an educational outreach project for TNC as well, with application in locating and evaluating eligible private forest landowners for potential TNC-led courses. GIS was also used to create a set of criteria to determine the appropriate audience to receive informational pamphlets that would invite them to forest usage seminars. By using local landowner databases in conjunction with National Land Cover Databases, the GIS team was able to pull 449 applicable parcels from 35,987 total parcels in order to build a targeted curriculum around these landowners. The use of GIS in these two partner projects showcase the versatility of this technology for location analysis as well as educational outreach.

Undergraduate

ACHIEVING CARBON NEUTRALITY AT BRIDGESTONE NATURE RESERVE AT CHESTNUT MOUNTAIN

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We examined options to achieve carbon neutrality at The Nature Conservancy's Bridgestone Nature Reserve at Chestnut Mountain. We conducted a basic energy audit for the primary structure (office), as well as secondary structures, vehicles and power equipment, to determine needed energy efficiency improvements. We concluded that small enhancements, such as adding insulation and replacing appliances, can maximize energy efficiency and reduce carbon footprint. We also contacted outside entities to conduct formal commercial energy audits and provide cost estimates for installing a wind turbine and solar panels. Our final proposal includes estimated cost and timeline of transitioning all facilities and equipment from commercial energy production and fossil fuel use to renewable energy. The use of carbon offsets with forested land is a potential temporary measure to achieve carbon neutrality. Full carbon neutrality can be achieved at this facility through a combination of energy use reduction, renewable energy generation, and allocation of a small piece of forested land for carbon sequestration.

Undergraduate

SUSTAINABILITY IN RURAL AREAS

Primary Author: Charleston Pritchett, Environmental and Sustainability Studies

Advisor(s): David Hajdik

The very infrastructure of rural America is inherently unsustainable. However, there are ways to make everyday life more sustainable in these small towns through recycling, sustainable energy sources, and community involvement. The key is that local governments have to create an incentive to make people want to lead more sustainable lives while making sustainability attainable. According to environmental sustainability experts, the goal would be to create rural areas with a zero waste system. While this may be difficult to achieve, it is not impossible. If local governments implemented accessible public transportation, encouraged sustainable waste practices such as recycling, started take-back plans, and repurposed old buildings with energy efficient utilities, it could create a whole new stream of revenue for the area while saving the local towns and citizens tax money. This all begins with a six step plan for community mobilization with six types of capital: cultural, social, human, economic, physical, and natural. The purpose would be to make improved and sustainable rural areas that benefit the environment and quality of life of those who inhabit them.

Undergraduate

PROVIDING RESOURCES FOR FEMALE FORESTLAND OWNERS

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Co-Author(s)/Collaborators: Caroline Curtis; Jamie Ownby; Kitty Philips; Kyle Evans

Advisor(s): Steven Sharp

Sixty-five percent of forestland in Tennessee is owned by women, either independently or jointly, but few women-focused resources are available. We worked in cooperation with the Tennessee chapter of The Nature Conservancy and developed curricula to provide educational opportunities specifically for women forestland owners. Topics include plant identification, invasive plant eradication and control, watershed and soil ecology, forest management, and estate planning. We also created two databases – one as a repository of forestland management resources, funding opportunities, and stewardship organizations for land owners, and the other to identify landowners of 10-100 acres in the Upper Cumberland. Access to the database of stewardship resources can enable private forest landowners to realize the full potential of their land and the opportunities available, while the database of landowners can be used for advertising the courses created for women. We provided both databases and the curricula to The Nature Conservancy in Tennessee for their use.

Whitson-Hester School of Nursing

Undergraduate

WOULD ANNUAL A1C TESTING DECREASE MORTALITY IN UNDIAGNOSED TYPE 1 DIABETIC CHILDREN?

Primary Author: Alison Bean, Nursing

Advisor(s): Dolores Bowman

Children across the globe are experiencing a life-threatening illness known as diabetic ketoacidosis. Diabetic ketoacidosis, or DKA, is a serious complication of type 1 diabetes that consists of high blood glucose levels (300+ mg/dL), the presence of ketones in the urine, and a low blood pH (metabolic acidosis). According to the MMWR, the rate of hospitalizations due to DKA increased 54.9% between the years of 2009 and 2014; furthermore, the Diabetes Cares Journal states that 22,225 children 17 years old and younger were hospitalized with DKA in 2017. Oftentimes, children experience DKA as the first symptom of type 1 diabetes. This is especially important because if these children do not yet know that they have diabetes, they will not know if their blood glucose levels are high or how to get it down. Consequently, they will go into DKA and may face serious illness unless treated appropriately.

The good news is that DKA is preventable. Through our question, we propose that testing a child's A1C at annual physicals could prevent DKA and death in undiagnosed type 1 diabetics. A1C is a blood test that tests the average amount of glucose that adheres itself to red blood cells over 3-4 months. With this test, we would be able to see if a child has diabetes, and we could correct their blood glucose before they fell into DKA- which could save lives.

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