Michigan Technological University

2026

Undergraduate Research & Scholarship Symposium

Welcome to the 2026 Undergraduate Research & Scholarship Symposium!

Research begins with curiosity—the kind that asks bold questions, challenges assumptions, and seeks new ways of understanding the world. Today, that curiosity comes to life as Michigan Tech's undergraduate researchers share the discoveries, insights, and innovations they've developed over the past year.

Each student presenting at the symposium has taken on a journey that is both rigorous and rewarding. With the support of dedicated faculty mentors, they have navigated the challenges of the research process—from early questions and experimentation to analysis, refinement, and communication of their findings. Along the way, they've developed not only knowledge in their fields, but also the persistence, creativity, and critical thinking that define impactful research.

The work showcased today reflects an impressive breadth of disciplines and perspectives, highlighting the wide range of opportunities available to undergraduate researchers at Michigan Tech. Many of these projects have been supported by programs such as the Summer Undergraduate Research Fellowship (SURF) and the Undergraduate Research Internship Program (URIP), made possible through the generous support of the Copper Shores Community Health Foundation, the John Edgar McAllister Foundation Trust Undergraduate Research Fund, DeVlieg Foundation, and the Great Lakes Research Center. This collective investment—along with the mentorship of faculty and the encouragement of families, departments, and colleges—plays a vital role in making these experiences possible.

As you explore the symposium, I encourage you to connect with the presenters. Ask questions, share perspectives, and engage in conversation. Your curiosity and participation help create an environment where ideas grow and learning deepens.

Today is a celebration of discovery, dedication, and the future of research. Thank you for being part of it.

Sincerely,

Marika Seigel
Dean, Pavlis Honors College

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1. LVEFangio: Predicting Left Ventricular Ejection Fraction (LVEF) Using Deep Learning on ICA Videos

Student Presenter: Adam Christley, Computer Engineering
Faculty Advisor: Dr. Weihua Zhou, Medical Imaging and Informatics Lab

Authors: *Adam Christley*

Introduction:
Cardiovascular disease (CVD) is a leading cause of death, responsible for approximately 17.9 million deaths annually, with a one in four lifetime risk of developing heart failure (HF) [1], [2]. Cardiac imaging techniques such as echocardiography and gated SPECT myocardial perfusion imaging are commonly used to assess heart function and estimate left ventricular ejection fraction (LVEF). LVEF measures how effectively the left ventricle pumps blood and is calculated using end-diastolic volume (EDV) and end-systolic volume (ESV) as (EDV − ESV) / EDV. It is a key metric for patient classification and treatment planning.

Materials and Methods:
This study proposes a hybrid deep learning framework for automated left ventricular ejection fraction (LVEF) estimation from invasive coronary angiography videos. The dataset consisted of 1,041 angiographic sequences acquired across multiple views, with corresponding clinically reported LVEF values used as regression targets. Videos were temporally normalized to a fixed number of frames per cardiac cycle and spatially resized, followed by intensity normalization and augmentation to improve model robustness.

Spatiotemporal feature extraction was performed using a three-dimensional convolutional neural network (3D-CNN) backbone, which captures both spatial cardiac structure and temporal motion patterns. The resulting feature embeddings were fed into a Transformer encoder incorporating multi-head self-attention to model long-range temporal dependencies across the cardiac cycle. The network was trained end-to-end using supervised learning with Huber loss.

Model performance was evaluated on held-out data using regression metrics including mean absolute error and Pearson correlation coefficient. This architecture was designed to improve temporal modeling and generalizability compared to CNN-only approaches.

Results and Discussion:
The proposed 3D-CNN and Transformer framework demonstrated accurate estimation of left ventricular ejection fraction (LVEF) from invasive coronary angiography videos. On the held-out test set, the model achieved a mean absolute error of 4.7% and a root mean squared error of 7.4%. Predicted LVEF values showed a statistically significant, moderate positive correlation with clinically reported ground truth (Pearson correlation coefficient = 0.496, $p = 7.73 \times 10^{-14}$). For clinically relevant stratification, the model achieved 95% accuracy when classifying patients with LVEF above 40%, supporting its utility for identifying preserved systolic function.

Bland–Altman analysis indicated low systematic bias, with most errors falling within the 95% limits of agreement. While imaging variability and label noise may contribute to residual error, these results indicate that the model captures clinically meaningful cardiac function from angiographic video. The

strong performance in preserved LVEF classification suggests potential use as a decision-support tool, while the moderate correlation reflects known inter-observer variability in clinical LVEF assessment.

2. Investigating Influences on pH in Lake Erie and Lake Superior

Student Presenter: Anna Proulx, Environmental Engineering
Faculty Advisor: Noel Urban, GLRC

Authors: *Anna Proulx*

Introduction:
Quantifying pH and understanding what influences it is important for a number of reasons. Many aquatic species can only tolerate water within a certain pH range. Additionally, pH affects the solubility of metals and other contaminants in the water, which can negatively affect human and aquatic health. There are a number of factors that influence lake pH, including but not limited to temperature, algae concentrations, CO2 concentrations, and lake sediments/geology. This work aims to understand what causes differences in pH between lakes Erie and Superior, both of which are invaluable freshwater sources.

Materials and Methods:
Buoys were placed in Lake Superior and Lake Erie with instruments to measure pH, air and water pCO2, dissolved organic carbon (DOC), air and water temperature, nutrient concentrations, dissolved oxygen (DO) concentrations, and chlorophyll concentrations, along with several other parameters. Additionally, throughout the year, several cruises were made to collect additional data, including alkalinity and total inorganic carbon (TIC) measurements at set depths corresponding to the top, middle, and bottom of the water column. Depth profiles were also made using an instrument measuring conductivity, temperature, and depth (CTD). By analyzing correlations between pH and other variables, I will identify parameters that co-vary with pH and that may cause differences in pH. Changes in DO concentrations indicate the magnitude of algal photosynthesis and CO2 uptake; the effect of such changes in CO2 on pH can be determined by modeling inorganic carbon chemistry in Lake Erie and Lake Superior.

Results and Discussion:
This research is still ongoing. I have compiled all relevant data measured to date, but have not yet completed correlation analysis and modeling of carbonate chemistry. We know that Lake Erie generally has a higher pH than Lake Superior, though the specific combination of factors influencing these differences is to be determined. I would expect that the differences in lake depth affect temperature and rates of lake warming, and these differences may exacerbate pH differences as the effects of climate change increase and the planet sees increased warming. Understanding factors controlling pH in these two large lakes will help to predict pH changes in other large lakes. An understanding of all of the myriad factors affecting pH can only be done in complex models that link biogeochemical processes with hydrodynamic mixing processes. The data collected here will be used to validate such a model that may be used to predict future changes in the pH of the Great Lakes.

3. Precision Aerosol Analysis Through Interferometry and Cavity-Enhanced Photoacoustic Spectroscopy

Student Presenter: Andrew Konop, Physics
Faculty Advisor: Claudio Mazzoleni, Physics

Authors: *Andrew Konop*

Introduction:
Atmospheric aerosol science focuses on how small particles suspended in the atmosphere interact with the surrounding atmosphere. Interactions between aerosol particles and electromagnetic radiation result in changes in local atmospheric conditions as well as the climate at large; cloud nucleation, local temperature and humidity, and global air currents are some of the phenomena affected by aerosol/light interactions. My work has focused on the development of improved instrumentation to more precisely determine how much energy is released into the atmosphere through aerosol light absorption by increasing the signal intensity of photoacoustic spectroscopy through use of a Fabry-Perot optical cavity.

