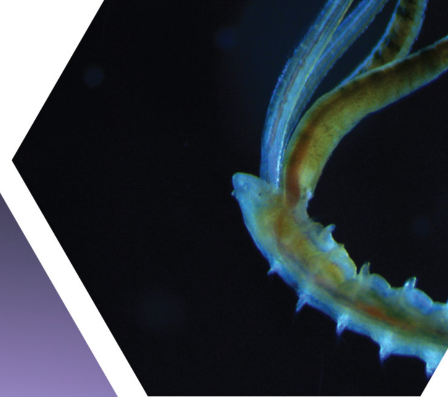
18th Annual

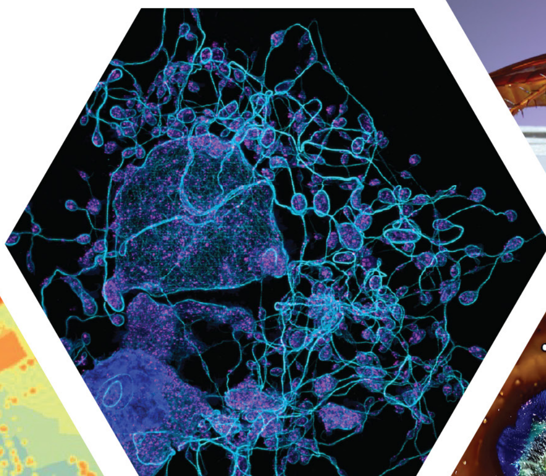
Graduate Student Research Symposium

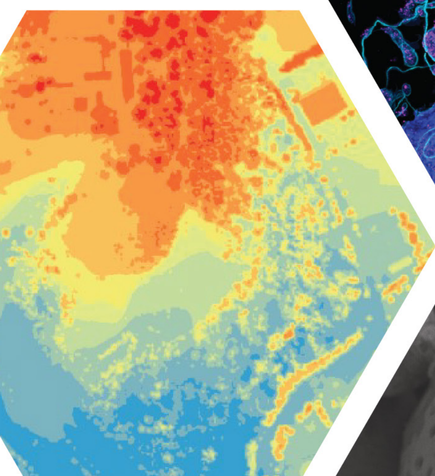
ABSTRACTS

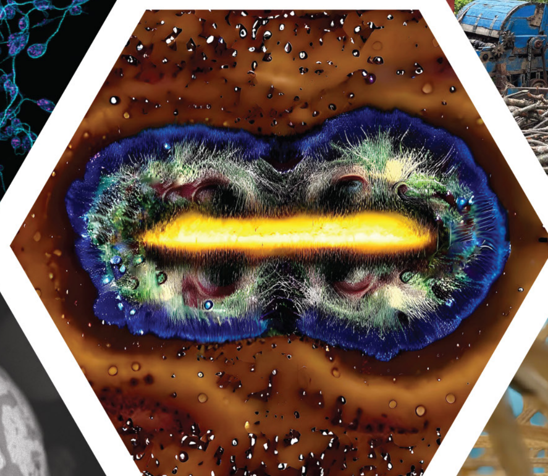


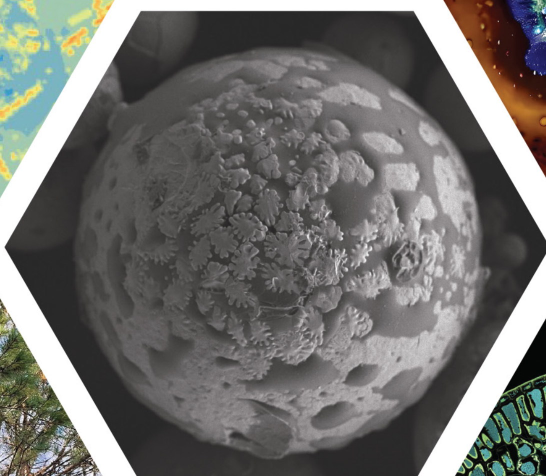
Wednesday, April 2, 2025

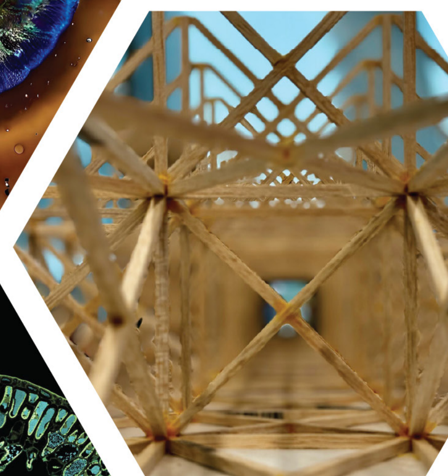
McKimmon Center

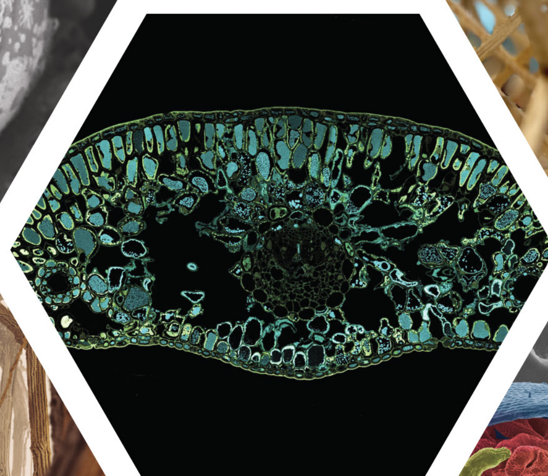


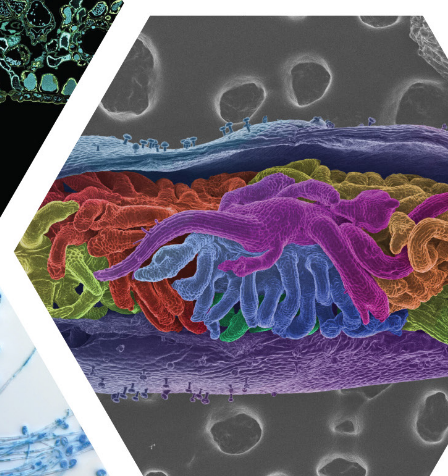


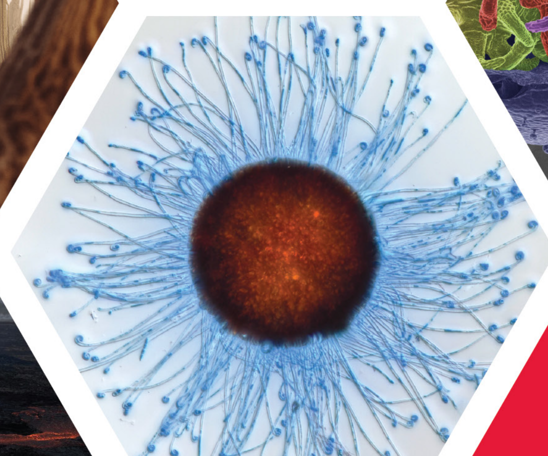












NC STATE UNIVERSITY

18th Annual
Graduate Student Research Symposium
North Carolina State University

ORGANIZERS OF SYMPOSIUM

Graduate School

Dr. David Shafer – Assistant Dean (Primary Organizer and Symposium Lead)
Bridget Foy – Administrative Assistant
Gregory Hedgepeth – Director of Marketing and Communications
Todd Marcks – Fellowship and Grants Administrator
Darren White – Webmaster

Graduate Student Association

Naimul Haque – Forest Biomaterials (GSA VP for Academic Affairs/Symposium Lead)
John Britt – Genetics and Genomics
Veronica Diaz Pacheco – Operations Research
Ashwini Ganesh – Electrical and Computer Engineering
Hope Hairston – Higher Education Administration
Emma Hepworth – Toxicology
Ben Kasierski – Technical Communication
Ian Livengood – Mathematics
Jordyn McCrimmon – Psychology
Kim McKeever – Bioinformatics
Cornelius Ojo – Design
Duc-Huy Pham – Industrial and Systems Engineering
Dushyanth Kumar Tammineni – Food, Bioprocessing, and Nutrition Sciences
Aakash Upadhyay – Forest Biomaterials

Abstract Book Cover

Giuli Hoffmann – Media Arts, Design, and Technology

AGENDA

12:00 - 1:00 p.m.	Poster Set Up (All set up their posters)	Area 1
1:15 -1:30 p.m.	Welcoming Remarks and Symposium Overview Mr. Shubham Rawat, GSA President Dr. Peter Harries, Dean of the Graduate School Dr. David Shafer, Assistant Dean of the Graduate School	Area 1
1:30 - 4:00 p.m.	Poster Session and Competition	Area 1
4:15 -5:30 p.m.	Announcements of Awards and Reception Dr. Peter Harries, Dean of the Graduate School Mr. Shubham Rawat, GSA President Dr. David Shafer, Assistant Dean of the Graduate School	Room 2

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Wilson College of Textiles

ABSTRACTS

College of Agriculture and Life Sciences

Steve Amerige
Graduate Program: Horticultural Science
Advisor: Jing Zhang
Poster Number: 7

A Scalable Framework for Integrating AI and Phenomics in Small Fruit Research

High-throughput plant phenotyping has the potential to revolutionize small fruit breeding by integrating computer vision, predictive analytics, and data visualization. This research bridges horticulture, computer science, and statistics to enhance phenotypic data analysis in small fruits, particularly blueberries and strawberries. We present a framework for a mobile application designed for crop assessment, providing a foundation for future development. The proposed system aims to enable plant breeders, researchers, and growers to collect and analyze phenotypic data efficiently. It is designed as an extensible framework capable of integrating multiple data sources, including images, geospatial and environmental data, and user-entered notes. This study focuses on the conceptual design and technical consideration of the application, addressing key challenges such as lossless data compression for efficient storage, synchronization algorithms for merging offline and online datasets, and interactive visualization tools for exploring high-dimensional data. By integrating AI-driven feature extraction with statistical modeling, this framework lays the groundwork for delivering actionable insights to breeders and farmers, facilitating data-driven decision-making and accelerating breeding cycles. By presenting this framework, we contribute to the field of phenomics by outlining a scalable approach to integrating diverse datasets and computational tools. Future work will focus on implementing and testing the proposed features to realize the full potential of this system.

Ajinkya Atkare, Jonathan Allen, and Minliang Yang
Graduate Program: Food, Bioprocessing and Nutrition Sciences
Advisor: Minliang Yang
Poster Number: 10

Comparative Environmental Sustainability of Animal-source Foods via Nutrition-based Life-cycle Assessment (nLCA)

Introduction: Many studies have been conducted to understand the environmental impact of animal-source foods via life-cycle assessment (LCA). However, prior LCA studies heavily focused on quantifying footprints based on mass or volume of product with limited emphasis on nutritional value. Animal source foods play an important role in providing nutrients for human health. Thus, it's critical to incorporate nutrition and environmental impacts into one metric to better understand the sustainability of foods.

Methods: The study involves assessing nutritionally based environmental impacts for various animal-source foods (beef steak, beef sausage, pork ham, pork bacon, and pork sausage) via a nutrition-based life-cycle assessment (nLCA) method. Farm-to-factory gate LCA models of each animal source food were developed, and the corresponding life-cycle environmental impacts were calculated using SimaPro and R. A nutritional LCA (nLCA) model was further built to calculate the nutritional environmental footprint (NEF) on a scale of 1 to 5 by giving equal weight to both nutritional and environmental footprint. A product having lowest NEF result is considered the best among the products compared. NEF is calculated per serving, per 100 kcal supplied and per 50g protein provided by pork and beef products.

Results: Overall, global warming potential for pork products (4.4 kg CO2e/kg of pork sausage, 4.8 kg CO2e/kg of ham and 4.9 kg CO2e/kg of bacon) is lower than beef products (32.4-34.7 kg CO2e/kg of beef sausage and 32.2-34.5 kg CO2e/kg of steak). The cattle production stage is the highest contributor to GHG emissions as well as other environmental impacts. As far as NEF is considered, it is the lowest for pork ham and highest for beef steak. The difference in NEF score among products changes depending on the selection of functional unit (per serving, per 50 g protein or per 100 kcal energy).

M. Bahr[1], A. McCarty[1], M. Poore[1], D. Smith[2], K. Pohler[2], C. Maltecca[1], and F.A.C.C. Silva[1]
Graduate Programs and Institutions: Animal Science[1]; Texas A&M University, College Station[2]
Advisor: Felipe A.C.C. Silva
Poster Number: 12

Feeding Rumen-inert Unsaturated Fatty Acids and Rumen-protected Choline Modulated Interferon Signaling, Fatty Acid Metabolism, and Cell Organization Pathways in Uterine Luminal Epithelial of Pregnant Multiparous Beef Cows

Early embryonic mortality is a major concern to the beef industry, as nearly 32.3% of multiparous cows will not maintain pregnancy past the first sixteen days of gestation. During this period, the uterine environment provides nutrients to support embryonic growth and development. Therefore, our objective was to modulate the uterine environment sixteen days after breeding in pregnant cows receiving a targeted dietary supplementation to support embryonic development. One hundred multiparous Bos taurus cows were weighed, body condition recorded, and stratified to be allocated in pens. Cows were acclimated to the individual feeding system for 15 days. On d -30, cows within pens were randomly assigned to receive either TARG) 100 g of a rumen-inert mono- and polyunsaturated fatty acid source plus 60 g of a rumen-protected choline source or CON) 114 g of a saturated fatty acid source. Treatments were top-dressed daily into a similar total mixed ration. Starting on d -10, all cows were synchronized using the 7-day CO-synch + CIDR protocol. On d 0, ovarian ultrasonography was conducted, and cows were bred by TAI by the same technician. On d 16, blood collection was performed to analyze the concentration of progesterone (P4), and a subset of cows were subjected to a cytobrush collection to harvest uterine luminal epithelial cells for further RNA extraction and RNA-seq (TARG = 7 and CON = 6). Functional enrichment analyses were performed using Ingenuity Pathway Analysis. The fixed effects of treatment, group, and their interactions on P4 were analyzed by ANOVA. There were no differences in P4 at d 16 ($P = 0.23$). There were 418 differentially expressed genes (FDR ≤ 0.05) between treatments, where 379 genes were upregulated, and 39 genes were downregulated in TARG. In conclusion, the dietary supplementation provided herein modulated the uterine environment and fertility outcomes deserve further investigation.

Brynna Bruxellas[1], Robert Austin[1], Susana Milla-Lewis[1], James Kerns[2], and Qiyu Zhou[1]
Graduate Programs: Crop and Soil Sciences[1]; Entomology and Plant Pathology[2]
Advisors: Robert Austin and Susana Milla-Lewis
Poster Number: 23

Phenotypic Evaluation of Turfgrass using UAVs, Machine Learning, and Deep Learning

In turfgrass, the third-most grown crop in the U.S., phenotypic traits are measured and compared to evaluate the progeny from crosses. The phenotypic characteristics are assessed by assigning a numeric score to observable traits such as leaf color, disease presence, or drought tolerance. These scores guide breeding decisions, plant selection, and improvement. However, there are inherent challenges in this approach due to the low-throughput nature of manual ratings, bias from rater preference, and uncertainty resulting from changing environmental conditions such as time of day and cloudiness. The current system is limited in both reproducibility and scalability.

Pairing imagery captured from Unmanned Aerial Vehicles (UAVs) with emerging methods in machine and deep learning has the potential to change how plant breeders assess phenotypic traits in turfgrass. Imagery collected from drones provides an unbiased assessment of plant characteristics that is highly scalable and high-throughput. Additionally, the relatively low cost and ease of image acquisition, along with greater temporal resolution results in a method with reduced labor costs, increased data acquisition, and the potential to increase breeding efficiency.

Turfgrass quality ratings were collected alongside UAV imagery from two research stations and three commercial sod farms, covering four warm-season turfgrass species (Bermuda, Saint Augustine, Centipede, and Zoysia). Low-altitude true-color and multispectral imagery were also captured. Models paired UAV imagery with turf quality ratings, demonstrating that deep learning and machine learning models show significant potential. This Artificial Intelligence approach could revolutionize phenotypic trait assessment by freeing plant breeding programs from the burdensome task of manual, phenotypic ratings. By integrating UAV imagery with advanced machine learning techniques, raters can spend more time analyzing results to help meet stakeholder needs and enhance agricultural sustainability.

Asa Budnick, Delecia Utley, and Heike Sederoff
Graduate Program: Plant Biology
Advisor: Heike Sederoff
Poster Number: 24

Network Analysis of Circular and Linear RNAs in Lotusjaponicus Symbiosis

Plant-microbe symbiosis increases the plant's ability to acquire limiting nutrients. Understanding the genetic regulation of plant-microbe symbiosis can offer strategies to improve agricultural sustainability. Recently, endogenous circular RNAs have been implicated as important gene regulatory molecules. We used the symbiosis model plant Lotus japonicus in an experiment with rhizobial bacteria and arbuscular mycorrhizal fungi to elucidate the role of circular RNAs in transcriptional and post-transcriptional regulation of genes. Deep sequencing of ribosomal RNA-depleted Total RNA (~100M Reads/Sample) yielded a comprehensive view of both linear and circular RNAs. This dataset includes mRNA, long-noncoding RNA, and over 20,000 unique circRNAs.

Circular RNAs contribute to the regulation of genes through a variety of mechanisms. Here we focus on post-transcriptional regulation of RNA-stability through miRNA sponging. Circular RNAs can also contribute to RNA-stability by acting as competing endogenous RNAs (ceRNAs) - binding miRNAs and thereby protecting the miRNAs other RNA targets from degradation. In L. japonicus, we identified circRNAs with putative miRNA Recognition Elements and constructed a network of miRNA:circRNA:mRNA targeting to identify circRNAs which may act as ceRNAs and affect symbiosis gene regulation.

Soumi Chandra[1], Roderick M. Rejesus[1], and Chito Yorobe[2]
Graduate Programs and Institutions: Agricultural and Resource Economics[1]; Economics and Management, University of the Philippines at Los Banos[2]
Advisor: Roderick M. Rejesus
Poster Number: 30

Can Alternate Wetting and Drying (AWD) Save Water Without Reducing Rice Yields?

Water scarcity challenges rice farmers, as traditional cultivation requires continuous flooding. Alternate Wetting and Drying (AWD) is a water-saving technique where fields dry intermittently instead of remaining submerged. This method allows fields to be "non-flooded" for 1 to over 10 days before re-irrigation. AWD ensures rice roots receive sufficient water from initial flooding, even without visible ponded water. By reducing water use while maintaining yields, AWD offers a sustainable alternative to traditional irrigation, helping farmers adapt to water shortages in major rice-producing regions.

The literature shows AWD saves water, but its effects on yield and profitability are mixed. Early studies in the Philippines, based on pump irrigation, found significant water savings but no yield or profit changes. Later studies in gravity-based irrigation systems reported both water savings and increased yields and profits. Our study examines AWD in a large gravity-based system in the Philippines, using a Random Encouragement Design and a two-year panel for a DiD analysis. Unlike prior studies relying on simple mean comparisons, our approach better addresses bias from unobserved confounders. Additionally, we analyze heterogeneous AWD impacts across upstream, midstream, and downstream farmers.

We find strong positive impacts on water savings and no penalty in terms of rice yields, with more pronounced water saving effects for midstream farmers. These findings suggest that AWD training and encouragement by irrigation authorities (or other rice extension institutions in the Philippines) has the potential to increase water use efficiency in large gravity-based irrigation systems.

A random encouragement design(RED) was implemented to estimate the impact of AWD on water savings and rice yields. The first year data was collected in May/June 2016. We then implemented the intervention by exposing the randomly selected 'treatment' farmers to AWD through trainings and information sessions to strongly encourage AWD for the upcoming dry season (2016/2017). After the intervention, farmers in the region then proceeded with producing rice in their fields from December 2016 until March/April 2017. Follow-up (second year) data from both 'control' and 'treatment' farmers were then collected during May/June 2017. The final dataset had 404 control and 406 randomly AWD encouraged farmers.

A potential empirical specification to estimate the impact of AWD exposure on outcomes of interest can then be expressed as follows:

$\Delta Yi = \beta 1 + \beta 2 Encouragei + \Delta \upsilon i$

where deltas (Δs) represent the difference between a variable pre and post intervention (i.e. AWD encouragement). It is important to mention here that there was no "forced" implementation of AWD at any levels. Hence, not all farmers who were encouraged AWD not necessarily adopted AWD.

Kimberley Cheatham
Graduate Program: Agricultural and Extension Education
Advisor: Annie Hardison-Moody
Poster Number: 31

Exploring the Motivations of 4-H Extension Agents to Enter the Field as a Youth Service Professional

The NC Cooperative Extension 4-H program has consistently provided youth development programming that promotes agricultural education, experiential learning, and service to the community. 4-H Extension Agents serve as the backbone of the youth development programs, designing and delivering tailored, educational experiences that empower young people to grow, lead, and actively engage in their communities. While extensive literature examines program development, implementation, and evaluation, less is known about the motivations of those who choose careers in youth development – particularly within 4-H Extension. Given the high turnover rates in the out-of-school time profession and the number of youths that do not participate in formal out-of-school time activities, understanding the motivations of youth development professionals is critical. This qualitative study explores the motivations of 4-H Extension Agents in North Carolina in pursuing a career in Extension. Using convenience sampling, nine agents across the five Extension districts were interviewed about their prior knowledge of 4-H/Extension, previous employment experiences, alignment between their personal vision for their program and the organization's, rewarding aspects of their work, and how their role supports their long-term career goals. Findings indicated that agents were motivated by an intrinsic desire to support youth in developing essential skills, a passion for creating programs that address community needs, and a strong connection to their alma mater – one of the two land grant institutions in NC. These insights highlight the importance of understanding motivation among youth development professionals, given the need for more individuals in these roles and the lasting, positive impact they have on youth and their communities.

Dionata (John) Filippi[1], Luke Gatiboni[1], Deanna L. Osmond[1], David H. Hardy[2], Rachel Vann[1], and Stephanie Kulesza[1]
Graduate Programs and Institutions: Crop and Soil Sciences[1]; North Carolina Department of Agriculture, Raleigh, NC[2]
Advisor: Luke Gatiboni
Poster Number: 54

A High Soil P Content Does Not Increase the Net Return Per Acre of Corn and Soybeans in North Carolina

Phosphorus (P) is essential for achieving optimal corn and soybean yields. For this reason, P fertilization must be optimized to maintain soil P levels near the recommended critical index of 50 for North Carolina, ensuring profitability and minimizing extra input costs. This study calculated the net return per acre of soybean and corn considering different phosphorus indexes in the soil in three long-term trials in NC at the Piedmont, Coastal Plain, and Tidewater regions. Corn and soybeans were cultivated during 2022, 2023, and 2024. Across each trial, P application rates ranged from 0 to 120 lb/ac of P2O5 to create a gradient of the P index in the soil. The grain budget was calculated using information available from Agricultural and Resource Economics NCSU. The net return per acre was obtained from the gross receipt (yield receipt) minus variable and fixed costs. Results showed that net return per acre increased linearly with crop yield, peaking at the P index critical level, beyond which no further gains were observed. The net return of $411/acre was obtained with P-I 12 at the Piedmont site; $61/acre with P-I 29 at the Coastal Plain site; and $358/acre for soybeans and $54/acre for corn with P-I 44 at the Tidewater site. NC farmers do not need a high P-I in the soil to increase the net return of corn and soybeans. Other factors such as water or genetics may limit yield potential if P and other nutrients are not limited. Revising the recommendations could lead to better cost-effective fertilization practices, reducing the risk of over-fertilization, and minimizing soil buildup to protect water quality.

Jade M. Fluharty, Linlin Ma, Brenna M. Zimmer, Joseph J. Barycki, and Melanie A. Simpson
Graduate Program: Molecular and Structural Biochemistry
Advisor: Melanie A. Simpson
Poster Number: 58

Dissecting the Transcriptomic Impacts of UDP-Glucose Dehydrogenase Activity in Prostate Cancer

Nucleotide sugar metabolism promotes cancer metastasis through its roles in glucuronidation, hyaluronan production, and glycosaminoglycan biosynthesis. These processes rely on uridine diphosphate (UDP)-glucose dehydrogenase (UGDH), which functions as a dynamic sensor to integrate the cellular metabolic needs with UDP-GlcA priority. Due to the tight regulation of UDP-GlcA availability, UGDH prioritization can influence downstream canonical and noncanonical signaling pathways to promote tumorigenesis. Previous research in our lab has found that UGDH is an androgen-stimulated gene product and its elevated expression prioritizes glycosaminoglycan biosynthesis for tumor-promoting extracellular matrix and cell surface components. However, the loss of androgen-stimulated UGDH disrupts androgen-glucuronide secretion through glucuronidation and leads to reduced cellular proliferation rates in androgen-dependent (AD) prostate cancer cells. As the only known enzyme who produces UDP-GlcA, UGDH serves as a potential target option for regulation of these key metabolic processes in prostate cancer. This research examines the transcriptomic impacts of UGDH expression in androgen-sensitive and castration-resistant prostate cancer. Using bulk RNA-sequencing, we compared differentially expressed genes in AD cells with UGDH knockdown and overexpression. RNA expression patterns align with known growth control pathways involving glucuronidation and androgen response, coinciding with protein-level expression. Additionally, RNA-sequencing analysis allowed for the identification of several differentially expressed transcripts positively correlated with UGDH expression. Further analysis will elucidate key transcript- or protein-level regulatory mechanisms linked to UGDH activity in prostate cancer.

Grace Fuller[1], Daniel Barletta Sulis[2], Matthew Neubauer[2], Jack Wang[2], and Rodolphe Barrangou[1]
Graduate Programs: Genetics[1]; Forestry and Environmental Resources[2]
Advisor: Rodolphe Barrangou
Poster Number: 62

Advancing Genome Editing Tools for Precision Breeding in Eucalyptus

The development of CRISPR as a genome editing tool revolutionized biotechnology, with CRISPR-Cas9 emerging as the first widely adopted system. Since then, extensive mining efforts have identified diverse CRISPR-Cas systems with advantages over Cas9. Among them, CRISPR-Cas12a stands out as a Class 2 single-protein effector with simplified guide RNA requirements, AT-rich PAM compatibility, and the ability to generate staggered cuts, enhancing homologous recombination and editing precision. Additionally, Cas12a functions efficiently across a broader temperature range and exhibits reduced off-target effects, making it an ideal candidate for genome editing in plant species. Recent work leveraged metagenomic mining of the cow gut microbiome to identify and characterize five novel Cas12a effectors with potentially improved efficiency over the canonical LbCas12a. Given the economic and ecological significance of Eucalyptus spp., optimizing gene editing tools for these species is essential. This work aims to evaluate the efficiency, specificity, and editing outcomes of these five novel Cas12a effectors in Eucalyptus spp. protoplasts. Findings will provide valuable insights into the suitability of novel Cas12a effectors for tree genome engineering, paving the way for enhanced precision breeding in Eucalyptus spp. and other forestry species.

Victoria Geniac[1], Donald L. Wright[2], Scott A. Bowdridge[3], and Andrew R. Weaver[4]
Graduate Programs and Institutions: Animal Science; Southwest Agricultural Research and Extension Center; Animal and Nutritional Sciences, West Virginia University
Advisor: Andrew R. Weaver
Poster Number: 67

Effect of Copper Oxide Wire Particles on Parasitism and Growth in Katahdin Lambs Divergently Selected for Fecal Egg Count Estimated Breeding Value: Year 2

Gastrointestinal nematodes (GIN) pose a significant threat to the sheep industry. The objective of this project was to evaluate the effects of copper oxide wire particles (COWP) and selection for fecal egg count (FEC) estimated breeding values (EBV) on GIN infection and growth in Katahdin lambs. 39 Katahdin ram lambs selected for high FEC EBV (HFEC) or low FEC EBV (LFEC) were managed on pasture as one contemporary group at the Southwest Virginia Agricultural Research and Extension Center (Glade Spring, VA). Lambs were three-way dewormed at weaning (June 13). Week 0 of the project (July 17th), lambs were administered 5,000 L3 Haemonchus contortus. Packed cell volume (PCV), FEC, FAMACHA scores, and body weights were collected bi-weekly for 16 weeks. Lambs were randomly selected to receive 2g COWP boluses at weeks 4, 8, and 12 (HFEC-COWP, n = 10; LFEC-COWP, n =10) or to serve as the control (HFEC-Con, n = 9; LFEC-Con, n = 10). Additional fecal samples were collected on weeks 4, 8, and 12 for coproculture. FEC data were log transformed for normality and statistical analyses were performed using PROC Mixed Procedure with repeated measures in SAS (SAS Institute, Cary, NC). COWP treatment had no effect on FEC ($P = 0.13$), FAMACHA ($P = 0.38$), or overall ADG ($P = 0.78$). COWP-treated lambs had lower PCV compared to control lambs (29.1% vs. 30.7%, respectively; $P < 0.05$). FEC was lower in LFEC lambs than in HFEC lambs (1015 vs. 1853 eggs/g, respectively; $P < 0.01$) but genotype had no effect on FAMACHA score, PCV or overall ADG ($P = 0.35$, $P = 0.52$ and $P = 0.42$, respectively). COWP did not alter infection level, however selection for LFEC can help mitigate the effects of GIN and should be considered with additional tools to control parasite burden in sheep.

Vamery González Hernández[1], Augustin Engman[2], and Alonso Ramírez[1]
Graduate Programs and Institutions: Applied Ecology[1]; School of Natural Resources, University of Tennessee[2]
Advisor: Alonso Ramírez
Poster Number: 70

Macroinvertebrate Assemblages in a Tropical Urban River, Puerto Rico: Diversity, Temporal Variability, and Effects of Non-native Fishes

Stream ecosystems in Puerto Rico have flashy hydrologies that favor native species, rather than the expected non-native ones. However, a drought allowed Red Devil cichlids to become dominant in the main urban watershed in the San Juan Metropolitan Area. We assessed macroinvertebrate assemblage composition and structure to understand potential changes due to the presence of non-native fish populations. Three sites along the Rio Piedras main stem were selected and two reaches were delimited (control and fish manipulation) in each site. We sampled macroinvertebrates, chlorophyll, and benthic organic matter at each reach before and two months after the removal of non-native fishes in the manipulation reach. Benthic macroinvertebrate assemblages were dominated by Chironomidae (Diptera), followed by three genera of mayflies, one snail, and worms. Overall, 67 taxa were found in the Rio Piedras. Macroinvertebrate abundance reflected changes in hydrology. Our March sampling coincided with a rainy period, while June with a dry spell. Macroinvertebrate abundance was low during March and highest in June. Non-native fish removal had no effects on macroinvertebrate abundance and biomass. However, ordination analysis highlighted differences in assemblage composition and structure between control and fish removal. Differences were related to changes in the dominant groups of Chironomidae in the Upper and Middle reaches, while Americabaetis (Ephemeroptera) became dominant in the Lower reach. Overall, our study highlights the importance of short life cycles as a strategy for macroinvertebrates inhabiting this tropical urban river. Although fish effects were relatively minor, the presence of red devils has a significant impact on the structure of benthic communities.

Alexa R. Gormley[1], Zixiao Deng[1], Brock Ashburn[2], Robert Bryant[3], and Sung Woo Kim[1]
Graduate Programs and Institutions: Animal Science[1]; Highland Brewing Company, Asheville, NC[2]; Warren Wilson College, Swannanoa, NC[3]
Poster Number: 71

Effect of a Trub, Hops, and Yeast Mixture on Jejunal Mucosal Immune Status, Oxidative Stress Status, Structure, and Growth Performance of Nursery Pigs

A trub, hops, and yeast mixture (THYM) derived from the production of craft beer contains high levels of hop acids and yeast cells, and a comparable nutritive value to traditional feedstuffs. The purpose of this study was to investigate the effects of increasing levels of THYM (Highland Brewing, Asheville, NC, USA) in diets for nursery pigs on the jejunal mucosal immune and oxidative stress status, jejunal structure and repair, and growth performance. Thirty-two newly weaned pigs (6.8 ± 0.3 kg body weight) were allotted into 4 dietary treatments, using a randomized complete block design. The dietary treatment was the increasing levels of THYM (0.0, 0.7, 1.4, and 2.1%). The THYM replaced a mixture of 40% corn and 60% soybean meal in the basal diets. Pigs were fed for 28 d in 3 phases (9, 11, and 8 d, respectively). On d 28, all pigs were euthanized for sampling of jejunal tissue and mucosa for further analysis. Increasing levels of THYM linearly increased ($P < 0.05$) gain to feed ratio of pigs, whereas average daily gain and feed intake were not affected. Increasing levels of THYM linearly increased ($P < 0.05$) the relative gene expression of interferon-γ but did not affect the amount of inflammatory cytokines, immunoglobulins, or oxidative damage products in the jejunal mucosa. The increasing levels of THYM linearly increased ($P < 0.05$) the percentage of Ki-67+ cells in the crypt, whereas villus height and crypt depth were not affected. In conclusion, a trubs, hops, and yeast mixture obtained from craft beer production improved feed efficiency of nursery pigs that may be related to the increased interferon-γ in the jejunal tissue, causing activation of intestinal stem cells to proliferate in the jejunal crypt. Increased turnover of jejunal enterocytes may potentially increase nutrient absorption and utilization, thereby enhancing feed efficiency.

Aakilah S. Hernandez and Christian Maltecca
Graduate Program: Animal Science
Advisor: Christian Maltecca
Poster Number: 78

Investigating Gut Microbial Differences in Lactating Sows Across Physiological Stages

Sow health is especially vital to the agricultural industry because of their ability to have significant influences on productivity through their moderate litter sizes. Previous research on the gut microbiome as a health predictor illustrated healthy and stable microbial communities fare better than those with dysbiosis which then later resulted in disorders. These production setbacks have increased maintenance costs and decreased facility efficiency. So far, minimal studies have discussed the relationship with pregnant sows and the transition their microbiome experiences during and after gestation. The objective of this study is to profile gut microbial changes before and after farrowing and highlight key differences. A total of 1,000 multiparous crossbred sows (Landrace x Large White) were selected for 16S sequencing of fecal microbial samples. Samples were collected at four physiological points: Pre-Farrowing, Farrowing, Post-Farrowing 1, and Post-Farrowing 2. A linear mixed effects model was used to test significance on physiological stage on alpha diversity. Between the four stages, there was a significant difference in alpha diversity, except between post-farrowing 1 and post-farrowing 2. Physiological stage also significantly influenced community structure (beta diversity) of gut microbiota with each stage displaying different clustering. These results suggest different bacterial communities aiding in sow health at certain stages of gestation. More research needs to be done to recognize which communities are most prevalent and determine the implications of utilizing these communities for maintaining sow health.

Arina Hidayati[1], Suzanne D. Johanningsmeier[2], Fred Breidt[2], and Matthew Allan[2]
Graduate Programs and Institutions: Food Science[1]; U.S. Department of Agriculture, Agricultural Research Service, Southeast Area, Food Science and Market Quality & Handling Research Unit[2]
Advisor: Suzanne D. Johanningsmeier
Poster Number: 79

Development of Reduced-Sodium Pickled Vegetables for Healthy-Labeled Consumer Products

The global market size for pickles in 2024 was $14.38 billion and is projected to grow in 2025. In the U.S., over 67% of households consume pickles. Developing ‘healthy-labeled pickles’ potentially expands the market and product variety. Reducing sodium in pickles to ≤10% DV/serving would be required for compliance with FDA ‘healthy’ labeling guidance. This research investigated the effect of lowering sodium on product safety and quality. Cut asparagus, baby carrot, and whole cucumber were pickled for 21 days at 28°C using fermentation (inoculated with Lactiplantibacillus pentosus LA0445) or direct acidification treatments using three sodium chloride (NaCl) levels (0.4%, 0.9%, and 1.9%). Brine and vegetable pHs were monitored for the acid penetration study. Fermentation brines were sampled on days 0,3, 7, 14, and 21 for sugars and organic acids analysis. Pickled vegetables’ firmness values were measured using a texture analyzer and color was analyzed with a spectrophotometer. Fermented vegetables reached a pH below 4.6 by day 2, while acidified vegetables were below 4.6 after pasteurization at all salt levels. Equilibration times for fermented asparagus, carrot, and cucumber were 3,4, and 7 days; while acidified vegetables equilibrated within 1 day of pasteurization. Fermented asparagus and cucumber had residual sugars 3.5 and 5.7 mM while the fermented carrot had 37 mM. Lactic acid concentration in fermented asparagus, carrot, and cucumber were 114 mM, 186 mM, and 138 mM respectively. Pickling treatments and salt concentrations had no significant impact on carrot and cucumber textures. In contrast, the shoot tip portion of the asparagus fermented in 1.9% NaCl were firmer than the acidified treatment ($p < 0.05$). Color intensity was generally higher in acidified cucumber and asparagus compared to the fermented treatments. This research demonstrates the potential for development of reduced-sodium fermented or acidified pickled vegetables with retained texture and color and adequate acidification.

Blake Horton[1], Joseph Tolsma[1], Kanjana Laosuntisuk[1], Jacob Torres[3], Jeff Richards[3], Nicholas Deason[4], Jose Pruneda-Paz[4], Imara Y. Perera[2], and Colleen J. Doherty[1]
Graduate Programs and Institutions: Biochemistry[1]; Plant and Microbial Biology[2]; LASSO, Kennedy Space Center[3]; Biological Sciences, University of California San Diego[4]
Advisor: Colleen J. Doherty
Poster Number: 82

Simulated Microgravity Disrupts Circadian Rhythms in Arabidopsis Thaliana

Understanding plant growth in altered gravity will be crucial for future long-term spaceflight. Despite decades of growing plants in space, little is known about the molecular effects of altered gravity on plant growth. In spaceflight fluid dynamics may be altered due to microgravity, potentially disrupting biological processes. One such biological process may be the circadian clock, a network of transcriptional and translational feedback loops responsible for the precise coordination of a plant's internal biological and molecular processes with its external environment. Coordinating environmental responses to the 24-hour day/night cycle is necessary for optimal performance in plants and humans.