Materials and Methods:
The objective of this project was to properly calibrate a confocal spherical mirror Fabry-Perot interferometer for use with a 785 nm pulsed laser and to create a working laboratory setup with the interferometer and a microphone to reduce the uncertainty in absorption measurements for various atmospheric aerosols. To calibrate the interferometer, a Class I visible light laser was used to center a visible beam in the cavity. A Class III 785 nm pulsed laser was aligned through two apertures marking the ideal beam path found with the visible laser. To determine the alignment precision, a function generator connected to the laser power supply was used to sweep through a small wavelength range by modulating the current entering the laser. Adjustments to the alignment were made until a proper Airy pattern was produced. From here, a microphone was chosen and mounted inside of the optical cavity and the output signal was sent to a lock-in amplifier, which is used to find and isolate the photoacoustic signal being produced. Tests on the photoacoustic spectroscopy method have been performed on samples suspended on the tip of a needle to initially test the current detection methods.

Results and Discussion:
Once correctly calibrated, the interferometer produced a series of distinct, isolated peaks when scanned across using a peak-to-peak voltage of 10 millivolts. From the oscilloscope, it was determined that the experimental interferometer currently has a finesse of $F = 22.5$, leading to approximately 7 times the input laser intensity in the cavity. Knowing that the mirrors in the experimental Fabry-Perot interferometer have a reflection coefficient of 0.994, it can be determined from theory that the maximum finesse for an idealized version of this Fabry-Perot interferometer is $F = 261.0$.
Testing is ongoing to determine how to best implement photoacoustic spectroscopy inside of the optical cavity. Currently, tests are being conducted on non-aerosolized samples. However, the final detection method will require tests on true aerosol samples. Since aerosols need to be injected into the Fabry-Perot cavity, a line of tubing and pump will be rigged under a fume extractor on the optical table. Testing with various microphone chips to determine how to best measure the photoacoustic effect is also ongoing. Once a measurement process has been chosen, kerosene soot will be used to test the system, determining the precision of the cavity-enhanced photoacoustic spectrometer.

4. Migration of Technology to Enhance Future Code Critiquing

Student Presenter: Bethany Brown, Computer Science
Faculty Advisor: Leo Ureel, College of Computing

Authors: *Bethany Brown, Daniel Masker, Joseph R, Teahen, Leo Ureel*

Introduction:
One way to increase the understanding of programming languages for new programmers is through immediate, clear feedback. One method of giving this feedback is through the use of code critiquers. Dr. Leo Ureel and the Computer Science Education Research group has developed a critiquer called WebTA. WebTA has been used in many introductory courses at Michigan Tech through its time. However, the framework that WebTA was originally built on is approaching an end, so to extend the lifetime of WebTA, my work this summer was in assisting moving WebTA to a new framework.

Materials and Methods:
The main method of research when it comes to this work is trial and error while writing code. This requires frequent use of resources such as document pages and APIs to learn what functions in the new framework are similar to the ones in the old framework. The work also required teamwork and coordination between members to ensure that the correct code segments were being worked on and transitioned correctly. This was done through regular meetings where new work was divided up, and completed work was peer reviewed before moving to the next segment.

Results and Discussion:
The new design of WebTA is being done so that it can be accessible as an API, allowing the critiquer functionality to be built into multiple different softwares and displays. Doing this requires the back and front ends to be split into separate directories, allowing each to function independently.
My work focused on the backend, particularly on the system that accepts file submissions and does file management. For example, folder submissions needed to be navigated to find the source code files to send to the critiquer. The work I did on the front end was the page where a student would actually do the file submission and make use of the backend. The front end allowed for more use of code from the old framework, highlighting the similarities between frameworks.
This transition of WebTA to a new framework will not only extend the lifetime of WebTA for student use, but opens the door for new features to be added to enhance the user experience. A future addition that is now possible is an AI chatbot and integration into learning management systems such as Canvas. Features such as these will help with advancing the understanding of students learning to code.

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5. Improving Autism Symptoms via Optogenetic Stimulation in the Dorsal Striatum

Student Presenter: Conlan Houston, Biomedical Engineering
Faculty Advisor: Dr. Yu, Biomedical Engineering

Authors: *Conlan Houston*

Introduction:

Autism spectrum disorder is a complex neurological condition affecting social behavior and learning in many individuals globally. Autism has complex physiological causes and symptoms, making treatment difficult and demanding more research into the condition. A prevailing theory of autism is that it is caused by an imbalance of excitatory and inhibitory signals within the brain from a dysfunctional striatum. This study aims to examine this theory through the use of optogenetic deep-brain stimulation in an attempt to treat symptoms in autism mouse models. The goal is to better understand the striatum's role in causing symptoms of autism.

Materials and Methods:

The BTBR mouse strain, a common animal model for autism spectrum disorder, is the subject used in this study along with a control group of wild-type (C57BL/6j) mice used as a control. Light-sensitive proteins called opsins are injected into each side of the brain in the dorsal striatum, along with fiber-optic heads used for delivering stimuli. Two types of opsins are used: an inhibitory opsin, stGtACR2, and an excitatory opsin, ultrafast Chronos. The stimulus used is blue laser light. Testing is done to determine the effects of both inhibitory and excitatory stimulation on the sociability of BTBR mice. Mice are placed in an open box with a stimulus mouse of the same age and sex enclosed in a wire mesh cylinder placed in the middle. The animal is allowed to roam free during the experiment, and its movements are tracked by an overhead camera, allowing us to determine whether stimulating increases or decreases social behavior. Continuous reinforcement testing is also used, in which a mouse is placed in a small feeding chamber and must learn to press a lever to obtain a sugar pellet. Testing will determine the effects of stimulation on the mouse's ability to learn.

Results and Discussion:

The described research is ongoing and will hopefully lead to a better understanding of the role the dorsal striatum plays in autism spectrum disorder. From this study, we hypothesize that by stimulating inhibitory neurons in the dorsal striatum, we will see an improvement in social and learning performance within the BTBR autism mouse models. We also hypothesize that inhibition of the dorsal striatum will not produce beneficial effects. From this research, we hope to discover the potential benefits of optogenetic deep-brain stimulation in treating autism spectrum disorder. This research will also help us understand the striatum's role in autism and how to combat symptoms of the condition.

6. Creating Understanding of Statutory Rules Through Formal Computational Representations

Student Presenter: Connor Fleser, Computer Science
Faculty Advisor: Dr. Charles Wallace, Computer Science

Authors: *Connor Fleser*

Introduction:
Statutory rules, such as legal codes, use complex and intricate language to achieve precise and accurate meanings. This can alienate them from the non-experts who are most directly affected by them. To address this, our research group is seeking to answer the question: how, and to what extent, can computational models be used by stakeholders as a learning tool for understanding the consequences of statutory rules? This work expands on a growing body of research in this field by exploring this in a non-legal framework, investigating the Michigan Tech Registrar's rules regarding course registration and prerequisites.

Materials and Methods:
For this study, a formal representation of the rules regarding course registration and prerequisites was developed in the Alloy Specification language. This was then expanded upon using a "Degree Audit Spec" format capable of representing the major components of a variety of different degree audits. This allowed a translator program to be capable of converting this degree audit into valid Alloy Specification compatible with the solver engine, which was able to be embedded into a backend service and connected to a front-end interface that would be friendly to individuals working with the tool.

To evaluate the capability of the software tool for informing stakeholders on the nature of the statutory rules, we developed problems that we asked participants to work through and attempt to solve using the tool. To measure the gained intuition and understanding of the the nature of the rules and their interactions, we also developed a semi-structured pre and post interview that seeks to gauge understanding through questions about the problems the subjects were posed with, about the nature of registration requirements, and about how the participants have generally worked through such problems in the past and how this tool may support answering them in the future.