To examine the effect of microgravity on the circadian clock, we utilized the Random Positioning Machine (RPM) to simulate microgravity. Control and RPM-grown Arabidopsis seedlings were collected every 2 hours for 48 hours. Shoot tissue from each time point was used for transcriptional analysis to observe the effect of microgravity on the core circadian clock as well as downstream circadian-regulated genes.

This RNA-seq analysis provides a comprehensive observation of the molecular effects of the plant response to microgravity. Analysis of rhythmic genes in both 1g as well as simulated microgravity shows a disruption in core circadian clock components in both the morning and evening complexes. Consequently, downstream circadian-regulated genes also show disrupted rhythmic expression. This work demonstrates that microgravity impacts the internal circadian clock, and emphasizes the need for further research of these effects for future long-term spaceflight missions.

Aliyah Warris Jackson[1], Virginia M. Moore[2], Chris Reberg-Horton[1], Steven B. Mirsky[3], and Ramon Leon[1]
Graduate Programs and Institutions: Crop Science[1]; Integrative Plant Science/Plant Breeding and Genetics Section, Cornell University[2]; U.S. Department of Agriculture, Agricultural Research Service, Beltsville, MD[3]
Advisor: Ramon G. Leon
Poster Number: 181

Differential Germination and Seedling Growth Response of Weed Species to Allelochemical Toxicity in Vitro

Cereal rye (Secale cereale L.) is widely utilized as a cover crop due to its ability to improve soil health and suppress weed growth through allelopathy. Allelopathy refers to the production and release of chemicals from root exudates that damage seedling tissues, thereby restraining the emergence and growth of nearby weeds. However, the impact of allelopathic compounds on the germination of weed seeds with varying levels of vigor remains insufficiently studied. This research examined the allelopathic effects of cereal rye on the germination of Palmer amaranth (Amaranthus palmeri L.), crabgrass (Digitaria sanguinalis L.), giant foxtail (Setaria faberi Herrm.), and lettuce (Lactuca sativa L.). Seeds were germinated in vitro on media containing allelochemicals from cereal rye roots with differing allelopathic activity, ranging from high to low. In addition, seeds were subjected to accelerated aging to modify their vigor. The results indicated a 31% reduction in total germination for aged seeds compared to non-aged seeds. The suppression of germination due to allelopathic compounds differed across species. Setaria faberi displayed a hormetic response to low allelopathy levels, with a greater than 20% increase in germination compared to untreated seeds. Digitaria sanguinalis showed no significant response to seed aging, while the high allelopathy treatment caused a minor (less than 10%) reduction in germination. Amaranthus palmeri demonstrated the highest total germination and was unaffected by both aging and allelopathy. Seed aging had a more pronounced negative effect on germination rate, with allelopathy having a lesser effect. These results suggest that incorporating allelopathic cereal rye varieties into crop rotation systems could be a valuable strategy for weed suppression. However, the age structure of the seed bank may affect the efficacy of allelopathic compounds in inhibiting weed seedling emergence.

Caitlin Kestell[1], Ralph Dewey[1], Josh Strable[2], William Smith,[1] and Carol Griffin[1]
Graduate Programs: Crop and Soil Sciences[1]; Molecular and Structural Biochemistry[2]
Advisor: Ralph Dewey
Poster Number: 93

Seedless Fruits Through Mitochondrial Genome Editing

We are utilizing a novel genome editing technology that targets the mitochondrial, rather than nuclear, genome to test the consequences of eliminating gene function from the organelle after the gene has been repurposed to function as a nuclear gene. While investigating the consequences of eliminating the function of the essential mitochondrial atp1 gene in a background containing an ATP1 reading frame adapted to function in the nucleus under the control of the widely used CaMV 35S promoter, we discovered that two novel traits of interest were manifest: (1) a pollen sterility phenotype; and (2) a seedless fruit phenotype. Both of these traits have tremendous agronomic potential. The 35S CaMV promoter is not expressed at high enough levels during pollen formation for the 35S:nATP1 construct to compensate for the missing atp1 gene. In addition, CaMV 35S appears to be minimally expressed during seed development. Our initial results were recently published (Front. Plant Sci. 14:1253640, https://doi.org/10.3389/fpls.2023.1253640).

Consumers have shown a marked preference for seedlessness in many of the fruits and vegetables we enjoy. Nevertheless, there remain several commodities for which no seedless options are available. Caneberries (raspberries and blackberries) and muscadine grapes are examples of fruits that are important to the state of North Carolina, for which there are no seedless varieties on the market. The seedless fruit trait observed is akin to that found in seedless watermelons (small, soft underdeveloped seeds). Our strategy has the potential to develop seedless versions of fruit species for which seedless options are currently not available. To test this, we applied our system to tomato and showed that the abortive seed development trait was similarly manifest in this crop species.

Emily T. Klein, Ben C. Smith, and Steven D. Frank
Graduate Program: Entomology
Advisor: Steven D. Frank
Poster Number: 95

Evaluating Lingering Hemlocks With Three Mechanisms of Resistance

Hemlock woolly adelgids (HWA) are invasive insects that kill eastern and Carolina hemlocks, which are a keystone species. However, some trees survive in stands where most hemlocks have died. These are called 'lingering hemlocks' and may be resistant to, or tolerant of, HWA feeding. It is unknown whether lingering hemlocks provide resistance to HWA. To test whether lingering hemlocks are resistant to HWA, we propagated 200 hemlock trees comprising 48 genotypes from 10 locations. One hybrid variety acted as our resistant control, and one group of wild-type eastern hemlocks as our susceptible control. The hybridized trees, known to be resistant, provide a comparison for our lingering genotypes. We tested the primary types of host plant resistance: antibiosis, antixenosis, and tolerance. To test antibiosis, we measured HWA density, survival, and fecundity on different hemlock genotypes by caging infested branches on each tree and counting HWA as nymphs and adults. We found that wild-type eastern hemlocks (susceptible control) do not reduce HWA survival, but the hybrid (resistant control) and 11 lingering hemlock genotypes do. To test antixenosis, we conducted a preference experiment in which HWA nymphs could choose between lingering and non-lingering hemlock cuttings. This experiment showed that HWA do not demonstrate a preference between lingering and wild type genotypes. To test tolerance, we measured hemlock growth relative to HWA density. We found three lingering hemlocks with significantly more growth than our wild-type eastern hemlocks. We think antibiosis is playing a role in lingering hemlock resistance because we have 11 genotypes decreasing HWA density across multiple life stages, whereas preference has no influence. The results of this study should help determine which lingering hemlock trees exhibit resistance that can be propagated for reforestation and for breeders to use. Having resistant hemlocks in the field can help manage HWA populations in the future.

Jamie Lanzalotto[1], Bill Cline[1], Melissa Muñoz[2], Michael Bradshaw[1], and Sara M. Villani[1]
Graduate Programs: Plant Pathology[1]; Horticulture[2]
Advisor: Sara M. Villani
Poster Number: 97

Characterization and Aggressiveness of Fusarium oxysporum f. sp. mori isolates causing Fusarium Wilt of Blackberry in North Carolina

Fusarium oxysporum f. sp. mori (Fom), the causal pathogen of Fusarium wilt of blackberry (FWB), has been increasingly devastating blackberry production in the eastern and foothills regions of North Carolina. FWB is characterized by wilted and chlorotic leaves, a large black lesion extending vertically up one side of the cane, and loss of yield. Blackberries are a perennial crop with large upfront costs that are offset by 15-20 years of production. Plants with FWB often die within three years of infection, dramatically reducing their profitability. A survey was conducted on cultivated blackberries and the wild blackberry, Rubus allegheniensis, to determine the extent of Fom in major production regions of four counties in North Carolina. Primocane, floricane, and root tissue were sampled from seven cultivars and the wild species. Isolations were made from each tissue type of symptomatic and asymptomatic cultivars and from roots of the asymptomatic wild species. Pure isolates were putatively identified as F.oxysporum and the complete ITS, IGS, EF-1alpha, and TUB loci were amplified and sequenced for phylogenetic analysis. In total nine genotypes were identified and isolates representing each of these genotypes were evaluated for pathogenicity and virulence on the highly susceptible cultivar, 'Prime-Ark 45'. Differences in aggressiveness across isolates and genotype were observed with isolates from the most commonly recovered genotype causing the greatest level of disease severity. In a separate experiment, six commonly grown cultivars in NC were inoculated with a highly aggressive, moderately aggressive, and weakly aggressive Fom isolate. After 12 weeks, differences in disease severity were observed between cultivars inoculated with the highly aggressive and intermediate isolate only. Results from these studies can be used in breeding blackberry cultivars by providing a wider scope of the genetic diversity of Fom to screen the resistance of new lines.

Timothy Martin
Graduate Program: Soil Science
Advisor: Owen Duckworth
Poster Number: 109

Understanding Rare Earth Element Chelation, Uptake, and Utilization by Methylotrophic Bacteria for Sustainable Rare Earth Element Acquisition

Methylotropic bacteria have been shown to utilize rare earth elements (REYs) in cofactor of the PQQ-dehydrogenase enzyme. The combination of a REY dependency and a well-characterized uptake system implies that a REY uptake strategy, similar to the well-understood model of siderophore production and uptake for iron, may be employed by microbes for REYs. To determine if REY chelators, or lanthanophores, are being produced, Methylorubrum extroquens AM1 and Pseudomonas putida KT2440 were grown in REY deplete and replete media, and the resulting exudates were analyzed using mass spectrometry and metabolomics. Comparison of the exudates from the REY replete and deplete media resulted in the identification of a previously characterized novel compound involved in the lanthanide utilization pathway, methylolanthanin, in both the P. putida and M. extroquens deplete experiments. Analysis of the P. putida grown in depleted media also identified an additional novel putative lanthanophore. Further structural analysis on the putative lanthanophore may aid in understanding lanthanide chelation in the environments, information that could aid in the development of clean and sustainable uptake of rare elements from electronic waste and other sources.

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Graduate Programs and Institutions: Food, Bioprocessing and Nutrition Sciences and Center for Marine Sciences and Technology, Morehead City, NC[1]; Department of Food, Bioprocessing and Nutrition Sciences[2]
Advisors: Alexander Chouljenko and Lynette Johnston
Poster Number: 113

Enhancing Inactivation of Escherichia coli, Pseudomonas, and Vibrio spp. in vitro by Sequential Application of Alkaline and Acidic Electrolyzed Water

Microorganisms, such as Escherichia coli, Pseudomonas aeruginosa, and Vibrio parahaemolyticus are significant threats to food safety, contributing to contamination and foodborne illnesses. Electrolyzed water (EW) is a safe, cost-effective disinfection technology, with two forms: acidic EW (AEW) and alkaline EW (ALEW). Their antimicrobial activity can be enhanced with sequential application.

This study evaluated the antimicrobial efficacy of AEW, ALEW, and their sequential combination against microbial strains relevant to food safety in vitro.

AEW and ALEW were generated using 0.5% sodium chloride and potassium chloride solutions in an Eco One HOCL generator. Stock cultures (1 mL) of E. coli ATCC 33625 (108 CFU/mL), Pseudomonas aeruginosa ATCC 23993 (108 CFU/mL), and Vibrio parahaemolyticus EB101 (109 CFU/mL) were exposed to 9 mL of each EW solution for 1 min, followed by a 1 mL transfer to 9 mL fresh solution for an additional 1 min. Sequential treatments applied ALEW followed by AEW under the same conditions. Controls included deionized water (E. coli and Pseudomonas) or phosphate-buffered saline (Vibrio). Treated samples were neutralized with 0.5% sodium thiosulfate, serially diluted, and analyzed via pour plating (E. coli and Pseudomonas) or the MPN method (Vibrio).

The pH values were 2.54 ±0.01 for AEW, 11.65 ±0.02 for ALEW, and 3.51 ±0.02 for mixed EW. ORP values were -143 ±52.26 mV (ALEW), 1336 ±4.79 mV (AEW), and 1262 ±19.44 mV (mixed EW). Chlorine content ranged from 15.5 ±0.55 mg/L (ALEW) to 36.6 ±0.48 mg/L (mixed EW). Mixed EW achieved significantly higher bacterial reductions than single treatments ($P < 0.05$): 7.2 ±0.24 log CFU/mL (E. coli), 5.2 ±0.2 log CFU/mL (Pseudomonas), and 8.72 ±0.21 log MPN/mL (Vibrio).

This study highlights the enhanced microbial inactivation of foodborne microbial strains using sequential EW technology, offering potential for diverse food applications.

Kimberly Montalban[1], Katherine D'Amico-Willman[1], Rachel Herschlag[2], Carolee Bull[2], Prasanna Joglekar[1], David Ritchie[1], Alejandra I. Huerta[1]
Graduate Programs: Entomology and Plant Pathology[1]; Department of Plant Pathology and Environmental Microbiology, Pennsylvania State University[2]
Advisor: Alejandra Huerta
Poster Number: 114

A Polyphasic Approach to Detect, Diagnose, and Study the Biology of Pseudomonas amygdali pv. sesami Causal Agent of Bacterial Spot of Sesame

Bacterial plant pathogens contribute to significant crop loss worldwide. Timely and accurate detection and identification of disease is key for prompt deployment of management tactics that can protect crop quality and yield. Sesame, mainly produced in Asia and in southern mid-western states in the U.S., is being explored in North Carolina (NC) as an alternative crop. In 2022 at a sesame variety trial at the Sandhills Research Station in Jackson Springs, NC, an outbreak of a bacterial disease was reported. This study characterized and developed accessible diagnostic tools for the causal agent of the bacterial spot disease outbreak, identified as Pseudomonas syringae pv. sesami. Through this work, we generated new and improved genomic resources for this understudied disease and pathogen, including eight closed genomes of the causal agent through PacBio sequencing technology which insighted a taxonomic reclassification from P. syringae pv. sesami to P. amygdali pv. sesami. Comparative phenotypic, morphological, epidemiological, and genomic analysis revealed the NC isolates exhibited distinct traits to those of the pathotype strain. This includes higher virulence on three different sesame varieties and the presence of unique genes in the NC isolate pangenome. In summary, we characterized an emerging disease in a new crop in NC and developed diagnostic markers for early detection of P. amygdali pv. sesami. We also reclassified this group of pathogens by taking a polyphasic approach. The knowledge generated through this work provides the Pseudomonas scientific community and sesame production stakeholders with updated pathogen diversity profiles, genomic resources, and accurate detection methods to better understanding and manage bacterial spot of sesame epidemiology.

Anju Pandey[1,3], Rajan Paudel[2], Tika Adhikari[2], Frank Louws[1,2] and Dilip R. Panthee[1,3]
Graduate Programs and Institutions: Horticultural Science[1]; Entomology and Plant Pathology[2]; Mountain Horticultural Crops Research and Extension Center, Mills River, NC[3]
Advisor: Dilip R. Panthee
Poster Number: 134

Association Study to Identify the Novel Genetic Markers Linked to SLS Resistance in Tomato

Septoria leaf spot (SLS), caused by Septoria lycopersici, is an emerging disease of tomato with significant economic impact, particularly in the northeastern United States and Canada. Under favorable environmental conditions, SLS can lead to complete defoliation and substantial yield losses. Breeding for resistance is a key objective in tomato improvement programs; however, resistance to SLS has yet to be widely incorporated into cultivated varieties. To address this challenge, a genome-wide association study (GWAS) was conducted using 220 diverse tomato accessions, including advanced breeding lines from North Carolina State University (NCSU) and germplasm from the USDA Plant Genetic Resources Unit and the Tomato Genetics Resource Center (TGRC), California. Resistance was evaluated through seedling assays, and disease severity was quantified using the area under the disease progress curve (AUDPC). The results identified significant variation in resistance, with 17 accessions classified as resistant, 46 as moderately resistant, and 157 as susceptible. Leaf samples were collected for DNA extraction, and genotyping was performed using Genotyping-by-Sequencing (GBS) for GWAS analysis. This study enhances our understanding of the genetic architecture of SLS resistance and identifies molecular markers associated with resistance loci, which will be valuable for breeding programs aimed at developing durable resistance to SLS in tomato."

Seongmin Park and Stephanie Kulesza
Graduate Programs: Crop and Soil Sciences
Advisor: Stephanie Kulesza
Poster Number:135

Can Lignite and Lignosulfonate Reduce Ammonia Loss in Poultry Production?

High ammonia concentrations in the air of poultry houses threatens bird health, contributes to air pollution, and reduces the value of resulting poultry litter as a fertilizer. Lignite (L) and lignosulfonate (LS), by-products of the coal and paper industries, could reduce ammonia loss due to their acidity and high cation exchange capacity. Two experiments were conducted to determine the effects of L and LS on ammonia volatilization from poultry litter for two weeks and to assess their impact on nitrogen mineralization of the resulting litter when applied to three types of soil. In the volatilization experiment, a total of 12 treatments were tested, which included five application rates of L and LS (0.75, 1.5, 3, 4.5, and 6 kg m-2), sodium bisulfate (PLT), and a control. Four of the treatments – 3 kg m-2 of L and LS, PLT, and untreated litter – were assessed in a 56 day soil mineralization study. Cumulative ammonia emissions followed an exponential decay function as the rate increased for both L (R2 = 0.983) and LS (R2 = 0.971) treatments. All treatments with L, LS, and PLT significantly reduced cumulative ammonia emissions compared to untreated litter. Additionally, L (3 kg m-2) and LS (1.5 kg m-2) significantly reduced the ammonia emissions by 64.2 and 68.4 %, respectively, compared to litter treated with the industry standard, PLT. Total nitrogen in the resulting poultry litters did not differ among treatments; however, the ammonium content significantly increased in litter treated with L (3 kg m-2 or higher) and LS (1.5 kg m-2 or higher), compared to the untreated control. In the soil mineralization study, the ammonium content on day 14 was higher in all three soils that received litter treated with LS compared to untreated control, and the mineralization rate increased with L and LS compared to untreated poultry litter only in sandy loam soil.

Christopher S. Pascual[1], Lirong Xiang[1], John Classen[1], Steven G. Hall[1], Jackson Evans[1], Stevee McGee[1], and Ricardo Hernandez[2]
Graduate Programs: Biological and Agricultural Engineering[1]; Horticultural Science[2]
Advisor: Steven G. Hall
Poster Number: 137

Optimization of Nutrient Conversion and Recovery in Marine Aquaponics

Aquaculture production continues to increase and surpassed capture fisheries for the first time in 2022, accounting for 51% of global fish production. Despite this growth, aquaculture faces significant challenges. Wastewater from aquaculture contains high levels of nutrients, particularly nitrogen, phosphorus, and CO2 emissions, contributing to ecological and environmental degradation. These environmental risks highlight the urgent need for sustainable waste management solutions. While aquaculture generates nutrient-rich wastes, this could be valorized and utilized for crop production through aquaponics. Aquaponics, which merges aquaculture and hydroponics, offers a sustainable solution by creating a symbiotic relationship among plants, fish, and bacteria. However, most research focuses on freshwater culture, leaving the potential of marine aquaponics largely untapped. Marine aquaculture accounted for 55%, producing 71.7 million tons annually, while freshwater aquaculture contributed 45%. This project explores the integration of marine fish species like striped bass and edible salt-tolerant crops such as kale and salicornia in a closed-looped marine aquaponics system. The system is designed to convert fish waste into plant nutrients through nitrification within a biofilter tower while incorporating CO_2 dispersion and extraction to enhance plant growth and development. Additionally, solid waste is repurposed for soil-based or media-grown plants, minimizing or eliminating nutrient discharge into the environment. This innovative approach enhances resource efficiency, mitigates environmental impacts, and advances marine aquaculture sustainability.

Rajan Paudel[1], Norman Muzhinji[2], Anju Pandey[3,4], Dilip R. Panthee[3,4], Ralph A. Dean[1], Frank J. Louws[1,3], and Tika B. Adhikari[1]
Graduate Programs and Institutions: Entomology and Plant Pathology[1]; University of the Free State, Department of Plant Sciences, Plant Pathology Division[2]; Horticultural Science[3], Mountain Horticultural Crops Research and Extension Center (MHCREC)[4]
Advisors: Tika B. Adhikari and Frank J. Louws
Poster Number: 139

Whole Genome Sequence Analysis of Alternaria linariae, the Causal Agent of Early Blight in Tomato, Isolated from North Carolina

Early blight is one of the most economically significant foliar diseases affecting tomato production, leading to substantial yield losses. Previously, early blight on tomatoes was primarily attributed to the fungus Alternaria solani; however, accumulating evidence has shown that A. linariae, formerly A. tomatophila is the predominant cause. A strain of this pathogen, A. linariae 25, was isolated from early blight infected tomatoes in Swain County, North Carolina. The identification of this isolate was confirmed through the examination of its asexual morphs, cultural characteristics, and PCR analysis. The genome architecture, and determinants of host specificity of A. linariae on tomatoes remain unknown, therefore we sequenced its whole genome to elucidate its structure and compare its genomic features with those of other Alternaria species. This information is essential for understanding its pathogenicity and host specificity as well as for developing effective management strategies. The assembled genome measures 33.1 Mb and comprises 18 rRNA genes and 117 tRNA genes. The genome comprises approximately 272, 542bp (0.8%) of repetitive elements and includes 11,768 predicted gene models of which 221 genes were identified as putative candidate effector proteins, along with 573 CAZymes and 37 secondary metabolite gene clusters. Comparative mining of effector genes among different Alternaria species revealed specific effectors in A. linariae 25 that are related to colonization and infection. This near-complete genome will enhance our understanding of A.linariae's genetic make-up and sets a precedent for genomic research in the A. linariae species, providing a foundation for future studies in taxonomy, evolution, host specificity and ecology.

Taynara Possebom and Dominic Reisig
Graduate Program: Entomology
Advisor: Dominic Reisig
Poster Number: 144

Understanding Pheromone Traps for Monitoring Stink Bug Populations in Varied Soybean Stages

Stink bugs (Hemiptera: Pentatomidae) are important pests in the southern US and are challenging to control in many crops. Stink bugs caused an average of $314 million in soybean costs and losses across 18 US states from 2020 to 2023. Information on indirect monitoring systems could support current field-based direct scouting techniques. Our research goals were to determine the trap that captured the most stink bug numbers and the soybean stage that hit the threshold for the species we targeted. Using field as a replication, we placed seven (delta, black pyramid, yellow pyramid, and blue, clear, yellow, and white sticky cards) stink bug pheromone traps in 68 soybean fields from August to December 2023 and 2024. We used two types of pheromone lures that targeted different species of stink bugs. Every two weeks we checked the traps and counted the total number of stink bugs; we also identified stink bug species and replaced the pheromone lure or trap if needed. In addition, we conducted biweekly scouting with 100 sweeps positioned in the field at 15-row intervals from the traps. We recorded the total number of stink bugs from these traps and for the sweep net. Stink bug numbers varied depending on the pheromone trap and soybean stage. This research provides soybean producers and consultants in the Southeastern United States with a more efficient stink bug monitoring tool. By evaluating pheromone traps and identifying key soybean stages of stink bug abundance, the study offers an alternative to time-consuming sweep net sampling. These findings can be potentially applied to monitoring pest populations in other crop systems.

Elisabeth Q. Ramsey[1], Catherine E. Sanders[1], Annie Hardison-Moody[1], Katherine McKee[1], Micheal Schulman[1], and Andy Smolski[2]
Graduate Programs and Institutions: Agricultural and Human Sciences[1]; Agricultural Economics, Sociology, and Education, Pennsylvania State University[2]
Advisors: Catherine E. Sanders and Annie Hardison-Moody
Poster Number: 149

Through Their Own Lens: Understanding the Experiences of Black Women Farmers in North Carolina's Agricultural Landscape

Black farmers in the United States face systemic barriers that shape their experiences in agriculture, from land access and financial resources to community support and institutional discrimination. Black women farmers, in particular, are significantly underrepresented, making up only 500 of the producers in North Carolina. This study centers on the voices of 10 Black women farmers, utilizing digital storytelling and in-depth interviews to document their lived experiences and perspectives in agriculture.

Participants reveal the struggles they face, including financial exclusion, bureaucratic roadblocks, cultural isolation, and systemic discrimination. Despite these challenges, they employ strategies such as grassroots organizing, community-based networks, and innovative farming practices to sustain their work. Preliminary findings highlight how resilience—rooted in ancestral connections and the need for representation—has shaped their agricultural journeys. While navigating an industry that often excludes them, these farmers remain committed to their work, driven by a desire to inspire future generations and reclaim economic and land sovereignty.

By employing digital storytelling, this research amplifies the narratives of Black women farmers, advocating for equity, fostering a deeper understanding of the role marginalized farmers play in shaping agriculture, and offering participant-driven insights to inform policies and programs that promote diversity and inclusion. Ultimately, this study underscores the urgent need for systemic change to ensure the long-term success of Black farmers in the agricultural sector.

Melina Schopler[1], Will Petry[1], and, Elsa Youngsteadt[2]
Graduate Programs: Plant Biology[1]; Biology[2]
Advisors: Will Petry and Elsa Youngsteadt
Poster Number: 156

The Effects of Climate Change-Induced Wild Bee Pollinator Declines on Network Structure and Plant Fitness

Climate change is contributing to insect declines worldwide, and yet it is unclear how local pollinator extinctions will affect plant populations. When a pollinator species is lost, plant-pollinator network structure can change in ways that may buffer or exacerbate the loss of pollination service to a given plant species. Hotter air temperatures under future climate conditions could lead to the decline of the most heat-sensitive wild bee species. One way to measure bee species vulnerability to climate change is to compare bee body temperatures during forging to their upper thermal limit (CTmax) in the lab. In warm climates, such as here in Raleigh, North Carolina, some bee species are already operating close to their CTmax. In this study I used pollinator flight cages to experimentally simulate the heat-driven extinction of five common North Carolina bee species to examine how the loss of bee species and subsequent network rewiring affects the pollination of five focal plant species. I experimentally assembled bee communities ranging from five to one bee species in flight cages, following the extinction order predicted by CTmax. To quantify the effect of bee species losses on network structure and plant reproduction I collected visitation data on the five focal plant species and collected fruit and seed set data on a subset of the plant species. I also collected stigmatic pollen loads and bee body pollen data to analyze patterns of pollinator visitation and pollen transfer within the experimental plant-pollinator networks. We found that when bees are removed from the community, the remaining bees rewire their interactions (i.e. change their fidelity and visitation frequency) to the plants, which can have implications for pollination. The change in pollination service following bee species loss depends on the focal plant, the pollination effectiveness of the pollinator species, and the competitive interactions before and after the species loss.

Leigh Schwinden
Graduate Program: Horticulture
Advisors: Acer Vanwallendael and Kedong Da
Poster Number: 157

Development of Robust Floral-Dip Transformation Protocol of Weedy and Domesticated Proso Millet (Panicum miliaceum)

Proso millet (Panicum miliaceum) was domesticated around 10,000 years ago in northern China and is valued for its nutritional benefits and stress-tolerance. A related subspecies, wild proso millet, is an invasive weed in several regions of the US. Despite its potential, this fast growing cereal grain lacks a reliable transformation protocol to support genetic research, and little is known of the genetic basis of weediness in this system. This study aims at developing a reproducible agrobacterium-mediated floral dip transformation protocol for proso millet, enabling the integration of beneficial genetic traits found in its wild relatives. Using optimized plasmids inserted into agrobacterium, we achieved efficient gene integration and expression. This protocol demonstrates high transformation efficiency and gene expression stability, highlighting its potential to support detailed studies on grass traits that contribute to both domestication and weediness. Few weedy species have established transformation protocols, making this study a significant advancement in understanding genetic factors attributing to their competitiveness in agricultural settings.

Jacob Seiter, Anna Whitfield, and Dorith Rotenberg
Graduate Program: Plant Pathology
Advisor: Dorith Rotenberg
Poster Number: 158

Developing Methods for Gut Content Analysis of the Corn Planthopper to Identify Reservoirs of Maize Mosaic Virus in Surrounding Vegetation of Maize Production Farms in Hawaii

Maize (Zea mays L.) is among the most agronomically significant crops in the world. Despite the success of this crop as a global commodity, its sustainable production faces significant challenges posed by the persistence of devastating vector-borne viral diseases, particularly in tropical and subtropical climates. The corn planthopper (Peregrinus maidis) is a piercing-sucking insect in the order Hemiptera and the exclusive vector of maize mosaic virus (Alphanucleorhabdovirus maydis, MMV). In recent years, MMV has re-emerged as a severe persistent disease of maize seed production in Hawaii. In some cases, producers have reported near complete yield loss due to this disease. A principle component of understanding the epidemiology of vector-borne plant diseases is the identification of alternative host refuge, defined as plants with the capacity to harbor insects and/or act as sources of virus inoculum. While the corn planthopper and MMV are significant pests of maize, limited information is known about alternative hosts in the natural landscape. Gut content analysis is a technique that allows researchers to infer the dietary history of an organism through the metagenomic analysis of conserved genes used for taxon identification. In this study, we develop methodologies for the optimization of gut content analysis in the corn planthopper, leveraging next-generation sequencing technology for high-throughput identification of potential alternative hosts. Using existing and modified methodologies for gut content analysis, we optimized this technique to enable analysis of the corn planthopper in field samples collected from the Hawaiian Islands. In addition to gaining insight into basic plant-arthropod interactions of this system, this study will inform producers on these dynamics for the development and implementation of integrated pest management strategies for the sustainable protection against a severe vector-borne diseases.

Charity Stallings, Catherine Sanders, Joy Morgan Flemming, and Kimberly Allen
Graduate Programs: Agriculture and Human Sciences
Advisor: Catherine Sanders
Poster Number: 165

Examining Alumni and Student Perceptions: A Qualitative Evaluation of an Alumni Career Coaching Program

Mentorship is a common student support resource in higher education, where mentorship is directly linked to successful educational programs. Alumni mentoring programs in higher education are rising in popularity among higher education research. Alumni are effective as they provide a resourceful wealth of knowledge and experiences. Career coaching is historically utilized in the workplace by enhancing professional and personal skills and employable competencies, and is not seen in higher education. The College of Agriculture and Life Sciences (CALS) Alumni for Student Success (CASS) Career Coaching Program (CCP) strategically matches one CALS alumni with one CALS student for one academic year of career coaching. Coach and coachee teams attend a required training, where the coach aims to support their coachee in setting and achieving a specific career goal by the end of the program. SMART (Specific, Measurable, Attainable, Reasonable, and Timely) Goals through a construct of Goal Setting Theory are incorporated into the CCP. Literature suggests students who set specific and challenging goals incorporate more effort and are more motivated in reaching their goals. Literature identifies quantitative measures of evaluating alumni mentoring programs dominate qualitative, there are few studies measuring student perceptions of participating in a program, and no studies investigate alumni perceptions in a related higher education program. The study sought to understand participant perceptions of mentorship, coaching, motivations, alumni career coaches, and program successes/challenges. Findings indicate students mentorship and coaching work collaboratively in the program, where alumni are effective coaches that foster student success. Coach results illustrate alumni desire to give back to the college and their involvement does foster student development.

Alex Swanson-Boyd and Josip Simunovic
Graduate Program: Food Science
Advisor: Josip Simunovic
Poster Number: 168

Design and Development of Shelf-Stable Therapeutic Foods for Female and Older Adult Use Across Physiological and Medical Conditions

Individual nutritional needs are a collection of intrinsic and extrinsic factors and differ across ages and conditions. Proper nutrition is required for functioning of any individual and mitigates the onset of nutrition-related disease. Logistical and financial hurdles discourage maintenance of an appropriate diet throughout life stages. Therapeutic foods can help more effectively meet these needs and accommodate nutritionally sensitive populations across life stages and conditions. To help expand accessibility and choice of nutritive foods for a variety of in-need populations, 6 therapeutics were developed: 3 formulations for female adults and 3 for older adults. A base formulation for female adults (ages 19-59 years) was designed to accommodate most nutritional needs of healthy individuals within the group. Two additional therapeutics were created to address differing needs throughout pregnancy and nursing. A base formulation for older adults (ages ≥60 years) without unique needs was developed then modified for end-of-life care and individuals with dysphagia. Both therapeutics for end-of-life care and dysphagia are viable for inpatient or outpatient settings and intended as direct consumables (not for nasogastric use). Enzymatic components allow for more efficient digestion and delivery across all formulations and promote appropriate rheological parameters for older adults with dysphagia. All therapeutics are sweet potato-based and microwave-processed; orange-fleshed sweet potato is used for female adult formulations and purple-fleshed for older adult formulations. Shelf stability ranges from 21-27 months to promote accessibility and reduce energy usage and cost. Additional ingredients, nutritional content, and post-processing structure differ across formulations to best accommodate averaged needs of each population.

Jennifer C. Tapia
Graduate Program: Plant and Microbial Biology
Advisor: Colleen J. Doherty
Poster Number: 169

Decoding the Clock: Exploring Host-Pathogen Interactions Under Warmer Nighttime Temperatures

Climate change is an inescapable reality of our time. It represents a significant threat to agriculture and food security. One critical aspect of climate change is the timing of daily temperature changes. Nighttime temperatures are increasing faster than daytime temperatures. This reduces the temperature difference between day and night.

Circadian-controlled genes are particularly sensitive to warmer nighttime temperatures (WNTs). WNTs disrupt the rhythmic expression of circadian clock-regulated genes in rice, interfering with the timing of critical processes such as photosynthesis, starch biosynthesis, and respiration. Alterations in starch biosynthesis pathways can have a significant impact on starch structure and amylose content, leading to a decline in grain quality. These alterations, together with increased nighttime respiration and disrupted grain filling, contribute to yield losses. Additionally, WNTs can misregulate hormonal rhythms, such as abscisic acid and ethylene. Hormonal disruption intensifies stress responses and affects stomatal control, exacerbating the negative impacts on crop productivity. Despite notable progress, research on the impact of WNTs on the circadian clock has primarily focused on rice, resulting in an insufficient understanding of the impacts on other crops. Additionally, most research has examined plants in isolation, overlooking the impact of environmental conditions on the interactions between plants and other organisms. Disruptions to the circadian clock are known to affect host-pathogen interactions. To explore this further, our research explores how WNTs influence interactions between organisms, focusing on the tomato-nematode (Meloidogyne hapla) pathosystem. Our approach involves identifying quantitative trait loci that drive the interaction between the plant, pathogen, and environment (WNTs), with the goal of identifying genes associated with climate resilience. By elucidating the physiological and molecular mechanisms underlying these interactions, we aim to provide insights for developing climate-resilient crops.

Hope Thome
Graduate Program: Horticultural Science
Advisor: Katie Jennings
Poster Number: 171

Developing a Weed Management Program for Yellow Nutsedge (Cyperus esculentus) Control in Sweetpotato (Ipomoea batatas)

Yellow nutsedge is among the most troublesome weeds in row crop production systems in the southern United States (Webster and Nichols 2012), including sweetpotato production. Additionally, the Weed Science Society of America ranks nutsedge as being among the most troublesome weeds in vegetables (Van Wychen 2019). Season-long yellow nutsedge interference can reduce total marketable sweetpotato yields 6 to 80% at nutsedge densities of 5 to 90 shoots m-2, respectively (Meyers and Shankle 2015). Few herbicides are available for controlling yellow nutsedge. Previous research has shown that by transplanting 'Beauregard' sweetpotato later in the planting window, fewer broadleaf weeds emerged in the sweetpotato field (Seem et al. 2003). Therefore, a study was conducted in Kinston, NC in 2024. Treatments consisted of three factors: herbicide (glyphosate, halosulfuron, EPTC, bentazon, and tiafenacil), planting date (early and late), and herbicide rate (1X or 2X the registered labeled rate). Nontreated weed-free and weedy plots were included for comparison. Yellow nutsedge was allowed to germinate in the spring and then herbicide treatments were applied prior to bed formation and prior to transplanting sweetpotato. Data collected included crop stand count and weekly visual ratings of yellow nutsedge control and crop vigor for the first 5 weeks following treatment. Storage roots were harvested, graded, and weighed, and a sample of roots from each treatment were cut to check for internal herbicide damage. Analysis showed that bentazon, halosulfuron, glyphosate, and tiafenacil are promising options.

Asher Utz, Brenna Zimmer, Pooja Narasimhan, Dalton Hilovsky, Xiaojing Liu, Joseph Barycki, and Melanie Simpson
Graduate Program: Molecular and Structural Biochemistry
Advisor: Melanie Simpson
Poster Number: 176

UDP-glucose Dehydrogenase is a Novel AGC Kinase Target That Promotes Prostate Tumoroid Formation and Glycome Aberrations

Aberrant proteoglycan expression is a significant and driving feature of cancer progression. The synthesis of proteoglycans requires UDP-glucuronate, a sugar precursor produced by a sole enzyme, UDP-glucose dehydrogenase (UGDH). UGDH is implicated in the progression and severity of several epithelial cancers, and its regulation of glucuronate presents an attractive target for the control of biosynthetic processes that drive invasion and metastasis. Computational and in vitro studies of UGDH revealed a highly conserved phosphorylation site (Ser 316) near the dimeric interface of the homohexameric UGDH assembly. Kinases RSK2, S6K1, and SGK1 were found to phosphorylate UGDH Ser316 in vitro. To test functional consequences of S316 phosphorylation, we performed site-directed mutagenesis to generate UGDH phosphodeficient (UGDH S316A) and phosphomimetic (UGDH S316D) point mutants. The UGDH mutants behaved similarly to WT UGDH in assays that measured the stability and kinetic activity of purified protein but had significant functional impacts when expressed in prostate cancer cells. Cells bearing the phosphomimetic UGDH S316D mutation exhibited increased tumoroid growth and elevated global glycan expression, compared to those with wild-type UGDH. In contrast, cells expressing the phosphodeficient UGDH S316A mutation had markedly less tumoroid growth and reduced glycan expression. These results support a functional role for UGDH phosphorylation status at S316 in directing UDP-glucuronate into biosynthetic pathways, thereby promoting anchorage-independent growth, a hallmark of tumorigenesis. Further studies aim to determine the contribution of each of the three kinases in phosphorylation of UGDH S316 in vivo and the underlying mechanisms controlling tumor growth.