Results and Discussion:
An IRB application is in progress for the user testing portion of the project. Once testing has completed and results have been analyzed, we expect to better understand how intuition about rules is built when interacting such a model. Further, the interviews with participants will provide context on the issues that are faced when navigating this type of statutory rules and the possible role that software tools like the one developed may be able to fill. It will also provide feedback on the usefulness of the tool developed, which will provide more empirical evidence of gained understanding.

The results from this study will have implications for the ability of similar tools to enfranchise individuals as they navigate statutory rules, and the types of situations where such models would be appropriate. It may also reveal possible frictions that attempting to create a tool like this may introduce.

7. Temporally Driven Binary Segmentation to Extract Entire Arterial Trees in Sequential ICA Frames

Student Presenter: Caeden Kidd, Computer Science
Faculty Advisor: Weihua Zhou, Applied Computing

Authors: *Caeden Kidd*

Introduction:
Coronary artery disease (CAD) is a leading cause of death in the US and imposes a significant burden on healthcare systems. Traditionally, invasive coronary angiography has been used by physicians to visually diagnose many tasks of CAD, such as determining stenosis severity. However, these approaches are "subjective and … error prone, often resulting in marked variability in [patient] assessment" [1], To address this, AI and computer vision can now automatically annotate coronary anatomy, facilitating "the extraction of quantitative measures like…stenosis severity and Fractional Flow Reserve" [2], reducing subjectivity and error while supporting less invasive paths to better patient outcomes.

Materials and Methods:
To improve the accuracy of coronary arterial segmentation, I developed a novel multi-frame architecture by building off of FACU-Net, a pre-existing state-of-the-art arterial segmentation model capable of extracting high resolution vascular anatomy through innovative Fourier-based attention and saliency modules [3]. While the original FACU-Net processes only isolated frames, my modification incorporates temporal context by processing two sequential invasive coronary angiograms (ICA): a context frame and a target frame.

The modified architecture utilizes a two-stage refinement pipeline. In the first stage, both the context and target frames are independently segmented at a 256x256 resolution to produce coarse binary masks. These masks are then upscaled to 512x512 and concatenated with the original high-resolution frames. This combined input is fed into the second stage, which functions as a time-corrective refinement module to produce the final 512x512 segmentation for the target frame.

Experiments were conducted using the Medical University of South Carolina (MUSC) dataset, split into small (464 pairs) and large (1,054 pairs) subsets. All variants were trained for 1,000 epochs on two NVIDIA Tesla V100 GPUs. Performance was evaluated using the Dice similarity coefficient to measure the impact of the additional temporal information.

Results and Discussion:
The multi-frame FACU-Net achieved final Dice scores of 76.25% on small MUSC and 78.76% on large MUSC. This performance was compared directly to the vanilla FACU-Net, which scored 71.68% and 79.03%, respectively. Importantly, the improvement between the first and second stages of the multi-frame model was minimal (1.07-1.89%), mirroring the 1.25% gain seen in the vanilla model's two-stage processing. This indicates that the added temporal context from a single adjacent frame did not meaningfully boost segmentation accuracy. The 4.57% boost in performance multi-frame FACU-Net has over vanilla FACU-Net on the small MUSC dataset is most likely caused by a form of self data augmentation. On this dataset, Multi-frame FACU-Net may benefit from the additional context that more frames provide, despite most of that performance improvement not stemming from learned multi-frame awareness. These findings suggest that single end-diastolic frames already contain most of the

information needed for accurate segmentation, implying that more sophisticated temporal modeling strategies are required to meaningfully improve performance beyond single-frame analysis.

8. A Robust Fluorescence Protocol for Assessing Viability in Human Cancer Cells

Student Presenter: Emily Morrin, Biochemistry
Faculty Advisor: Paul Goetsch, Biological Sciences Department

Authors: *Emily Morrin, Abbie Bergmann, & David Avery*

Introduction:
Viability assays are necessary for accurate quantification of cellular responses to potential therapeutics. Commercially available viability assay kits are challenging for high-throughput usage due to premium pricing. We aim to develop a more cost-effective viability assay using bulk Ethidium Homodimer-1, Calcein AM, and Hoechst 33342. The tri-color fluorescent assay we create will allow for characterization of cell viability and nuclear morphology by evaluating plasma membrane permeability as well as active dye uptake and localization. We aim to utilize the viability assay to assess the response of human cancer cell lines to various experimental conditions in vitro.

Materials and Methods:
The cellular viability assay will utilize three fluorescent dyes, Calcein AM, Ethidium Homodimer-1, and Hoechst 33342. These dyes will be added directly to the cells in a diluted PBS solution and observed using the EVOS® FL Auto Imaging System equipped with the optional onstage incubator to acquire high-resolution time-lapse movies of experiments. Living cells will take up Calcein AM and the dye will then be hydrolyzed by intracellular esterases, resulting in green fluorescence. Dead cells lack membrane integrity, which then allows for Ethidium Homodimer-1 to enter the cell and bind to nucleic acids, producing a red glow. Hoechst 33342 acts as a general nuclear stain which conveniently matches the excitation/emission profile of the DAPI channel. This blue stain should be present in all cells regardless of esterase activity or membrane permeability, making it a good indicator of the total cell count and ensuring even cells not stained by the Calcein AM or Ethidium Homodimer-1 are included in the total count. A negative control population of healthy cells will be run for baseline viability. This control will be compared to drug-treated samples, and subsequent changes in fluorescence will be observed.

Results and Discussion:
Ongoing research is anticipated to produce a cost-effective, high-throughput cell viability assay. Results from the EVOS auto imaging system will be quantified to produce a kill curve showing the percent of surviving cells over a period of time. Live cells will fluoresce green due to Calcein AM, and dead cells will fluoresce red due to Ethidium Homodimer-1. Hoechst 33342 fluoresces blue and will be used to find an overall count of the cells and reveal any cells that do not fluoresce red or green. These results will be analyzed via ImageJ/FIJI to produce both a total cell count and a live/dead ratio for each image produced by the EVOS.

This assay will be a nearly universal method of assessing viability in vitro, with applications in basic biology, disease research, and drug discovery. In the Goetsch laboratory, this assay will further research on the cytotoxicity of potential therapeutics on cancer cells. With health research funding in jeopardy for

many laboratories, added financial strain has raised demand for cost effective protocols. Our in-house tricolor viability assay leverages affordable bulk powders to effectively circumvent the need for proprietary kits that cost significantly more for a fraction of the throughput.

9. Analyzing Physical, Chemical and Environmental Factors that Affect Contaminant Concentrations Within Walleye in the Upper Peninsula of Michigan

Student Presenter: Ethan Cook, Environmental Engineering
Faculty Advisor: Dr. Urban, Dr. Perlinger, CEGE

Authors: *Ethan Cook*

Introduction:
This project is centered on two prevalent contaminants (mercury and PCBs) within walleye found in the study area (Baraga, Houghton, and Keweenaw counties). Walleye are chosen for this analysis not only because of their cultural importance, but also for their role in subsistence fishing by the Keweenaw Bay Indian Community. Differences in habitat conditions, growth rates, and food web structures among local lakes can potentially affect the contaminant concentrations within walleye in the same population. The goal of this project is to identify the specific lake characteristics and trends that have an impact on spatial differences within contaminant concentrations.

Materials and Methods:
This project builds upon the Tribal Landscape System, an NSF-funded study of causes and impacts of fish contaminants in regional lakes. Data already measured or gathered in that study include characteristics of walleye (size, age, sex, C:N ratios, lipid content, stable isotope ratios, concentrations of PCBs and mercury) harvested from about 10 lakes. I have gathered additional data on the lakes including trophic state, lake size, watershed size, and hydrologic class. I will utilize statistical tools in excel (correlation, regression analysis, ANOVA, t-tests) to identify important variables and to quantify the impacts of these variables on fish contaminant concentrations.

Results and Discussion:
Work is ongoing and results are still being obtained. One of the surprising early results was that fish condition factor was high in both eutrophic and dystrophic lakes. The C:N ratios, on the other hand, were highest in mesotrophic lakes. We hypothesize that lower condition factors will be associated with higher concentrations for lipophilic contaminants such as PCBs, but not necessarily for mercury. We further hypothesize that fish growth rate will be negatively correlated with contaminant concentrations because of biodilution. Mercury and PCBs are delivered to lake watersheds from the atmosphere except for lakes such as Torch Lake that have local sources of contamination. For mercury, the more wetlands in the catchment, the more mercury will run off into rivers and lakes. We hypothesize that mercury concentrations in fish will be proportional to wetland area. In contrast, PCBs falling on the catchment tend to remain trapped in soil and organic matter. Therefore, we hypothesize that lakes with larger surface areas will have greater inputs of PCBs and also fish with higher PCB concentrations. Because

many of the variables measured in this study may interact, I will use some multivariate statistical analyses (2-way ANOVA, multiple regression) to reveal the interactions.

10. Hypercoagulable States in LAAO Patients

Student Presenter: Elise Zahrt, Biomedical Engineering
Faculty Advisor: Hoda Hatoum, Biomedical Engineering

Authors: *Elise Zahrt, Hoda Hatoum, Ahmad Bshennaty*

Introduction:
A common treatment method for patients with Atrial Fibrillation (AF) who are not suitable for oral anticoagulation therapy is Left Atrial (LA) Appendage (LAA) Occlusion (LAAO) device implementation. This device blocks the LAA, a common location of thrombus formation in these patients. Risk associated with this treatment is device-related thrombosis (DRT) in which clotting occurs due to disruptions in flow patterns. This can be increasingly affected by blood viscosity, which is influenced by hypercoagulable disorders [1]. This study aims to identify the thrombosis risk associated with different hypercoagulable states for AF patients with a LAAO device implanted.

Materials and Methods:
AF patients that underwent the LAAO procedure implementing the Watchman device (Boston Scientific, Marlborough, MA, USA) were used for this analysis. Computed tomography (CT) and echocardiography data was obtained for these patients and used to segment the LA of the patient through Mimics Research 24.0 and 3-Matic 16.0 (Materialise, Belgium) prior to device installation. Finite element simulations were used to replicate the deployment of the LAAO device by FEops (Ghent, Belgium) [1][2]. Computational Fluid Dynamic simulations were carried out in Ansys Workbench 2021 using both Newtonian and Carreau blood viscosity models with varying established parameters to represent different diseased states. Mitral valve velocity waveform was used to establish a pressure waveform imposed in the simulations as the driving force for fluid movement, and an element size of 1mm was used based on a mesh independent study [1][3]. 5 simulations were run for each patient to simulate Newtonian-healthy, Carreau-healthy, Carreau-anemic, Carreau-diabetic, and Carreau-thrombophilic blood imposing respective viscosities [4]. From the simulations, Time Averaged Wall Shear Stress (TAWSS), Oscillatory Schear Index (OSI), Relative Residence Time (RRT), and Velocity were calculated and assessed for both the LA walls and the surface of the LAAO device.

Results and Discussion:
Present results show minor differences in distribution of parameters between the Newtonian and non-Newtonian models. This indicates that high-shear flow is present in LA after LAAO. Of the non-Newtonian models, TAWSS had the most significant differences amongst the healthy, anemic, and diabetic models. Parameters for the Healthy and thrombophilia models were most similar. The anemic model presented the lowest average TAWSS value of 1.11 ± 0.83 Pa and the diabetic model presented the highest value of 1.66 ± 1.54 Pa. Due to WSS being directly impacted by changes in viscosity that occur most frequently around the walls of the atria due to shear stress changes, it is not surprising that TAWSS was the most sensitive parameter. The difference between the anemic and diabetic model based on TAWSS alone can indicate a decreased likelihood of thrombosis formation in diabetic patients which

is not reflected in literature as clinical studies often show an increase of thrombosis in diabetic patients when compared to anemic ones [5]. As this data does not reflect clinical findings, this project should be continued to include more patients with more complex anatomy as well as different device deployment depths, which are realistic factors that could affect DRT.

11. EvoDREAM: Investigating Conservation of the DREAM Transcriptional Repressor Complex Across Animalia

Student Presenter: Felix Powell, Biochemistry and Molecular Biology
Faculty Advisor: Paul Goetsch, Biological Sciences

Authors: *Connor Donahue, Emily Taylor, Nayelis Manon, Felix Powell,*
Caden McCloskey, Paul Goetsch

Introduction:
The DREAM complex is an eight-subunit transcriptional repressor complex involved in cell cycle regulation. The disruption of the DREAM complex is associated with cellular proliferation. Previous efforts to identify DREAM orthologs have focused on model species and those with high annotated genomes, ignoring vast amounts of available genetic data. Here, we use techniques like dN/dS and clade-level consensus sequences to illustrate the evolutionary conservation of DREAM across Animalia.

Materials and Methods:
To discover and tag potential orthologs, three separate sequence databases (PHMMER, BLASTP, and TBLASTN) with overlapping coverage are used for a preliminary search for orthologs. After curating the combined database, a reciprocal BLAST search will be used to confirm potential ortholog candidates. dN/dS scores will indicate the selection pressures present for each sequence. Multiple Sequence Alignments will be generated for sequences within a designated clade, and an "average" consensus sequence scored based on the similarity of each amino acid to the "average" sequence.

Results and Discussion:
Database construction is ongoing, but preliminary searches have shown that the combined database yields more homologous sequences than any of the individual three. We anticipate finding a similar yet larger pool of DREAM orthologs when compared to conventional methods, as well as anticipating a lack of orthologs in under sequenced clades (such as Nematoda) which corresponds with the known anthropocentric bias towards human-like animals. This research will further our understanding of DREAM's evolutionary history, and the automatic pipeline being developed will increase the throughput of ortholog annotation in the future.

12. Investigating the Thickness of Cherenkov Light-Cones Through the Connection Between Its Radiation Spectrum and Light Curve as Simulated in Python 3.12

Student Presenter: Juan Botha, Physics
Faculty Advisor: Dr Robert Nemiroff, Department of Physics

Authors: *Juan Botha, Ögetay Kayali, & Robert Nemiroff*

Introduction:

Cherenkov radiation occurs when particles traveling at superluminal speeds in a dielectric medium emit radiation. When this happens, a cone of radiation is emitted by the particle similar to how a jet creates a sonic boom after breaking the sound barrier. Despite the Cherenkov Cone being treated mathematically as a monochromatic, infinitesimal shell, some observations have revealed it to be a thick cone with a continuous spectrum. This project aimed to investigate the Cherenkov Cone's thickness and how different parts of its spectrum contribute to its observed light curve over time.

Materials and Methods:

The investigation began with a detailed analysis of the Frank-Tamm theory that relates Cherenkov radiation intensity to wavelength. It was found that the Frank-Tamm equation only considers a single refractive index value for all wavelengths in water. However, the refractive index in water varies significantly across the 0-1000 nm spectral range. Furthermore, since the refractive index is used to determine the radiation cone's emission angle, a variable refractive index might yield different angles for different wavelengths, thus producing a thick cone. Using data compiled by Segelstein, an interpolation model for the refractive index in water was created in Python 3.12. Using this model in conjunction with the Frank-Tamm equations, the spectral intensity and emission angle for different wavelengths were determined computationally. The Frank-Tamm theory was then further modified by introducing Segelstein's absorption data to more accurately reflect how a detector might measure different parts of the Cherenkov spectrum after passing over some distance. With these results in place, some trigonometric arguments were made to create a temporal simulation of how a detector might observe a multi-wavelength, angularly thick Cherenkov cone over time.