Katie Vollen[1], Matthew Neubauer[2], Jose Alonso[1], Anna Stepanova[1]
Graduate Programs: Plant Biology[1]; Forestry and Environmental Resources[2]
Advisors: Jose Alonso and Anna Stepanova
Poster Number: 179

From Enemy to Ally: Hacking Plant Viruses to Engineer Plant Genomes

The introduction of CRISPR-based precise genome editing technology has revolutionized medicine, agriculture, and biotechnology. CRISPR/Cas9 creates sequence-specific double-stranded breaks in DNA which are typically repaired through non-homologous end joining (NHEJ), introducing random, small insertions or deletions into a cut site. An alternative pathway, known as homology directed repair (HDR), offers the potential for more precise DNA editing using DNA template to generate sequence-specific insertions or gene replacements. However, HDR remains technically difficult and inefficient to leverage in genome editing in plant systems. Researchers face the hurdle of supplying sufficient amounts of repair template to encourage HDR over NHEJ. One solution is to exploit viral replication by incorporating repair template sequences into plant viruses, which can generate thousands of copies of the template per cell. Our lab has previously demonstrated the utility of Beet Curly Top virus (BCTV) for recombinant protein expression and gene-targeting via HDR in transient assays. However, it remains to be demonstrated whether BCTV can be used to deliver repair template for HDR in stable transformants. I aim to integrate the BCTV viral cargo delivery system with CRISPR/Cas9 to generate a simple set of GoldenBraid-compatible vectors for high-efficiency gene targeting in Arabidopsis thaliana.

Hannah Wall
Graduate Program: Biological and Agricultural Engineering
Advisors: Jay Cheng and Ryan Sartor
Poster Number: 180

Selective Breeding of Duckweed for Biobutanol Production

Duckweed is a small aquatic plant with significant potential as a bioenergy crop due to its rapid growth rate and ability to accumulate starch. Additionally, duckweed is able to treat swine wastewater, a nutrient-rich and readily available resource in North Carolina. Despite its many benefits as a feedstock for biofuel production, duckweed has never been systematically improved through selective breeding, unlike most modern crops. This project aims to develop advanced lines of Lemna gibba, a species of duckweed, through selective breeding and high-throughput phenotyping trials. Selection will be based on the biomass growth rate and starch content to optimize starch yields for biobutanol fermentation. Increasing the starch content of duckweed through selective breeding will not only enhance feedstock efficiency but also lower production costs, making biobutanol fermentation more economically viable. By utilizing duckweed as a biobutanol feedstock, this research supports a sustainable fuel alternative that avoids competition with arable land, improves production efficiency, and contributes to nutrient recycling. The results of this research project will demonstrate and quantify whether the starch content of duckweed can be significantly enhanced through selective breeding, paving the way for further research that utilizes duckweed as a bioenergy crop.

Matthew Willman[1], Daniela Miller[1], Amanda Hulse-Kemp[2,1], and Gina Brown-Guedira[2,1]
Graduate Programs and Institutions: Crop Science[1]; USDA-ARS, Raleigh, NC[2]
Advisors: Gina Brown-Guedira and Nonoy Bandillo
Poster Number: 186

Development of a Regional Pangenome Reference Model for Soft Red Winter Wheat

Advancements in genome modeling have accelerated gene discovery and breeding as well as evolutionary biology and conservation research in common wheat (Triticum aestivum). However, cost of sequencing and large genome size (16 billion base pairs) prohibit large-scale genome assembly of numerous wheat varieties. Modern genotyping workflows involve alignment of sample sequence data to a reference model derived from a single variety. Limitations of this approach include reference bias, where allelic diversity is misrepresented in samples with low similarity to the reference variety. This issue is complicated by wheat hexaploidy and limits discovery of large genetic structural variants, a prevalent feature in wheat. Common wheat is divided into market classes based on kernel texture, grain color, and growth habit. Soft Red Winter Wheat (SRWW) is the predominant wheat class grown in the United States (US) Eastern region states, including North Carolina. However, no standard genome reference currently exists for SRWW. To better model genetics of US SRWW, assemblies were constructed for two important cultivated varieties. Analysis of these assemblies has revealed insights into genomics of regional germplasm including structural variation and gene functional characterizations which were previously unattainable using the previous standard model. Application of these SRWW genome models as alignment references also improve genotyping accuracy of related germplasm. These findings support further development of a comprehensive regional pangenome model for SRWW. Anticipated benefits of this model include rapid gene discovery and improved germplasm characterization, important foundations for effective crop breeding.

Anna Yaschenko, Chengsong Zhao, Jose Alonso, and Anna Stepanova
Graduate Programs: Plant Biology
Advisor: Anna Stepanova
Poster Number: 189

Effects of Promoter Architecture and Motif Characteristics on Gene Expression in Plants

Understanding gene expression regulation is central to the development of biotechnological solutions for several pressing agricultural problems. The advent of synthetic biology methods has opened the door to programmable genetic constructs in plants that confer tunability and spatiotemporal regulation to gene expression. However, the relationship between promoter elements within the promoter of a gene and that gene's expression levels is not well defined. To explore this relationship, we have built synthetic promoters harboring up to ten transcription factor (TF) binding sites using GoldenBraid technology and subcloned these promoters upstream of a reporter gene. This was done by inserting one to ten copies of a protospacer, a 23bp recognition sequence for an S. pyogenes derived dCas9 coupled with an activation domain to create a synthetic TF, into a 1kb neutral promoter sequence that has no known TF binding sites in plants. We assembled the reporter gene to express a mCherry-Luciferase fusion protein as a readout and transiently co-expressed it along with a dCas9 activation system in Nicotiana benthamiana to test the effects of protospacer position, orientation, helical face, copy number, and spacing on reporter expression. We find that both orientation and helical face of the protospacer in relation to the transcription start site (TSS) have no prominent effect on the level of reporter expression. Experiments testing protospacer position indicated that the ideal location of the TF binding site is about -150 base pairs (bp) upstream of the TSS and 119 upstream of the TATA box. Surprisingly, increasing protospacer copy number is linearly correlated with a boost in gene expression only for up to four copies of the protospacer, with a sharp drop in reporter activity seen for five or more copies of this cis-element. Further experiments indicate that this effect is likely due to complex interactions between native/artificial TFs and genetic parts that are currently not fully understood. Increasing spacing between protospacers was correlated with a boost in expression until about 123 bp, after which expression slowly decreased to the level of one protospacer suggesting that distant placement of the cis-element is not effective at supporting transcription initiation. Lastly, results indicated that stacking two distal motifs within 146bp of each other may lead to an increase in gene expression. Future and ongoing studies will examine the translatability of these findings by utilizing a dCas9 from a different species, S. thermophilus, to determine the generalizability of the rules dictating promoter architecture derived from this project.

Seung Hyun Yoo
Graduate Program: Food Science
Advisor: Minliang Yang
Poster Number: 190

Nutrition-based Life Cycle Assessment (nLCA) for Sustainable Agri-Food Systems

Agri-food systems are responsible for approximately ⅓ of total anthropogenic greenhouse gas emissions. At the same time, increasing access to healthy and nutritious food is crucial for addressing the global rise in micronutrient deficiency and ensuring food security. Integrating nutrition metrics into environmental life-cycle assessment (nLCA) has been proposed to comprehensively evaluate the life-cycle impacts of food and diets. However, given that nLCA is in the early stage of development, a robust methodological framework is needed to effectively capture the complexity of environmental and nutritional dimensions. The purpose of this study is to (1) review the current status of nLCA and established frameworks, (2) analyze existing nLCA case studies, and (3) identify opportunities and challenges for future nLCA development. We find that existing diet-specific nLCA frameworks are more beneficial in assessing the impacts of local food. Additionally, frameworks integrating nutrient indices offer a more detailed impact assessment, considering both nutrient-rich compounds and nutrient-limited substances. Ultimately, this study can help diverse stakeholders, such as producers, distributors, consumers, and policymakers, to improve sustainable practices, make informed choices, and develop evidence-based policies that promote healthier, more sustainable agri-food systems.

Zhenghua Zhang
Graduate Program: Biological and Agricultural Engineering
Advisor: Lirong Xiang
Poster Number: 193

Development of A Bionic Hexapod Robot with Adaptive Gait and Clearance for Enhanced Agricultural Field Scouting

High agility, maneuverability, and payload capacity, combined with a small footprint, make legged robots well-suited for precision agriculture applications. This study introduces a novel bionic hexapod robot designed for agricultural applications to address the limitations of traditional wheeled and aerial robots. The design features a hexapod robot with high agility and dexterity. A significant innovation of this robot is its terrain-adaptive gait and adjustable clearance, which ensure body stability as the robot travels over different terrains and crosses obstacles of varying heights. These features are critical to the robot's ability to adapt to complex and dynamic environmental conditions. The robot is equipped with a high-precision Inertial Measurement Unit (IMU) for real-time monitoring of its attitude during movement. This configuration gives the robot the ability to adjust its attitude to maintain balance dynamically. In addition, an advanced version of the robot equipped with an optional advanced sensing system has been designed to enhance obstacle detection and self-navigation capabilities. This advanced version includes LiDAR, stereo cameras, and distance sensors. The sensing capability allows the robot to dynamically adjust the clearance between its base plate and the ground, thus effectively minimizing collisions with surrounding crops. The study tested the standard robot under different ground conditions, including hard concrete floors, rugged grass, climbing slopes, and crossing obstacles. The adaptability of the hexapod robot to complex field environments, combined with its lightweight design, has demonstrated significant potential in improving agricultural practices by increasing efficiency, lowering labor costs, and enhancing sustainability.

College of Design

Ololade Sophiat Alaran
Graduate Program: Advanced Architectural Studies
Advisor: Traci Rider
Poster Number: 3

Mitigating Health Risks Through Moisture-Resistant Wall Assemblies: A Comparative Analysis of Design, Climate and Construction Strategies in Lagos, Nigeria and New Orleans, Louisiana

This research aims to address the prevalence of building moisture issues, which are often understood qualitatively rather than quantitatively. Approximately one-third of households globally face excessive dampness and mold growth, impacting health and the economy. Challenges in built environments have intensified with changing construction methods and airtight demands. Tropical regions characterized by high humidity due to climate factors face unique challenges affecting comfort, health, and infrastructure. Dampness occurs when excess water infiltrates through building components, causing the growth of molds and mildew spores, which can ultimately lead to occupants' health challenges and building degeneration. This study examines construction methods and wall assemblies in residential buildings to understand how they might better "protect occupants from moisture-related health risks and harmful indoor air quality." With an in-depth analysis of two cities with comparable rainfall and temperature but very distinct construction practices, Lagos, Nigeria, and New Orleans, USA, a model to predict future risk based on a range of extreme weather scenarios and analyze how changing climate conditions would affect the two localities differently was developed. This research study was executed through a five-stage research process incorporating literature reviews, case studies, comparative analysis, simulations, and quantitative and qualitative survey methodologies. The final results showcased a significant flaw in the design for climate resilience in Lagos, Nigeria, which led to the design of a wall assembly solution.

Kweku Baidoo
Graduate Program: Graphic & Experience Design
Advisor: Helen Armstrong
Poster Number: 14

Navigating Decision: Designing Digital Tools for Enhancing Clinical Confidence and Accuracy for Early-Career Physicians

Clinical decision-making is at the core of daily medical practice, especially in primary care, where physicians must diagnose and manage a wide range of conditions under tight time constraints and uncertainty. Striking a balance between evidence-based practices, patient needs, and the risks of misdiagnosis, unnecessary testing, and treatment costs is critical. While effective decision-making can reduce preventable hospital visits, early-career physicians often face challenges such as diagnostic uncertainty, cognitive biases, and decision fatigue, leading to delays in care and potential patient harm. Additionally, the increasing burden of clerical tasks further heightens stress and detracts from meaningful patient interactions.

This gap presents an opportunity to apply UX design research methods to develop solutions that support clinical decision-making, particularly for early-career physicians. By integrating design frameworks, visual explorations, and scientific methods for conveying medical uncertainty, this investigation examines experiential techniques for designing an AI-powered digital decision-support tool. It will also involve prototyping to demonstrate how this AI-driven decision support tool can enhance decision confidence, improve diagnostic accuracy, reduce uncertainty, and streamline documentation

Alexis Boone
Graduate Program: Graphic and Experience Design
Advisors: Kermit Bailey and Deborah Littlejohn
Poster Number: 19

Navigating the College Transition: Building Self-Advocacy through Mobile Communication for Pre-College Students Living with Sickle Cell Disease

Sickle Cell Disease (SCD) affects approximately 100,000 Americans, predominantly African Americans, posing significant challenges during the transition to adulthood. Pre-college students with SCD must navigate evolving needs, balance personal and academic goals, and effectively communicate their experiences, often facing stigma and misunderstanding. Current SCD transition programs neglect broader communication needs crucial for independent living and psychosocial well-being. This research investigates these challenges and explores the development of a user-centered mobile communication app to empower pre-college students with SCD as they prepare for higher education. This project centers on creating a personalized app that supports students in building self-advocacy and navigating the college transition. The app incorporates daily gratitude journaling, which has been shown to reduce stigma and promote self-acceptance by fostering positive self-perception. Importantly, the app leverages AI to analyze journal entries and suggest tailored prompts, enabling users to create targeted messages for diverse key individuals and improving communication effectiveness in various academic and social settings. These prompts empower students to communicate their needs and experiences. The app also allows for automated messaging for key contacts during crises or absences, ensuring timely support. Leveraging behavior-change techniques, the app aims to build self-advocacy and confidence over time, fostering greater independence in communicating beyond clinical settings. Preliminary design and user feedback will inform iterative development. This innovative approach addresses the limitations of existing programs by equipping pre-college students with SCD to effectively communicate with healthcare providers, educators, and peers, ultimately promoting smoother transitions to college and improved quality of life. This user-centered app has the potential to significantly improve communication skills, reduce stigma, and empower pre-college students with SCD to successfully navigate the complexities of higher education and independent living.

Sara Fisher
Graduate Program: Design
Advisor: Tania Allen
Poster Number: 56

Queer Video Game Mechanics

This research expands on the observations of queer game developers and researchers to consider how the structure of rules in game design can be reframed through a queer perspective, which challenges and subverts heteronormative social rules. Over the past 20 years, the means to develop games has become much more openly accessible, which has allowed the opportunity for unique and exploratory game design by queer developers. With the use of a grounded theory methodology, this research aims to develop a theory of queer game mechanics through the documentation and analysis of existing queer games.

Shruti Gandhi
Graduate Program: Industrial Design
Advisors: Kelly Umstead, Audrey Barnes, and Sharon Joines
Poster Number: 64

Reducing Neck Strain in Dentistry: An Ergonomic Solution

Dentists face significant physical strain due to prolonged static postures and repetitive movements, leading to a high prevalence of musculoskeletal disorders (MSDs). Despite the use of loupes, designed to reduce neck flexion, and ergonomic stools, observational studies and interviews reveal that dentists still experience excessive neck flexion when accessing deeper angles inside a patient's mouth, particularly during restorative procedures that last one to two hours. This prolonged strain contributes to chronic pain, fatigue, and long-term spinal issues, increasing the risk of developing musculoskeletal disorders beyond short-term discomfort.

This research investigates the limitations of current ergonomic solutions and takes a human-centered design approach to enhance visibility without compromising posture. Utilizing qualitative interviews, observational studies, and ergonomic analysis, the study identifies critical pain points and gaps in existing tools. The findings emphasize the need for a more adaptable visualization system that allows dentists to maintain a neutral posture while achieving full intraoral visibility.

The proposed solution integrates adaptive visual technology that eliminates the need for excessive neck movement, offering greater comfort, precision, and efficiency during procedures. Through iterative prototyping and user testing, the design aims to provide a seamless and intuitive integration into dental workflows. By addressing a fundamental ergonomic challenge, this project not only improves the well-being and performance of dental professionals but also underscores the role of industrial design in advancing healthcare ergonomics.

Lira Gomes
Graduate Program: Advanced Architectural Studies
Advisor: Shawn Protz
Poster Number: 69

Terroir, Typologies, and Circular Economies

Originally rooted in French language, terroir refers to "...the impact of all sorts of natural forces - soil condition, sun, wind, and rain - that enables us to bring primary produce to the table with its own distinctive characteristics" (Meyer, n.d.). More broadly, the term terroir is used to describe the intrinsic identity of a place and its geographical relationship between produce and land. These natural and physical systems of terroir shape not only cuisine but also culture, taste, history, and overall landscape (Hermansen, 2012).

In the context of food, terroir embodies the taste of a place through locally sourced ingredients and culinary techniques that highlight the essence of a dish. Design terroir can be similarly described as the constructed identity of a space and embedding locality through site context, materials, and processes. Much like food terroir, design terroir extends beyond the final product but rather the interconnected systems that prioritize flow over static outcomes, resilience over resistance, longevity over short-term gains—all contributing to the development and identity of a community.

This research investigates food terroir as a framework to reframe architectural design processes.The development of this design process embraces the methodologies of circularity and critical regionalism guided by principles of adaptability, locality, and economy. This approach overcomes resistance to globalization and fosters resilient design alongside 21st century economic thinking- social adaptability, regenerative design, and context-sensitive solutions. Through comparative analysis of case studies on food and architecture, alongside the discourse on circular economies, this study formulates a methodology—akin to a recipe—to recenter design practices in the context of North Carolina.

J.D. Harris
Graduate Program: Industrial Design
Advisors: Yuanqing "Ching" Tian, Kelly Umstead, and Connor Irwin
Poster Number: 75

Laparoscopic Entry: Rethinking Ergonomics and Visualization

Laparoscopic surgery is a widely used minimally invasive technique for common abdominal procedures. This approach utilizes a laparoscope, a long, thin camera inserted through small holes in the abdominal wall, providing real-time visualization of the internal organs. Long, thin surgical instruments are introduced through separate access points to manipulate, cut, and suture tissues. While laparoscopic surgery offers significant benefits over conventional "open" surgery—such as reduced blood loss and minimal scarring—the initial entry into the abdomen remains a high-risk maneuver, with errors resulting in life-threatening complications for the patient.

Trocars, handheld stake-like devices, are essential for laparoscopic entry, helping surgeons puncture through the abdominal wall and create ports for the laparoscope and surgical instruments. Traditional trocars are inserted blindly, requiring experienced hands to place them precisely and avoid injuring internal organs and blood vessels. Newer optical trocar designs feature a transparent sharp end, allowing the laparoscope to be used for visualization during entry. Despite these advancements, surgeons report ergonomic and usability concerns with current devices.

This research investigates the ergonomic challenges associated with optical trocar devices and their impact on surgeon technique and perception. Through initial surveys and interviews with laparoscopic surgeons, key pain points were identified, including muscle fatigue with extended use and obtrusive cables. Simulated entry procedures with market-available trocars further validated these concerns. Insights from these findings informed user needs and guided the ideation and prototyping of improved trocar designs. A usability study is underway to evaluate a variety of prototypes based on performance, perceived comfort, and muscular effort. Alternative modes for visualizing entry will also be investigated. By rethinking modern trocar design, this research aims to help enhance surgeon confidence, reduce fatigue, and improve the overall safety of laparoscopic entry.

Matthew Hawks
Graduate Program: Design
Advisor: Soolyeon Cho
Poster Number: 77

Engineering Framework for Thermal Mass Energy Storage: Design Development and Case Study Evaluation

Thermal Energy Storage (TES) for building heating and cooling offers a unique opportunity to leverage several system benefits while also solving a critical energy challenge. Demand side TES systems can support grid flexibility via peak load shifting and other Demand Side Management (DSM) strategies, which reduce peak loads and thereby energy demand. More impactfully, TES can unlock the utilization of intermittent energy supplies like Renewable Energy (RE) and passive thermal energy for a major energy consumption. Therefore, this design research study develops the engineering framework and evaluates the applied performance of building-scale, thermal mass-based TES for building heating and cooling systems. First, a framework for Thermal Mass Energy Storage (TMES) is developed using several design constraints and a cellular architecture. Transient thermal computer modeling and simulation is used to analyze the TMES battery cell thermal performance and to optimize the cell physical properties for thermal capacity and power. The completed TMES framework utilizes optimized cells operated in parallel to create battery packs. Then, the TMES framework is applied to three existing Case Study Buildings (CSB) of different commercial building types located in Raleigh, North Carolina. TMES batteries are designed for each CSB based on the building drawings and the utility data's peak heating day load. Battery cells are designed first for each CSB and then scaled in quantity to meet the required capacity and power loads. The results of the case studies demonstrate that the TMES framework can scale to match any desired thermal load while remaining flexible to fit within buildings with minimal impact. The TMES framework has additional benefits relative to other battery technologies, such as no safety risks, no degradation from cycling, easy construction and operation, and minimal maintenance. The TMES framework provides simple yet robust TES that can passively power building heating and cooling systems.

Amber Johnson
Graduate Program: Art + Design
Advisor: Marc Russo
Poster Number: 86

Crafting the Unreal: Translating Surrealist Stop-Motion Aesthetics into Immersive VR Experiences

This project explores how virtual reality (VR) and game technologies can use remediation theory to translate traditional surrealist stop-motion animation aesthetics. Drawing inspiration from Edgar Allan Poe's "Ligeia," the project puts handcrafted stop-motion models into an immersive VR experience using photogrammetry. This method preserves the tactile qualities of physical art while recontextualizing it within an immersive digital space. In the virtual world users won't be a passive observer. Instead, they assume the identity of an avatar to navigate and interact with surreal scenes. Physical details and digital overlays merge seamlessly. This interactive environment illustrates how remediation transforms legacy art forms, elevating them into vibrant, engaging experiences and bringing relevance to newer ones. By merging historical art forms with modern technology, this project opens new avenues for interactive expression. The Ligeia project serves as an example of this process. Records of each stage, from capturing handcrafted models to integrating them into the VR environment, offer valuable insights for artists and technologists seeking to explore similar approaches. This documentation not only highlights technical and aesthetic considerations but also underscores the broader implications of remediation theory. It demonstrates how established art forms can be revitalized, and the potential of games and VR to be shown as legitimate art mediums. The project invites contemporary audiences to engage with classic narratives in new ways. It also contributes to the ongoing discussion on the evolution of art in the digital age.

Paige Kanipe
Graduate Program: Advanced Architectural Studies
Advisors: Dana Gulling and Traci Rider
Poster Number: 89

Building Deconstruction for Reuse and Recycling

The U.S. generates approximately 600 million tons of construction and demolition waste (CDW) annually, contributing to significant environmental impacts. This project investigates deconstruction, a process that prioritizes the careful disassembly of buildings to recover materials for reuse and recycling, offering a more sustainable alternative to traditional demolition.

Focusing on a recently completed campus building, this study conducts a material inventory to assess recoverable resources and evaluates current deconstruction practices to identify opportunities for maximizing material recovery. Additionally, the project explores reuse and recycling pathways, examining how architectural materials can be reintegrated into new construction or repurposed. Based on these findings, the study will propose design modifications that facilitate future deconstruction efforts, enhancing resource conservation and minimizing waste.

This research advocates for a regenerative approach to the built environment—one that prioritizes circular material use and long-term sustainability by shifting the perception of buildings from disposable structures to material banks. Through thoughtful design and planning, deconstruction can become a key strategy in reducing CDW, lowering environmental impact, and promoting material stewardship in architecture and construction.

Leo Li
Graduate Program: Media Arts, Design, and Technology
Advisors: Patrick FitzGerald, Topher Maraffi, Justin Johnson
Poster Number: 100

Meta-AI: Designing Realistic Human-AI Interactions with Lifelike Embodied Agents

Advancements in artificial intelligence have significantly improved digital human simulation, yet achieving natural and lifelike interactions remains a challenge. Meta-AI is an experimental research project focused on developing AI-powered virtual humans capable of dynamic engagement. This study investigates effective methodologies for enhancing human-AI interaction by integrating Convai's AI platform with Unreal Engine's Metahuman technology, enabling the design and animation of high-fidelity digital avatars.

Unreal Engine provides procedural 3D character creation, real-time facial animations, and dynamic interactions, while Convai's context-aware AI capabilities, speech processing, and behavior modeling enhance the avatars' ability to engage in spatially aware, emotionally responsive, and adaptive conversations. Additionally, the Leonardo da Vinci AI project integrates graphic design elements to create a historically immersive experience. This includes the use of 3D-scanned period-accurate costumes, detailed 3D models of Leonardo's inventions and artifacts for interactive demonstrations, and scene design in Unreal Engine to authentically recreate a Renaissance-era setting.

Through iterative prototyping, including the Leonardo da Vinci AI prototype, this research refines AI-driven avatars to simulate natural emotional and behavioral responses, optimizing their adaptability for interactive digital experiences in education, gaming, and professional applications.

This work contributes to the evolving field of Human-AI Interaction by providing insights into design principles, digital character design, and real-time AI-driven interactions. By advancing lifelike embodied agents through a design-centric approach, Meta-AI explores new possibilities for creating visually and behaviorally realistic AI avatars that enhance user engagement across various digital environments.

Abigail Morris
Graduate Program: Design
Advisors: Justin Johnson, Iyare Oronsaye, and Andres Tellez
Poster Number: 116

Handmade Horizons: Game Design Study Highlighting Imposter Syndrome Experienced by Women in the Creative Fields

I aim to design a video game that explores the psychological foundations of player engagement and creativity while seamlessly integrating game mechanics that enhance storytelling and gameplay. I will use self-determination theory as the theoretical framework for the game's overall design to subtly provide players with resources for self-reflection with visual metaphors and game interaction. The game's premise will abstractly represent my personal experience with Imposter Syndrome and highlight the confidence I gained when I began world-building through play. By addressing these themes, the game will foster a sense of relatedness, encouraging players to reflect on their own experiences with imposter syndrome and fear of failure. Through interactive mechanics and narrative elements, players will confront these issues while maintaining emotional distance, allowing them to process the content without feeling overwhelmed. As part of this project, I will develop a game design document that outlines key design elements aimed at improving player experience alongside a vertical slice of gameplay. This vertical slice—a polished segment of the game—will showcase core mechanics, visual style, and overall player experience, serving as a demo for stakeholders to visualize the game's potential. It will demonstrate how players engage in world-building as they explore the game map. The project scope includes designing the game's mechanics and structuring the storyline to ensure a comprehensive understanding of its technical aspects, reflected in both the game document and the vertical slice. I aim to deliver a polished vertical slice that exemplifies the creative, technical, and theoretical aspects of my thesis work. Establishing the foundation for this game will propel me toward creating an honest and engaging experience that explores the universal challenge of self-belief—an experience that blends self-reflection with playful discovery.

Marina Mustakova
Graduate Program: Advanced Architectural Studies
Advisor: Thomas Barrie
Poster Number: 121

The Role of Housing in Developing a Sense of Belonging of International Migrants

Migration has been on the rise. The war conflicts, natural disasters, and unforeseen challenges continue to grow the influx of displaced people around the globe. While there are a plethora of developments that focus on the physical aspects of migrant settlements, this study unfolds the social dimensions of housing, examining how the built environment can foster a sense of belonging and help migrants find a place to call home. The research is structured around three core subjects: sense of belonging, migrant community, and housing. The study specifically explores the sense of belonging within the framework of the built environment, home, place, and migration. Investigating relevant articles, books, and studies within a literature survey provided the theoretical foundation to explore the concept of sense of belonging, establish its key definition, determine its primary aspects, and examine the factors influencing its development or lack thereof. To complement the theoretical framework, data analysis was conducted using U.S. Census data, migration institution reports, and maps to analyze the national migrant community and identify a specific group for further study. Community engagement through interviews and surveys provided valuable insights about migrants' housing experiences and the challenges they encounter. Additionally, a precedent study of recently built social housing projects was carried out to explore what design approaches architects employ nowadays to create an affordable and sustainable environment for migrants, while nurturing their sense of belonging. The research concludes by identifying three key principles of housing that can support international migrants in integrating into a new environment and fostering a sense of belonging. The study outlines potential areas for further research such as developing Belonging Index to assess neighborhoods and communities, an examination of homeownership policies for migrants in the US, and an exploration of alternative housing models, such as co-housing, that better address migrants' needs.

Olha Novikova
Graduate Program: Graphic and Experience Design
Advisors: David Oh and Deborah Littlejohn
Poster Number: 127

From Bureaucracy to Usability: Rethinking Public Service Design

Government services are often difficult to navigate, leaving users frustrated and underserved. These services, ranging from filling out forms to accessing benefits, are often built around bureaucratic processes rather than the needs of the people who use them. This thesis project examines how User Experience (UX) research tools, driven by emerging technologies, can reshape the design of public sector services by gathering diverse user insights, creating adaptable personas, and improving communication with key stakeholders. By incorporating user feedback, digital twins, and data visualizations, the project aims to make government services more inclusive, efficient, and centered around the user. Ultimately, it seeks to streamline the design process for essential services, ensuring they are better aligned with user needs while enhancing accessibility for everyone.

Jabria Oliver
Graduate Program: Industrial Design
Advisors: Kelly Umstead and Yuanqing Tian
Poster Number: 132

Tackling Period Poverty for Homeless Women

Homeless women are disproportionately impacted by period poverty, the inability to consistently access menstrual products, and private sanitation facilities to change, clean, and dispose of their menstrual waste hygienically. Semi-structured interviews revealed that financial constraints and living conditions compel homeless women to use unsafe alternatives for managing their periods, such as makeshift products made from tissue, rags, socks, or plastic bags. Others extend the use of disposable products beyond recommended durations, increasing their risk of infections such as Toxic Shock Syndrome (TSS). Frequently, these women must make the difficult choice between purchasing menstrual products and necessities like food, often opting for the latter due to limited resources. Many homeless women depend on shelter and organization donations for menstrual products, but these resources are usually inconsistent, limited in quantity, and do not always meet menstrual flow needs. Additionally, findings reveal that current menstrual products do not fully support their circumstances: disposable options require continuous purchasing, reusable products have high upfront costs and require special cleaning, and free menstrual product vending machines are sparsely located. When menstrual products are obtained, finding a safe place to change and clean oneself remains difficult due to stigma and restricted restroom access. Surveys and interviews with shelter staff and homeless women revealed key design considerations: accessibility, affordability, and independence.

This research adopts a human-centered design approach to tackling period poverty by prioritizing iterative user feedback to alleviate these challenges. Participants have reported feelings of shame, stress, and vulnerability about the inability to manage their menstrual hygiene properly. Analysis of the primary source data informs a design solution of a hybrid reusable-disposable menstrual product requiring minimal water requirements. This study seeks to combat period poverty and inspire the development of menstrual hygiene solutions that restore dignity and improve the quality of life for homeless women.

Iyare Oronsaye
Graduate Program: Doctor of Design
Poster Number: 133

Mapping GenAI's Role in Animation Production: A Multisystem Approach Using Bronfenbrenner's Model

Integrating Generative Artificial Intelligence (GenAI) into animation production presents both transformative opportunities and significant challenges. This research employs Bronfenbrenner's Ecological Systems Theory to analyze how GenAI reshapes creative decision-making, production accessibility, and organizational structures, particularly for independent creators and newcomers. By leveraging a phenomenological approach, the study explores the lived experiences of creators and stakeholders engaging with GenAI in their production workflows. Through qualitative methods, the research examines how AI-driven automation enhances creativity, streamlines workflows, and fosters inclusivity within the animation industry.

Additionally, this study explores how Decentralized Autonomous Organizations (DAOs) may disrupt traditional studio hierarchies by enabling more collaborative and equitable creative environments for both human-to-human and human-to-machine collaboration. While GenAI and DAOs create new possibilities for decentralizing content production, they also raise ethical questions concerning authorship, ownership, and potential bias in AI-generated media. The findings contribute to a broader conversation on the intersection of AI, decentralized governance, and creative industries, offering insights into how emerging technologies can challenge and enrich animation production practices.

By employing Bronfenbrenner's multisystem framework, this research provides a holistic view of GenAI's impact across production ecosystems, from the microsystem level of individual creators to the macrosystem level of industry-wide transformations. Ultimately, the study highlights strategies for sustainably integrating AI-driven tools while preserving artistic originality, ensuring inclusivity, and addressing key ethical considerations in AI-assisted creativity.

Rebecca Planchart
Graduate Program: Graphic and Experience Design
Advisor: Helen Armstrong
Poster Number: 141

Visualizing System Capabilities and Limitations: Designing Automated Decision-Support Tools to Augment Human Discretion in Child Welfare

Child welfare systems are increasingly adopting data-driven tools to enhance objectivity and efficiency in case management (Petersen et al., 2020). However, effectively leveraging these tools requires a clear understanding of their strengths and limitations (Tomsett et al., 2020). This project explores how visualizing system capabilities and limitations in automated decision-support tools can enhance human-machine teaming and enable social workers to appropriately leverage their expertise in high-stakes decision-making scenarios. Grounded in principles of explainable AI (XAI), this project investigates how user experience and interface design techniques can promote transparency, mitigate bias, and improve human-AI collaboration. Using a human-centered design methodology, this project incorporates case studies, stakeholder interviews, and iterative prototyping to examine the impact of system transparency, interpretability, and user engagement on decision-making processes. The findings propose key user experience and interface design strategies to augment human decision-making and foster deeper cognitive engagement.

Kelby Stallings
Graduate Program: Landscape Architecture and Environmental Planning
Advisor: Gavin Smith
Post Number: 166

From Parks to Preservation: Community Design on the Gulf Coast

This poster explores a 3-month internship with the Gulf Coast Community Design Studio in Biloxi, Mississippi. The studio, based out of Mississippi State University, is a non-profit firm established following Hurricane Katrina to provide disaster and climate resilient design and planning assistance to local communities. The Gulf Coast is a complex, dynamic system supporting diverse pollinators and migratory birds, critical waterways for fisheries, and a multi-cultural community of people. It is vulnerable to natural hazards such as sea level rise, saltwater intrusion, tropical storms, hurricanes, storm surge, and flooding, which are exacerbated by the impacts of climate change.

Throughout this internship, I applied systems and design thinking strategies to climate change issues. Systems thinking generates an understanding of the interconnectedness between social health and well-being, ecosystem diversity and preservation, and disaster preparedness and recovery. Design thinking uses visual media to convey how local projects support community climate resilience by addressing components of the complete system.

My internship addressed projects including park and memorial designs, bayou restoration planning, and a coastal hazards overlay district guide. This type of community design work requires consistent grant funding, local partnerships, and the creation of aesthetic and attainable designs to promote local climate resilience.

Erin White
Graduate Program: Design
Advisors: Tania Allen and Kofi Boone
Poster Number: 184

Applying Policy Integration to Regional Food Systems Transformation Strategies: Participatory Action Research in the Sandhills Region of North Carolina

Social, economic, and environmental crises are challenging our contemporary food system. In response, many scholars have called to radically transform the food system. Food systems transformation strategies adopt systemic, participatory approaches to address multiple food system issues with diverse actors, connecting food system sectors, scales, and localities. Policy and planning approaches provide mechanisms of control and change in the food system, but often act in silos that reduce their capacity for structural transformation. The theory of policy integration offers a framework to understand the nature and potential of intersecting sectors, scales, and localities being purposefully connected to solve cross-cutting societal challenges, such as food. Policy integration is well understood as an analytic framework for change, but greater research is needed in the practical application of the theory. That is, how might policy integration be used to develop new strategies for food systems transformation? This qualitative study seeks to answer that question through a regional food systems planning project using a participatory action research methodology, where policy integration principles will be explored as a planning frame and analytic strategy for a series of participatory design workshops. This study intends to generate a co-created planning product to advance a regional food system transformation as well as new knowledge explaining how policy integration theory can be applied to food systems transformation strategies.

College of Education

Margaret Borden
Graduate Program: Mathematics Education
Advisor: Erin Krupa
Poster Number: 20

Investigating Mathematics Teachers' Interactions with Curricular Resources: Selecting and Adapting for Project-Based Learning

This study explores how secondary mathematics teachers who use project-based learning (PjBL) interact with curricular resources to plan projects for their classes. While much of the existing research on PjBL focuses on classroom implementation, this study centers on the planning process, drawing directly from the expertise of teachers engaged in this work. Using a multiple case study design, the study first surveyed 145 secondary mathematics teachers who use PjBL to identify their curricular interaction preferences—off-loading, adapting, or improvising. Then five of the teachers (two off-loaders, one adapter, and two improvisers) participated in semi-structured and clinical interviews, providing deeper insights into their planning approaches. Findings indicate that most PjBL mathematics teachers favor adapting or improvising rather than off-loading curricular materials, largely due to the limited availability of high-quality PjBL resources for secondary mathematics. Regardless of interaction preference, teachers shared a common approach to resource-seeking: they prioritized aligning learning objectives with real-world contexts. However, improvisers were distinct in their strong emphasis on external audiences, leveraging professionals outside the classroom to enhance authenticity, whereas off-loaders struggled to incorporate this element. These findings have implications for the development of PjBL resources, professional learning, and policy support for mathematics teachers. As the push for innovative STEM instruction continues, creating conditions that support effective mathematical PjBL will require investment in high-quality curricular resources, professional development tailored to teachers' interaction preferences, and structural support within schools. This study contributes to the growing body of research on PjBL by offering a detailed look at how mathematics teachers engage with curricular materials in the planning phase, highlighting opportunities to better support teachers in designing meaningful and authentic mathematical learning experiences.