Results and Discussion:

The results produced by this project have had some interesting implications. Segelestein's data indicated that the refractive index of water falls below unity for wavelengths below 92 nm. Based on this and the threshold condition for Cherenkov radiation, it was shown that it would be impossible for the Cherenkov spectrum in water to include wavelengths below 92 nm. As such, the results have established a lower bound on the Cherenkov spectrum. Further analysis revealed that the Cherenkov spectrum can theoretically extend far beyond just the visible regime. Despite the effects of absorption removing several emitted wavelengths from detection, the detectable Cherenkov spectrum would still consist of UV, visible, near IR, and radio wave radiation. Calculations involving the emission angle of the radiation have revealed it to vary from 0-84 degrees as opposed to a single conic shell at 42 degrees. Finally, since the refractive index of water was revealed to not be monotonic, it is possible for two

completely different wavelengths to share an emission angle. As such, there is an inherent degree of degeneracy associated with the distribution of the spectrum through the conic shells of the Cherenkov cone.

13. Quadrature Approximations Within Integral Deferred Correction

Student Presenter: Joanna Workman, Mathematics, Applied/Computational
Faculty Advisor: Dr. Benjamin Ong, Department of Mathematical Sciences

Authors: *Joanna Workman, & Benjamin Ong*

Introduction:
Integral deferred correction is a method for approximating the solution to initial value differential equation problems. A key step in integral deferred correction is to approximate an integral of a residual, which is accomplished using a quadrature method. There are many quadrature methods, including Composite Newton-Cotes and Gaussian Quadrature. Computational cost and convergence rates must be taken into account when choosing a quadrature method. This work explores various quadrature methods and their impact on deferred correction, as well as the computational cost and accuracy of fitting a low-order least-squares polynomial to a set of data, and then integrating that polynomial.

Materials and Methods:
The primary method for this project was performing numerical experiments in Julia, a scientific computing language. Algorithms were built to explore convergence rates of different methods.

The least-squares polynomial fit is achieved by forming a Vandermonde matrix and solving an over-determined linear system for the polynomial coefficients using QR decomposition. This process minimizes the L2 error between the polynomial and the data points. The error of the polynomial best fit is measured by taking the norm of the vector of errors at each node. The integral approximation is then found by integrating the best-fit polynomial. The integral approximation error is measured by subtracting the estimated integral value from the actual value if known or a better approximation.

Results and Discussion:
The convergence rates of the least-squares polynomials on uniform nodes are well known to be $k+1$ for a polynomial of degree k. Less is known about the convergence of the integrals of these polynomials. Numerical experiments in this project indicate that the integrals converge at a rate of $k+1$ for odd degree polynomials, but $k+2$ for even degree polynomials. Furthermore, the numerical experiments indicate that the value of the integral is the same for a function f approximated on n nodes for a polynomial of degree k and a polynomial of degree $k+1$. Further studies are needed to understand the reason for this relationship.

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14. How Can We Store Parameters of Large Language Models? The Landscape of File Formats and Comparisons

Student Presenter: Job Siy, Electrical + Computer Engineering
Faculty Advisor: Bo Chen, Security and Privacy (SnP) Lab

Authors: *Job Siy, Bo Chen*

Introduction:

Large language models (LLMs) have recently been used extensively. Each LLM is essentially a transformer-based deep learning model trained on massive text corpora. The "large" in LLM typically refers to hundreds of millions to hundreds of billions of parameters, and efficiently storing and using those parameters is critically important for LLM applications. This work aims to understand the landscape of file formats used in storing and organizing LLM parameters. We also experimentally evaluate each format to understand its performance in model loading and inference. Finally, we provide our tips for selecting the right formats for different application scenarios.

Materials and Methods:

Each format was researched to determine its strengths and weaknesses. To conduct the benchmarks, each format was used to load and operate on a fixed set of inputs. The benchmarks were employed on the same computer to determine the computational strength of each format in the specific conditions.

Results and Discussion:

Each format has different strengths and use cases. The fastest one according to a simple benchmark was GGUF, due to its lightweight nature. GGUF is well suited to single batch real-time systems, TensorRT works well in high throughput situations, ONNX and Torch is great for platform interoperability and prototyping, and SafeTensors provides a safe and reasonably fast method of storing and using Large Language Models.

15. Effects of Stand Structure on Microclimate and Warm-Affinity Seedling Growth in an Adaptive Climate Silvicultural Treatment

Student Presenter: Kaylie Simpson, Applied Ecology and Environmental Science
Faculty Advisor: Dr. Julia Burton, College of Forest Resources and Environmental Science

Authors: *Kaylie Simpson*

Introduction:

Forest capacity to adapt to climate warming is a critical study point among many conservationists, with biological responses crucial to understanding the long-term impacts of climate change on forests globally (Carnicer et al. 2021). Silvicultural manipulations of stand structure in conjunction with assisted migration plantings of species adapted to predicted future climate conditions are used to facilitate adaptation (Zellweger et al. 2020). This study examines whether the manipulation of stand structure affects local microclimate trends and the growth of planted tree seedlings. Understanding these interactions helps determine the role of alternative silvicultural treatments and species compositions in assisted migration plantings in supporting forest adaptation and informing future management strategies that optimize microclimate and regeneration conditions for long-term ecosystem stability (Nauertz et al. 2004).

Materials and Methods:

I deployed a series of 24 Onset HOBO Pro v2 sensors to gather relative humidity and air temperature measurements along the forest floor, and 24 Onset HOBO Pendant temp sensors to gather soil temperature 10 cm under the soil surface. The sensors were deployed within "Transition" treatment units consisting of open patch and shelterwood substructural elements, with each sensor marked using a GPS pinpoint. These recorded measurements on 10 minute intervals from the beginning of May until the end of September. Simultaneously, I collected a pre–growing season, evenly distributed sample of 8 warm-affinity seedling species (black cherry, bitternut hickory, shagbark hickory, shellbark hickory, eastern white pine, tulip poplar, white oak, red oak) planted across patch and surrounding shelterwood structures. 20 seedlings per species were sampled within each of the four patch cuts and four surrounding shelterwoods. Initial measurements of root collar diameter and height were recorded for each seedling, and each was tagged with a unique code used to label GPS coordinates for each individual. Final measurements of the same seedlings were obtained in September using these marked locations.

Results and Discussion:

Initial data analysis revealed seasonal trends in microclimate conditions within the "Transition" treatment zones. Early in the growing season, patch cuts exhibited higher soil and air temperatures and lower relative humidity compared to shelterwoods. However, a midseason shift in these patterns was observed, likely driven by the development of dense ground-layer vegetation within patch cuts increasing near-ground moisture retention and moderating soil temperature later in the season. Shelterwoods maintained more stable microclimatic conditions throughout the growing season, with reduced temperature variability due to partial canopy cover. These microclimate dynamics corresponded with significant differences in seedling growth. ANOVA results indicated a strong treatment effect on seedling height (Fvalue= 13.41, p = 0.0003), with greater height growth generally observed in patch cuts. Root collar diameter was also significantly influenced by treatment (Fvalue = 26.53, p < 0.001),

and a significant species × treatment interaction (Fvalue = 2.61, p = 0.018) suggested species-specific growth responses.