Robin E. Bulleri
Graduate Program: Learning and Teaching in STEM
Advisor: Soonhye Park
Number Poster: 26

New Standards, New Strategies? - A Study of Rural North Carolina Science Teachers' Perceptions and Integration of Science and Engineering Practices in Light of New Standards

This study examined how rural high school science teachers in North Carolina perceived, planned, and implemented the newly adopted North Carolina state science standards, which emphasize Science and Engineering Practices (SEPs) as a means for students to learn the concepts, procedures, and epistemology of science. These standards represent a shift from traditional, teacher-centered approaches to a more dynamic, student-centered model that mirrors the practices of real scientists. However, integrating SEPs presents challenges, particularly in rural schools, where limited resources and support complicate the transition. This research examines how teachers navigated these changes over a semester, focusing on their experiences with the SEPs and identifying the barriers and supports they encountered. Using a mixed-methods design, the study combined quantitative data from the Science Instructional Practices survey (Hayes et al., 2016) and qualitative data from constructed response survey items and semi-structured interviews with science teachers in a rural North Carolina district. The findings showed that teachers' positive perceptions of the SEPs remained constant over the semester. Teachers reasoned that the SEPs were beneficial to student science learning by addressing critical thinking skills, mathematics and computational thinking, and methods of inquiry. Teachers' planned and actual implementation of the SEPs were mostly aligned, although teachers reported differences in their ways they approached teaching many of the SEPs, such as incorporating lessons that used guided inquiry and data analysis. As such, this study underscores the need for context-sensitive support to ensure effective SEPs integration in rural schools, ultimately contributing to better science education outcomes in rural areas. While implementing the new standards, teachers faced significant challenges related to time, resources, and professional development opportunities. Teachers also reported receiving extensive support from school and district administrators as well as their Professional Learning Communities. This study provided insights into the challenges and supports rural teachers faced when implementing new science standards, like a lack of resources and challenges with student readiness. Further, this study makes commendations for refinements in teacher education to address the SEPs, subject-specific professional development, and resource allocation.

Laura Chalfant
Graduate Program: STEM Education
Advisor: Soonhye Park
Poster Number: 29

Investigating the Role of Science Practices and PCK in the Implementation of Modeling Instruction

This study investigated the relationship between teachers' pedagogical content knowledge (PCK), use of science practices, and the implementation of Modeling Instruction (MI) in high school biology classrooms. Informed by both the Refined Consensus Model and the Pentagon Model of PCK, we analyzed how teachers' personal and enacted PCK influenced their use of MI over one school year. This study utilized a multiple case study approach wherein we analyzed data from three biology teachers who participated in professional development focused on MI. The study examined teachers' use of science practices using the Science Instructional Practices Survey (SIPS), observed classroom practices using the Modeling-Based Teaching Observation Protocol (MBTOP), and teachers' PCK using the PCK mapping approach. We found teachers with more complex PCK demonstrated higher fidelity in MI implementation and that the relationship between MI implementation and use of science practices in instruction deviated from the expected patterns developed in previous research. This study highlights the importance of PCK in curriculum implementation and highlights the need for more investigation into the relationship between modeling instruction and the use of science practices in instruction. This research has implications both for research and those involved in designing and delivering teacher professional development.

Jessica Chestnut
Graduate Program: Education, Learning and Teaching in STEM
Advisor: Carla Johnson
Poster Number: 33

Development and Initial Validation of the Undergraduate Introductory Chemistry Students' Experiences Survey

Undergraduate introductory chemistry is a gatekeeping course preventing students from persisting in STEM degree programs. It is important to understand students' experiences of introductory chemistry to provide insights on how to retain students at the course level and further inform possible routes for academic interventions and curriculum reform. Literature has previously focused on a multi-disciplinary approach to understanding students' motivations in STEM programs and has not highlighted individual introductory courses. Additionally, community colleges are often left out of research efforts, despite the critical role they play in educating STEM students. This study reports on the development and initial validation of a survey instrument to measure undergraduate introductory chemistry students' experiences and their identity-based motivation at both four-year universities and community colleges. The pilot survey was initially reviewed by content experts in chemistry and education before its deployment in the Fall 2024 semester through the Qualtrics platform. The 28 survey items were administered to four-year university and community college students across a southeastern US state. Cognitive interviews with 8 students were conducted to inform item revisions based on students' interpretations. The 90 completed surveys were analyzed by exploratory factor analysis (EFA) in STATA. The EFA results indicated a three factor model with Cronbach's alpha for internal consistency reported at 0.9061. One item was eliminated due to high skewness and kurtosis values, and four items were eliminated due to crossloadings on other factors. The final 23 items will be administered to four-year universities and community colleges across five southeastern US states in Spring 2025 for confirmatory factor analysis. Additionally, linear regression models will examine the relationship between students' chemistry course experiences, identity-based motivations, and ability beliefs along with any differences that may arise based on student demographics and institution type.

Jennifer DeLarm
Graduate Program: Teacher Education and Learning Sciences, Learning Design and Technology
Advisor: Julia McKeown
Poster Number: 42

Enhancing Student Motivation in Higher Education for Marginalized Populations with Technology and Artificial Intelligence: A Systematic Literature Review

Recent research on student motivation in higher education highlights significant disparities in technology access and integration, as well as varying levels of institutional support for marginalized populations. The purpose of this study was to investigate current research on the role of technology and Artificial Intelligence (AI) in improving student motivation among marginalized populations in higher education. The systematic review analyzed peer-reviewed empirical studies that addressed the research questions, focusing on technology integration and access, institutional support, and student motivation outcomes. Initial findings suggest that addressing technological barriers and structural inequities through a multi-faceted institutional approach is essential for enhancing student motivation. Recommendations for future research should examine (1) specific institutional interventions that effectively bridge the digital divide, (2) the long-term impact of technology support programs on student motivation, retention, and success, and (3) equitable implementation strategies for AI-enhanced learning tools that support marginalized student populations. Further examination of these topics will provide institutions with evidence-based approaches to create inclusive digital learning environments and improve student motivation for marginalized populations.

Mariam Elias
Graduate Program: STEM Education
Advisor: Aaron Clark
Poster Number: 51

Online Curriculum: Technology & Engineering Teachers in Higher Education in Transitioning to Online Teaching as They Engage in Online Curriculum Development

In an era where technology and engineering play an increasingly integral role in daily life, ensuring literacy in these fields is critical. Technology and Engineering (T&E) education is traditionally rooted in hands-on, project-based learning, making the transition to online teaching particularly complex. The COVID-19 pandemic accelerated this shift, forcing higher education faculty to adapt face-to-face instruction to virtual platforms with little preparation. This transition raises fundamental questions about how educators develop online curricula while maintaining the integrity of hands-on learning experiences.

This study investigates the experiences of higher education T&E instructors as they navigate online curriculum development. Using a hermeneutic phenomenological methodology, this research explores the challenges and pedagogical content knowledge (PCK) required for effective online instruction in T&E education. The study will focus on educators who are members of the International Technology and Engineering Educators Association (ITEEA) and have transitioned their in-person Technology and Design Education (TDE) courses to an online format. Data collection will involve two semi-structured interviews per participant, providing deep insight into their lived experiences, instructional strategies, and curriculum adaptation processes.

Findings from this study will contribute to the broader understanding of how technology and engineering educators conceptualize online curriculum development and implement effective online teaching practices. The study aims to identify essential pedagogical strategies that support student engagement, hands-on learning, and knowledge transfer in a virtual environment. Insights gained will inform best practices for designing effective online T&E curricula, ensuring that educators are equipped with the necessary skills and frameworks for future online learning transitions. By addressing the pedagogical shifts required for online T&E instruction, this research seeks to advance the discourse on engineering and technology education in the digital age.

Stephanie Fiocca
Graduate Program: Teacher Education and Learning Sciences
Advisor: Sarah J. Carrier
Poster Number: 55

K-12 Teachers' Experiences Completing an Environmental Education Certification Program: A Mixed Methods Study

Teachers who have an interest in expanding their content knowledge and instruction in environmental education (EE) may choose to participate in an Environmental Education Certification Program (EECP). There are currently 13 states that offer this certification and while each program is unique, they are all grounded in common EE and professional development guidelines. Using a convergent mixed methods study design, this research examines K-12 teachers' motivations for seeking and completing an EECP, their experience with the program, and their perceptions of how the program influenced them professionally and personally. Understanding teachers' motivations to seek and complete an EECP may provide important insights into the role of specialized certification on teacher's practical implementation.

Quantitative data from an online survey are supplemented by in-depth interviews with a purposeful sample of teachers that represent the range of states' EECP programs and varying professional teaching experiences. A convergent mixed methods approach integrates survey and interview data to tell the story of teachers' experiences with EECPs and its applications in their classrooms.

This study contributes to the broader field of EE and K-12 education literature by examining teachers' motivations to participate in an EECP and its influence on teachers' lives and teaching. Exploring teachers' experiences could lead to meaningful insights for EECP programs about teacher motivations for pursuing EECP despite having limited financial or professional gains. These findings can also benefit teachers considering pursuing and completing EECPs. Additionally, understanding the influence of EECPS on teachers' instruction can further inform EECPs support for K-12 teachers sharing EE with their students.

Anna Howard
Graduate Program: Elementary Education in Mathematics and Science
Advisor: Temple Walkowiak
Poster Number: 83

Transitioning from Learner to Teacher: The Development of Mathematical Identity in Elementary Prospective Teachers

Research over the last few decades has shown the importance of mathematical identity development in both learners and teachers. However, more research needs to be conducted on the development of mathematical identities in prospective teachers who are beginning to develop their professional teacher identity during their mathematics methods courses. The purpose of this study was to conduct a thematic analysis and develop a collective narrative around the development of mathematical identity in prospective teachers over the course of the junior year in a teacher education program. In order to accomplish this, artifacts were collected at the beginning of the first mathematics methods course and then at the end of the second mathematics methods course. The first artifact was used to determine themes that arose when investigating the previous mathematics experiences of elementary prospective teachers at the beginning of their mathematics methods courses in their teacher preparation program, as well as what possible selves they envisioned for their future as a mathematics teacher. For the second artifact, elementary preservice teachers were asked to reflect on their experiences over the course of the year and any influences on their mathematical identity. The purpose of collecting data at these two time points was to determine how elementary prospective teachers' mathematical identity shifts, if any, over the course of their first year in a teacher preparation program and to determine what factors they believe influenced them. The analysis of these two artifacts showed that themes arose across the participants based on their learner mathematical identity development in previous years. In addition, during their year in the teacher education program shifts began to occur in their mathematical identity development as a teacher. These findings may have implications for the development and implementation of mathematics methods courses, but more research is needed to support these conclusions.

Aisha Kanwal
Graduate Program: Educational Leadership, Policy and Human Development
Advisor: Alyssa Rockenbach
Poster Number: 90

Social Media and Digital Presence: A Tool for Advancing Women's Leadership in Higher Education

Despite progress in gender equity, women remain underrepresented in higher education leadership. Digital presence has emerged as a powerful tool for enhancing visibility, networking, and influence, enabling women to navigate traditional leadership barriers. This poster explores how social media fosters professional branding, mentorship, and policy advocacy, contributing to leadership development for women in academia. Drawing on intersectional feminist leadership theory and digital capital theory, the study examines the benefits and challenges of digital engagement, including gender bias, online harassment, and institutional resistance. Through analyzing existing literature, case studies, and social media trends, this work highlights the best practices for leveraging digital presence to amplify women's voices and advance leadership pathways. Recommendations for institutions and women leaders emphasize strategic digital engagement, institutional recognition of online leadership, and policies ensuring digital safety. This research underscores the transformative potential of social media in shaping equitable leadership opportunities for women in higher education.

Amber J. Meeks[1], M. Gail Jones[1], Caitlin Haedrich[2], Kathleen Bordewieck[1], Tanzimul Ferdous[1], Adrian Kuhlman[1], Madeline Stallard[1], and Toluwalase Salako[1]
Graduate Programs: Learning and Teaching in STEM[1]; Geospatial Analytics[2]
Advisor: M. Gail Jones
Poster Number: 111

The Efficacy of Tangible Augmented Reality as a Tool for Teaching Phosphate Sustainability

Excess phosphate runoff poses a significant threat to life. An estimated 1.62 billion tons of phosphate runoff invade our freshwater annually, increasing the likelihood of contamination, toxins, and fish kills. Yet, in K-12 and public education, there is little communication and research on tools used to teach this topic. Although immersive and interactive tangible augmented reality tools have been used to model and engage students with earth science phenomena, these tools have not been used to model phosphate runoff in K-12 settings. This mixed methods study examined the efficacy of learning with a Tangible Landscape System by comparing the learning gains of students who participated in traditional 2D instruction. Pre and post-assessments were used to calculate and measure student learning gain scores from pre to post-intervention. Results showed that treatment students had significantly higher gain scores than control students. Interviews with case study treatment (n=22) and control (n=23) students revealed that treatment students relied on dynamic visualization and haptic feedback of the Tangible Landscape System when making decisions, while the control group relied on static visualization (color and landmarks). Given the findings of this study, future studies should examine the specific affordances of the Tangible Landscape System for learning geoscience concepts and farm runoff processes and measure how these systems aid in information processing.

Doreen Mushi
Graduate Program: Teacher Education and Learning Sciences
Advisors: Kevin Oliver and Shiyan Jiang
Poster Number: 119

Exploring the Development of Learning Analytics Skills Among Early-Career Educational Researchers in a Community of Practice

This study explores the development of learning analytics skills among early-career educational researchers through their participation in a learning analytics community of practice. Learning analytics skills are becoming increasingly crucial, as they offer the potential to generate actionable insights into learners and their learning environments. Learning analytics communities of practice have been playing a crucial role in supporting development of learning analytics skills among education researchers. However, despite the emergence of learning analytics professional learning programs, little is known about how researchers acquire these skills while participating in such programs.

This instrumental case study investigates a learning analytics community of practice offered by a university in the Southeastern United States. The study participants are four early-career education researchers who took part in the program during the summer of 2024, engaging in labs on machine learning, text mining, and social network analysis. The study is guided by two research questions: (i) How does participation in a learning analytics community of practice influence the development of learning analytics skills among education researchers? and (ii) What are the key design principles for developing effective learning analytics communities of practice?

Data were collected through semi structured interviews, observation, and document analysis of participants' learning deliverables such as code scripts, datasets, and instructional plans. Using thematic analysis, the findings indicate that participation in the community of practice contributed to the development of conceptual knowledge in learning analytics, as well as technical, pedagogical, and collaborative skills. Furthermore, key design principles for effective learning analytics communities of practice included making considerations for researchers' backgrounds, technical support, community engagement, and centralized resource sharing.

These findings highlight the value of structured communities of practice in fostering interdisciplinary skill development, emphasizing the need for intentional design to support researchers in effectively applying learning analytics into their areas of interest.

Victoria Newton
Graduate Program: Teacher Education and Learning Sciences
Advisor: Paula McAvoy
Poster Number: 124

"It Kind of Opened My Eyes": Counternarratives of Redlining in Critical Historical Inquiry

This paper presents the findings of a qualitative study incorporating counternarrative into technology-assisted historical inquiry into redlining. In a weeklong curricular intervention for high school sophomores, students used an AI-modeling platform to investigate hundreds of primary sources from the HOLC's "residential security maps" in the 1930s, coupled with investigations of scholarly and first-hand neighborhood descriptions. They then examined a counternarrative of the Bronzeville neighborhood of Chicago. Through the process of critical historical inquiry, students engaged in analysis of government descriptions compared to perspectives from the actual neighborhood. In this paper, I asked: How did student inquiry with Bronzeville as a counternarrative influence their understandings of the role of race both historically and in current society? Initial data analysis has highlighted that the example of Bronzeville led students to question their previous understanding of "redlined" neighborhoods and to emphasize the importance of multiple perspectives.

Kennedy Ruff
Graduate Program: Clinical Mental Health Counseling
Advisor: Christina Braga
Poster Number: 153

How Access to Mental Health Resources, Social Support, and Finance influences Postpartum Depression in Black Adolescent Mothers

Adolescent mothers have a rate of 14%- 32% for postpartum depression, while adult mothers have a rate of 7.2%-16%2. During COVID, black adolescent mothers experienced higher rates of postpartum depression from the lack of access to mental health resources, loss of earnings, and change of social support. Prescreening for depression during prenatal care and ensuring all mental health resources can be obtained are a few ways black adolescent mothers impacted by postpartum depression can be supported.

Hamid Sanei
Graduate Program: STEM Education
Advisor: Hollylynne Lee
Poster Number: 155

Data Physicalizations: Tangible Data Storytelling Mediums

Conventional data representation methods, such as numerical summaries and visualizations, play a crucial role in shaping individuals' understanding of data and storytelling. However, these methods present challenges, particularly for individuals with varying levels of data, numerical, and visualization literacies. This study explores the potential of data physicalizations—tangible data representations that engage multiple human senses (e.g., touch, gesture) alongside vision—as an alternative approach to improving college students' data comprehension and storytelling abilities. This phenomenological study investigates the experiences of five college students who participated in a structured intervention, progressing from data analysis to visualization and ultimately creating a physicalization to convey a data-driven narrative. Findings indicate that while data physicalizations may not enhance data comprehension as effectively as conventional methods, they offer unique affordances that support learning in ways numerical and visual representations alone cannot. Moreover, students confirmed that conventional methods played a crucial role in guiding the design and construction of their physicalizations. The insights gained through numerical and visual analysis were later embedded in their tangible representations, demonstrating that effective data physicalization requires a thorough prior analysis of the dataset to extract meaningful insights. Notably, the most significant impact of data physicalizations lies in their ability to enhance storytelling. By engaging audiences in a multisensory, interactive manner, physicalizations facilitate deeper connections with the data, evoke emotional responses, and improve the communication of insights embedded in the narrative. These findings underscore the potential of tangible representations as a valuable complement to traditional data communication methods in statistics and data science education.

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Graduate Program: Learning and Teaching in STEM Education
Advisor: M. Gail Jones
Poster Number: 164

Rural High School Science and Math Teachers' Experiences with Micro-Credential-Based Professional Development: A Collective Case Study

This study investigates the impact of micro-credential-based professional development on rural Appalachian STEM teachers' beliefs, knowledge, and skills. Using a collective case study methodology, data were gathered through pre-and post-surveys, and a series of semi-structured interviews conducted across one academic year. Participants completed three STEM-focused micro-credentials hosted on a national micro-credential platform, and were supported in their professional development by STEM coaches who guided evidence collection and resubmissions. Findings showed that the micro-credential program had a differential impact on teachers depending on their capacity to engage in self-directed learning. Those teachers who had the motivation and time to commit to self-directed professional development benefited more than their peers who had struggles with motivation, as well as time and work demand challenges. These results suggest that the effectiveness of micro-credential-based professional development may depend on teachers' capacities for self-directed learning, highlighting the need for tailored support strategies to ensure equitable benefits across varying levels of self-regulatory skills.

College of Engineering

Nafi Ahmed
Graduate Program: Industrial Engineering
Advisor: Rohan Shirwaiker
Poster Number: 1

Data-Driven Optimization of Digital Light Processing (DLP) Bioprinting of Collagen-Riboflavin Hydrogels for Cultivated Meat Applications

The increasing demand for sustainable, nutritious food and the limitations of traditional livestock farming have driven interest in alternative protein sources, such as cultivated meat. However, achieving scalability and biofunctionality remains a major challenge, primarily due to high production costs and limitations in current biomanufacturing techniques. Digital Light Processing (DLP) bioprinting offers a promising approach due to its high speed and scalability, with the potential to significantly reduce manufacturing costs. However, traditional DLP techniques mostly rely on non-edible photoinitiators, which are not suitable for food applications. Toward this, this study explores an edible collagen-riboflavin bioink (8 mg/mL type I collagen with 0.1% riboflavin) for cultivated meat applications. A data-driven approach was employed to systematically screen and optimize DLP bioprinting parameters. Furthermore, the DLP bioprinted collagen-riboflavin hydrogels were assessed comprehensively through rheological, mechanical, and biological analyses. Rheological assessments, including storage modulus (G'), loss modulus (G''), and loss tangent (tan δ), demonstrated hydrogel stability under deformation across a strain range of 0.01–500%. Compression testing revealed significant improvements in compressive modulus and peak stress in bioprinted constructs compared to collagen-only controls ($p<0.05$), with values comparable to traditional chicken breast. Furthermore, biocompatibility studies showed increased cell density and live cell area over four days in culture ($p<0.01$), supporting its feasibility for cultivated meat applications. Taken together, this study demonstrates the potential of DLP bioprinting with edible collagen-riboflavin bioinks as a scalable and cost-effective strategy for cultivated meat production, addressing key limitations in existing biofabrication technologies.

Didarul Alam
Graduate Program: Electrical Engineering
Advisor: Iqbal Husain
Poster Number: 2

Ultra-Low-Cost, All-SiC Modular Power Converters for Extreme Fast Charging Directly Connected to Medium-Voltage Distribution Systems

The widespread adoption of electric vehicles (EVs) is essential for reducing transportation-related carbon emissions and advancing a sustainable energy future. However, two major challenges hinder mass adoption: prolonged charging times and high infrastructure costs. Current EV fast chargers require 30–60 minutes to fully charge a vehicle, significantly longer than traditional refueling. Additionally, installation costs are substantial, exceeding $200,000 for a 250 kW charging station, and scaling to $800,000 for a 1 MW system. This high cost is driven by reliance on the low-voltage (LV) grid, which necessitates low-frequency medium-voltage (MV) transformers, additional switchgear, and extensive land use—factors that complicate deployment in urban and space-constrained areas. This research introduces a medium-voltage extreme fast charging (MV-XFC) system that directly connects to the MV grid, eliminating the need for bulky low-frequency transformers and switchgear. At the heart of this system is an innovative solid-state transformer (SST) that combines advanced power conversion technologies to efficiently deliver power. The SST features a cascaded H-bridge structure with input-series active front-end power stages, followed by muti-active bridge (MAB) converters that provide galvanic isolation through a compact high-frequency transformer. Rated at 1 MVA, the SST outputs 500 V DC, enabling the connection of multiple dc/dc converters tailored to various EV battery capacities. The MV-XFC system reduces charging times dramatically, achieving full EV charging in under 10 minutes, comparable to traditional refueling. By directly connecting to the MV grid and removing reliance on traditional transformer-based designs, this system reduces infrastructure costs by 85%, lowering the cost for a 1 MW station to approximately $120,000. Furthermore, its compact design significantly minimizes spatial requirements. A key advantage of this system is its seamless integration with renewable energy sources, such as solar and wind, enabling direct renewable energy utilization and reducing strain on the grid. Additionally, its decentralized control architecture ensures effective voltage regulation and module-level power balancing, while its distributed protection framework enhances fault resilience. Beyond technological innovation, the MV-XFC system redefines EV infrastructure by making charging as fast, cost-effective, and space-efficient as traditional refueling. Its widespread adoption could cut transportation-related emissions by over 60%, accelerate the global transition to clean transportation, and support international decarbonization goals. This transformative technology bridges the gap between accessibility, efficiency, and sustainability, paving the way for EVs to become the preferred mode of transportation.

Hayden Bland
Graduate Program: Nuclear Engineering
Advisor: Alexander Bataller
Poster Number: 17

Viscosity of Molten Salts via Passive Microrheology

Among the next generation of nuclear reactors is the Molten Salt Reactor (MSR), whose defining characteristic is the utilization of molten salts as a fuel solvent, a coolant, and as a thermal energy storage medium. Molten salt reactors (MSRs) have been studied since the 1950s and have experienced a resurgence of interest across both public and private sectors. Although molten salts for nuclear applications have been examined for many decades, their fundamental fluid properties remain in question. This issue is exacerbated by the vast number of salt species and compositions that are possible for future MSR designs. Overall, quantifying the fluid properties of molten salts is vital for neutronic, thermal hydraulic, and safety calculations of these future reactors. This work introduces a newly applied technique to the study of molten salts for measuring viscosity.

The viscometer features a darkfield optical microscope, a custom high temperature laser transmission furnace, and flame-sealed capillaries containing microsphere suspensions of test liquids. The Brownian trajectories of individual microspheres were captured in long image sequences and analyzed for their mean square displacement, which provides viscosity via the Stokes-Einstein-Sutherland relation. The viscometer was validated at room temperature with glycerol-water mixtures and at high temperature with water and molten nitrate salt. The measured viscosity was in good agreement with literature values of each liquid across all temperatures studied (20-450°C). The measured diffusion coefficient and liquid viscosity achieved <1% and 2-3.3% uncertainty, respectively, where the latter was limited by the coefficient of variation of the microsphere size distribution. The viscometer could reach temperatures up to 760°C, 1 mL sample sizes, high throughput capability with ~1 min acquisition time, and low cost sample vessels. Importantly, the viscometer recovers the dynamic viscosity without requiring knowledge of other material properties nor a calibration liquid.

Haven Brown
Graduate Program: Computer Science
Advisor: Justin Bradley
Poster Number: 22

Updateable Markov Decision Processes for Online UAS Planning

As the use cases of Uncrewed Aircraft Systems (UAS) and corresponding missions expand with modern technology there has been increased interest in decision making solutions that are computationally inexpensive, explainable, and reproducible. Markov Decision Processes (MDPs) provide a model-based approach to planning problems that produce inherently explainable policies that can be constrained to fit within the computational resources available on a UAS at runtime. Currently, the planning space of an MDP is limited by the state and action space it is given at the start of planning. However, in autonomous UAS applications the full state and action space is unavailable due to the changing landscape of the real world. In order for UAS applications to leverage the benefits of MDPs, the state space of an MDP should be able to reflect new information the vehicle encounters in the field. Our solution, the Updateable Markov Decision Process (UMDP), contains a state space that is able to expand for new information and prune unnecessary states to fit within the time and memory limitations of a size, weight, and power (SWaP) constrained vehicle, allowing for a model that can adapt to surprises at run-time and rapidly re-plan in an unpredictable environment. Here we present UMDPs, and show how they can be used in an example UAS mission to adapt to uncertain environments and changing mission parameters on-the-fly.

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Advisor: David Lalush
Poster Number: 39

Development of an Anatomical Standard for MR Knee Images using a Two-Channel Template

Magnetic resonance (MR) imaging is a common tool used to study Osteoarthritis (OA) due to its high soft tissue contrast and its ability to effectively visualize cartilage affected by OA. While this is an effective technique, singular voxel values in an image are not necessarily a statistically significant indicator of cartilage quality even when utilizing quantitative MRI. To get around this problem, other MRI-based studies have segmented images into regions of interest (ROIs) or utilized anatomical standardization of a population of images. Standardization via an anatomical template allows for voxels to be correlated from one individual to another when individual images are fit to this template. Standardized images allow for statistically significant ROIs to not be restricted to predetermined regions. This has been an effective method in studying functional MRI values in the brain, but the knee has proved to be slightly more difficult to standardize due to greater variations in anatomy between individuals. We propose a two-channel method of constructing an anatomical knee template utilizing both an anatomical MR knee image and a label image segmenting the tibia and femur to facilitate the goal of a finer grained analysis of the cartilage surface. Using these methods, four-dimensional T1rho volumes were effectively warped into the space of the anatomical knee template and used to create a quantitative T1rho map of the subject's anatomically standardized knee cartilage. Despite voxel size differences between T1rho volumes (0.4375mmx0.4375mmx4mm) and the anatomical knee image (0.3125mmx0.3125mmx1mm), the cartilage was able to be cleanly warped over most of the cartilage surface. Problems were only experienced on the extreme posterior and anterior ends of the femoral condyles where there is a high amount of anatomical variation among subjects. This standardization ultimately allows for the future goal of creating a finer-grained analysis of the cartilage surface over a population.

Fernando Delgado-Licona
Graduate Program: Chemical and Biomolecular Engineering
Advisor: Milad Abolhasani
Poster Number: 44

A Data-Rich Self-Driving Fluidic Lab for Accelerated Development of Colloidal Quantum Dots

The rapid discovery of advanced functional materials is critical for overcoming pressing global challenges in energy and sustainability. Self-driving labs (SDLs) are emerging as a powerful tool to speed up materials research, development, and manufacturing. By integrating lab automation, robotics, and artificial intelligence (AI), SDLs can autonomously explore complex synthesis-property parameter space of advanced materials based on human-defined objectives. The SDLs' developments over the past few years have been driven by process intensification (PI) principles, toward Self-Driving Fluidic Labs (SDFLs) that leverage flow synthesis technologies and real-time characterization for efficient data generation.

SDFLs equipped with microscale fluidic reactors benefit from enhanced heat and mass transfer rates, short start-up and equilibration times, and reduced chemical consumption. When interfaced with high-throughput in-situ characterization techniques, SDFL platforms enable accurate mapping between material properties and reaction conditions. However, current data generation schemes in SDFLs focus only on steady-state measurements, overlooking observations during transient states. Properly leveraging the transient data of flow chemistry platforms can offer deep insights into material synthesis mechanisms, potentially speeding up experiments and providing valuable information to the AI agents of SDFLs. This study introduces dynamic flow experiments as a data-rich method for mapping quantum dot (QD) synthesis space to material properties operating at least an order of magnitude faster than traditional strategies.

The dynamic flow strategy utilizes in-situ characterization to generate time-series data from varying reaction parameters. By linking instantaneous flow conditions to steady-state residence times, the approach increases data throughput over 10-fold while reducing chemical consumption by at least three times and cutting experiment time in half. We use cadmium selenide (CdSe) QDs as a case study to demonstrate accelerated parameter space mapping capabilities. The resulting dataset enables creating a digital twin of the reactive system, allowing autonomous closed-loop experimentation for multiple target emission wavelengths.

Arjun Earthperson
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Advisor: Mihai A. Diaconeasa
Poster Number: 48

Data-Parallel Monte Carlo Methods for Quantifying Risk Using Probabilistic Circuits

Nuclear safety analysis relies on Probabilistic Risk Assessment (PRA) to estimate the likelihood of critical failure scenarios. Most PRA approaches hinge on enumerating minimal cut sets, a computationally daunting process that grows exponentially with model size. Analysts often resort to approximations—such as restricted logic gates, bounding techniques, or probability truncation—which can hamper accuracy and still demand considerable runtime. To address these challenges, we propose a data-parallel Monte Carlo framework that bypasses exhaustive enumeration by sampling global component states directly. This strategy naturally incorporates both success and failure events in a single pass, granting analysts more freedom to model complex dependencies.

Our implementation uses vectorized bitwise operations on graphics processing units (GPUs), multi-core CPUs, and field programmable gate arrays (FPGAs) to perform high-throughput, integer-bitpacked logic evaluations. Through a structured network of probabilistic circuits, probability distributions flow across gates in parallel, enabling rapid updates of system-level failure probabilities. An emergent effect is the ability to conduct sensitivity analysis by constructing circuits that perform partial-derivatives on input flows. These features compare favorably against industry-standard PRA tools, delivering dramatic runtime improvements for large models.

Nevertheless, accurate quantification of rare events remains challenging: extremely low-probability outcomes often require large sample sizes or variance-reduction strategies, such as importance sampling. Our framework supports these methods but demands future extensions to handle correlated common-cause failures at scale. By introducing block sampling to capture joint distributions, we aim to retain hardware-accelerated performance while accommodating complex correlation patterns. Further, integrating partial derivatives with an auto-differentiation layer opens the possibility for gradient-based learning of gate or component reliabilities from operational data.

Emily K. Eichenlaub and Jason R. Franz
Graduate Programs: Biomedical Engineering
Advisor: Jason R. Franz
Poster Number: 50

Determining the Feasibility of Deploying Ecologically Relevant Lab-Based Perturbation Paradigms in Older Adults with Dementia with Lewy Bodies

Falls within our older adult population present a serious public health concern, with an estimated 3 million emergency room visits due to fall-related injuries each year1. As our aging population continues to increase, the prevalence of Dementia is expected rise. Specifically, individuals diagnosed with Dementia with Lewy Bodies (DLB) are nearly two-times more likely to fall than age-matched controls and their annual incidence of falls is more than three-times of those with Alzheimer's Disease2, 3. Due to this increased risk of falls, many studies have sought to develop interventional cognitive and physical exercise programs to improve balance in populations with Dementia4, 5. Other studies have compared across multiple types of dementia to differentiate subtype-specific characteristics in static postural control compared to healthy individuals6. However, to the best of our knowledge, no studies have deployed ecologically relevant lab-based perturbation paradigms to understand neuromechanical changes in balance control caused by DLB. We sought to determine the feasibility of deploying balance perturbations in older adults with DLB. Specifically, participants responded to rapid treadmill-belt accelerations and decelerations during standing and walking. Our preliminary results (n =4, age = 75.8±4.7 yrs, preferred walking speed = 0.72±0.4 m/s, Montreal Cognitive Assessment score = 20.5±1.7) showed a 98±4% completion rate for standing perturbations and 67±38% completion rate for walking perturbations, suggesting high feasibility of deploying perturbations in this population. Based on Likert scale exit survey scores, all participants responded that they would be somewhat (4/5) to very likely (5/5) to complete a study like this again (4.5±0.6). Based on these preliminary results, the use of ecologically relevant balance perturbations in those with dementia shows promise for 1) earlier diagnosis and monitoring of disease progression and 2) evaluating the efficacy of physical, cognitive, and/or pharmacological intervention.

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Advisor: Sara Shashaani
Poster Number: 52

Stochastic Constraints: Analyzing and Plotting Feasibility

Stochastic constraints when used in simulation optimization can be difficult to conceptualize and even more so to analyze numerically. There is extensive knowledge regarding the analysis of deterministic constraints, for which a solution is binarily considered either feasible or infeasible. An area of further study is that regarding how to determine the feasibility of solutions that are subject to stochastic constraints. This is difficult because it can be challenging to describe feasibility once we lose the binary nature provided by deterministic constraints. By using stochastic constraints, we introduce uncertainty into whether a solution is determined to be feasible and must now judge solutions on how likely it is that they are feasible. We aim to build off previously introduced methods of estimating how "close" the expected performance of a solution is to being feasible through real experimentation using a stochastic activity network with stochastic constraints describing the allowable average longest path to a certain node within the system. We show various methods for analyzing and plotting the feasibility of a number of given solutions, including a solver's progress towards feasibility over runtime and feasibility vs optimality of solutions. By incorporating the use of bootstrapped error estimates, we also show how to compare the performance of different solvers in relation to each other when finding solutions that are closer to feasibility.

Aaron Frye
Graduate Program: Chemical and Biomolecular Engineering
Advisor: Fanxing Li
Poster Number: 60

Sustainable Styrene Production through Chemical Looping Oxidative Dehydrogenation

Styrene serves as an important monomer for rubber and plastic production. Current methods for catalytic dehydrogenation of ethylbenzene are burdened by high energy usage and equilibrium limitations, leading to significant CO2 emissions. In response, our recent study introduced a chemical looping oxidative dehydrogenation (CL-ODH) technique that offers higher yields and potential emissions reduction. Building on this innovation, we conducted a detailed technoeconomic comparison between CL-ODH and conventional dehydrogenation processes. Our analysis, based on laboratory-scale experiments, evaluates energy consumption, CO2 emissions, capital and operating costs, and projected gross margins for both approaches. The comprehensive study reveals that CL-ODH could reduce energy consumption by 40% and cut CO2 emissions by the same margin compared to current methods, with an estimated 122% increase in gross margin. Optimistic scenarios and further catalyst enhancements suggest potential energy savings of up to 87%. Importantly, our findings indicate that CL-ODH meets the targeted energy efficiency standards set by the US Department of Energy for styrene production.

Jack Grunenwald
Graduate Program: Mechanical and Aerospace Engineering
Advisor: James Braun
Poster Number: 73

Fully Resolved Heat Flux Prediction in Rotating Detonation Engines Abstract

Rotating Detonation Engines (RDEs) are a rapidly advancing propulsion technology offering higher thermodynamic efficiency and power density than conventional engines, promising substantial military advantages in launch cost, speed, and weight for defense systems. These benefits arise from the use of pressure-gain combustion through one or more detonation waves; however, the high-frequency, intense heat flux associated with the detonation waves presents novel challenges for thermal management, impeding broader implementation. This research will address these challenges by characterizing the heat flux within an RDE using experimentally validated simulations and developing the reduced order tools necessary for the rapid design of reliable, flight-ready RDE hardware.

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Poster Number: 81

Measuring the Potential of a Swelling Assay for Mucus

Motivation: Mucins are stored in granules within secretary cells along the superficial airways. ATP triggers release of the mucins from granules where they are in an acidic, high calcium microenvironment. When released into free solution, mucins rapidly expand, forming a protective mucus gel layer that can both trap and clear pathogens. In normal physiology, this process occurs over seconds to minutes. However, it has been shown that in cystic fibrosis (CF), roughly 50% of mucins do not swell into free solutions [Markovetz et al. 2022]. This is thought to hinder pathogen clearance and amplify dehydration of the ASL, resulting in decreased pulmonary function. Currently, the swelling properties of mucus are largely overlooked in the pulmonary field as there is no standard for performing swelling assays. The purpose of this study was to analyze a potential methodology for swelling measurements in mucus and compare the data among various mucus sources.

Methods: Samples of porcine gastric mucus (PGM) and human saliva were utilized for this study and prepared to a concentration of 2% solids. For each sample, a volume of 500 uL mixed with fluorescent beads was added to a 3 mL round-bottom tube. An equal amount of phosphate buffer solution was then added to the top. At timepoints of 15 minutes, 30 minutes, 1 hour, 1.5 hours, 2 hours, and 24 hours, 30 uL was taken from the top of the tube and used to run particle tracking micro rheology (PTMR) to collect physical property data. The same process was used with samples without fluorescent beads to conduct multi-angle light scattering (MALS), collecting data for chemical compositions. The PTMR and MALS data will together give insight to the rate that each mucus source expanded into free solution.