16. Forest Management Impact on Soil Moisture at the Ford Forest

Student Presenter: Lauren Jeffrey, Applied Ecology and Environmental Science
Faculty Advisor: Kathryn Hofmeister, College of Forest Resources and Environmental Science

Authors: *Lauren Jeffrey*

Introduction:
Soil moisture is the amount of water stored in the unsaturated zone of the soil and plays a crucial role in ecosystems by influencing nutrient availability, plant growth, and carbon cycling. Soil moisture is influenced by climate, topography, soil properties, and vegetation [1]. Forest management practices are evolving to adapt to changes in climate and can impact more than just the trees [2]. My research explores how soil moisture varies among different forest management treatments and how site characteristics (microtopography, forest floor thickness, and canopy cover) influence moisture retention. This research project will help identify how different management approaches affect soil moisture and temperature.

Materials and Methods:
This project took place at the Michigan Tech Ford Center in L'Anse, Michigan. I measured soil moisture in the top 20 centimeters of soil using a handheld probe, following established methods used by my faculty mentor [3]. Each full round of soil moisture and temperature measurements took one day to collect. I made additional field visits to measure canopy cover and collect soil cores for gravimetric and volumetric water content analyses, which are necessary to calibrate the soil moisture probe to soils at the Ford Center. Other researchers working at the site measured tree species composition and density, down dead wood, and ground cover, which I used in my analysis. I statistically analyzed these factors to test their relationships with soil moisture in addition to exploring how soil moisture and temperature vary among the treatments and throughout the growing season. I managed and integrated my data into existing project databases. Once data collection was complete, I used Minitab and ArcGIS to test my hypotheses.

Results and Discussion:
Forest management impacts soil moisture.
The more intense forest management treatment (i.e., greater vegetation removals), on average, the moister the treatment area was. This is likely linked to the overall basal area reduction, because canopy cover did not have a significant relationship with soil moisture.
Precipitation 2-weeks, 5 days, and 3 days pre-measurements had a significant impact on soil moisture. As the summer proceeded, in general, soil moisture decreased.

This research will inform climate-adaptive forest management efforts at the Ford Center. This project will also contribute to the broader ACTS study, which provides foresters from all over information on best management practices for climate adaptation.

Further applications include developing strategies for conserving soil moisture to help mitigate drought effects and improving seedling survival by identifying optimal spots for planting and conservation of tree species threatened by climate change.

Soil moisture and temperature are key drivers of soil respiration, which is an important flux in the global carbon cycle. Changes to moisture and temperature patterns could lead to alterations in forest carbon cycling, possibly causing the forest to become a source of carbon instead of a sink.

17. Applying Hemicyanine-based Ratiometric Fluorescent Probes to Monitor Real-Time Mitochondrial pH in HeLa Cells During Metformin Exposure

Student Presenter: Lynsey Baker, Medicinal Chemistry
Faculty Advisor: Dr. Rudy Luck, Chemistry

Authors: *Lynsey Baker*

Introduction:

The mitochondria is a complex organelle that has a variety of biochemical functions within an organism, specifically cell maintenance and development. When the mitochondria is subject to harmful conditions, the organelle's health can decline, indicated by a shift in the proton gradient characteristic to the mitochondria's function resulting in the intra-organelle pH to shift. In this project, a novel, hemicyanine-based ratiometric probe, referred to as Probe AH+, was developed to monitor the pH changes within the mitochondria of HeLa cells when exposed to metformin, as well as other mitochondrial specific changes, such oxidative stress.

Materials and Methods:

Probe AH+ was synthesized and purified using conventional organic synthesis techniques, which included reflux, vacuum filtration, and column chromatography. For the preliminary characterization of the probe, the probe stock solution was subject to various pH buffer solutions ranging from pH 3.56 to pH 8.65, and the resulting absorbance and fluorescence spectra were obtained. In addition, to increase the integrity of probe AH+, a photostability test was conducted for an acidic, neutral, and basic solution, along with a selectivity test with a variety of biologically active species. Once the probe was determined to effectively detect pH changes while minimizing complications that may occur within living organisms, the probe was applied to HeLa cells. The cytotoxicity of the probe was determined using various concentrations of the probe and MTT reagent incubated within HeLa cells, and colocalization was used to determine the mitochondrial-specificity. Probe AH+ was then allowed to be utilized to indicate mitochondrial-pH within the HeLa in both static and dynamic biological processes. Finally, the probe was applied to monitor pH changes when the HeLa were incubated with the commonly prescribed Metformin drug.

Results and Discussion:

The absorbance and fluorescence spectra revealed a ratiometric response from probe AH+, allowing the probe to be used as a method to quantify pH. The photostability and selectivity tests indicated that probe AH+ would successfully monitor pH changes without detecting other biologically active compounds that may be present in cell studies. The probe was shown to be mitochondrial specific and was able to monitor static, controlled pH of the HeLa cells, indicated using the confocal microscope. Probe AH+ also could monitor dynamic cellular activity, like starvation, oxygen deprivation, and oxidative stress, showing the HeLa becoming slightly more acidic which is characteristic to these processes. Finally, when incubated with Metformin, the HeLa cells were shown to become slightly more acidic, giving insights to how Metformin interacts with the mitochondria. Thus, probe AH+ shows

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potential as a fluorescent probe that can be utilized in monitoring mitochondria health or drug interactions regarding this organelle.

18. Personalized Pathways to Proficiency: Evaluating Canvas Mastery Path for Spatial Visualization Development in First-Year Engineering

Student Presenter: Michael Keppert Jr., Mechanical Engineering
Faculty Advisor: AJ Hamlin, Engineering Fundamentals

Authors: *Michael Keppert, Amber Kemppainen, AJ Hamlin*

Introduction:

This evidence-based practice paper focuses on the unique application of Canvas Mastery Path to help provide individualized learning support to first-year engineering students in the development of their spatial visualization skills. This work represents the first steps of a two-year effort aimed at replacing a traditional, standalone course designed to develop spatial visualization skills by incorporating the materials into a standard first-year engineering program. The primary objective of these first steps is to determine if the Mastery Paths, when tested separately, can achieve spatial visualization gains comparable to or exceeding the original instructional formats in first-year engineering courses.

Materials and Methods:

This study was used to determine if the Canvas Mastery Path could be used to create an effective customized learning path, specifically for spatial mastery in first-year engineering students. To determine this, we needed to determine if the new mastery module (pilot) approach was comparable to or improved students' spatial mastery compared to the previous year's traditional instruction. This pilot study was conducted in two stages, the first during the additional spatial mastery course for first year students, and the second during the traditional first-year engineering courses. The determination is made by comparing Purdue Spatial Visualization Test: Rotations (PSVT:R) scores from the pilot program compared to scores from years using traditional instruction.

Results and Discussion:

Pilot 1: The result of this analysis is that there was a statistically significant improvement in student scores when moving to the new piloted canvas mastery approach compared to the traditional instruction approach. With the Canvas Mastery Paths implemented in the Fall 2024 Spatial Visualization Skills Development course resulting in as good or better gains on the PSVT:R than in the Fall 2023 Spatial Visualization Course.

Pilot 2: The result of the second pilot test is that there was no statistical difference between the post test scores of the traditionally instructed students and the students being taught using the new piloted method when excluding students who did not take the additional spatial mastery development course. This result shows that the new piloted method of instruction better serves students who fell into the "failing" category and is comparable to the previous instruction method for students in the passing group.

19. Hypertrophic Cardiomyopathy Beat by Beat: The Role of Sodium Channel Nav1.8

Student Presenter: Melia Austin, Biological Sciences
Faculty Advisor: Dr. Robert Larson, Biological Sciences

Authors: *Melia Austin, Robert Larson, Jenna Disser, & Amber Howard*

Introduction:
Hypertrophic cardiomyopathy (HCM) is the world's most prevalent genetic heart condition, affecting 1 out of every 500 people. There is potential to slow or prevent HCM disease progression by targeting voltage-gated sodium channels such as Nav1.8 on sensory neurons. This channel is active in areas of inflammation such as the tissue within a heart affected by HCM. It increases sodium influx to make neurons more excitable, meaning neurons will fire in response to mild stimuli. We propose that targeting Nav1.8 could reduce activity in the excitatory cardiac spinal afferent nerves, thereby reducing cardiac norepinephrine release and disease progression.

Materials and Methods:
HCM was studied in a mouse model using FVBN mice bred to develop HCM from the Larson lab colony. Mice were anesthetized with isoflurane and subcutaneous osmotic pumps were implanted. These pumps delivered saline to the control group and a Nav1.8 blocker (A-803467) to the experimental group for two weeks. At the end of the infusion period, mice were anesthetized with isoflurane and left ventricular (LV) pressure was recorded. Chlorisondamine was administered to remove autonomic reflex function and the beta-1 adrenergic receptor agonist, dobutamine, was injected. Mice were euthanized by cervical dislocation and their tissues were removed for measurements of cardiac fibrosis and protein expression.

Results and Discussion:
Increases in heart rate in response to dobutamine were attenuated in the A-803467 group compared to saline control. In contrast, increases in dP/dT max were augmented in the A-803467 group compared to saline control. Dobutamine infusion elicited similar maximum systolic LV pressure and end diastolic pressure in both groups. Ongoing studies will examine beta-1 receptor and tyrosine hydroxylase (rate-limiting enzyme for norepinephrine production) protein expression in the LV and right atrium.

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20. PVN SK Channel Blockade Alters Sympathetic Burst Characteristics and Transduction in Sprague-Dawley Rats

Student Presenter: Nikolas Johnson, Biological Sciences
Faculty Advisor: Dr. Robert Larson, Biological Sciences

Authors: *Nikolas R. Johnson, Jenna R. Disser, Amber L. Howard, Melia K. Austin, Madeline Espinoza-Laguna, Qinghui Chen, Robert A. Larson*

Introduction:

The paraventricular nucleus (PVN) of the hypothalamus serves as an integrative control center for sympathetic nerve activity (SNA). Small conductance Ca^{2+}-activated K^+ (SK) channels serve as negative feedback regulators of neuronal excitability, and we've previously reported that PVN SK channel dysfunction contributes to sympathoexcitation in hypertension. The PVN regulates SNA and its spectral content by producing frequency-specific patterns that promote cardiovascular homeostasis. Bursts of SNA cause norepinephrine release, augmenting mean arterial pressure (MAP) in subsequent cardiac cycles. Therefore, the aim of this study was to examine renal SNA (RSNA)-MAP transduction before and after blocking PVN SK channels with apamin.

Materials and Methods:

All experiments were performed in ventilated, anesthetized (urethane 800mg/kg & α-chloralose 80mg/kg) male Sprague-Dawley control rats. RSNA signals were rectified and integrated, and bursts were detected using standardized criteria. Statistical analysis was performed with 2-way ANOVA and paired t-tests. Results are expressed as mean±SE. Differences were considered statistically significant at a critical value of $p < 0.05$.

Results and Discussion:

PVN microinjection of the SK channel blocker apamin (12.5pmol, 50μL) significantly ($p < 0.05$) increased RSNA (Δ140±46%) and MAP (Δ33.5±8.9 mmHg) compared to baseline. In contrast, PVN microinjection of apamin significantly reduced RSNA burst frequency (baseline 2.49±0.31 vs. max 1.56±0.28 Hz; $p < 0.05$) and RSNA burst incidence (baseline 40.76±3.697 vs. max 26.24±3.626 burst/100 heart beats; $p < 0.05$). RSNA bursts occurring during the maximum response to apamin elicited significantly (treatment $p < 0.05$) greater increases in MAP in the following 12 cardiac cycles compared to burst that occurred during baseline. In conclusion, blocking SK channels in the PVN augments RSNA through mechanisms that do not include elevations in burst quantity, but result in increased RSNA-MAP transduction.

21. Design of Experiments to Investigate PEGDA Hydrogel Sensors for Non-Invasive Glucose Monitoring

Student Presenter: Precious Mubanga, Chemical Engineering
Faculty Advisor: Maria Gencoglu, Chemical Engineering

Authors: *Precious Mubanga, Charles Schoff, Raven Gaus & Maria Gencoglu*

Introduction:

Glucose monitoring is important for effective diabetes management, but our current technologies are often invasive or costly. Hydrogels are 3-D polymer networks that are sensitive to stimuli such as changes in pH or glucose levels. Hydrogel-based glucose sensors offer a promising alternative due to their biocompatibility and tunable mechanical properties. In this research, we investigated polyethylene glycol diacrylate (PEGDA) hydrogels by evaluating its glucose-sensing capabilities, swelling behavior, and mechanical stability. This research is essential for developing reliable, minimally invasive glucose monitoring systems.

Materials and Methods:

PEGDA hydrogels preparation involves dissolving PEGDA polymer in water with a photoinitiator. In this study, we use a design of experiments (DOE) to systematically evaluate the effects of the PEGDA concentration, photoinitiator concentration, and UV exposure time on hydrogel performance. Hydrogel responses such as swelling behavior were evaluated in this DOE experiment. A second DOE was performed to observe the response of hydrogel in glucose. These hydrogels were infused with glucose oxidase to act as a glucose-sensing agent. When in contact with glucose, glucose oxidase produces hydrogen peroxide and gluconic acid. These responses were evaluated using a hydrogen peroxide assay kit. The hydrogel formulations were exposed to glucose samples of varying concentrations. These glucose samples were made to reflect the typical range seen in Type 2 diabetics, and the hydrogels' behavior was monitored. Their swelling and ability to return to their original state was measured by monitoring changes in color or size.

Results and Discussion:

DOE studies on PEGDA and collagen identified 5% PEGDA, 1% photoinitiator, and 1-minute UV exposure as optimal for highest swelling behavior. Adding glucose oxidase is expected to cause the hydrogel to respond differently as glucose levels change within normal biological ranges. A second DOE has been shown that the optimal glucose concentration is XXXX for highest swelling behavior. For future work, SEM analysis will be used to identify properties that maximize efficiency, sensitivity, and durability. These results will help determine which formulations work best for glucose sensing and how sensitivity balances with strength. This work can guide the design of reliable hydrogel-based glucose sensors for minimally invasive monitoring.

22. Space-Trash: A Game for Alzheimer's Diagnosis

Student Presenter: Robby Johnson III, Computer Science
Faculty Advisor: Dr. Leo Ureel, Computing

Authors: *Robby Johnson*

Introduction:
Alzheimer's disease, a progressive neurological disorder causing memory loss, confusion, and changes in behavior, affects millions worldwide, making early diagnosis critical for effective intervention. Early diagnosis of Alzheimer's disease presents many challenges for both medical professionals and researchers. Subtle cognitive and motor impairments often appear before clinical symptoms, making early detection difficult. Video games have emerged as a promising tool for assessing cognitive and motor functions in an engaging and non-invasive manner (Ito, 2022; Morgan, 2016). Space Trash is a game designed to analyze player controller movement data to help identify early signs of Alzheimer's disease. By collecting and analyzing movement patterns, this game could provide meaningful insights into motor control changes associated with the disease, and prevent someone from forgetting who their family is.

Materials and Methods:
The main focus of this research sprint was to develop a fun and accessible way to help determine whether someone should consider being screened for Alzheimer's. We accomplish this by using a camera to track the user's hand movements during gameplay. From this, we collect data such as hand position, the number of correct and incorrect objects hit, missed items, average hand speed, and overall area coverage. Together, these metrics can provide insight into potential cognitive or motor concerns and help indicate whether the user should seek a formal medical evaluation from a healthcare professional.