Results: We show that viscosity measured increases as time after diffusion begins, slowly at first, and then a sharp increase. This trend mimics that of viscosity over increasing mucus concentrations. Thus, the results gathered from this study support the idea that the sample concentration is increasing over diffusion time. By matching the viscosity data points collected from sample diffusion to that from varying concentrations, a plot can be made demonstrating how the concentration of the diffusion samples increased over time. Based on this, the use of PTMR and basic diffusion experiment proves to be a promising method for measuring the swelling rate of mucus samples. Further studies will look to validate this procedure and utilize it to determine swelling rates from various controls of healthy mucus.

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Advisor: Qingshan Wei
Poster Number: 85

Shape and Size-Dependent Surface Plasmonic Resonances of Liquid Metal Alloy (EGaIn) Nanoparticles

Liquid metals (LM) are emerging plasmonic nanomaterials with transformable surface plasmon resonances (SPR) due to their liquid-like deformability. This study delves into the plasmonic properties of LM nanoparticles, with a focus on EGaIn (eutectic gallium-indium)-based materials. Leveraging Finite-Difference Time-Domain (FDTD) simulations and experimentally, we explored the localized SPR (LSPR) effects of EGaIn nanoparticles with various shapes, including nanospheres, dimers, nanorods, nanodisks, nanoellipses, nanocubes, and nanocuboids, in the broad range of ultraviolet (UV)-visible-near infrared (NIR) spectrum. EGaIn, known for its unique properties such as low toxicity, negligible vapor pressure, and excellent electrical and thermal conductivity, is appealing in broad wavelength plasmonic applications. In particular, this study reveals uncovered LSPR effects in the visible and NIR wavelength ranges, providing a comprehensive map of LSPR peaks and cross-sections for different shapes of EGaIn nanoparticles. The findings offer insights into correlating EGaIn nanoparticle geometry with their optical properties for diverse applications, ranging from biosensing, nanoelectronics, to optomechanical systems.

Naveen Narasimhachar Joshi
Graduate Program: Materials Science and Engineering
Advisors: Jagdish (Jay) Narayan and Roger J. Narayan
Poster Number: 87

Wafer-Scale Integration and Extraordinary Properties of Q-Carbon

Q-carbon is a new metastable phase of amorphous carbon discovered by the Narayan Research Group at NC State University in 2015. Q-carbon has attracted significant attention due to its intriguing structure and multifunctional capabilities, finding applications in superconductivity, spintronics, protective coatings, and biomedical engineering. Here, we report the facile growth of Q-carbon films over a large area and propose a detailed mechanism to describe its formation via the low-energy ion bombardment in the PECVD process. The energy of these ions is just adequate to generate a Frenkel pair, which facilitates the conversion of twofold coordinated sp2 carbon units in the as-deposited carbon layer to fourfold sp3-bonded tetrahedral carbon units in Q-carbon but does not induce damage to the formed structure. This enhances the sp3 content and the atomic number density due to the random packing of tetrahedral units in the Q-carbon structure. The cluster of four tetrahedra leads to the formation of the diamond unit cell, which provides a nucleus for diamond growth. Thus, seeding with Q-carbon facilitates barrierless nucleation and the growth of high-quality diamond film over a large area. Attributing to its unique structure, we show that Q-carbon is ferromagnetism at room temperature, while the untreated amorphous carbon is diamagnetic. As a wide bandgap material, wafer-scale deposition of Q-carbon opens up new avenues in the development of diamond-based heterostructures for next-generation solid-state devices.

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Poster Number: 92

Using Bin Packing Optimization to Investigate the Transportation Challenges Impeding School Start Times Changes in Wake County Public Schools

The American Academy of Pediatrics (AAP) published research in 2014 that recommended later school start times (after 8:30 AM) for adolescents to promote their health and academic success. Wake County Public School System (WCPSS) is the largest school district in North Carolina, with nearly 200 schools and over 160,000 students, and all its middle school and high school students start school at 8:30 AM or earlier. In the 2023–2024 school year, a national bus driver shortage made daily student transportation challenging and delayed the school board's ability to prioritize school start time changes. This study used a mathematical optimization model following a bin packing approach to minimize the number of buses required to complete all the routes in the nine sub-districts within Wake County. Scenarios that changed the school start times to abide by AAP recommendations were generated and tested using bus route information from the 2023–2024 school year. Preliminary results show that areas with a higher concentration of magnet and special schools require a greater increase in the number of buses needed to swap elementary and high school start times. The results also indicate significant interactions between the sub-districts, which challenge WCPSS's ability to logistically isolate a sub-district to use as a case study for start time changes. This research investigates the current relationship between transportation requirements and school start times. It provides analysis that could inform decision-making and planning as WCPSS hires more bus drivers and pursues the best outcomes for its students.

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Poster Number: 94

The 2-D Bin Packing Problem with Multiple Levels of Prioritization: A Spatial Optimization Perspective

Traditional two-dimensional (2-D) bin packing formulations focus on minimizing unused space, yet many real-world scenarios require more nuanced placement strategies. This research introduces a novel spatial optimization framework integrating multi-level prioritization into 2-D bin packing. By borrowing ideas from facility layout planning, we incorporate custom "priority weights" between items and between items and reference points. These weights can be constructed to achieve a variety of desired layouts, from prioritizing the clustering of specific groups together to emphasizing distance to entry or exit points.

We formally define this enhanced bin packing model and present a mixed-integer linear programming formulation that captures item-level and group-level prioritization and constraints such as orientation and adjacency. Because exact methods struggle with the complexity of larger instances, we develop decomposition-based approaches that outperform standard commercial solvers on challenging problem sets. Numerical experiments show that by simply adjusting priority weights in the objective function, one can produce layouts tailored to diverse operational needs—ranging from rapid off-load configurations in combat loading to efficient "marshaling" formations. This flexibility positions our framework as a robust tool for organizations looking to balance practicality, adaptability, and spatial optimization in bin packing tasks.

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Graduate Programs and Institutions: Biomedical Engineering[1], Electrical Engineering[2]
Advisor: Nitin Sharma
Poster Number: 96

Data-Driven Modeling of Exoskeleton Walking with Sonomyography and Electromyography

Modeling exoskeleton-assisted walking incurs high computational cost due to nonlinear dynamics of the human-robot system. Data-driven linear models have the potential to facilitate real-time model-based optimal control of multi-joint exoskeletons. Using electromyography- and sonomyography-derived measures of muscle activity, we derived linearized models of exoskeleton walking. Two participants with no disabilities and one participant with spinal cord injury performed treadmill walking with a lower-limb exoskeleton using partial motor assistance, and personalized models were derived for each. The inclusion of ground reaction force as a disturbance was found to increase model prediction accuracy for the participants with no disabilities. The inclusion of muscle activation metrics, and in particular the combination of sonomyographic and electromyographic metrics, was also found to increase model prediction accuracy, but only marginally for the participant with spinal cord injury.

Patrick Leavitt
Graduate Program: Operations Research
Advisors: Benjamin A. Rachunok and Brandon M. McConnell
Poster Number: 98

Human-Centered Machine Learning for Interpretable Disaster Response Strategies

Natural disasters, especially hurricanes, threaten human life, property, and infrastructure in vulnerable coastal regions. Despite the critical role of evacuation in minimizing disaster impacts, many residents choose to shelter in place—a decision that can lead to heightened distress and strain on emergency services. The devastating effects of Hurricane Harvey in 2017, with its record rainfall and widespread flooding, underscore the complex nature of evacuation decisions, which are influenced by factors such as limited transportation, economic hardship, and intricate household dynamics. This study investigates the underlying reasons for non-evacuation by integrating distress call data from the Cajun Navy with socio-demographic and economic variables from the American Community Survey, aggregated at the census block group level. We aim to identify areas with a higher likelihood of sheltering in place by developing a predictive framework using cross-validation and machine-learning techniques. This model accounts for the diverse risk factors at play and provides valuable insights that can help emergency planners and policymakers target resources more effectively. Ultimately, the insights gained from this research are intended to enhance our understanding of why specific populations opt not to evacuate, thereby informing the development of improved disaster preparedness and response strategies. By identifying key vulnerabilities and forecasting areas at risk, this work contributes to more efficient resource allocation and a more resilient approach to managing future disasters.

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Advisor: Yong Zhu
Poster Number: 99

Liquid Crystal Elastomer Soft Robots for Biomimetic Locomotion

Soft robotics is driving transformative advances in biomimetic locomotion and manipulation. However, current platforms face limitations in energy efficiency, scalability, and actuation frequency. In this work, we address key challenges in soft robotics by fabricating liquid crystal elastomer (LCE)-based electrothermal actuators. Our process leverages precise laser cutting, scalable mesogen-alignment training, and simple electrothermal integration to produce LCEs in diverse forms, including complex shapes, sheets, and fibers. This method is highly scalable, covering ~2.5 orders of magnitude in actuator size, making it suitable for both small and large robotic systems.

These fabrication advancements enable the development of soft robotic components that mimic natural movements, such as crawling, inspired by species like Papilio zelicaon caterpillars, Lepidoptera larvae, and Pleurotya ruralis. Soft robots built with this approach achieve agile, life-like motion reaching speeds of 0.72 cm/s with actuation frequency up to 0.264 Hz, at a low actuation voltage (from 2V to 5V).

Key performance metrics—actuation frequency, maximum strain, and cycle durability—are characterized, highlighting the robustness and adaptability of these systems. This work lays the foundation for next-generation soft robots that combine advanced materials engineering with biomimetic design for efficient, resilient, and versatile performance.

Tristan Mullins
Graduate Program: Computer Science
Advisor: Rudra Dutta
Poster Number: 118

Using Spatio-Temporal Consistency to Detect Dishonesty within a Multi-Agent Cyber-Physical System

Uncertainty within deployments of cyber physical multi-agent systems, such as drones, necessitates evaluating agents' intent. Established a priori trust or trusted third parties are not guaranteed, as operations of these systems often occur in remote areas. Decentralized agents generate models of their environment through data fusion for decision making. Detection of faulty or dishonest agents, which may skew the models generated by honest agents, is critical to task completion and accuracy. Leveraging underlying physical properties of the sensing volume and the cyber physical capabilities of participants, agents can detect inconsistent data reports given by others. Chaotic environments pose a unique challenge in detecting inconsistencies, as the turbulence greatly influences the plausibility of extreme and rapidly changing measurements from participants. This work studies the use of Bayesian Inference to identify temporal inconsistencies of spatially dispersed measurements in a multi-agent system monitoring a wildfire.

Vincenzo Musico[1], Noah P. Holzapfel[1], Ryan DeBlock[2], Jeffery Long[2], and Veronica Augustyn[1]
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Advisor: Veronica Augustyn
Poster Number: 120

Temperature Effect on Li+ Insertion into Nb-W-O Wadsley-Roth Compounds

The demand for energy storage materials for space-limited and low temperature applications drives the search for electrode materials that can exhibit both high volumetric capacities and fast kinetics. One strategy to achieve this is through the use of ion insertion-type electrodes that can undergo at least 1 e- transfer (for high volumetric capacity) with little structural change (fast kinetics). To investigate this strategy, we examined ion insertion behavior in Nb-W-O Wadsley-Roth compounds. These compounds contain orthogonal crystallographic shear planes, which are planes of edge-sharing MO6 octahedra, that form a m x n block structure around a corner-sharing network. In this study, we directly compared three different Wadsley-Roth compounds: Nb12WO33 (3 x 4), Nb14W3O44 (4 x 4), Nb16W5O55 (4 x 5). The presence of crystallographic shear planes is proposed to increase ion insertion kinetics because they decrease the lattice flexibility of the material. By changing the block size, we will alter the electrochemical ion insertion behavior of these materials.

To test this hypothesis, we performed galvanostatic charge discharge (GCD), galvanostatic intermittent titration technique (GITT), and potentiostatic electrochemical impedance spectroscopy (pEIS) in a non-aqueous electrolyte at 25 ºC and at 0 ºC to study the kinetics of Li+ insertion into the different block size Wadsley-Roth compounds. At 25 ºC, all three Wadsley-Roth compounds underwent the insertion of > 1 Li+ per transition metal (T. M.) with the largest block size, Nb16W5O55 (4 x 5), inserting 1.2 Li+ / T.M. and achieving a volumetric capacity of 1200 mAh/cm3. Rate capability measurements at 25 ºC and 0 ºC show increased capacity for larger block sizes at slow (dis)charge rates and possess greater rate capability compared to smaller block sizes. Diffusivity measurements conducted using GITT show that all three compounds possess Li+ diffusion rates (DLi+) between 10-10 cm2/s to 10-9 cm2/s with little dependence on block size.

Amirreza Naseri, Varun Nalam, Woolim Hong, Ming Liu, I-Chieh Lee, and Helen (He) Huang
Graduate Program: Biomedical Engineering
Advisor: Helen (He) Huang
Poster Number: 122

Enhancing Robotic Prosthesis Safety with an Active Fault Tolerance Mechanism

Robotic prosthetic legs are an emerging technology that has improved the capabilities of prosthetic devices in assisting individuals with lower limb amputations. While the intelligence of AI-driven control systems in robotic prostheses enables functions like interpreting user intentions and adapting to terrain, these systems also introduce risks. Notably, decision errors stemming from prosthetic controllers can disrupt the user's gait and balance, potentially leading to falls and injuries. Despite these challenges and their significance, very limited research aims to address errors in intelligent lower-limb wearable robots. We introduce a novel fault tolerance mechanism (FTM), the first of its kind, designed to enhance the reliability and safety of robotic prostheses by dynamically responding to errors. Inspired by human reflexive reactive responses, the FTM adjusts prosthetic command in response to detected errors, mimicking the natural, rapid adjustments the human body makes to maintain balance and stability in the case of disturbances. The FTM design was built upon thorough analysis of various sensory inputs from the prosthesis under erroneous conditions. Employing machine learning, the FTM uses the least error-sensitive parameter to estimate the expected normal behavior of the most sensitive parameters to the errors in real-time. This process enables real-time comparisons between estimated normal patterns and actual measurements, facilitating the prompt detection and mitigation of deviations to prevent further disruption to the user's balance. The effectiveness of this approach was validated through treadmill walking experiments with individuals having a transfemoral amputation, where errors were manually induced. Preliminary results demonstrate significant improvements in fall prevention and risk mitigation related to balance perturbations, confirming the FTM's potential to enhance safe operation based on user perception. This study sets the foundation for adapting this algorithm to various real-world scenarios, such as level ground, ramps, and stairs, highlighting its potential for enhancing user safety in diverse environments.

Pranit Pawar
Graduate Program: Electrical Engineering
Advisor: Wensong Yu
Poster Number: 140

Wide Input Local Power Supply with Variable Frequency Adaptive On-time Modulator for Modular Solid State Transformer

AI integration in everyday tools has increased rapidly as models are becoming more capable. This capability comes at the cost of increased computations and power consumption. From 2020-2024, data centers saw a 100% increase in power demand and are projected to reach 200 TWh/year by 2030, contributing substantially to national energy needs. To meet this demand a modular, scalable infrastructure is crucial. Solid State Transformers (SSTs) are seen as a promising replacement to bulky 60Hz transformers, as they can actively manage energy flow using integrated semiconductor switches. This flexibility makes SSTs key for scalable infrastructure and presses the need to address challenges hindering SST modularization. This research solves one of these challenges - Local Power Supply (LPS). LPS powers the ancillaries inside the SST module by stepping down high internal bus voltage (thousands of volts) to few tens of volts (12V). In addition to this high step-down, the LPS is expected to turn on at a low voltage. Thus, the LPS is required to operate across a wide input range, withstand high input voltage, and provide a low voltage, low power output. This is very difficult to achieve in a small form factor. Current state-of-the-art solution utilizes an additional MVAC-LVAC transformer which increases solution size and impacts modularization. This research proposes an LPS which solves the above-mentioned challenges at once. Unlike previous hardware-oriented works, this research addresses the problem fundamentally with first principles. The result is a unique Variable Frequency Adaptive On-time Modulator. With this proposed modulator, the LPS is able to maintain fixed 12V output even when input swings from 200-2100V, and load steps from 2-20W. Furthermore, the LPS achieves this in a form-factor smaller than credit card, facilitating easy integration. Thus, this research not only meets functional requirements, but also system level requirement by enabling true modularization.

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Graduate Programs and Institutions: Electrical and Computer Engineering[1]; Mechanical Engineering and Intelligent Systems, The University of Electro-Communications, Chofugaoka, Chofu, Tokyo, Japan[2]
Advisor: Aranya Chakrabortty
Poster Number: 142

Optimal Distribution of GFM and GFL Converters for Charging Control of Electric Vehicles

Abstract: DC fast charging stations are connected to electric distribution grids via voltage source converters (VSCs) that operate in grid following (GFL) mode. In this mode, grid synchronization is achieved via a phase-locked loop (PLL) that may induce small-signal instability (SSI) during weak grid and transient conditions. To tackle this issue, recent studies have demonstrated that electric vehicle charging stations (EVCSs) can also be modeled as grid-forming (GFM) loads, which are naturally immune from PLL-induced SSI, albeit at the cost of reducing voltage stability margin of the grid. As the integration of EV charging infrastructure grows, a natural question for grid operators, therefore, is - for any given operating point, what should be the optimal ratio of GFM and GFL modes for operating the EVCSs in the grid to maintain an acceptable balance between small-signal stability and voltage stability? We address the problem of determining the optimal combination of GFL versus GFM modes of control of EVCS to maintain an acceptable balance between small-signal stability and voltage stability of electric distribution grids. We recall the state-space dynamic models of EVCSs operating in GFL and GFM modes, and demonstrate how high EV charging rates in the GFL mode can induce SSI. We then optimize the GFL-to-GFM ratio while also determining the optimal EV charging setpoints and a state-feedback controller to minimize the H2-norm of the grid transfer function (TF). To make the proposed optimization computationally favorable, we use participation factor analysis to identify the most dominant EVCSs in the GFM mode so that they can be prioritized for the optimization. We validate our results using a modified model of the IEEE 33-bus power distribution test system with ten EVCSs.

Haitao Qing
Graduate Program: Mechanical Engineering
Advisor: Jie Yin
Poster Number: 147

Spontaneous Snapping-induced Jet Flows for Fast, Maneuverable Surface and Underwater Soft Flapping Swimmer

Manta rays utilize wing-like pectoral fins to achieve remarkable oscillatory swimming, providing valuable inspiration for designing fast, efficient, and maneuverable soft swimming robots. However, such capabilities have not yet been fully realized in soft robotics. A key challenge remains in integrating high speed, efficiency, and maneuverability into a single soft swimmer, particularly using simple actuation and control. Haitao Qing et al. developed a manta-inspired soft swimmer that leverages spontaneous snapping strokes in a monostable flapping wing to address this challenge. The wing is pneumatically actuated, enabling it to snap downwards instantly during a power stroke and snap back upwards without additional energy input. This mechanism greatly simplifies design, actuation, and control, achieving a record speed of 6.8 body lengths per second—1.7 times faster than the fastest tunabot—as well as high energy efficiency, maneuverability, and resilience to collisions in unstructured underwater environments. By adjusting a single-input actuation frequency, this soft swimmer navigates complex underwater settings with obstacles, making it highly suitable for real-world applications in environments such as deep-sea exploration (e.g., ecosystem monitoring, surveillance, and detection) and environmental monitoring (e.g., assessing water quality, pollution, and ecological changes).

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Advisor: Hooman V. Tafreshi
Poster Number: 148

Novel Approach to Model Nanofiber Formation in Advanced Needle-based Electrospinning Using Computational Fluid Dynamics and Discrete Element Method

Electrospinning is a cost-effective technique for producing micro-and nanofibers by applying a high-voltage electrostatic field to a polymer solution, directing it from a charged needle toward a grounded collector. Electrospun nanofiber materials have achieved a widespread interest in recent years due to their broad range of industrial applications such as particle filtration, membrane desalination, self-cleaning, tissue engineering, and drug delivery among many others. Despite its widespread use, electrospinning remains an empirical process that can only be optimized through trial-and-error during experiments. This is mainly due to the complex multi-physical interactions that take place between many factors influencing the fiber formation during the electrospinning. Additionally, the outcomes of an electrospinning process are highly sensitive to nonlinear dependencies on the three-dimensional electrostatic field, polymer concentration, material properties (e.g., molecular weight, elastic modulus), and environmental factors such as temperature and humidity. With growing industrial demand, electrospinning technology has evolved to enhance fiber production rates. As a result, modern setups now incorporate multiple needles in various orientations, dynamic collecting surfaces, and external airflow to control fiber deposition. This study presents a novel computational approach for simulating fiber formation in advanced electrospinning, including multi-needle and air-assisted configurations. The aerodynamic and electrostatic fields were modeled using computational fluid dynamics (CFD) in COMSOL, while the fiber formation process was simulated via a quasi-one-dimensional discrete element method (DEM). Our CFD-DEM simulations were calibrated for different polymers and their predictions were compared with experiments. Our simulations, consistent with experiments, showed that varying electrostatic fields in advanced electrospinning setups influence fiber formation and deposition. Moreover, increasing sheath air velocity reduces fiber diameter, while added airflow minimizes whipping instability, leading to more precise fiber deposition. The proposed computational framework provides a predictive tool for optimizing electrospinning parameters, facilitating more efficient and precise fiber production in advanced electrospinning processes.

Mohan Reddy
Graduate Program: Computer Science
Advisor: Yannis Viniotis
Poster Number: 150

Mobile User Plane Architecture Using Segment Routing for Distributed Mobility Management

The evolution of 5G networks has introduced unprecedented advancements in mobile connectivity, enabling ultra-high-speed data transmission, low latency, and seamless mobility. However, these advancements present significant challenges, particularly in managing user equipment (UE) mobility at high speeds. Traditional centralized mobility management approaches struggle to efficiently handle dynamic session routing, leading to increased handover delays and suboptimal traffic routing. To address these limitations, this work explores the integration of Segment Routing over IPv6 (SRv6) with Distributed Mobility Management (DMM) principles, leveraging the Mobile User Plane (MUP) architecture. SRv6 offers network programmability and an IPv6-based flexible routing paradigm, making it ideal for scalable mobile architectures. The proposed system utilizes MUP to transform session management into routing updates, thereby eliminating the dependency on static mobility anchors. A core component of this system is the MUP Controller (MUP-C), which dynamically creates session-transformed routes (ST routes) based on real-time session updates received from the 5G control plane. These ST routes are then distributed across Provider Edge (PE) nodes using BGP-based mechanisms, ensuring efficient path optimization and load balancing. Additionally, the integration of Mobile User Plane Components, such as Interwork and Direct Segments, enhances the system's ability to maintain continuous connectivity for high-speed UEs. The MUP-C autonomously discovers PE nodes and facilitates seamless handovers by leveraging ISD and DSD routes. This architecture significantly reduces handover latency and packet loss during UE transitions between gNBs, particularly in high-mobility scenarios. Through the implementation of a GoBGP-based routing framework and SRv6 endpoint behaviors, our system demonstrates improved efficiency in handling mobile traffic. Performance evaluations highlight reductions in handover disruption, making SRv6 MUP a promising approach for future 5G mobility management. This study presents a novel framework that paves the way for a fully distributed, resilient, and scalable 5G user plane architecture.

Jacob D. Thompson
Graduate Program: Biomedical Engineering
Advisor: Matthew B. Fisher
Poster Number: 172

Impact of Sex Hormones on Size, Organization, and Mechanics of the Adolescent Porcine Anterior Cruciate Ligament and Potential Mechanisms Through Estrogen Receptors

Adolescent female athletes are 3–4 times more likely to have ACL injuries, with some studies suggesting a link between menstrual cycle phase and injury risk. However, evidence remains inconclusive, and the impact of sex hormones on ACL mechanics and structure is not well understood, particularly during growth. This study investigates associations between ACL biomechanics, size, biochemistry, and serum estradiol-to-progesterone (E/P) ratio in an adolescent porcine model. Additionally, gene and protein expression of matrix molecules and hormone receptors were assessed across growth. In the first study, post-pubertal female Yorkshire crossbreed pigs (n=8) were analyzed. Serum estradiol and progesterone concentrations were measured, and ACL properties were assessed using MRI, six-degree-of-freedom robotic testing, and biochemical assays. No significant associations were found between joint laxity or ACL stiffness and serum E/P ratio ($p>0.05$). However, ACL cross-sectional area negatively correlated with serum E/P ratio ($R^2=0.78$, $p=0.004$), and PL bundle T2* relaxation time was positively associated with serum E/P ratio ($p=0.003$). Glycosaminoglycan content was 40% higher in the AM bundle compared to the PL bundle ($p=0.006$), while collagen content was similar between bundles ($p>0.05$). In the second study, ACLs from pre- (2 months) and post-pubescent (8-12 months) pigs (n=6) were analyzed. Post-pubescent ACLs had higher ERα, lumican, and matrix metalloproteinase III gene expression, while pre-pubescent ACLs had greater gene expression of collagen and tenomodulin. ERα protein analysis showed a biphasic dimer-to-monomer ratio in post-pubescent samples. While serum E/P ratio was associated with ACL size and PL T2*, there were no direct associations with ACL mechanics. These findings highlight the need for future studies tracking estrus cycle phase and hormone receptor changes to better understand hormone-mediated effects on ACL structure and function.

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Advisor: Emily Berglund
Poster Number: 178

Equitable Access to Affordable and Clean Water in Small Cities: Water Quality and Tap Water Avoidance

Access to clean and affordable water is spatially heterogeneous within a water distribution system, caused by complex spatio-temporal dynamics of changing consumer demands, technical operation, and fundamental hydraulics. Deteriorating water quality can lead to negative health outcomes, and households that seek alternative water sources bear a substantial cost. Previous work has looked at affordability on a community or city level, but research has not explored the intra-system changes in water quality that lead to poor water quality experienced by households or neighborhoods, and the effect that has on water affordability. An agent-based model (ABM) is developed to simulate the movement of individual agents to and from home, work, and leisure locations. The cost of buying water is calculated using the demand specified in the hydraulic network. Equity is assessed using the cost of water as a percentage of income for households in the lower 20% of incomes. An ABM is applied to a hydraulic system synthesized for Clinton, North Carolina. The hydraulic model is created using street maps to place pipes and nodes, well locations to place water sources, and building types to determine the demand required. Household incomes are distributed to represent Clinton, NC using census data. Results demonstrate spatial changes in water quality that lead to economic inequities. The modeling framework that is developed in this research can be applied to assess equity impacts of water quality changes such as those associated with pandemic scenarios or extreme weather events.

Trent Wiens
Graduate Program: Computer Science
Advisor: Justin Bradley
Poster Number: 185

Sliding Markov Decision Processes for Online, Adaptive Planning

Mission and flight planning problems for un-crewed aircraft systems are typically large and complex in space and computational requirements. With enough time and computing resources some of these problems may be solvable offline and then executed during flight. But dynamic environments and responsiveness to changes in the mission demand online adaptation and replanning. We propose using a combined sliding resolution and receding horizon approach to build and solve Markov Decision Processes (MDP) in practical planning applications for Uncrewed Aircraft Systems (UASs). In our strategy, the underlying state space is regularly rediscretized according to its informational proximity and utility while a receding horizon algorithm allows us to consider immediate next steps while keeping the primary goal state in mind. This approach allows for dynamic decision making and replanning by a UAS in an uncertain and dynamic environment in which mission objectives could change. Our methods show an ability to create recursively optimal policies, under conditions of limited computing power and time, that perform similarly to the optimal policy of the associated fully-modeled flat MDP.

Mohammad Javad Zarei, Sreekiran Pillai, Omar Eldaly, Adil Majeed Rather, Sravanthi Vallabhuneni, Mohammed A. Zikry, and Arun Kumar Kota
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Advisor: Arun Kumar Kota
Poster Number: 191

Hyperelastic Superomniphobic Surfaces

Superomniphobic surfaces are extremely repellent to both high surface tension liquids like water and low surface tension liquid like oils. In this work, we present hyperelastic superomniphobic surfaces designed to maintain simultaneous stretchability and flexibility without coating delamination, even under 400% strain and after thousands of stretch-release cycles. To achieve this remarkable performance, we developed a novel structure featuring an array of discrete microprotrusions on a hyperelastic substrate. These microprotrusions effectively redistribute stresses out-of-plane during elongation, keeping the tops of the protrusions nearly stress-free and preserving the coating integrity even at high strains. To gain insights into the wetting transition on these surfaces, we developed a theoretical model to predict breakthrough pressures, contact angles and sliding angles. In practical applications, the hyperelastic superomniphobic surfaces demonstrated exceptional durability, retaining their properties during twisting, bending, over 5,000 stretch-release cycles, and simultaneous twist-and-stretch deformations up to 400% strain. We envision our robust hyperelastic superomniphobic surfaces will unlock diverse applications in stretchable electronics, functional textiles, flexible sensors, and droplet manipulation platforms.

Elias Zauscher
Graduate Program: Civil Engineering
Advisor: Emily Berglund
Poster Number: 192

PipeNetGen: Validating a Tool for Water Distribution Network Model Generation

Water utilities process and deliver millions of gallons of water daily to consumers over wide geographical areas. Utilities are tasked with identifying leaks, managing water quality, and planning infrastructure improvements. To accomplish these goals many utilities use water distribution network (WDN) models to manage their system and simulate strategies before they are implemented. Unfortunately, many water utilities do not have WDN models and are limited in their ability to efficiently manage their system. This research develops and validates PipeNetGen, a tool for WDN model generation. PipeNetGen generates a WDN model that approximates both network hydraulics and topography. PipeNetGen applies a mixed integer linear programming (MILP) formulation to size and place pipes with open access information as inputs. A clustering algorithm is integrated to partition systems into small clusters of nodes before the MILP is applied. A hydraulic solver corrects linear assumptions, and a fire flow algorithm is applied to resize pipes and ensure fire demands are satisfied. This research validates PipeNetGen by comparing a generated network and the existing water utility network for Lakewood, California. PipeNetGen predicts the topography of the existing network within 1% of true values, average pipe velocities within 10%, and average diameter within 35%. Additional sensitivity analysis demonstrates that hydrant spacing and network demands have the greatest impact on generated network diameters. These results suggest that PipeNetGen could be a valuable tool for under-resourced utilities and researchers to address emerging and existing problems in the operation and management of water distribution systems.

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Graduate Program: Mechanical Engineering
Advisor: Jingjie Hu
Poster Number: 194

A Multi-modal Embolic Gel System for Long-term Fluorescence Imaging and Photothermal Therapy

Minimally invasive embolization is an essential technique for restricting blood flow to abnormal tissues, such as tumors, and enabling targeted drug delivery. However, current embolic agents have notable drawbacks Solid embolics lack adaptability to varying vessel sizes, risking incomplete occlusion and migration, while liquid embolics rely on toxic solvents, raising safety concerns.

This study presents a novel nanoclay-alginate (NCA) gel embolic agent incorporating indocyanine green (ICG) for dual fluorescence imaging and thermal ablation. The NCA/ICG gel demonstrates excellent shear-thinning properties, ensuring injectability and in situ conformability like liquid agents, without toxic solvents. At the same time, it offers the structural stability of solid embolics for post-injection. Its fluorescence remains stable for over 28 days, surpassing conventional ICG solutions and enabling real-time imaging with prolonged post-procedural monitoring. Additionally, the gel efficiently converts near-infrared (NIR) laser energy into heat, offering potential for photothermal therapy. The gel's biocompatibility and antibacterial properties further underscore its promise as a multifunctional embolic agent for vascular interventions.

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Poster Number: 154

Dynamic Patient-Specific Computer Simulation of Transcatheter Aortic Valve Replacement Using the Evolut R and SAPIEN 3

Valvular heart diseases, including aortic valve stenosis, are increasingly common as the global population ages. Transcatheter aortic valve replacement (TAVR) has become the standard treatment for severe aortic stenosis due to its minimally invasive nature, offering better recovery compared to surgical valve replacement. Accurate computational modeling can improve device design, regulatory approval, and treatment planning by predicting device behavior in patient-specific anatomies. This study aims to compare the performance of two popular FDA-approved TAVR devices, the CoreValve Evolut R and the SAPIEN 3, through dynamic computer simulations in a patient-specific model. We employed the immersed finite element-difference (IFED) method to simulate fluid-structure interactions within the transcatheter valve, native valve, and flexible aortic root. The patient-specific model anatomy was reconstructed from pre-procedural CT images. Both native and bioprosthetic valve components were modeled as hyperelastic materials. To simulate realistic cardiac conditions, we implemented a time-dependent elastance-based left heart model at the inlet and a Windkessel model at the outlet of the aortic root. The simulations revealed distinct flow patterns and performance differences between the two devices. The Evolut R exhibited a minor paravalvular leak near the sealing skirt, a common complication, while the SAPIEN 3 achieved a secure seal without leakage, attributed to intentional over-expansion of the stent frame. The simulations generated physiological flow rates and effective orifice areas that are in the range of clinical data. This study highlights the significance of incorporating flexible aortic roots and detailed device geometry to improve the accuracy of TAVR simulations. The framework demonstrated enhanced predictive capabilities, particularly in reducing paravalvular leakage, which could lead to better clinical outcomes, improved diagnostic accuracy, and more reliable assessments of device performance. Future work can include validating the model through in vitro experiments and exploring the impact of stent-crimp-induced leaflet injury on thrombosis.

College of Humanities & Social Sciences

Lee Alonzo
Graduate Program: Sociology and Anthropology
Advisor: John Millhauser
Poster Number: 6

Las Coyolxauhqui: The Intentional Manifestation of an Aztec Deity

Since the 19th century, there have been six monumental sculptures of the Aztec deity Coyolxauhqui discovered in close proximity to the Templo Mayor in Mexico City. More recent studies have suggested a number of other pieces which may also feature the goddess. Looking at the iconographic and contextual changes of the imagery of Coyolxauhqui from known and newer sculptures and artifacts, we look into the issue of how the icons were conceptualized and manifested, as well as how the process related to the socio-political interests of the Tenochca elite in Postclassic Mexico. With the earliest depiction of Coyolxauhqui dating to 1440 and the iconographic design becoming more monumental and complex over time, Coyolxauhqui seems to be a purposeful conception of a deity, made specifically to represent the enemies of the empire of Tenochtitlan with no similar sculptures being found in any other polity. Coyolxauhqui and her image as a defeated woman warrior are intended to be the contrast and opponent of Huitzilopochtli, the male patron deity of Tenochtitlan. Looking at the conceptualization and manifestation of Coyolxauhqui as a presence only in Postclassic Tenochtitlan lends evidence as to how the empire maintained control through ideology and metaphorical comparisons. Although the grandness of the sculptures would indicate Coyolxauhqui's importance in the religious and political dogma of the Tenochca, she is only confirmed to be depicted in Postclassic Tenochtitlan with no examples from outside the polity or time period. Coyolxauhqui's very existence and genesis provides evidence of the methods used by the empire to implement religious ideology and maintain control of narratives emphasizing the necessity of warfare and sacrifice. With a single creation event, Coyolxauhqui was intentionally manifested as an embodiment of "the enemy" of Tenochtitlan. The increased monumentality of the Templo Mayor and the appearance of Coyolxauhqui both correlate with the rise of Tenochtitlan in the mid-15th century. As Tenochtitlan became a powercenter, it became increasingly necessary to cement a narrative of divine right and power.

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Advisor: Jennifer J. Carroll
Poster Number: 9

Syndemics Approach of Infectious Disease Among Refugees: A Study on the U.S. Humanitarian Organizations' Perspective

Out of 43.7 million global refugee population, 60,050 individuals were admitted to the United States as refugees in 2023 (1,2). Given suffering from pre- and post-migration stressors, refugees are more prone to infectious disease, comparing to the U.S. citizens (3). Humanitarian organizations and local health authorities annually allocate enormous resources to treating infectious diseases or focusing on individual health education as a preventive measure among refugees, often attributing the rise of these diseases to refugees' cultural norms and behavioral patterns. However, despite these efforts, such interventions are not always fully effective. This account elaborates the necessity of studying the underlying causes of infectious disease prevalence among refugees residing in the United States. The aim of the study is to introduce syndemic theory to the health issues of refugees, which acknowledges the intricate interplay of social forces with biological factors, creating and perpetuate health inequities. Also, the study intends to assess whether humanitarians implement syndemic analysis in their health programs. Seven ethnographic, semi-structured interviews were conducted with the U.S.-based health professionals and humanitarian workers specializing in refugee health. While humanitarians have traditionally attributed unsuccessful health interventions to the lack of health literacy, the inadequate functioning of U.S. healthcare services, and cultural behaviors, health professionals recognized the syndemic framework for infectious diseases. They emphasized the crucial, synergistic role of social factors in their prevalence, highlighting that infectious diseases are not isolated events but are deeply intertwined with environmental and social conditions, such as poor living environments. The social determinants, with their synergistic effects, can exacerbate the spread and impact of infectious diseases. Therefore, humanitarian organizations should apply holistic interventions that address both biological and social factors simultaneously, as this approach significantly enhances the effectiveness and efficiency of health initiatives for vulnerable communities, ensuring their well-being in a dignified manner.

Martha Batul
Graduate Program: Psychology
Advisor: Kelly Lynn Mulvey
Poster Number: 15

Promoting STEM Interest Through Virtual Collaboration

Engaging in activities outside of formal learning environments has been shown to promote interest in STEM. Peer-to-peer interaction in these informal environments also fosters student learning and retention. However, little is known about how informal virtual learning environments foster STEM interests. Thus, the study examined whether collaborating with others in an informal virtual learning environment can foster interest in STEM. Participants (N = 209, Mean age=16.21) with 53.4% females engaged in a 10–week virtual STEM project (The World Smarts STEM Challenge) that partnered with adolescents in Ghana and in the United States to identify and solve a common STEM problem in society. A subset of participants (N = 23),12 from the US and 11 from Ghana, were interviewed after the project to identify its impact on their interest in STEM. Themes such as confidence in capabilities and creativity through collaboration were identified from the interviews. Participants indicated improving their confidence in using STEM concepts and acquiring skills needed to succeed in STEM careers. Also, they acknowledged the benefits of working with their peers with support from their teachers, which played a role in their success in the program and promoted their interest in STEM. The findings indicate that virtual collaboration provided students with essential skills and fostered a supportive environment conducive to personal and academic growth. Overall, findings indicate that informal virtual environments with mentors' and peers' support might promote interest in STEM. Current findings support the need to create opportunities for students to engage in rich learning environments, such as through virtual partnerships that support peer-to-peer interactions.

Sara Bulla
Graduate Program: World Languages and Cultures
Advisors: Valerie Lambert and Sara Zahler
Poster Number: 25

¡Hola, ChatGPT! Exploring Student Perceptions of AI in Spanish Language Acquisition

Artificial Intelligence (AI) tools are becoming increasingly prominent in the instruction of several disciplines-primarily in the sciences. However, their role in humanities studies remains an evolving and less explored area of study. Previous research has examined the growing usage of AI in higher education and how students and instructors integrate or avoid it completely (Sebesta & Davis, 2023).

The current study investigates the role of AI, specifically ChatGPT, by analyzing students' perceptions of its effectiveness as a tool for Spanish language acquisition. To achieve this, four surveys were conducted to examine students' perceptions of and experiences in using ChatGPT to prepare for their in-class assessments, with both closed and open-ended responses. These surveys assessed students' confidence in their Spanish reading, conversation, and writing skills both before and after utilizing ChatGPT for assessment preparation.

Preliminary results indicate an increase in students' confidence, particularly in writing and speaking, after using ChatGPT to practice these skills. Additionally, students reported an increase in their satisfaction with how ChatGPT was integrated into their studies, compared to their initial desire to use AI to facilitate learning Spanish. However, results also suggest a nuanced perspective on ChatGPT's integration into language learning, with some students expressing preferences for more interactive approaches alongside AI tools.

These findings contribute to the ongoing discussion on the impact of AI on second language acquisition, highlighting both its benefits and limitations in fostering linguistic proficiency.

Rebecca Cantor
Graduate Program: English Linguistics
Advisor: Agnes Bolonyai
Poster Number: 28

"I don't hate Jews but": A Discourse Analysis of Antisemitic Hate Speech on Social Media

Antisemitism has existed for thousands of years, adapting to fit the time period and the need of antisemites to reproduce their hate. Today, social media is the new medium for hate to spread, taking advantage of the reach, discursive inventory, and information available online. This project uses a mixed-methods approach to analyze a corpus of 7,339 antisemitic comments, text posts, and direct messages collected on Instagram, TikTok, Threads, and X between early 2021 and January 19, 2025, to better understand what attracts antisemitic users and those who engage in hate speech to social media, as well as the linguistic characteristics and strategies of antisemitic discourse online.

Drawing on research from Decoding Antisemitism and their definitions for different features in online antisemitism (2024), the data was coded across 11 categories based on prominent themes and features, including encoded antisemitism, like emojis and dogwhistles (Becker, Troschke, Allington 2021), conspiracy theories, and intersectionality with other kinds of hate, like misogyny and Islamophobia. Additionally, a Critical Discourse Analysis (CDA) approach was used to understand the discursive strategies in online antisemitism that reconstruct ideologies of hate (Wodak 2015). Social media facilitates the spread of popular ideologies and reinforces the structures that sustain antisemitism.

This corpus and research stand as a testament to the state of antisemitism online and in the world today. Hate speech is not just words—it reproduces and maintains structures of hate. This project not only contributes to the growing body of research in online antisemitism but also demonstrates to social media users and companies, including content moderators, how multifaceted antisemitism is and how the ideology spreads.

Kacey Cooper
Graduate Program: English: Rhetoric and Composition
Advisor: Jason Miller
Poster Number: 38
Welcome to Wilson, NC, Mr. Hughes

This research investigates Langston Hughes' 1949 visit to the rural Wilson, NC during National Negro History Week.

His spoken performances fundraised for the Wilson County Negro Library's bookmobile, which would successfully share more literacy materials with community members-whether they were in their neighborhoods or working in the tobacco fields. This digital project's field research enhances our multidisciplinary understanding of cultural literacies in the contemporary composition classroom, especially through the study of cultural and rural literacies when traditional literacy resources were limited.

Hughes was driven into Wilson, NC by Dr. George Kenneth Butterfield Sr., father of Congressman GK Butterfield. He then visited various historical African American sites where he performed poetry and participated in Black history exhibits held in his honor. My field research in Wilson, NC facilitated a 2024 recreation of Hughes' historic tour alongside Wilson community members. Findings in this mixed-methods digital research project include analysis of interviews with witnesses of Hughes' visit along with oral histories about segregated libraries shared by community members. Also featured is Congressman G.K. Butterfield's recount of his father's role in the event. The project additionally analyzes detailed itineraries and diary entries from that day, drawing connections with other African American libraries across North Carolina.

As part of Hughes scholar Dr. Jason Miller's comprehensive digital project, "Backlash Blues: Nina Simone and Langston Hughes," this research explores the literacy impacts of both artists through the lenses of culture and education. Through geospatial mapping technologies, this primary and secondary research explores "Negro libraries" in rural areas and the dissemination of literacy, finds archival gaps in this historical event, and reveals more about the communication of cultural and extracurricular literacies that students draw upon. Its curation provides community members, educators, and researchers with access to Hughes' legacy regarding African American libraries and literacies learning.

Paula A. Dechima
Graduate Program: World Languages and Cultures
Advisor: Alison Turner
Poster Number: 41

Collaborative Learning through Peer Feedback: Impacts on Writing Proficiency in Second Language Education

Peer feedback has been increasingly implemented in second language (L2) writing instruction, aiming to improve students' writing skills and foster collaborative learning. Rooted in Vygotsky's sociocultural theory, peer feedback enables social mediation that promotes higher-order cognitive development, which is crucial for L2 learners as they advance their writing skills through constructive peer interactions. This research examines the cultural and instructional factors that impact L2 students' engagement with peer feedback, focusing on how cultural frameworks shape learners' perceptions of authority and trust in peer review. A multiple case study methodology was employed by analyzing the assignments and journals submitted by 31 international students from WLEN 101 at North Carolina State University. Throughout the Fall '24 semester, participants engaged in four instances of peer feedback, which focused on improving the writing of a final project, and later reflected on each of the experiences. They were asked to consider whether giving and receiving feedback helped them improve their writing and critical thinking skills, their perception of receiving feedback from a peer in comparison to the instructor's feedback, and whether they encountered any challenges working with classmates from different cultures and languages. Preliminary results show a positive attitude from participants towards peer feedback, highlighting the increased confidence they gained in providing constructive feedback and in their writing and critical thinking skills. Although some participants expressed concerns about the reliability of peer feedback compared to the instructor's feedback, many of them emphasized the importance of both types of feedback, recognizing that peer review encourages collaboration and diverse perspectives, while instructor feedback provides authoritative guidance and clarity. These findings contribute to the growing discourse on peer feedback as a central strategy in L2 writing pedagogy, emphasizing its potential to bridge cultural differences and enrich the writing learning experience.

Stephany Delgadillo Flores
Graduate Program: Spanish Literature and Cultural Studies
Advisor: Shelley Garrigan
Poster Number: 43

Resistance to Oblivion and Impunity through Activism: The River Sonora Case

In 2014, Mexico experienced the most severe mining-related environmental disaster in its history. The extractivist company Minera Buenavista del Cobre, a subsidiary of Grupo México, spilled 40,000 cubic meters of acidified copper sulfate into the Tinajas stream in Sonora, Mexico. This spill caused severe, cumulative, and irreversible damage to the environment, public health, and the quality and way of life of the affected communities. In response to this state of impunity and environmental injustice, individuals and activist groups have emerged, developing various resistance strategies. Studies on the Río Sonora disaster have been approached from multiple perspectives, including sociological, legal, and environmental justice frameworks. This research is situated within the field of Latin American cultural studies on the environment, proposing that, following Yuri Herrera's argument in El incendio de la mina El Bordo, the methodologies associated with literary and artistic research also serve to illuminate the human and environmental dimensions of this tragedy. Drawing on Diana Taylor's concepts of archive and repertoire in The Archive and the Repertoire: Performing Cultural Memory in the Americas, I analyze the resistance strategies embedded in Sonoran activism and reconstruct a narrative that, on the one hand, fills the gaps left by the official discourse and, on the other, highlights agency and the construction of a collective memory that emerges from the ephemeral. This interdisciplinary research integrates literary analysis, archival material review, and fieldwork conducted in the region affected by the Río Sonora spill, where interviews and photographic documentation were collected. Based on these data, I seek to analyze and contrast the narrative of subalternity with the hegemonic official archive.

Emma Jo Donnelly
Graduate Program: Public History
Advisor: Ajamu Dillahunt-Holloway
Poster Number: 47

Golden Exiles in the American Empire: Financial Motivations for Privileging Cuban Émigrés, 1959-1973

During the fifteen years following the Cuban Revolution of 1959, Cuban exiles received far greater political and economic support than any other immigrant group in American history. Scholars generally attribute these privileges to anti-communist Cold War policy and to the whiteness, wealth, and education levels of Cuban émigrés. However, Cubans received substantially more aid over a much longer period than other anti-communist refugees with similar demographics. American imperialism in pre-revolutionary Cuba is key to understanding the privileged status and assistance offered to early Cuban émigrés in the U.S. The Castro government's expropriation of American property factored into U.S. federal and private initiatives to encourage Cuban emigration, which American politicians believed would weaken the new regime. Though discussed marginally, the role of American imperialism in the privileging of Cuban exiles has remained underexplored by scholars. Reading commercial and governmental records alongside testimonies by leaders of Cuban aid programs reveals relationships between refugee support and American attempts to recover expropriated property. Viewed together, these documents demonstrate that the expropriations factored significantly into the unique funding and immigration policies provided for Cuban exiles by the U.S. government and American corporate executives. Unpacking this relationship is particularly useful for understanding the sorts of policies employed by empires that seek to simultaneously protect and obscure their imperial activities.

Michayla Gatsos
Graduate Program: Anthropology
Advisor: Jennifer Carroll
Poster Number: 66

Exploring Therapeutic Logics in Adult Drug Treatment Court

Drug treatment courts (DTCs) serve as alternative "correctional" pathways for certain individuals convicted of a drug-related crime. The purpose of this study is to explore the therapeutic and rehabilitative goals of DTC staff and participants and how those goals are shaped by variable social constructions of addiction and recovery within the DTC system. Data obtained from a year of observations and interviews with DTC staff members illustrates how differing explanatory models contribute to ideas of citizenship and risk that have real consequences for DTC participants. For example, participants in this DTC program were sanctioned with electronic monitoring and jailtime for missing appointments and drug screens, which indicated what DTC staff thought were the reasons behind substance use, as well as which actions helped curb substance use. In this setting, judges and DTC staff make decisions about the meanings and consequences of "addiction," and about who is deemed viable for recovery versus incarceration. DTCs thus provide an important window into the social construction of "addiction" and "recovery" inside the legal system.

John Gibson
Graduate Program: World Languages and Cultures
Advisor: Valerie Lambert
Poster Number: 68

Fernanda Trias' Geocriticism of Extractivist Capitalism in Mugre rosa

In this essay, I geocritically examine the landscape of Fernanda Trías' 2020 Mugre rosa, translated into English in 2023 as Pink Slime. The city is one of the novel's most important characters. The spatial turn in the humanities and social sciences over the last forty years has shown that geography is generative and constitutive instead of, as was frequently thought after the Enlightenment, subsidiary. Trías richly details the port, based upon Montevideo, Uruguay, where she grew up, from the viewpoint of the narrator's memories of her childhood and her current experience through broadcast television news, taxi rides and walks in the epidemic-infested metropolis that constitute an odyssey of discovery. Although the novel never gives a definitive cause for the epidemic, it points to waste from a large meat processing plant, which is central to the urban, if not national, economy, and is financed in part by foreign capital, thereby laying at the feet of extractivist capitalism an environmental catastrophe that threatens not only the port city but also the interior of the country and the rest of the world.

Katelin Mueller
Graduate Program: Communication
Advisor: Lynsey Romo
Poster Number: 117

Bending but Not Breaking: A Study of Scoliosis and Uncertainty

Adolescent Idiopathic Scoliosis (AIS), affecting approximately one in 25 children, presents significant physical and psychosocial challenges for affected individuals. While existing literature acknowledges the uncertainty surrounding scoliosis, there is limited research on how individuals navigate their uncertainty throughout their lives. This study applies uncertainty management theory (UMT) to examine participants' uncertainty as associated with AIS. This qualitative study identifies key sources of uncertainty and management strategies through semi-structured interviews with 21 participants. While some sought to reduce uncertainty by engaging with healthcare providers and support networks, others maintained uncertainty by avoiding medical information or delaying treatment decisions. Additionally, many adapted to their uncertainty by reframing their experiences, engaging in self-care, and finding support through religion or personal growth. Findings suggest that uncertainty is a persistent aspect of living with scoliosis, influencing individuals' physical health, emotional well-being, and interpersonal relationships. This study contributes to the growing body of research on chronic illness and uncertainty by providing insight into the lived experiences of individuals with AIS. The results highlight the need for greater medical, psychological, and social support for those diagnosed with scoliosis, as well as the importance of developing tailored uncertainty management strategies to improve their quality of life.

Nicole Riggs
Graduate Program: English Rhetoric and Composition
Advisor: Kirsti Cole
Poster Number: 151

Humanity and the BrAIn: How GenAI Influences our Metacognition and Creativity

Generative Artificial Intelligence (GenAI) and Large Language Models (LLM) have become widely accessible tools capable of producing hundreds of words inspired by a single prompt. Such programs have now become ubiquitous within writing classrooms. As these models evolve at incredible speeds and produce more nuanced content, how do intelligent systems impact the metacognitive capabilities of students?

This study explored the influence of GenAI on creative thinking, critical thinking, and prompt analysis capabilities within the general public. Participants interacted with prompts relating to the skills in the above categories. After engaging with each prompt independently, they collaborate with LLM programs to revisit and elaborate on previous answers. The results depict a careful balance between human context and critical analysis of content produced by LLMs. Implications of the study explore the balance between human intellectual autonomy and GenAI.

Charity Sullivan
Graduate Program: Anthropology
Advisor: John Millhauser
Poster Number: 167

A Comprehensive Review of Anthropogenic Landscape Modifications and Environmental Engineering by the Maya Civilization in The Three River Region of Belize: Synthesis of Archaeological Scholarship

Human societies have long shaped and modified their environments, leaving lasting imprints on landscapes through agriculture, resource extraction and infrastructure. Environmental archaeology provides a crucial lens to understanding these transformations, integrating paleoecology, zooarchaeology, site formation and preservation, environmental conditions, scientific dating and soil properties, to reconstruct past land-use strategies and their ecological consequences. This paper will provide an exploration of precolonial Maya landscape modifications in Belize. This review aims to analyze literature focused on topics dealing with human-environment interactions to determine the types of changes made by ancient populations, why those changes were made and the results of those changes. The literature is divided into three sections; Agroforestry and Deforestation, Agriculture Terracing and Terrace Farming, and Water management systems. Each article explores Maya land use through archaeological examinations to understand the complexities behind these environmental transformations and the connections to the civilizations' social, economic and political functions. This synthesis will contribute to the broader conversation of environmental problems and the Maya reorganization. Through this paper, I will challenge preconceived notions of the Maya "collapse" during the Late/Terminal Classic period and what it means to be "sustainable".

Greer Taylor
Graduate Program: Anthropology
Advisor: John Millhauser
Poster Number: 170

Cemetery Photogrammetry: Historical Archaeology Data Collection Results from Oberlin Cemetery, Raleigh, North Carolina

Photogrammetry involves creating three-dimensional models using photographs of an object which can provide more detailed documentation than the photographs alone. This technique could be used to record and assist in the future preservation of grave markers. This poster presents the results of photogrammetry in Oberlin Cemetery, located in the historic African-American community of Oberlin Village in Raleigh, North Carolina. It has recently been mapped with geophysical tools by local professionals and rejuvenated by volunteer clean-up initiatives. I aim to contribute to the Oberlin community and the ongoing rehabilitation of Oberlin Cemetery through photogrammetry.

Alexander Tsynkov
Graduate Program: Technical Communication
Advisor: Huiling Ding
Poster Number: 173

Creating a Website and Student Guidebook for the Center for Research in Scientific Computation

The Center for Research in Scientific Computation is a is a formally recognized, multidisciplinary center administered by North Carolina State University. Its purpose is to foster research in scientific computing and provide a focal point for research in computational science, engineering and applied mathematics. In order to reflect the Center's growth and progress, its website requires renovating, and bringing up-to-date with relevant information. By using the WordPress Software, as well as gathering data from the faculty of the Center, this project aims to create a new CRSC website, as well as design an information booklet containing details about the CRSC, for use by students, associated researchers, and external partners looking to collaborate with the Center.

Tanmai Vemulapalli
Graduate Program: Public History
Advisor: Xiaolin Duan and Nishani Frazier
Poster Number: 177

'Welcoming Ram Home': Ram Mandir Celebrations and Diasporic Hindu Nationalism in the United States

In January 2024, the grand Ram Mandir was inaugurated with much fanfare and celebration on the site of the demolished and disappeared Babri Masjid. Scholars and activists have pointed to the Ram Mandir inauguration as the consolidation of Hindu ethnonationalism in India, from the realization of a decade-long political promise to "rightfully restore" a temple at this site to support for distorted historical narratives and violence against minority groups. Fewer have examined the swell of support from across the Indian diaspora and the increasingly complex constitutions of Hindu nationalism as a global political and cultural force. Thus, I ask: Why have Ram Mandir celebrations become such an important element of Indian diasporic nationalism in the US?

In the context of the United States, home to the largest Indian diaspora, who are in turn the second largest and richest ethnic group in the country, Hindu nationalism is reproduced, refashioned, negotiated, and contested within diasporic realities. I utilize photos, media narratives, organized events, and statements from cultural and political organizations to analyze the dimensions of Hindu nationalism through the seminal Ram Mandir inauguration celebrations.

I argue that diasporic Hindu nationalism is adept at playing to Western multiculturalism on the one hand and Islamophobia on the other. This is the deeper success of the Ram Mandir as the locus of converging political, religious, and historical narratives: it can draw in supporters relying on one strand of the overall message, obscuring others which might elicit critique, and still collapse all perspectives and differences into the support of this symbolic and material gain for Hindu ethnonationalism in India. The concentrated organization and widespread support behind inauguration celebrations in the United States marks the "arrival" of the Indian diaspora as a powerful force capable of marshalling resources to shape local and global political realities.

Tory Worth
Graduate Program: Communication
Advisors: Andrew Binder, Jean Goodwin, and Ryan Hurley
Poster Number: 187

Health Identity Discourse of ADHD: An Online Community Content Analysis

Online spaces play an increasingly important role in connecting people for the purposes of sharing information and creating support communities, particularly for identities or conditions that are socially stigmatized like Attention-Deficit/Hyperactivity Disorder (ADHD). These online support communities enable large-scale discourse about a health identity experience from a first person perspective, and serve as an essentially important platform for health identity knowledge formulation. Discourse created within an online health identity community is useful to counter a dominant health discourse that often perpetuates stereotyped, limited, or inaccurate public conceptions of a particular health condition. The dominant health discourse of ADHD is shaped by neurotypical perspectives and clinical approaches, and focuses largely on deficits, impairments, and disruptions to society. Moreover, it overlooks the first person perspectives of marginalized identities, whose health experiences are not yet well accounted for by the dominant discourse. In this investigation I examine the discourse of a specific ADHD subreddit (r/adhdwomen), a health identity social media community, in order to analyze the health discourse of a community for whom the dominant discourse inadequately represents lived experience. Using a mixed-methods approach, I analyze language patterns, sentiment, and thematic trends in order to characterize community members' health experience of ADHD. Lastly I use the findings from my content analysis to inform a health belief model of ADHD which incorporates the r/adhdwomen community representation of the perceived benefits, barriers, susceptibility, and severity of the condition. The findings here highlight the evolving role of online community discourse in ADHD knowledge generation, identity formation, and negotiation of clinical versus lay models of ADHD. Overall this research advances public understanding about the lived health experience of a particular marginalized health identity community and highlights the importance of studying health discourse created in online health identity communities.

College of Natural Resources

Shaikat Chandra Dey
Graduate Program: Forest Biomaterials
Advisor: Sunkyu Park
Poster Number: 45

Low Temperature Processing of Bio-oil for Sustainable Biographite Production

This study reports biographite production from pyrolysis bio-oil using iron as catalyst. Extensive foaming is observed when iron is mixed into the bio-oil due to the presence of organic acids in bio-oil. To address foaming, five different pathways were explored, including the use of defoamers, the use of iron oxide (Fe2O3) as graphitization catalyst, adjusting the acidity of bio-oil, coking of bio-oil (300-500 °C), and low-temperature pretreatment of bio-oil (150-200 °C). The addition of defoamers failed to prevent foaming, while adding iron oxide in place of iron resulted in no foaming. However, the quality of biographite produced using iron oxide catalyst was poor. Adjusting bio-oil pH to 11 helped prevent foaming; however, no attempt was taken to make biographite form the highly alkaline bio-oil. The coking pathway (300-500 °C) converted the bio-oil into a highly swelled coke carbon structure when bio-oil was heat treated at 300-500 °C without iron under a nitrogen atmosphere. Milling this swelled coke into fine powder was challenging, which led to poor mixing with iron. A low-temperature thermal pretreatment pathway (150-200 °C) effectively converted the raw bio-oil into a physical powder form well suited for iron mixing and subsequent conversion into Lithium-ion battery-grade biographite anode.

Jose Alejandro Fernandez
Graduate Program: Forest Biomaterials
Advisor: Richard Venditti and Joel Pawlak
Poster Number: 53

Understanding the Fundamentals of the Biodegradability of Polymer Blends and Additives for Nonwovens Application

Polylactic acid (PLA), is an industrially compostable polyester derived from renewable resources. It is of interest to understand how modifications to the PLA impact the rate and extent of biodegradation. This research investigates the composting behavior under industrial composting (58 ± 2°C and 50% humidity) and the physicochemical properties of PLA fibers, including neat PLA and blends with polycaprolactone (PCL) and starch spun under different conditions. The drawing process involves mechanically stretching of fibers to align polymer chains during fiber processing, enhancing crystallinity, tensile strength, and overall mechanical performance. These structural changes directly influence fiber morphology, and most likely affect the biodegradability behavior. Fibers, both undrawn and drawn, were produced using the Nonwoven Institute fiber extrusion line (Hills LBS bicomponent extrusion line with a 3-zone extruder). Key properties, including crystallinity, thermal transitions, and tensile performance, were characterized using X-ray diffraction (XRD), differential scanning calorimetry (DSC), and tensile testing. The drawing process was found to significantly improve fiber crystallinity and tensile strength, but it also reduced the extent of biodegradation. Undrawn fibers exhibited greater flexibility and faster biodegradation (64.3 ± 7.8 %) compared to drawn fibers (55.0 ± 8.2) after six months of industrial composting. Decreases in the molecular weight and melting temperature confirmed progressive polymer chain degradation during the experiment. Scanning electron microscopy (SEM) revealed fibrillation in undrawn fibers and uniform cracking in drawn fibers during composting, highlighting distinct degradation mechanisms. Blending PLA with PCL resulted in reduced thermal stability and limited drawability due to phase separation, as confirmed by DSC, XRD, and SEM analyses. This research highlights the relationship between molecular orientation, material composition, and environmental conditions on the biodegradability and performance of PLA fibers.

Pinar Guner
Graduate Program: Forestry and Environmental Resources
Advisor: Trevor D. Walker
Poster Number: 74

Witches' Broom Mutation in Loblolly Pine

Witches' broom, an aberration characterized by the proliferation of short, densely packed branches, is occasionally observed on isolated branches in the crowns of Pinus spp. Some witches' brooms are apparently caused by somatic mutations and result in dwarfism segregating in progeny from their cones. Our study seeks to characterize the genomics of the witches' broom mutation in Pinus taeda (loblolly pine). We sampled needle tissue and cones from more than 20 trees with witches' brooms, as well as from the trees' normal branches. DNA was extracted from needle tissues and genotyped using the Pita50K SNP array to investigate marker associations. Nutrient profiles, cone morphology, hormone levels, and tissue anatomy via microscopy of afflicted and normal branches were compared. Seeds were extracted from open-pollinated cones collected from brooms and their neighboring typical branches for sowing in the greenhouse. Open-pollinated seeds from the dwarf P. taeda nana were collected from the JC Raulston Arboretum at NC State University (which originated from witches' broom cones). Mutant foliage exhibited lower levels of potassium, calcium, magnesium, and manganese compared to normal foliage. However, mutant foliage displayed significantly higher levels of phosphorus compared to normal foliage. 6 out of 14 Nana open-pollinated seedlings exhibited dwarfism and were on average 30 cm at 20 weeks compared to 20 cm for their non-dwarf half-siblings. A practical application of dwarfism would be the development of rootstock for grafted pine seed orchards, which presently require heavy bucket-lift equipment to harvest cones for reforestation due to their tall stature. While dwarfing rootstock is common in fruit trees, there is no forestry analog, which could facilitate safer and faster cone harvest.

Kristin Hilborn[1], R. Talbot Trotter[2], and Ethan Doherty[3]
Graduate Programs and Institutions: Forestry and Environmental Resources and Entomology and Plant Pathology1; U.S. Forest Service[2]; Clemson University[3]
Advisors: Kelly Oten and Robert Jetton
Poster Number: 80

The Surveying Costs and Non-Market Value Loss of a Potential Asian Longhorned Beetle (Anoplophora glabripennis) Infestation in North Carolina

The Asian longhorned beetle (ALB) (Anoplophora glabripennis) was recently detected in South Carolina in 2020 and serves as a threat to neighboring states, such as North Carolina. New ALB infestations can cause significant ecological, economic, and social impacts; however, the economic impact of invasive forest insects often focuses solely on the loss of the market value of timber. Historically, ALB infestations have primarily occurred in urban areas with previous studies broadly estimate the cost of removing and replacing street trees in urban settings. Previous estimates fail to include the added non-market value of urban and street trees provided through ecosystem services (e.g., carbon storage, water run-off avoided, energy savings). Providing a tool that can estimate both management costs (e.g., surveys, tree removal) and non-market value loss can supply an inclusive view of the potential economic impacts of ALB. This study aims to investigate the potential economic impact of a future ALB infestation in Durham, North Carolina, by utilizing real street tree and active infestation data. We incorporated an agent-based model developed by a postdoctoral researcher at Clemson University to simulate a fake infestation allowing for the basis of our simulation. A tool was developed to conduct surveys (e.g., ground vs. climbing) to detect infested trees in the landscape. As trees are detected the cost of removal and non-market values are added to surveying costs to determine the economic impact of various surveying strategies. The results of this study provide insight into the relationship between the potential surveying strategies and non-market costs of a potential ALB infestation in North Carolina.

Md Nazrul Islam[1], Shaikat Chandra Dey[1], Ming Liu,[2] and Sunkyu Park[1]
Graduate Programs: Forest Biomaterials[1]; Nuclear Engineering[2]
Advisor: Sunkyu Park
Poster Number: 84

Secrets to Commercial-grade Catalytic Bio-graphitization: "Decoding Iron-carbon Interactions Shaping Graphitic Architecture Through In-situ and Ex-situ Investigations."

Addressing climate challenges requires innovative solutions to reduce dependence on fossil fuels and shift toward sustainable energy systems. Electrical energy storage is critical to this transformation, facilitating a dependable and efficient integration of traditional and renewable energy sources. This research focuses on a scalable approach to the production of high-performance graphite by utilizing carbon-rich biomass residue as a renewable alternative to traditional anode materials for next-generation energy storage applications. The investigation addressed both in situ and ex situ observations of how iron catalysts changed amorphous biomass that was hard to organize into crystalline graphitic structures, making graphite-based electrodes work better in high-performance batteries. In addition to the conventional thermal and surface characterizations, we used a special high-temperature real-time X-ray diffraction analyzer and positron annihilation lifetime spectroscopy (PALS) to study the different stages of graphitic development. The features in the 1500°C heat-treated iron-assisted bio-graphite are comparable to commercial graphite. The detailed mechanisms and efficiency of catalytic biomass graphitization offer an excellent prospect for future work on commercializing sustainable materials for energy storage and promoting advancements in cleaner and renewable energy technologies.

Brooklynn N. Joyner[1], Emily Smith[1], Kat Deutsch[1], Kingston Armstrong[2], Emma Tirjan[3], Benjamin Regester[3], Henry Kelso[3], and Lincoln R. Larson[1]
Graduate Programs: Parks, Recreation, and Tourism Management[1], Civil, Construction, and Environmental Engineering[2]
Undergraduate Programs: Environmental Sciences[3]
Advisor: Lincoln R. Larson
Poster Number: 88

Measuring Public Trust in Science Across North Carolina: A New Multi-dimensional Instrument

Trust between public and scientific communities plays an integral role in creating equitable and effective solutions to environmental and public health crises. Yet, the creation of a robust and theoretically grounded tool for defining and measuring public trust in science and scientists has remained a challenge for researchers. To advance this work, we designed a quantitative survey instrument that improves on the reliability and validity of existing trust in science scales. Our scale-validation study not only distinguishes trust in science from trust in scientists, but identifies multidimensional forms of trust (or lack thereof) that may require consideration when addressing concerns between public communities and scientific communities.

Pilot-testing yielded a 10-item quantitative survey instrument consisting of two subscales: six items assessing trust in science (Cronbach's $\alpha = 0.90$, Eigenvalue = 3.58) and four items assessing trust in scientists (Cronbach's $\alpha = 0.81$, Eigenvalue = 2.64). After pilot-testing, we further validated the instrument via intercept surveys of the general public in rural eastern North Carolina ($N = 450$, results in prep). Items are based on Stern and Coleman's trust theory framework for collaborative natural resource management, which notably distinguishes four dimensions of trust captured in our final scale: rational, dispositional, procedural and affinitive. Our instrument acknowledges the highly contextual nature of trust, including the beliefs and emotions that inform development of trust between people and scientists. These are particularly important considerations for researchers engaging with highly polarized subject matter or those working with vulnerable populations where strained relations with researchers and scientific institutions may hinder resolution of salient social and environmental problems. We hope this tool will be used to better assess, understand, and enhance the public relationship with science and scientists across various contexts.

Peizhe Li[1], Abu Kibria[2], Xiao Xiao[3], and Erin Seekamp[1]
Graduate Programs and Institutions: Recreation and Tourism Management[1]; Department of Fisheries and Wildlife, Michigan State University[2]; School of Community Resources and Development, Arizona State University3
Advisor: Erin Seekamp
Poster Number: 101

Investigating Community Members' Place Connections and Adaptation Preferences to Cultural Resources and Landscapes Under Climate Change

Climate change threatens cultural resources and landscapes, influencing the place connections community members hold with these environments. This study investigates how current and future climate change impacts influence their place connections to cultural resources and how place connections may shape their preferences for adaptation strategies. An online survey was distributed to two (2) official partner organization members of Cape Lookout in February 2024 and collected 376 valid samples. Study findings suggest that community members' place connections to cultural resources include six (6) dimensions: community pride, economic value, uniqueness, individual connection, family connection, and intangible heritage and legacy. Community members' place connections were negatively influenced by climate change impacts, particularly for those members with high levels of place connections to Cape Lookout. In addition, this study found that community members generally preferred adaptation strategies of "transformation to intangible heritage" (e.g., oral histories, virtual experiences) while opposing adaptation strategies of "transformation to loss" (e.g., removing structures and letting go). The logistic regression model indicated that the community members' preferences for adaptation strategies were influenced by the different dimensions of place connections with varying effects. The findings of this study advance the place theories and quantify the impacts of place connections on the preferences of climate adaptation strategies. Study findings also provide valuable insights for integrating community perspectives into climate adaptation planning for cultural resources.

Debsree Mandal and Jingxin Wang
Graduate Program: Forest Biomaterials[1,2]
Advisor: Jingxin Wang
Poster Number: 108

Abandoned Mine Land Reclamation for Energy Crop Production to Improve Economic and Environmental Benefits in the Central Appalachian Region

Bioenergy from biomass offers a renewable alternative but poses challenges such as land use changes and water resource strain. Recent initiatives have explored the potential of reclaiming abandoned mine lands (AMLs) for energy crop production, offering a sustainable solution to these pressing issues. This research focuses on using bioenergy crops for mine land reclamation, emphasizing environmental remediation and economic feasibility. This study highlights the potential of integrating sustainability practices with land reclamation efforts to address the environmental and financial challenges of the central Appalachian region of the United States. By transforming AMLs into productive areas for energy crop production, this research contributes to both environmental and economic revitalization.

The study has developed a comprehensive approach to AML reclamation, including a systematic review of sustainable approaches, an assessment of mine land focusing on soil health, environmental impacts assessment to develop remediation strategies, and economic feasibility assessment for a suitable bioenergy landscape. The research explores differences between land use for four types of energy crops (sunflower, ryegrass, switchgrass, and willow crops) and their adaptability to poor soil conditions. The deep-root systems of these crops help stabilize the soil, reduce erosion, and sequester carbon, mitigating the impacts of climate change. Cultivating energy crops on AMLs can prevent the spread of invasive species and promote the return of native flora and fauna. Producing energy crops on reclaimed AMLs can create new job opportunities and stimulate local economies. Bioenergy from these crops can provide a renewable energy source, reducing dependence on fossil fuels and contributing to energy security.

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Poster Number: 112

Sustainable Soft Electronics with Biodegradable Regenerated Cellulose Films and Printed Recyclable Silver Nanowires

This study describes the production of biodegradable and recyclable flexible electronic devices created by screen-printing silver nanowires (AgNWs) onto regenerated cellulose films (RCFs). RCFs, derived from microcrystalline cellulose (MCC), are developed and further enhanced for flexibility with additives such as glycerol and poly(ethylene glycol) diglycidyl ether (PEGDE). The resulting cellulose films display relatively high tensile strength (up to 120 MPa), low Young's Modulus (down to 1500 MPa), and 90% optical transparency. Ink with AgNWs and poly(ethylene oxide) (PEO) as a binder is screen-printed on regenerated cellulose films. The printed AgNWs patterns exhibit high electrical conductivity, excellent electromechanical performance, and strong interfacial adhesion with RCFs. To demonstrate the application of printed AgNWs on RCFs for soft electronics, transparent conductive electrodes (TCEs) are fabricated. Grid and honeycomb structures are printed separately and evaluated in terms of sheet resistance and optical transparency. TCEs with around 80% transparency and very low sheet resistance (0.045 ohms sq^{-1}) are obtained. Furthermore, enzymatic hydrolysis of the cellulose substrate and the recovery for reuse of the AgNWs are demonstrated, showing the potential of integrating natural polymers and recyclable nanomaterials for eco-friendly and sustainable soft flexible electronics

Riley Nelson
Graduate Program: Parks, Recreation, Tourism, and Management
Advisor: Aaron Hipp
Poster Number: 123

Play for All: Access to Inclusive Playgrounds in Raleigh, North Carolina

Play is a fundamental aspect of children's development, fostering social, emotional, physical, and intellectual growth. However, children with disabilities often face barriers to play, particularly in accessing inclusive playgrounds. This thesis investigates the accessibility and availability of inclusive playgrounds in Raleigh, North Carolina, using geospatial information systems (GIS) to evaluate factors such as playground distribution, public transportation access, walkability, and demographic considerations.

The study focuses on 76 public playgrounds in Raleigh, auditing their compliance with the PARCS tool. Data sources include park audits, transportation routes, walkability indices, and demographic statistics. Key methods involve spatial analyses to identify accessibility gaps and categorizing playgrounds based on inclusivity levels.

Findings aim to inform city planners, stakeholders, and families about the state of inclusive play infrastructure. The project aspires to enhance play opportunities for children with disabilities and promote equitable access to recreational spaces. Anticipated outcomes include a publicly available dashboard for identifying accessible playgrounds and recommendations for future improvements in inclusive playground design and placement.

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Poster Number: 125

Rainfall and Temperature Modify Effects of On-Site Sanitation Intervention on E. coli Contamination in Bangladeshi Households

Weather events associated with climate change can influence the environmental spread and survival of fecal pathogens, potentially impacting the efficacy of water, sanitation, and hygiene (WASH) interventions. We used longitudinal data from a randomized controlled trial in Bangladesh to assess whether rainfall and temperature modified the effect of an on-site sanitation intervention on fecal contamination. Over 3.5 years, we enumerated E. coli in household samples along eight fecal-oral pathways (n=23,238 samples) and obtained daily weather data. The intervention included the provision of double-pit latrines, child potties, and scoops for removing child and animal feces, along with behavior change promotion. The intervention was associated with larger reductions in E. coli in/on mother hands, child hands, ponds, and flies (0.10-log to 0.91-log) following higher rainfall and in/on food, mother hands, child hands, soil, and ponds (0.11-log to 0.40-log) following higher temperatures, compared to drier and colder periods. The intervention slightly reduced E. coli in stored drinking water and had no consistent effect on E. coli in tubewell water, regardless of weather. Our findings suggest that sanitation interventions can help mitigate the effects of increased rainfall and temperature on environmental fecal contamination. Previous analyses of these data without stratification by daily weather only found small (approximately 0.10-log) reductions in E. coli in/on stored drinking water and child hands. Future WASH trials should incorporate weather data to identify periods of differential intervention effectiveness to understand how weather variability influences the outcomes of public health interventions and develop strategies to enhance resilience against climate change impacts in vulnerable communities.

Nicole E. Odell
Graduate Program: Parks, Recreation and Tourism Management
Advisor: J. Aaron Hipp
Poster Number: 129

The Association Between Bicycle and Pedestrian Advisory Boards and Physical Activity-Supportive Zoning in U.S. Municipalities

Physical activity (PA) is a health behavior that plays an important role in chronic disease prevention. Municipalities can make PA more accessible by creating environments that are easier and safer to travel by human-powered travel modes. Such environments allow people to incorporate more PA into their daily routines, which can lead to improved population health outcomes. As these transportation design decisions are made at the local level, some municipalities have established Bicycle and Pedestrian Advisory Boards (BPACs), which provide guidance to decision makers on these issues. Local transportation infrastructure is also impacted by zoning and development ordinances, which can mandate inclusion of PA-supportive features such as bike lanes and sidewalks. This study examines the association between BPAC presence and ten measures of PA-supportive zoning: sidewalks, crosswalks, bike-pedestrian connectivity, street connectivity, bike lanes, bike parking, bike-pedestrian trails/paths, mixed-use, active recreation, and passive recreation, and a composite PA-zoning score (range 0-10). We obtained 2020 zoning data from 2,090 municipalities across the 200 most populated counties in 41 states and Washington DC. We further identified municipalities with BPACs (n=217) and those established prior to 2015 (n=76) to allow for a 5-year policy lag. Municipal socioeconomic characteristics were obtained from American Community Survey (ACS) 5-year estimates. We will present findings from multivariate regression analyses examining the relationship between BPAC presence prior to 2015 and individual PA-supportive zoning conditions, as well as the composite PA-zoning score, while controlling for municipal socioeconomic characteristics. Our results will contribute to existing research on PA-supportive zoning, and provide insights of alignment (or misalignment) between municipal transportation and land use planning goals.

Hanne Parks
Graduate Program: Fisheries, Wildlife, and Conservation Biology
Advisors: Lara Pacifici, Alexander Krings, and Christopher DePerno
Poster Number: 136

Whodunit: Small Mammals and Root Herbivory on Smooth Coneflower (Echinacea laevigata, Fed T) at Picture Creek Diabase Barrens

Smooth coneflower (Echinacea laevigata, Fed T) is a perennial herb endemic to the southeastern U.S. Piedmont. Fire suppression and land use changes are thought to have restricted the species to scattered populations in four states. Picture Creek Diabase Barrens (PCDB) in Granville County, NC, hosts the largest known population of smooth coneflower. Here, a primary management objective is to expand the population into an adjacent woodland with augmentations. Recent augmentations have faced significant seedling mortality (>50%) due to root herbivory. Voles (Microtus spp.) are the suspected root herbivore, but have not been captured on-site. The objectives of this study were to develop a list of small mammals at PCDB and test an anti-vole soil treatment. The small mammal list was developed with a 3-week trapping survey in summer 2024, using Sherman and pitfall traps. One-hundred ninety-two seedlings of E. laevigata (4 yrs old; locally sourced) were planted in Dec 2023 in a randomized complete block design with replication. The experimental soil treatment consisted of one part soil to one part gravel. The seedlings were monitored every three months. In Oct 2024, all seedlings were extracted to assess level of root growth and damage, then subsequently replanted. No voles were trapped and evidence for vole herbivory was minimal. One-hundred fourteen plants (59%) survived to Oct 2024, lower than previous studies. The experimental treatment did not have a significant effect on seedling survivorship. Twenty-six white grub larvae (Phyllophaga sp.) were encountered beneath plants, but did not significantly impact plant height. Further work should utilize this study to inform augmentation methods that maximize survivorship of smooth coneflower.

John Polo[1], Ross K. Meentemeyer[1], Anders Huseth[2], Jean Ristaino[2], Shannon Jones[1], Eli Horner[1], Jean Ristaino[1], and Chris M. Jones[1]
Graduate Programs: Center for Geospatial Analytics[1]; Entomology and Plant Pathology[2]
Advisors: Chris M. Jones and Ross K. Meentemeyer
Poster Number: 143

Understanding trade-offs between modeling approaches to forecast disease spread and risk

Forecast models for the spread or risk of disease are important to plant disease management, and there are multiple approaches for these models available to stakeholders. We considered these approaches on a gradient from more spatially- to more temporally-focused models and their combination, where some model results are focused on location, while others are focused on when infections occur. We modeled two pathosystems: late blight, an agricultural disease of potato and tomato, and sudden oak death, a forest disease of several tree species and ornamentals such as rhododendron. The disease data for the agricultural system were spatially and temporally uneven ("sparse"), while the data in the forest system were spatially and temporally dense. The three models were a temporally focused model, a spatio-temporal model, and a spatially focused model. The management context in agricultural pathosystems often includes extensive spatial knowledge of the crop, easy access, and multiple options for management. In wildlands, the management context often lacks detailed spatial knowledge of hosts, access can be difficult, and management action is resource intensive, especially for the large geographic extents managed. Results from our work found that the temporal model is suited to disease control in the agricultural example due to the stakeholders' spatial knowledge; the infection data for this system was too sparse for the spatio-temporal model we tested to make any predictions. In the case of the wildlands pathosystem, the spatio-temporal model provided predictions with needed spatial detail, while the spatial model lacked the temporal resolution needed for management. Our research concluded that management context, such as spatial knowledge of hosts at risk, and data density are important to deciding on the right modeling approach. Model options are more flexible when the disease data are spatially and temporally dense, due to the data demands of most spatial models.

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Poster Number: 146

Post-Storm Visitation Intentions and Pro-Environmental Behaviors to Western North Carolina Parks: A Pilot Study of NC State Students

Natural disasters significantly impact outdoor recreation and tourism-dependent communities. Hurricane Helene, which struck Western North Carolina (WNC) in October 2024, severely damaged parks, infrastructure, and local economies. Prior research highlights how disasters disrupt visitor behavior, conservation efforts, and community resilience (Huang & Zhang, 2021; Mair et al., 2016). However, little is known about how university students perceive post-disaster parks and align their behaviors with conservation. As Asheville and WNC reopen parks to attract tourists, including Carrier Park and the French Broad River Greenway (WLOS, 2024) and state parks like Elk Knob and Lake James (NCDNCR, 2024), understanding visitor motivations and behaviors is crucial for recovery. This study examines NC State University (NCSU) students' visitation intentions and pro-environmental behaviors, exploring (1) visitation perceptions, (2) conservation intentions, (3) restoration concerns, and (4) how proximity and information sources shape attitudes. Grounded in the Theory of Planned Behavior (TPB) (Ajzen, 1991), this research investigates how attitudes, social norms, and perceived behavioral control influence decisions. A mixed-methods approach was used, combining a semi-structured interview with an NCSU student from Asheville and an online survey via WhatsApp and GroupMe. A total of 318 questionnaires were distributed, yielding a 60% response rate. Data analysis included Wilcoxon tests, Partial Least Squares Structural Equation Modeling (PLS-SEM), and Mean Weighted Discrepancy Scores (MWDS) to assess perceived importance versus concern for park features. Wildlife and unique geography ranked as top concerns (MWDS values closest to zero). Higher-awareness students reported lower intentions to protect facilities ($p = 0.051$), while prior visitors had greater perceived control over visitation ($p = 0.040$). Social norms reduced damaging behaviors ($\beta = -0.471$, $p < 0.001$), while attitudes predicted conservation behaviors ($\beta = 0.528$, $p = 0.024$). This research extends TPB applications in post-disaster recreation and integrates VBN Theory (Stern et al., 1999) and Place Attachment Theory (Kyle et al., 2004). It provides park managers with strategies to align restoration with public expectations, enhance conservation messaging, and reinforce pro-environmental norms.

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Graduate Program: Forest Biomaterials
Advisor: Lokendra Pal
Poster Number: 175

Innovative Microfibrillated Cellulose Coatings for High Barrier Fluorochemical-Free Paper and Packaging Materials

Microfibrillated cellulose (MFC) offers a high barrier against air, oxygen, and oil, but its limited water resistance restricts industrial applications. An innovative bilayer composite coating (BCC) is developed, consisting of a top layer providing water resistance and the MFC layer contributing to the gas & oil barrier and recyclability. The top coating integrates styrene-butadiene copolymer for its non-polar characteristics and nanoclay to create a hydrophobic surface that resists moisture with enhanced tortuosity. Scanning electron microscopy confirmed a stable interface between the paper substrate and the BCC. X-ray photoelectron spectroscopy (XPS) and Time-of-flight secondary ion mass spectroscopy (ToF-SIMS) show that the BCC prevents intermixing between layers, enhancing barrier performance and fiber recovery with reduced stickies during recycling. The BCC significantly improved barrier properties, achieving a 56% reduction in water vapor transmission rate, a ~630-fold decrease in air permeability, an oil & grease resistance of kit rating 12, and <5% weight gain from the hot oil test. These improvements highlight the efficacy of the BCC system for enhanced barrier and recyclability, especially in stickies reduction. This research demonstrates that the strategic combination of conventional and novel MFC materials can provide sustainable packaging with functional barriers and recyclability for a circular economy.

College of Sciences

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Graduate Programs and Institutions: Marine, Earth and Atmospheric Sciences[1]; Department of Atmospheric Sciences, University of Illinois at Urbana Champaign[2]
Advisor: Viney Aneja
Poster Number: 5

Impact of Meteorological Conditions on PM2.5 Transport During California's 2018 Wildfire Events

Extreme wildfire events have become more common and have emerged as a significant global threat. This study investigates the role of meteorological conditions and topographical features on the three-dimensional transport and distribution of PM 2.5 during California's 2018 wildfire season, with particular focus on two major wildfires the Mendocino Complex Fire and the Camp Fire. An integrated analysis of vertical convection, horizontal advection, and atmospheric dilution patterns through the troposphere was conducted using multiple data sources, including EPA ground monitoring stations, MODIS satellite products, and HYSPLIT trajectories. Results revealed that the Camp Fire, despite its smaller burned area and shorter duration, produced higher pollution levels due to persistent low boundary layer conditions and weak winds (≤2 m/s), creating pronounced atmospheric stagnation and leading to pollutant accumulation near the surface (~350 µg/m^3). Analysis of PM 2.5 -AOD (Aerosol Optical Depth) correlations demonstrated stronger relationships during wildfire events compared to baseline periods, indicating the significant role of the wildfire induced aerosols throughout the atmospheric column.

Sarah Arteta[1], Mawuli Deegbey[1], Nicolas Durand[1], Russell Kibbe[1], Johannes Floß[2], Alexandra T.Barth[1], Elena Jakubikova[1], Oliver Reiser[2], David C. Muddiman[1], and Felix N. Castellano[1]
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Advisor: Felix N. Castellano
Poster Number: 8

Mechanistic Insights to Visible-Light Induced ATRA Reaction Powered by the Symbiotic Relationship Between Cu(II)/Cu(I) Phenanthroline-Based Complexes

As the field of photoredox catalysis continues to identify available photocatalysts, there is an increased need to understand how they function to improve efficiency and expand utility. Copper-phenanthroline-based photocatalysts such as CuII(dap)Cl2 (dap = 2,9-di(p-anisyl)-1,10-phenanthroline) and [CuI(dap)2]Cl were both found to be equally capable of olefin activation through electrophilic atom transfer radical addition (ATRA) reactions. Although these molecular catalysts have proven successful, many of the intermediates suggested in the proposed catalytic cycle have never been detected. Another undetermined aspect was how one equivalent of CuII(dap)Cl2 generates a half equivalent of [CuI(dap)2]+. We used a more synthetically accessible model system CuII(dpp)Cl2 (dpp = 2,9-diphenyl-1,10-phenanthroline) to better understand the mechanistic pathway. We detected several intermediates involved in the ATRA photocatalytic cycle using this model chromophore and insights from electronic spectroscopy, IR-MALDESI, TD-DFT calculations, EPR spin trap experiments, and 1H NMR spectroscopy. We found that the unique ligand lability and coordinating properties of acetonitrile enable both the in-situ oxidation of [CuI(dap)2]+by tosyl chloride into CuII(dap)Cl2 and the visible-light-induced homolysis of the Cu(II)-Cl bond which initiates the conversion to [CuI(dap)2][CuICl2]. This extensive mechanistic study of the catalytic cycle demonstrates that the symbiotic relationship between CuII(dap)Cl2 and [CuI(dap)2]+ is the critical factor enabling the ATRA photoreaction, thereby explaining why both catalysts mediate this photochemical reactivity.

Jingtian Bai and Xinge Jessie Jeng
Graduate Program: Statistics
Advisor: Xinge Jessie Jeng
Poster Number: 13

Enhancing Transfer Learning Efficiency with Principled False Negative Control

Transfer learning has become a pivotal approach in machine learning, facilitating the transfer of knowledge from one domain to enhance predictive accuracy in another. This capability is particularly vital in applications where the target domain often suffers from limited labeled data or challenging feature spaces. Despite its promise, the practical deployment of transfer learning faces a critical challenge: heterogeneity across domains. Failing to address variations in data distributions, feature representations, and noise levels can lead to significant biases, resulting in suboptimal model performance. In this work, we present a novel transfer learning framework tailored for high-dimensional regression analysis. The framework incorporates high-dimensional false negative control (HD-FNC) to effectively retain signal variables while mitigating the influence of noise and domain-change-induced biases. Importantly, HD-FNC performs efficient dimension reduction by distinguishing noise variables from weak true signals. By combining HD-FNC with retraining strategies that adapt Ridge and Ridgeless regression models to target populations, our method ensures robust signal detection, improved predictions, and enhanced generalization.

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Graduate Programs and Institutions: Mathematics[1]; Maine College of Engineering and Computing, University of Maine[2]; Istituto di Matematica Applicata e Tecnologie Informatiche "Enrico Magenes'', Consiglio Nazionale delle Ricerche[3]; Mathematics, University of Madison-Wisconsin[4]
Advisor: Lorena Bociu
Poster Number: 21

Analysis and Optimal Control of Coupled Partial and Ordinary Differential Equations in Tissue Perfusion

Important biomechanical processes in the body, such as tissue perfusion, are governed by both local and global effects. The proposed model uses a 3D system of partial differential equations to model the local area of tissue perfusion as fluid flowing through a deformable poroelastic medium. The corresponding global effects of the circulatory system are then modeled by a system of ordinary differential equations, using the electrical analog of hydraulic components to describe the system. The two systems are coupled through interface conditions, by preserving the continuity of mass and the balance of stresses. The analysis of this multiscale interface coupling is important in the study of the development and progression of glaucoma in the eye, as the development of this disease has been linked to intraocular pressure and tissue perfusion (local factors), but also blood pressure (global factor). Our goal is to better understand the relation between all these factors and their influence on glaucoma, as well as to develop strategies to control and prevent the development of the disease. We investigate these questions mathematically, through wellposedness analysis, numerical simulations, and optimal control strategies.

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Advisors: Christopher B. Gorman and Reza A. Ghiladi
Poster Number: 32

Photosensitizer-Embedded Ionic Antimicrobial Material: Home Solution for Multidrug-Resistant Bacterial Infections

Multidrug-resistant (MDR) pathogens pose a significant threat to human and animal health, particularly due to the close contact between humans and companion animals, which facilitates bacterial transmission. Annually, tens of thousands of Americans contract zoonotic infections, with six out of every ten infectious diseases in humans originating from animals. This study introduces a general and convenient approach for utilizing photodynamic therapy (PDT) to treat MDR microbial infections in home and clinical settings. We developed biocompatible hydrogels with tunable mechanical properties (toughness 5 to 186 kJ/m^3) that leverage singlet oxygen (1O2) generation via a Type II PDT mechanism. By incorporating FDA-approved, commercially available photosensitizers—such as rose bengal—into hydrogels through electrostatics interactions and chain entanglement, we achieved a 6-log (99.9999%) reduction in methicillin-resistant Staphylococcus pseudintermedius (MRSP), and inactivation of HCoV-229E, Human Adenovirus, and Rhinovirus to detection limit levels. These results were obtained under moderate illumination using low-cost LED light (400–700 nm, λmax_1 = 450 nm, λmax_2 = 532 nm, 48 mW/cm^2) within 15 minutes. This work highlights PDT as a scalable, non-invasive, and effective strategy for combating MDR bacterial infections in both animals and humans, offering a practical solution for healthcare and infection control.

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Graduate Program: Chemistry
Advisor: Jonathan S. Lindsey
Poster Number: 35

Total Synthesis of Native Bacteriochlorophyll a

Bacteriochlorophyll a (BChl a) is one of the chief pigments in anoxygenic photosynthesis. Along with chlorophylls, bacteriochlorophylls play a crucial role in absorbing light to power the biosphere but have largely been neglected as targets of chemical synthesis. The advent of synthetic routes to the native photosynthetic pigments is expected to open a portal for addressing diverse questions in the plant sciences. An approach to BChl a relies on joining AD and BC halves via (i) Knoevenagel condensation followed by (ii) double-ring closure (Nazarov cyclization, SEAr, and MeOH elimination), which together form ring E and the aromatic macrocycle. The AD and BC halves were constructed via 3 key-steps: (i) Sonogashira coupling to join pre-A and pre-D or pre-B and pre-C constituents; (ii) anti-Markovnikov hydration of the internal alkynylpyrroles; and (iii) Paal-Knorr type cyclization to form the dihydrodipyrrin AD and BC fragments. The trans-dialkyl substituents of each pyrroline ring (B, D) are introduced via chiral hexynones, which are prepared in a stereoselective manner. To date, we have prepared the individual pre-A–D constituents from small commercially available molecules (≥10 mmol each) as well as the target bacteriopheophorbide a. The results validate the ability to carry stereochemically defined substituents over the entire course of the synthesis. The conversion of bacteriopheophorbide a to Bchl a and extension of the route to valuable analogues are under investigation.

Eduardo Cisneros de la Rosa
Graduate Program: Bioinformatics
Advisor: Xingcheng Lin
Poster Number: 36

Predicting RNA-Protein Binding Energy Using Novel IRIS Model Integrated with AlphaFold 3 and GROMACS

RNA-protein interactions are crucial for cellular function and regulation, making the accurate prediction of their binding energies is a key goal in molecular biology and bioinformatics. We introduce IRIS (interpretable protein-RNA interactions Informed by Structure), a novel model that leverages both computational predictions and experimental data to achieve high-precision RNA-protein binding energy estimates. By integrating AlphaFold 3, IRIS assesses the structural impacts of mutations on RNA sequences, particularly enhancing prediction quality for structures with four or more mutations. For sequences with three or fewer mutations, the integration does not degrade prediction accuracy. To validate our computational predictions, we utilized data from an RNA array high-throughput assay, focusing on the 2but RNA-protein complex. This assay generated a diverse collection of RNA sequences through variations of the hairpin, where different sequences were mutated using doped oligonucleotides. Barcoded RNAP initiation sequences were introduced to reduce sequencing errors and identify individual molecules within the population. These mutated sequences were then sequenced using Illumina technology to provide a comprehensive dataset for validation. Notably, structures with four or more mutations from the native sequence yielded unpredictable results until we incorporated AlphaFold 3 PDB inferred structures to calculate the new energy matrix. Our results highlight a significant improvement in the accuracy of RNA-protein binding energy calculations, particularly when combining computational models with machine-learning techniques to advance our understanding of RNA-protein interactions and their broader biological implications.

Elizabeth M. Davis and Emily C. Hector
Graduate Program: Statistics
Advisor: Emily C. Hector
Poster Number: 40

Heterogeneity-Adaptive Meta-Analysis

Meta-analytic methods tend to take all-or-nothing approaches to study-level heterogeneity, either limiting the influence of studies that are suspected to diverge from a shared model or assuming all studies are homogeneous. In this paper, we develop a heterogeneity-adaptive meta-analysis in linear models that adapts to the amount of information shared between datasets. The primary mechanism for the information-sharing is a shrinkage of dataset-specific distributions towards a new "centroid" distribution through a Kullback-Leibler divergence penalty. The Kullback-Leibler divergence is uniquely geometrically suited for measuring relative information between datasets. We establish our estimator's desirable inferential properties without assuming homogeneity between dataset parameters. Among other things, we show that our estimator has a provably smaller mean squared error than the dataset-specific maximum likelihood estimators, and establish asymptotically valid inference procedures. A comprehensive set of simulations illustrates our estimator's versatility, and an analysis of data from the eICU Collaborative Research Database illustrates its performance in a real-world setting.

Ashiqul Islam Dip
Graduate Program: Physics
Advisor: John David Brown
Poster Number: 46

Dynamics of Scalar and Electromagnetic Fields in Cylindrically Symmetric Vacuum Spacetimes

This poster explores the dynamics of scalar and electromagnetic fields in cylindrically symmetric vacuum spacetimes. We investigate the massive Klein-Gordon equation and the Maxwell equations under the assumption of cylindrical symmetry in the absence of matter. Cylindrically symmetric vacuum spacetimes - known as Levi-Civita spacetimes - are important as they describe the spacetime around the idealized cosmics strings. We present a detailed analysis of the quasi-normal modes of the scalar field and the electromagnetic potential fields. Specifically, we examine the asymptotic behavior of such quasi-normal modes in the Levi-Civita background. We explore the possibility of bounded quasi-normal modes and the existence of non-trivial propagating field solutions in the curved spacetime. We discuss the challenges in obtaining exact solutions and explore different approaches, including numerical methods and perturbative techniques. Furthermore, we analyze the energy-momentum tensor of the scalar and electromagnetic fields and its contribution to the spacetime geometry. Our results shed light on the fundamental nature of the interaction of the aforementioned fields with the background spacetime and provide a deeper understanding of the dynamics of these complex systems. We also discuss potential applications of these solutions in astrophysical contexts.

Louisa Ebby
Graduate Program: Biomathematics
Advisor: Mohammad Farazmand
Poster Number: 49

Wildfire Forecasting from Sparse Observational Measurements

As wildfires become more frequent and intense due to climate change, the need for accurate predictions increases. Estimating the size and location of a wildfire, however, is challenging when it cannot be fully observed. One method for state reconstruction from sparse observational measurements, Discrete Empirical Interpolation Method (DEIM), employs linear techniques to reconstruct the full state of a dynamical system. Yet, many physical quantities measured from biological systems have restricted ranges. In wildfire prediction, the model represents the proportion of an area that is burning, so values must remain between 0 and 1. The DEIM state estimation, unfortunately, can still include negative values, which are not physically meaningful. To address this, we introduce a new variant of DEIM, Constrained DEIM (C-DEIM), designed for states with restricted ranges. State estimations produced by C-DEIM not only exhibit smaller reconstruction errors but also consist of values strictly within the allowable range, making them suitable for use as initial conditions in model forecasts. We then apply this method using cellphone calls from the devastating August 2023 Maui wildfires to predict the final fire perimeter.

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Advisor: Ronald Baynes
Poster Number: 59

Pharmacokinetic and Pharmacodynamic Determination of IV Butorphanol and Morphine in Cattle

The use of analgesics in cattle has increased in recent years, driven by heightened societal concern for animal welfare. The lack of pharmacokinetic and pharmacodynamic (PK-PD) data on analgesics in cattle has hindered the establishment of known dosing strategies and withdrawal intervals (WDI) limiting their use due to food safety concerns. Currently there is little known about the dosing strategy, efficacy, or food safety of two commonly used opioid drugs, morphine and butorphanol. We aim to investigate the PK-PD profiles of morphine and butorphanol in healthy cattle to begin to understand the usefulness of these drugs. We hypothesize that morphine will produce greater sedation with a longer duration of action than butorphanol and that morphine will reach plasma concentrations consistent with those producing analgesic effects in other species. Eight Holstein-cross steers and six Holstein-cross heifers will be used in a blinded, randomized trial consisting of two treatments (0.2 mg/kg morphine & 0.02 mg/kg butorphanol) with a minimum 72-hour washout period between treatments. PD parameters, including heart and respiratory rate, temperature, sedation scores, excitation scores, and thermal threshold nociception will be collected before, during and after treatment. PK samples will be obtained at baseline and predetermined time points for 24 hours following administration. Preliminary data shows that both butorphanol and morphine are rapidly excreted and tolerated well at all doses in healthy cattle. This study, in conjunction with future tissue analysis, will provide valuable insights, potentially leading to more effective and safe pain management strategies in cattle.

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Graduate Programs and Institutions: Biological Sciences[1]; North Carolina Zoo[2]; Statistics[3]
Advisors: Jenny Campbell and Emily Lynch
Poster Number: 61

Assessing the Impact of Programming on Ambassador Snake Welfare

Zoos are crucial centers for public education and conservation. Ambassador animals are key to achieving these goals as they serve as powerful tools to engage the public during educational programs. While snakes are easy to manage and popular with audiences, research focused on their welfare is lacking, particularly in terms of how these programs affect their well-being. We examined the effects of programming on six ambassador snakes housed at the North Carolina Zoo to test how programming affected welfare. Welfare was measured through in-habitat and on-program behavioral profiles. In-habitat behavior was recorded via cameras using an ethogram to categorize activity as active, inactive, or interaction with a transparent boundary (ITB). Body exposure, location, and behavior were recorded as outcome measures. During programming, snakes were recorded on camera, and the footage was later reviewed by an observer using continuous observation in ZooMonitor to categorize behaviors as active positive, resting positive, or negative. We found that compared to non-program periods, when snakes were exposed only 21.42% of the time, exposure increased to 52.94% after a program. In that same non-program period, snakes were equally likely to be inactive or active (~50%) and had a 2.3% likelihood of ITB. Following a program, snakes were 8.4% more likely to engage in undesired behaviors (ITB) and 63.3% more likely to be active, suggesting heightened arousal or disruption in typical behavioral patterns. Notably, snakes spent 95 - 99% of program time in positive behavioral states, with negative behaviors observed for only 12.6 minutes out of 38 hours across 110 programs. These results will not only contribute to the understanding of best practices for monitoring the welfare of an understudied taxonomic group but also give insight and empower animal care staff to make informed, evidence-based decisions regarding the husbandry of snakes.

James Garrison
Graduate Program: Mathematics
Advisor: Ilse Ipsen
Poster Number: 65

Randomized Preconditioned Cholesky QR in Mixed Precision

We analyze rpCholesky-QR, a randomized preconditioned Cholesky-QR algorithm for computing the thin QR factorization of full rank, real matrices. The perturbation analysis is transparent and identifies clearly all factors that contribute to error amplification; it requires only a minimal amount of assumptions and produces interpretable bounds, rather than first-order estimates. We adapt our perturbation analysis in to show that preconditioning a Cholesky-QR algorithm in low precision does not affect the accuracy when the input matrix has condition number less than 10^8, and we implement our mixed-precision-Cholesky-QR style algorithm on GPUs in C++ to evaluate its speed.

Ian Grace and David B. Eggleston
Graduate Program: Marine, Earth and Atmospheric Sciences
Advisor: David B. Eggleston
Poster Number: 72

Deep-sea Methane Seep Mussel Larval Dispersal Inferred From Shell Trace Elemental Fingerprints

Larval dispersal is a key driver of population persistence and resilience of metapopulations and communities in marine ecosystems. Yet in the deep sea, larval dispersal remains poorly understood due to the limited applicability of traditional nearshore approaches, which is concerning given the increasing threat to deep-sea populations from commercial resource exploitation and marine heatwaves. Laser ablation inductively coupled plasma mass spectrometry was used to analyze shell trace elemental fingerprints (TEFs) of three deep-sea methane seep mussel species to infer- rather than directly measure- the larval dispersal of mussel populations among collection depths (500-3,000 m), seven seep sites, and three dispersal periods. Permutational analyses of variance (PERMANOVA) discriminated among dispersal periods and, separately, among depths and seep sites within certain dispersal periods. Post-hoc canonical analyses of principal coordinates (CAP) determined that differences among depths and sites were generally correlated with trace elements potentially related to organic matter uptake (i.e., larvae vertical position in the water column) such as Ba, Ni, and Mn. Overall, this work supports a recent assessment that TEFs can discern population pools at certain spatial scales and builds on it by determining that relatively shallow and deep methane seep populations and/or individual seep populations likely recruit from separate, temporally inconsistent larval pools.

Patrick Haughey
Graduate Program: Applied Mathematics
Advisors: Semyon Tsynkov and Mikhail Gilman
Poster Number: 76

Statistical Study of SAR Transionospheric Autofocus Procedure

Synthetic aperture radar (SAR) has been the imaging resource of choice for decades due to its all-weather capabilities and capacity to produce high-resolution images and penetrate densely textured environments like jungles and urban environments. For orbital satellites that emit long-wavelength signals, the free electrons in the ionosphere phase shift the signal causing image distortions and blur. This study is a continuation of previous work, which developed an autofocus algorithm to improve the image quality deteriorated by the ionosphere. The Earth's ionosphere is a source of significant phase perturbations for low-frequency orbital synthetic aperture radar (SAR) systems. We conduct a statistical analysis of the efficiency of optimization-based SAR autofocus algorithm developed in our earlier publications. We test the limits and sensitivity of our autofocus algorithm that includes a gradient-based optimizer applied to contrast-enhancing cost function. The effect of perturbation factors such as the magnitude of the ionospheric turbulence, the average clutter reflectivity, and the average level of background noise, are investigated. Using the advantage of computer simulation, we can compare the initial corrupted image, as well as the autofocus outcomes, to the “true” image obtained with the perfect compensation of ionospheric distortions. The autofocus effectiveness is evaluated using three image quality metrics: normalized cross correlation (NCC), integrated side lobe ratio (ISLR), and the average displacement in peaks, called peak desynchronization (PD). We find that our autofocus algorithm can improve image quality and achieving a high level of similarity to the true image in most situations, with the high clutter level identified as the most challenging part of the setup.

Kaitlin Karaffa[1], Sarah Larson[1], Kathie Dello[1,2], Antonia Sebastian[3]
Graduate Programs and Institutions: Marine, Earth and Atmospheric Sciences[1], Climate Office[2]; Environmental Sciences and Engineering, University of North Carolina at Chapel Hill[3]
Advisors: Sarah Larson and Kathie Dello
Poster Number: 91

Examining the Impacts of Hurricanes on Short-Term and Flash Drought Development and Termination in the Carolinas

In the Southeast United States, hurricane activity can compound with droughts and relieve dry conditions in an area. Previous studies have shown that precipitation brought into an area from a hurricane can terminate long-term droughts. The transition between these extremes can pose many challenges to water availability and management. There are two other drought types with a shorter duration that impact the Carolinas and could be affected by hurricane activity: short-term and flash droughts. Short-term droughts are defined as having a duration between 2 weeks and 2 months, and historically have a high occurrence along the coasts of the Carolinas. Flash droughts are defined by their rapid onset and intensification, usually over a period of 2 weeks. These drought events have a historically high occurrence in both the Coastal Plain and Mountain regions of the Carolinas. Both of these short duration droughts are projected to increase across the Carolinas. Like long-term droughts, these events can be terminated by precipitation from hurricane passage over the Carolinas, however, the rainfall from a hurricane could also initiate these short duration droughts. The surge of precipitation is followed by increased evapotranspiration rates, which can lead to rapid development of drought conditions. In this study, we look at three case examples of hurricanes that passed over the Carolinas: Hurricane Irene (1999), Hurricane Isabel (2003), and Hurricane Helene (2024). A firmer understanding of how these hazards interact would allow for better awareness by scientists and the public of how to manage these compound extremes.

Qiaochu Li
Graduate Program: Genetics
Advisor: Nathan Crook
Poster Number: 102

Understanding and Engineering Sink Microbiome Colonization by Enterobacter ludwigii

People spend over half their time in built environments such as homes, offices, and public transportation. In recent years, the healthiness of these environments has garnered increasing attention, with hospitals being a significant focus. Despite this interest, research on the microbiomes of built environments still reveals considerable gaps. This project focuses on hospital sinks, which serve as major breeding grounds for antibiotic-resistant microorganisms. We are interested in Enterobacter ludwigii (Elu), a non-pathogenic bacterium commonly found in sink P-traps. By understanding its biology and developing engineering tools, we aim to design probiotics for P-traps to promote a long-term healthy sink environment. To understand its nutrient requirements, we systematically tested the growth of three different isolates in simulated sink media and evaluated their resistance to sodium dodecyl sulfate (SDS), a common component of hand soaps. Additionally, a genomic DNA library was used to identify critical genes and pathways involved in Elu's attachment and adhesion to plumbing surfaces. From an engineering perspective, we developed engineering and barcoding tools to improve the modification and evaluation of engineered Elu. To construct a model Elu for future studies and applications, we designed and optimized an H_2S-sensing kill-switch system as a biocontainment method. By integrating biological and engineering research on Elu, this work provides a comprehensive example of how to understand bacterial behavior in an unexplored environment and systematically develop a "probiotic" to improve that environment’s function.

Nicole J. Long, Devin N. Williams, and Ann H. Ross
Graduate Program: Biological Sciences
Advisor: Ann H. Ross
Poster Number: 105

Applying Multidisciplinary Methods to Forensic Casework in North Carolina

As of January 1, 2025, there are 162 unidentified persons cases listed in the National Missing and Unidentified Persons System (NamUs) for the state of North Carolina. To address this crisis, the Human Identification and Forensic Analysis Laboratory at North Carolina State University (HIFAL-NCSU), in collaboration with state medical examiner's offices and law enforcement, employs a multidisciplinary approach. Modern methods of anthropological analyses are employed to develop biological profiles (e.g., biological sex, age at death, stature, and population affinity) for unidentified decedents (UIDs) and include radiographic comparisons and trauma analysis. Additional forensic techniques—such as population affinity estimation using 3D-ID, forensic genetic genealogy (FGG), and isotopic analyses—are integrated in the standard operating procedures for North Carolina casework. Results from one scientific method can inform other investigative aspects by providing supplementary information about the decedent, increasing the likelihood of identification. However, population affinity and isotopic analyses rely on robust reference datasets, underscoring the need for continued collection and publication of data to obtain global coverage.

More recently, HIFAL-NCSU partnered with the NC State Bureau of Investigation Bureau of Justice Assistance grant through the 2023 Missing and Unidentified Human Remains (MUHR) program to enhance multidisciplinary efforts and reduce the backlog of unidentified cases. Results from seventeen cases sent for FGG have resulted in ten positive identifications, five of which also applied isotopic analyses. Here, we present the isotopic and anthropological findings from three of those cases recovered in Mecklenburg County, North Carolina. Two of the individuals have been identified using multiple methods including modern anthropological methods, dental enamel and bone apatite isotopic analyses for geolocation, bone collagen isotopic analyses for dietary analysis, bomb-pulse dating to confirm the antiquity of the remains, and FGG. The third case has undergone anthropological and isotopic analyses, is presently undergoing FGG and remains unidentified.

Omar Madany[1], Benjamin Kincaid[1], Aqsa Shaikh[1], Elizabeth Morningstar[1], Abdulgani Annaberdiyev[2], and Lubos Mitas[1]
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Advisor: Lubos Mitas
Poster Number: 106
A New Generation of Effective Core Potentials: More Lanthanides and Heavy Elements

We present a new set of correlation consistent effective core potentials (ccECPs) for selected heavy s, p, d, and f-block elements significant in materials science and chemistry. The ccECPs are designed using minimal Gaussian parameterization to achieve smooth and bounded potentials. They are expressed as a combination of averaged relativistic effective potentials (AREP) and effective spin-orbit (SO) terms, developed within a relativistic coupled-cluster framework. Optimization is driven by correlated all-electron (AE) atomic spectra, norm-conservation, and spin-orbit splittings, with considerations for plane wave cutoffs to ensure accuracy and viability across various electronic configurations. Transferability of these ccECPs is validated through testing on molecular oxides and hydrides, emphasizing discrepancies in molecular binding energies across a spectrum of bond lengths and electronic environments. The ccECPs demonstrate excellent agreement with AE reference calculations, attaining chemical accuracy in bond dissociation energies and equilibrium bond lengths, even in systems characterized by substantial relativistic and correlation effects. These ECPs provide an accurate, transferable framework for valence-only calculations.

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Advisors: Lewis A. Owen and Karl W. Wegmann
Poster Number: 107

Geomorphic Effects of a Glacial Lake Outburst Flood in the Khumbu Himal, Nepal

Glacial lake outburst floods (GLOFs) pose a significant hazard in mountainous regions, worsened by the ongoing effects of climate change. As glaciers continue to melt, the formation and expansion of glacial lakes increase, putting additional pressure on their confining dams. GLOFs occur when (1) the dam of a glacial lake fails or (2) a large volume of rock/ice cascades from adjacent slopes into the lake, resulting in a sudden discharge of a large volume of water and entrained debris. Despite the complexities involved, assessing the potential for GLOFs and evaluating their temporal and spatial occurrence is important. On August 16, 2024, two glacial lakes in the Thame Khola Valley, located in the Khumbu Himal of Nepal, discharged catastrophically from their high-alpine valleys, causing devasting floods that destroyed buildings and farmland in the village of Thame while depositing extensive debris across the lower portion of the valley. Another concern arising from the Thame GLOF is the formation of a secondary landslide hazard due to a significant incision of the stream channel below the settlement. The geologic layers beneath the town are susceptible to slow-moving, deep-seated rotational landsliding when lateral support is removed during stream incision. During field investigations in the fall of 2024, drone imagery and ground photos of the GLOF deposits around Thame and the downstream incision/landsliding zone were collected to create detailed topographic models of landscapes using photogrammetry. These models will help estimate how paleo events have evolved in similar environments, providing valuable insights for future evaluations. The data gathered from the sediment deposits will also provide insights into the interactions between GLOFs and subsequent geomorphological changes, offering information for assessing long-term risks. By integrating field observations and photogrammetric models, this research aims to enhance our understanding of the dynamics of GLOFs and their cascading effects on mountain landscapes.

Andre M. Nogueira, Anil R. Marri, and David A. Shultz
Graduate Program: Chemistry
Advisor: David A. Shultz
Poster Number: 126

Photoinduced Ground State Electron Spin Polarization of Organic and Metallic Spin Centers Covalently Bonded to Platinum(II) Chromophores

Advances in molecular Quantum Information Science require the development of molecular qubits which possess well-defined quantum states with amplified magnetic resonance signals. Our approach for creation of such qubits makes use of ligand-to-ligand charge transfer (LL'CT) complexes comprised of diimine acceptors and catecholate (CAT) donors covalently attached via bridging units to stable radicals (e.g., nitronyl nitroxides, NN).

Previous work in our group established subnanosecond lifetimes of LL'CT excited states of platinum(II) complexes of such ligands, which decay from the 2T1 state with no indication of symmetry-forbidden intersystem crossing to 4T1. In frozen solvent matrices however, fast equilibration of 2T1 with 4T1 and/or localized NN radical excited states results in non-Boltzmann population of the ms = ±½ levels of 2T1. Since the 2T1 lifetime is shorter than the relaxation time (T1) of the NN spin, this polarization is delivered to the 2S0 ground state where it is detected by a transient electron spin resonance (TREPR) spectroscopy signal. Our previous results have uncovered a variety of molecular structure-property relationships that govern both the intensity and sign of the TREPR signal.

Recently, in addition to organic radicals, our group discovered polarization of paramagnetic Cu(II) and V(IV) spin centers covalently bonded to the same chromophore. As previously observed, the lifetimes of LL'CT excited states from these new compounds were also orders of magnitude shorter than the spin-lattice relaxation time, which indicates a previously unreported polarization of the ground state of a metallic spin center. Additionally, anisotropic features of the TREPR signal were detected, suggesting complex spin-spin interactions in the LL'CT excited state.

Casey O'Brien
Graduate Program: Biomathematics
Advisor: Alun Lloyd
Poster Number: 128
Modeling a Novel Gene Drive Targeting Immune Responses

Gene drive technologies hold promise for controlling invasive pests, mitigating disease transmission, and protecting local ecosystems and agriculture. However, their deployment hinges on resolving safety concerns, particularly the risk of unintended spread into non-target populations. Current confinement strategies rely largely on invasion thresholds which take advantage of unstable equilibrium points in allele frequency, below which the drive will not spread. This maintains local confinement by preventing migrants from spreading the drive in surrounding populations. While this is an effective strategy for gene drives meant to introduce a trait to a population, its success has been more limited in suppression gene drives. We circumvent this issue by designing a novel suppression drive system that targets the immune response of an organism to a local stressor (i.e., endemic virus, fungus, or a specialized parasitoid). The drive system increases the target organism's susceptibility to the stressor by increasing the likelihood of acquiring the infection or the impact of infection on the organism. This means that the drive system's fitness cost is dependent on the abundance of the stressor. We model several drive systems to consider the efficacy of the system in different settings.

Catherine Odhiambo
Graduate Program: Chemistry
Advisor: Gavin Williams
Poster Number: 130

Overcoming Bottlenecks to Oxidized Isoprenoids via Biosensor-Guided Engineering

Isoprenoids are a diverse class of naturally occurring organic compounds that have historically provided a reservoir for pharmaceutically active molecules1. Yet, the entire structural diversity of isoprenoids is derived from the condensation and polymerization of isopentenyl diphosphate and dimethylallyl diphosphate. This makes it challenging to manipulate isoprenoid biosynthesis to accept unnatural precursors. To address this problem, we have designed an artificial two-kinase pathway in E. coli, which can phosphorylate a series of alcohols to generate the core building blocks necessary for isoprenoid biosynthesis. The artificial pathway is fully leveraged by coupling it to a high-throughput screening platform to efficiently evolve improved variants for producing a valuable anti-cancer. Notably, the platform requires the development of a genetically-encoded biosensor that could selectively detect oxidized isoprenoid while simultaneously discriminating against its precursors. This work is anticipated to advance and contribute to initiatives in the design-build-test-learn cycle of synthetic biology to better comprehend design limitations and gain insight into structure-function relationships.

Tia Ogus[1], Catherine V Davis, and Carli Arendt
Graduate Program: Marine, Earth, and Atmospheric Sciences
Advisor: Carli Arendt
Poster Number: 131

Marine Phosphate Synthesis of Northern High-latitudes

Phosphate has been readily studied in mid-to-low-latitude marine regions; however, there are limited marine phosphate studies in northern high-latitude regions, despite the presence of unique circulation patterns and biogeochemical cycles in the Arctic Ocean. The limited existing northern marine studies have focused on isolated polar regions, however, there are no marine phosphate synthesis studies on a larger, high-latitude spatial scale. This study reviews and compiles existing phosphate depth profiles from GEOTRACES across four northern high-latitude regions: the Northern Pacific (> 50°N), the Alaskan Arctic (66-75°N), Greenlandic seawater (61-70°N), and the Eurasian Arctic (68-80°N). We analyze relationships between phosphate and depth by interpolating phosphate concentrations along regional transects and comparing average surface (0-300 m) phosphate concentrations. We further analyze phosphate variations between the four regions relative to salinity and temperature variations to identify water masses. From these approaches, we confirm that phosphate concentrations increase with depth along the Northern Pacific, Greenland, and Eurasian Arctic transects. The Alaskan Arctic exhibits a sharp decrease in phosphate concentrations at the intersection between the Bering Strait and the Chukchi Sea. However, phosphate concentrations start to increase with depth in the Chukchi Sea. We observe slightly higher phosphate in western Greenlandic water masses (i.e., Labrador Sea Water 1000-2500 m) than in eastern Greenlandic water masses (i.e., Iceland-Scotland Overflow Water 2000-4000 m), and we identify that surface phosphate concentrations were highest in the two major Arctic currents: Beaufort Gyre (Alaskan Arctic) and Transpolar Drift (Eurasian Arctic). Overall, the Alaskan Arctic and western Greenlandic seawater have consistently higher phosphate concentrations than Atlantic water, but lower concentrations than Northern Pacific water. This study provides the first synthesis of phosphate in marine northern high latitudes, which acts as a baseline that future studies can use to understand changes in regions, especially with continued climate change.

Daniel Profili[1], Hoon Hong[1], and J. Rafael Sendra[2]
Graduate Programs and Institutions: Mathematics[1]; Mathematics, CUNEF-University[2]
Advisor: Hoon Hong
Poster Number: 145

Conditions for Eigenvalue Configurations of Two Real Symmetric Matrices

Given two real symmetric matrices, their eigenvalue configuration is defined as the relative arrangement of their eigenvalues on the real line. We consider the following problem: given an eigenvalue configuration, find a condition on the entries of two real symmetric matrices such that they have the given eigenvalue configuration. The problem amounts to finding a finite set of polynomials in the entries of the two matrices, together with a combinatorial way of combining these as a boolean expression of equalities and inequalities. We give a novel method to systematically and efficiently produce a necessary and sufficient condition for all real symmetric matrices of a given size to satisfy an eigenvalue configuration. First, we translate the eigenvalue configuration problem into a set of univariate real root counting problems on a set of related polynomials in the entries of the two matrices. Then, we apply Descartes' rule of signs to solve the joint root counting problem, and the result is enumerated into the desired condition. The eigenvalue configuration problem generalizes Descartes' rule of signs, which has numerous applications in various fields, including control systems, black hole physics, network design, and functional analysis.

Andrew Shedlock and Teemu Saksala
Graduate Program: Mathematics
Advisor: Teemu Saksala
Poster Number: 160

An Inverse Problem for the Wave Equation on a Manifold

Properties of a material can be encoded into a partial differential equation to model how a wave propagates through a space. Similarly one can ask whether knowledge of how waves propagates in some observation set for all time can be used to determine the material on the entire space, including in regions outside of the observation set. We use Riemannian Manifolds as a model to study this problem in a coordinate-invariant way and show which material properties can be determined and which material properties cannot be determined by observing the waves. In this work we study a large family of wave equations in addition to the classical wave equation on a Riemannian manifold. This work highlights the power of the celebrated Boundary Control Method in reconstructing the space and material properties from observations of the waves. Further, as part of our work we show that waves can be used to approximate any function and its derivatives in finite time. Finally we show the existence of unique material preserving map between any pair of models which produce the same waves.

Naomi Singer, Ryan Martin, and Jonathan P. Williams
Graduate Program: Statistics
Advisor: Jonathan P. Williams
Poster Number: 161

Uncertainty Quantification of Model Structure using the Inferential Model Framework

A universal step in fitting a model to data is determining its structure, e.g. the number of parameters to fit in a linear regression or the number of clusters to fit in k-means. However, the uncertainty in this step is often overlooked due to a lack of satisfactory methods. Frequentists have no methods to construct confidence sets for a model's structure, and Bayesian posterior credible sets are sensitive to prior specification and do not achieve finite-sample coverage. In this paper, we propose a new method to construct confidence sets for a model's structure that can incorporate prior information if available and achieves finite-sample coverage. We demonstrate this method on simulated data from the standard linear regression model with and without prior information on the number of parameters to fit and their values. Finally, we apply our method to the non-linear Keplerian orbit model, often used in astronomy to determine the number of planets orbiting a star, with standard prior information incorporated.

Dongjae Son, Brian J. Reich, Erin M. Schliep, Shu Yang, and David A. Gill
Graduate Program: Statistics
Advisors: Brian J. Reich and Erin M. Schliep
Poster Number: 163

Spatial Causal Inference in the Presence of Preferential Sampling to Study the Impacts of Marine Protected Areas

Marine Protected Areas (MPAs) have been established globally to conserve marine resources. Given their maintenance costs and impact on commercial fishing, it is critical to evaluate their effectiveness to support future conservation. In this paper, we use data collected from the Australian coast to estimate the effect of MPAs on biodiversity. Environmental studies such as these are often observational, and processes of interest exhibit spatial dependence, which presents challenges in estimating the causal effects. Spatial data can also be subject to preferential sampling, where the sampling locations are related to the response variable, further complicating inference and prediction. To address these challenges, we propose a spatial causal inference method that simultaneously accounts for unmeasured spatial confounders in both the sampling process and the treatment allocation. We prove the identifiability of key parameters in the model and the consistency of the posterior distributions of those parameters. We show via simulation studies that the causal effect of interest can be reliably estimated under the proposed model. The proposed method is applied to assess the effect of MPAs on fish biomass. We find evidence of preferential sampling and that properly accounting for this source of bias impacts the estimate of the causal effect.

Alyssa R. 115[1], Patrick M. Haughey[1], Kyle C. Nguyen[3], John T. Nardini[4], Jason M. Haugh[2], and Kevin B. Flores[1]
Graduate Programs: Mathematics[1], Chemical and Biomolecular Engineering[2], Sandia National Laboratories[3]; Department of Mathematics and Statistics, The College of New Jersey[4]
Advisor: Kevin B. Flores
Poster Number: 183

Topologically Informed Model Selection of Agent-based Models for Collective Cell Motion

Fibroblasts in a confluent monolayer are known to adopt morphologies that differ from those of isolated cells. Moreover, confluent fibroblasts, though completely surrounded by neighboring cells, are known to be motile. Previous studies involving time lapse microscopy showed that confluent fibroblast cells spontaneously arrange themselves into a nematic order. We previously collected and analyzed new time lapse microscopy data to show that the movement of neighboring cells in confluent monolayers are oriented parallel to each other and often moving in opposite directions in a collective motion phenomenon we refer to as ‘‘fluidization’’ of the cell population. Here, we performed an in-silico model selection study to show that topological data analysis could be used to distinguish between biophysical mechanisms that generate distinct fluidization patterns in an agent-based model of cell motility. We have added a new mechanism to represent cell alignment to the existing D’Orsogna model. We have compared this model to the D’Orsogna model using Bayesian Information Criteria.

Simon Wu and Rongmon Bordoloi
Graduate Program: Physics
Advisor: Rongmon Bordoloi
Poster Number: 188

Tracing MgII in the Circumgalactic Medium (CGM) at z ~ 0.19-2.5

In the post-reionization universe, the gravitationally bound circumgalactic medium (CGM) plays a vital role in the galaxy baryon cycle regulating star formation. In the multiphase CGM, MgII absorption probes cool gas at temperatures of 104 K, providing insights into how the HI supply in the CGM fuels star formation and influences the transition of galaxies from star-forming to quiescent. Comparing MgII absorption to observables that trace morphological and dynamical histories may help explain the diverse distributions of cool gas in the CGM. In this work, we conduct a blind search for CGM-associated MgII absorption within 300 kpc of 13 quasar sightlines. Given the global evolution of galaxies over cosmological time, we introduce a novel statistical approach to distinguish star formation designations based on galaxy populations in distinct redshift bins. We compute equivalent widths and employ Monte Carlo Markov Chain (MCMC) methods to fit Voigt profile column densities, determining MgII absorption strengths and quantifying nondetections. Finally, we apply tools such as MCMC regression fitting to our sample to examine relationships of between variables—including impact parameter, specific star formation rate, and galaxy richness—and absorption strength to better understand how these factors influence the distribution of cool CGM gas.

College of Veterinary Medicine

Halle Cantor[1], Ella Rushing[2], Anastasia Sheridan[2], and Ashley Brown[2]
Graduate Programs: Comparative Biomedical Sciences[1]; Biomedical Engineering[2]
Advisor: Ashley C. Brown
Poster Number: 27

Optimization of Loaded Fibrin-specific Nanogels for Treating Sepsis-induced Disseminated Intravascular Coagulation

Background: Disseminated intravascular coagulation (DIC) is a deadly disorder characterized by the simultaneous occurrence of excessive systemic clotting and severe bleeding. In cases of human sepsis, DIC has been shown to contribute to a mortality rate nearly double that of septic cases without DIC, emphasizing the challenge clinicians have faced in effectively managing this disease. Fibrinolytic tissue plasminogen activator (tPA) and anticoagulant antithrombin-3 (AT3) are commonly used in septic DIC to restore hemostatic balance, but both have been associated with life-threatening off-target bleeding. Yet, there are still no approved therapies with targeted delivery of tPA or AT3 for DIC. We have developed fibrin-targeting nanogels (FSNs) that enhance clot maturation at sites of hemorrhage and dissolve existing clots when loaded with either tPA or AT3.

Aims: Establish tPA and AT3 dual-loaded FSNs as a therapy for DIC by investigating their efficacy at low loading doses and evaluating their dose-dependent effects.

Methods: We evaluated the loading efficiencies, drug release profiles, and clot-forming and fibrinolytic capabilities of different doses of tPA and AT3 in FSNs in vitro. We used a sepsis-induced DIC rat model to investigate the effects of different tPA and AT3 loading doses and dose-dependent effects of dual-loaded FSN treatment.

Results: tPA and AT3 have significantly greater loading efficiencies into dual-loaded FSNs at lower concentrations of 1.5 μg/mL and 1 mg/mL, respectively, compared to previously used doses in preclinical studies. Dual-loaded FSNs at these concentrations were significantly better at inhibiting clot polymerization and degrading clots under static and dynamic in vitro conditions. When administered to rats with sepsis-induced DIC, these FSNs significantly increase platelets, segmented neutrophils, and clotting ability and reduce neutrophil activation within 30 minutes.

Conclusions: This work demonstrates the potential of dual-loaded FSNs as a fast-acting therapy for DIC.

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Advisor: Lauren V. Schnabel
Poster Number: 37

Initial Investigation into the Effects of Clinically Used Antiadhesive Therapies on Intrasynovial Tenocytes in Vitro

In horses, tenosynovitis most commonly affects the digital flexor tendon sheath (DFTS). Injury to the deep and superficial digital flexor tendons (DDFT, SDFT) within the DFTS can result in the formation of intrasynovial adhesions, which carry a poor prognosis. Tissue plasminogen activator (tPA) is frequently used as an antiadhesive agent, and enalapril has recently been investigated; however, their effects on tendon healing have yet to be investigated. This study aimed to evaluate the effects of tPA and enalapril on tenocyte (1) viability and proliferation, (2) gene expression and protein production, and (3) migration in vitro. We hypothesized that neither agent would be cytotoxic or negatively affect tenocyte gene expression, protein production, or migration. Intrasynovial DDFT- and SDFT-derived tenocytes from eight horses were treated with tenocyte media alone or supplemented with clinically relevant doses of tPA or enalapril. Cytotoxicity was assessed through viability and population doubling assays. Gene expression was analyzed using the NanoString nCounter System, and a multiplex immunoassay will quantify protein production. Migration will be assessed using a 3D collagen gel assay. Preliminary findings revealed that tPA had no cytotoxic effects, whereas enalapril significantly reduced tenocyte viability and proliferation in a dose-dependent manner. Additionally, tPA decreased the expression of inflammatory genes, but also significantly downregulated collagen type I and extracellular matrix gene expression at higher doses. Gene expression analyses for enalapril are underway as are protein and migration assays. These results suggest that while tPA may mitigate inflammation, it may impair tendon healing at higher doses. Conversely, enalapril demonstrated dose-dependent cytotoxicity. The primary limitation of this study is that it was performed in vitro; however, these findings provide a foundation for future in vivo research on the therapeutic use of these agents in managing tenosynovitis.

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Advisor: Matthew Breen
Poster Number: 104

Molecular Discovery of Filarial Nematode DNA in an Endangered Galapagos Pinniped (Galapagos sea lion, Zalophus wollebaeki)

Rapidly changing environments contribute to the spread of invasive species and their associated pathogens into new and vulnerable ecosystems, such as the Galapagos archipelago. These pathogens represent a significant wildlife health concern for native Galapagos species. One such species is the Galapagos sea lion (Zalophus wollebaeki) (GSL), an endangered and endemic pinniped increasingly at risk of acquiring infectious diseases due to interactions with introduced companion animals. Previously, we reported the first documented case of antigens from Dirofilaria immitis, the parasite that causes canine heartworm disease, in the GSL. To further investigate, we developed a multifilarial PCR assay and detected DNA from D. immitis and the closely related D. repens in 10.7% of our sample cohort. Based on a conserved region in the filarial 28S gene, this assay can be used in conjunction with restriction endonuclease digestion or Sanger sequencing to recover the genus or species of the causative nematode. Our method proved effective without nonspecific amplification in a wide range of host species, detecting as little as one parasite, and can be used in cases of immature, low-worm burden, or all male infections. This molecular approach offers a sensitive and specific method for detecting filarial parasites in wildlife. Further investigations are necessary to confirm the pathology of filarial nematodes in the GSL and their prevalence in the population. Our findings underscore the urgent need for measures to manage the risk of pathogen transmission from introduced species to native wildlife.

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Poster Number: 115

The Overlapping and Differential Transcriptomic Roles of the TDP-43 Zebrafish Orthologs and Their Implications for Future ALS Research

Amyotrophic Lateral Sclerosis (ALS) is a neurodegenerative disease characterized by progressive motor deficits, resulting in paralysis and death. ALS can be classified as familial (5-10% of cases), whereas most cases are of unknown etiology (sporadic). The nuclear clearing and cytoplasmic aggregation of the TAR DNA Binding Protein of 43KDa (TDP-43) lead to motor neuron death and are hallmarks in both subtypes. TDP-43 is essential in RNA metabolism, including transcription, splicing, and transport. However, the consequences of TDP-43 dysfunction on the transcriptome remain poorly understood. This study evaluated transcriptional changes in a TDP-43 partial loss of function zebrafish model to gain insights into potentially catastrophic changes in essential neuronal pathways. We leveraged CRISPR/Cas9 gene editing to knock out TDP-43 (TDP-43 KO). While in mammalian models, TDP-43 KO is lethal, a genome duplication event in teleosts resulted in a duplication of TDP-43, thus allowing us to generate a viable model with significantly reduced TDP-43 function (tardbp-/-; tardbpl+/-). We employed RNA-seq to investigate the functional divergence and overlap between both paralogs at the transcriptome level and to identify differentially expressed genes (DEGs) as potential candidates in the establishment of ALS pathogenesis. We performed pairwise comparisons of (+/+);(-/-), (-/-);(+/+), and (-/-);(+/-), using (+/+);(+/+) as the control. The results showed 2037 DEGs shared among all groups, 588 DEGs exclusive to (-/-);(+/+), 1425 DEGs exclusive to (+/+);(-/-), and 1876 DEGs exclusive to (-/-);(+/-). We also identified shared essential neuronal health pathways affected among groups, like mitochondrial dysfunction, neddylation, and ERK/MAPK signaling, among others. Our findings highlight the overlapping and differential roles of tardbp and its paralog tardbpl at the transcriptomic level in zebrafish. They provide candidate targets for TDP-43 dysfunction and the neuronal pathways affected. Lastly, they validate the utility of the zebrafish as a mechanistic model system to continue unraveling ALS pathogenesis.

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Deciphering the Development of Repetitive Ozone-Induced Mucous Cell Metaplasia in Mice

The impact of ground-level ozone on respiratory health, marked by airway inflammation, impaired host defense, and exacerbation of lung diseases, highlights its global public health threat. In 2010, approximately one million adult deaths were linked to ozone exposure, as reported by Environmental Health Perspectives, highlighting the urgent need to understand the mechanisms underlying ozone-related pulmonary issues. Among these, mucous cell metaplasia (MCM) is a pivotal condition triggered by repeated ozone exposure. However, the kinetics of repetitive ozone-induced MCM and the specific cellular precursors to goblet cells remain unclear. To investigate these aspects, we first explored the kinetics of repetitive ozone-induced MCM by exposing 8–10-week-old C57 mice to 1, 2, 3, 5, or 9 doses of either filtered air or 1000 ppb of ozone for 4 hours per dose. Sample harvesting was done 12-16 hours following the final ozone dose to assess changes in airway epithelial dynamics. Additionally, we generated basal cell-specific (K5-Cre-ERT2+/Rosa-mTomFL/FL/mEGFP), club-cell specific (CCSP-Cre-ERT2+/Rosa-mTomFL/FL/mEGFP), and ciliated cell-specific (FOXJ1-Cre-ERT2+/Rosa-mTomFL/FL/mEGFP) reporter mice models. To identify the goblet cell precursors, we employed lineage tracing in these mice through induction of Cre recombinase activity using administration of tamoxifen, which was followed by a repetitive ozone-exposure paradigm (1000ppb, 4h/dose, 9 doses). We observed a progressive rise in airway epithelial cell proliferation, basal cell numbers, and goblet cell population post-exposure, with marked increments after two, three, and five doses, respectively. Lineage tracing, through immunolocalization of MUC5B and GFP, revealed that basal cells do not differentiate into goblet cells upon repetitive ozone exposure. Conversely, club cells and ciliated cells were suggested to transdifferentiate into goblet cells. This study concludes that repetitive ozone exposure induces mucous cell metaplasia and that club cells and ciliated cells, excluding basal cells, transdifferentiate into goblet cells. Collectively, this study enhances our understanding of ozone-induced MCM.

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Poster Number: 152

Cold Atmospheric Plasma Inactivation of Aspergillus Flavus Biofilm in Vitro

Purpose: A lack of antifungal drugs with activity against mature fungal organisms and biofilms severely limits successful treatment of fungal keratitis. Cold atmospheric plasma (CAP) is a novel disinfectant technique that ionizes a gas source to produce a composite of biologically active reactive oxygen and nitrogen species. The purpose of this study was to evaluate if CAP would inactivate mature fungal organisms and biofilms using an in vitro model of fungal keratitis.

Methods: A clinical isolate of Aspergillus flavus was cultured in a liquid broth suspension in 24 well plates and incubated for 24 hrs to achieve biofilm formation. Biofilms and non-inoculated broth wells were exposed to CAP generated by a dielectric barrier discharge device (DBD) using room air for 0-300 s under various CAP operating parameters (22 - 27 kV, 60 - 80 mA, 300 Hz). Fungal viability of treated samples and untreated controls was assessed by measuring metabolic activity via formazan salt (XTT) reduction assay and colony formation via colony forming unit (CFU) enumeration.

Results: Metabolic activity was significantly decreased in both 60 and 80 mA groups following CAP treatment of 180 s or more compared to untreated controls, with a maximal reduction of 91% in the 60 mA group ($p<0.0001$) and 65% ($p<0.0001$) in the 80 mA group. Colony formation was also significantly reduced in both 60 mA and 80 mA groups following CAP treatment of 120 s or more compared to untreated controls, with maximal reductions following 300 s treatment at 60 mA ($p=0.0005$). Interestingly, CAP treatment of 60 s resulted in a significant increase in metabolic activity of biofilms treated at 80 mA ($p=0.0002$), despite decreased colony formation.

Conclusions: Our results are consistent with the hypothesis that CAP exposure would inactivate mature fungal biofilms in vitro. We identified a dose-dependent reduction in fungal viability following CAP treatment, with significant decreases in metabolic activity and colony formation following treatments of 180 s or more. CAP generated at 60 mA was associated with greater reductions in biofilm viability compared to CAP generated at 80 mA. These findings contribute to ongoing research in identifying optimal parameters for CAP inactivation of FK associated biofilms.

Poole College of Management

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Poster Number: 159

Extreme Temperatures and Energy Consumption in Bangladesh

While extensive research has been conducted on the relationship between temperature and energy consumption in high-income countries, much less is known about these dynamics in poorer regions. This study addresses that gap by analyzing energy expenditure patterns in rural Bangladesh, where households depend on a mix of fuel types ranging from solid fuels to electricity. The study utilizes data from the Bangladesh Integrated Household Survey (BIHS), a nationally representative dataset spanning three rounds (2011–2012, 2015, and 2018–2019), and integrates it with temperature and precipitation data from the ERA5 reanalysis dataset, prepared by the European Centre for Medium-Range Weather Forecasts (ECMWF). By employing a temperature bin approach, the study estimates the effects of extreme temperatures on household energy expenditures in a flexible manner. The econometric strategy controls for village and year-fixed effects, ensuring that variations in energy expenditures are mainly driven by temperature fluctuations rather than broader economic or infrastructural factors. The analysis reveals distinct patterns of energy consumption: expenditures on solid fuels increase significantly during colder periods, while electricity expenditures decline in hotter temperatures. The robustness of these findings is confirmed through multiple econometric specifications, including degree days and quadratic models. These results suggest that rural households encounter severe constraints in adjusting their energy usage, which may stem from affordability, lack of infrastructure, or challenges in behavioral adaptation. This conclusion is crucial, given that this inability to adapt to temperature extremes can have serious consequences for household well-being, including increased health risks and mortality.

Wilson College of Textiles

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Poster Number: 4

Revolutionizing Heart Therapy: The Role of Pluripotent Stem Cells and Extracellular Matrix in Engineered Solutions

Cardiovascular disease is the leading cause of death globally, resulting from blood flow blockages that limit oxygen to the heart's contractile cells, ultimately leading to heart failure. Current treatment options are scarce, with organ transplantation being the only practical solution, a situation made more challenging by the lack of available healthy donor hearts. In response, cardiac tissue engineering is exploring the use of pluripotent stem cells to regenerate these essential contractile cells. However, translating laboratory findings to clinical settings has been hampered by a limited understanding of cardiac differentiation and how the microenvironment affects pluripotent stem cells. This study investigates the impact of substrate composition, specifically focusing on extracellular matrix (ECM) proteins derived from the atrial and ventricular regions of porcine hearts. Porcine hearts were dissected, and the atrial and ventricular regions were separated, decellularized through enzymatic and surfactant washes, followed by lyophilization and electrospinning with polycaprolactone (PCL). The resulting substrates were then seeded with stem cells and prompted to differentiate into a cardiac lineage. We characterized the mechanical and biological properties of these materials, enhancing our understanding of their potential applicability in cardiac tissue engineering. Our research contributes to the ongoing efforts to find viable treatments for cardiovascular disease by developing innovative tissue-engineered solutions that may eventually lead to effective therapies for heart failure.

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Poster Number: 11

Calcium Carbonate Mineralization and Polymorphs on the Preparation of High Modulus, High Tenacity Hemp Fibers

The mineralization of hemp fibers with calcium carbonate (CaCO3) presents a sustainable approach to developing high-modulus, high-tenacity bio-composites. This study investigates the influence of alkali metal spectator ions, specifically sodium (Na+) and potassium (K+), on the synthesis and mechanical properties of CaCO3-hemp fibers. According to the findings, Na^+ significantly accelerate the process of CaCO3 mineralization relative to K+. Further, CaCO3 mineralization enhanced the mechanical strength of hemp fibers when compared to their unmineralized counterparts; these increases in strength were influenced by its CaCO3 polymorph. Specifically, CaCO3-treated hemp demonstrated a remarkable increase in tenacity of approximately 92.3% and an enhancement in specific modulus of around 25.6%. Thermodynamically stable calcite crystals of CaCO3 conferred superior mechanical properties when compared to hemp mineralized with vaterite crystals. Further, the treatment of CaCO3-hemp fibers with alkaline solutions revealed an extraordinary enhancement in both tenacity and specific modulus to 273% and 31%, respectively—values that approach those of glass fiber. This substantial improvement was linked to the recrystallization of unstable vaterite crystals to stable calcite forms. This research elucidates the critical role of ion-mediated mineralization and process optimization in developing advanced biocomposite materials, having tailored mechanical properties.

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Poster Number: 18

3D Printed Optical Sensors to Detect Target Analytes

Single-walled carbon nanotubes (SWCNTs) display nano sensor abilities and are useful for detecting target analytes. Uniquely, semiconducting SWCNTs interact with light and exhibit non-photobleaching fluorescence in the near infrared region (NIR). The SWCNT surface can be functionalized, and a molecular recognition group can be added to allow for interactions with target analytes. After exposure to the target analyte, the fluorescence of the functionalized SWCNT will shift in either intensity or wavelength. The emission shifts can be measured to establish a correlation between the fluorescence changes and the concentration of the analyte. Integration of the SWCNTs into fibers, hydrogels, and 3D printed objects could capitalize on these capabilities and characteristics by integration into a portable optical sensor. Fibers allow for wearable applications that could be used for continuous monitoring while hydrogels have potential in vivo sensing application advantages. 3D printing permits variability in size and shape for both implantable, wearable, and physical substrate applications. In this research, we present a method that highlights 3D printing hydrogel technology to integrate SWCNT based optical sensors into a 3D printed structure with adjustable size, mechanics, and sensing capabilities.

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Poster Number: 63

Exploring Hemp Fibers as Sustainable Alternatives in Enhancing Biomaterial Cell Adhesion

Many people suffer from chronic skin damage such as diabetic ulcers and detrimental burns. Skin grafts can be the only available treatment in some of those cases. Obtaining skin from other areas of the body is difficult and costly. Skin tissue engineering aims at reconstructing the structural and functional components of skin, reducing scar formation, and improving the quality of wound healing. A vast majority of products used in tissue engineered applications use synthetic materials derived from fossil fuel/petroleum based materials/processing. This project focuses on identifying a sustainable approach to tissue engineering using hemp fibers. Sustainability aims to reduce waste, increase recyclability, and reduce the environmental impact. Hemp is a biodegradable material compatible with Human dermal fibroblasts (HDFs) and a potential sustainable alternative. The material created is a 100% hemp plain weave design. Characterization of the sample included assessments of hairiness & evenness, tensile strength, and water contact angle, in addition to biological testing involving HDFs. For biological analysis, HDFs were seeded on the samples and observed at days 3, 7, 10, and 14. Live/Dead assays were performed at each time period to determine sufficient cell viability and toxicity. Immunofluorescent staining was conducted to observe if the markers indicating healthy integrated HDFs were present. Of these markers are Vimentin, Fibronectin, and Collagen 1, which are important components of the extracellular matrix to provide tissue structure and integrity. An alamarBlue assay was conducted to calculate the quantitative measurement of cell viability and proliferation. Ongoing biocompatibility studies will provide preliminary data necessary to demonstrate effectiveness of hemp for skin tissue engineering applications. The samples should show biocompatibility once seeded with cells. This study investigates the potential use of sustainable, natural materials as alternatives to commonly used synthetic polymers for future use in skin tissue engineering.

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Poster Number: 103

Consumer Experience in Virtual Fashion Shows: a Perspective of Social Presence

Virtual Reality (VR) transforms fashion marketing by creating immersive and interactive brand experiences. VR fashion shows (VRFSs) enhance accessibility, engagement, and brand storytelling, yet consumer perceptions remain underexplored. Social presence—the perception of being with others in a virtual space—is crucial in shaping consumer engagement. This study examines how co-presence, immersion, and interaction influence consumer experiences in VRFS.

Literature Review: Existing VRFS research focuses on technological improvements rather than consumer experiences. While some studies identify barriers like limited garment detail visibility and disruptions in realism, the role of social presence in VRFSs is underexplored. Given its importance in virtual environments, this study investigates how it shapes engagement in VRFSs.

Method: A focus group study was conducted with 20 participants from the U.S. using VR headsets. They experienced the Mulberry 360 VRFS before participating in a 90-minute discussion. Data was transcribed and thematically analyzed.

Results and Findings

Co-presence: Participants felt connected to the event but noted a lack of real-time interaction, reducing shared experiences.

Immersion: Low resolution, depth perception issues, and headset discomfort hindered engagement.

Interaction: Participants desired audience communication and interactive runway features to enhance engagement.

Conclusions and Future Research: Enhancing social presence, interactivity, and audiovisual quality can improve VRFS experiences. Future studies should explore AI-driven engagement, haptic feedback, and consumer-brand relationships in VRFSs.

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Poster Number: 174

Integration of Stretchable Vertical Interconnect Access (VIA) in Multilayered Textile-Based Wearable Device

As wearable electronics gain widespread adoption, the demand for sophisticated and functional device integration within soft form factors continues to grow. This is particularly apt with regard to connecting discrete sensors on a soft substrate using interconnects. A key challenge in wearable interconnects lies in achieving stretchability, mechanical durability, and environmental stability while maintaining consistent electrical performance. This study presents the fabrication and characterization of a novel Vertical Interconnect Access (VIA) embedded within a multilayer textile substrate. The VIA was created by laser cutting a precise aperture in the multilayered textile substrate and subsequently filling it with 80/20 silver-silver chloride (Ag/AgCl) conductive ink. The multilayer substrate consisted of a single jersey knit fabric to ensure wearer comfort, while thermoplastic polyurethane (TPU) films served as both the base layer and encapsulant, enhancing the mechanical integrity of the interconnect. To evaluate the VIA durability, cyclic electromechanical testing was conducted under dynamic stretch-release conditions, with in-situ electrical resistance monitoring. Comparative analysis against conventional snap interconnects demonstrated that the VIA exhibited a low and gradual increase in resistance, whereas the snap interconnect showed significantly higher and unstable resistance variations. Furthermore, a textile-based electromyography (EMG) monitoring device incorporating both interconnect types was developed. The VIA-enabled configuration yielded high quality EMG signal acquisition, validating its functional performance in real-world physiological signal monitoring applications. These findings highlight the great potential of textile-integrated VIAs in advancing and transforming not only wearable medical diagnostics, but also enabling robust interconnect solutions for military, sports, gaming, and augmented/virtual reality (AR/VR) applications.

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Poster Number: 182

Material Analysis and Feasibility Study for Novel Reusable Protective Gloves for Medical Applications

Abstract: The COVID-19 pandemic revealed several weaknesses in the supply of personal protective equipment (PPE) especially medical gloves which experienced shortages endangering patients, healthcare workers, and the public. Reusable PPE pieces proved to be resistant to these shortages, and medical and biological laboratory workers who experience low exposure to common hazards such as blood were found to have an interest in incorporating reusable gloves into their supplies. Materials representative of a diverse range of technical approaches to creating a reusable medical glove through material-level tests and a wear trial. It was found that the polymer dipping construction method, especially when supported by a textile material, presented a viable path towards achieving a reusable medical glove.

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Poster Number: 195

Comparative Analysis of Thermal Treatments and Alternative Coagulation Methods on the Strengthening of Sustainable Sodium Alginate Fibers

Sodium alginate (SA), a biodegradable and biocompatible polysaccharide from brown seaweed, has gained interest for use in textile applications. However, its poor mechanical strength limits its usefulness as a textile fiber. SA fibers are typically produced via wet spinning. The water-based solution of SA is spun into an aqueous coagulation bath of calcium chloride ($CaCl_2$), but water retention reduces fiber strength. This study explores two independent approaches for enhancing the mechanical strength of SA fiber: the use of thermal annealing and organic baths for coagulation.

As-spun fibers were air-dried at 60°C and annealed at higher temperatures between 80°C and 160°C. The tenacity of SA fibers increased by 149% (from 0.57 to 1.42 cN/dtex) when fibers were annealed at 160°C, while maintaining values of elongation at break that are comparable to conventional textile fibers such as cotton. Infrared spectroscopy confirmed moisture removal, which facilitated intra- and intermolecular interactions between SA molecules.

Furthermore, the aqueous $CaCl_2$ bath was replaced by $CaCl_2$ in methanol for coagulation. This method enhanced fiber drawability, yielding finer fibers (38um vs 84um with the aqueous bath), while also improving fiber modulus and tenacity. The resulting fibers exhibited enough flexibility to form knots and to strain up 33% like wool.

Thus, these two strategies (of high temperature annealing and coagulation in an organic solvent) were shown to offer complementary pathways for improving the mechanical properties of SA fibers, while expanding their potential use among sustainable textiles.

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