Results and Discussion:
I anticipate that analyzing hand movement data collected through gameplay will reveal patterns related to motor control, reaction time, and spatial awareness. Variables such as accuracy, missed targets, average hand speed, and area coverage may help differentiate typical movement behavior from patterns that could indicate potential cognitive or motor impairment typical in Alzheimer's disease.

The anticipated outcome of this work is to demonstrate that a game-driven approach can serve as an accessible screening tool. If successful, this system could encourage users to seek professional medical evaluation earlier by lowering barriers to initial self-assessment. While this tool is not intended to provide a diagnosis, its potential implications include increased awareness and early intervention.

24. Parametric Study of Aero-PLA Foaming and Its Impact on Mechanical Properties

Student Presenter: Janelly Sanchez-Puentes, Mechanical Engineering
Faculty Advisor: Bhisham Sharma, Mechanical & Aerospace Department

Authors: *Janelly Sanchez-Puentes, Bhisham Sharma*

Introduction:
Weight reduction without compromising mechanical performance is a key challenge in engineering design, particularly for aerospace and structural applications. Aero-PLA fabrication through additive manufacturing enables internal foaming that can be controlled through processing parameters, directly affecting stiffness, strength, and failure behavior. This research is important because it establishes how specific manufacturing parameters influence foaming characteristics and resulting mechanical properties measured through experimental testing. By connecting processing decisions to quantifiable mechanical performance, this work provides practical guidance for designing lightweight, mechanically reliable additively manufactured components, with potential relevance to vibration and noise-related applications.

Materials and Methods:
This research uses Aero-PLA filament processed through fused filament fabrication (FFF) to investigate how selected printing parameters influence foaming behavior and mechanical performance. Key processing parameters, including extrusion temperature, print speed, and flow rate, are systematically varied while maintaining consistent specimen geometry and build orientation. Standardized mechanical test specimens are designed to isolate the effects of processing conditions. Foaming behavior is characterized through observed changes in internal structure and apparent density derived from geometric and mass measurements. Mechanical performance is evaluated through controlled mechanical testing, including tensile and compressive loading, to assess stiffness, strength, and failure behavior. All testing procedures are conducted under consistent conditions to enable direct comparison across parameter sets. This methodology is designed to establish clear relationships between processing parameters, foaming characteristics, and mechanical response, with exploratory consideration of acoustic behavior.

Results and Discussion:
Although this research is ongoing, the expected outcome is a clearer understanding of how printing parameters influence Aero-PLA foaming and, in turn, mechanical performance. Small changes in settings such as extrusion temperature and flow rate are anticipated to noticeably affect internal structure, leading to differences in stiffness, strength, and failure behavior during mechanical testing. These results are expected to highlight important trade-offs between lightweight design and mechanical reliability. By identifying trends rather than isolated results, this work aims to help engineers make more informed decisions when selecting printing parameters for foamed materials. Beyond mechanical behavior, the observed structural changes may also suggest potential benefits for vibration damping or acoustic performance, motivating future study. Overall, this research seeks to make Aero-PLA more

predictable and usable by connecting everyday manufacturing choices to real, measurable engineering performance.

25. Generation of Circulating Tumor (ctDNA) Reference Materials for Early Ovarian Cancer Detection

Student Presenter: Samantha Cooper, Chemical Engineering
Faculty Advisor: Maria Gencoglu, Chemical Engineering

Authors: *Samantha Cooper, Andrew Shore, Andrew Nielsen, Reeba Elizabeth Reji & Maria Gencoglu*

Introduction:

Circulating tumor DNA (ctDNA) is DNA released by tumors when cells lyse by way of apoptosis. The ctDNA is present in the bloodstream, so it can be used in oncology assay development for early cancer detection. ctDNA consists of shorter DNA fragments (~160-170 bp) and the fragments carry genetic alterations from the tumors. There is no clinically routine assay for ovarian cancer yet, so our lab is generating ctDNA reference materials that can be used toward developing a clinical diagnostic test for ovarian cancer.

Materials and Methods:

In this study, ovarian cancer cells (SKOV3) are treated with hypertonic stress compounds that cause cells to lyse through apoptosis. Compound concentrations between 10 µM to 100 µM are used to induce apoptosis without compromising the ctDNA. Growth media containing ctDNA had been collected at different time points (e.g., 4 h, 12 h, and 24 h) to pinpoint the best collection time. ctDNA is isolated from the cell culture media with the Apostle Bio ctDNA isolation kit, which is a widely used industry kit for isolating circulating nucleic acids (ctDNA/ctRNA) from blood. The extracted ctDNA samples are characterized with capillary electrophoresis (TapeStation).

Results and Discussion:

We have been able to induce apoptosis in the SKOV3 cell line to generate ctDNA reference materials with fragment sizes ~170 bp with two apoptosis-inducing compounds, and two concentrations (10 µM to 100 µM). These fragments were observed at 4 h across all conditions, confirming the successful generation of ctDNA reference materials. After the results of this experiment, we are looking to use methods like ddPCR to compare ctDNA reference materials to actual clinical samples.

26. Community Perspectives of NGO Effectiveness in California, El Salvador

Student Presenter: Victoria Ponta, Social Sciences
Faculty Advisor: Kari Henquinet, Social Sciences

Authors: *Victoria Ponta, Caitlyn Sutherlin, Luke Bowman, Kari Henquinet*

Introduction:
The aim of this project is to determine which characteristics of relief aid NGOs working in the town of California, El Salvador are associated with enacting positive long-term community change from the point of view of local community representatives through the qualitative analysis of semi-structured interviews conducted in the area.

Materials and Methods:
For my analysis, I analyzed five interviews of local community representatives:

The director of the California municipal level Civil Protection office.

Three members of community-level Civil Protection committees, each representing their own neighborhood in California.

A Civil Protection community representative in one of the neighborhoods who also worked in the mayor's office, with extensive experience with NGOs in the area.

Based on responses from my informants, I created a qualitative coding system to categorize statements made in the interviews. The main categories that appeared frequently in interviews are listed below with a question that describes what I was looking for as I continued to code interviews. I analyzed passages with these codes to look for cross-cutting and prominent characteristics of NGOs.

Leadership: What does good leadership from the NGOs look like? How does that help the community?

Community Involvement: How much do NGOs involve community members in decision-making? How do they motivate people to participate?

Community Organization: How do the NGOs organize community members to create divisions of labor or promote cooperation?

Trainings and Material Aid: What information or training do NGOs provide? What material aid?

Adapting to Community: When have NGOs adapted/tailored their projects to the community's needs?

Results and Discussion:
My analysis is still ongoing, but so far the following have emerged as characteristics of relief aid NGOs that community representatives in California consider to be the most important in enacting positive long term community change:

Showing empathy and patience
Creating a relationship with the community
Organizing the community
Clear and transparent communication
Promoting agreement between community members
Flexibility in adapting projects
Providing emergency response training
Sustainable projects
Collaborating with CCPC

Analysis of resource distribution

Although my project was based on a small sample size in a singular community, the research and its results can likely be put together with other case studies to add to the ongoing research on characteristics of NGOs that are associated with positive long-term community change.

27. Effects of Activated Sludge and Wetland Soil Application to Improve Freshwater Dune Stability

Student Presenter: Vera Denison, Environmental Engineering
Faculty Advisor: Dr. Ishi Keenum, Civil, Environmental, and Geospatial Engineering

Authors: *Ishi Keenum, Yasaman Abdolvand, Vera Denison, Mohammadhossein Sadeghiamirshahidi, Michelle Jarvie Eggart, and Rodney Chimner*

Introduction:

Sand dune systems are critical natural assets providing wildlife habitat, recreational opportunities, and protection against erosion [1]. Michigan's coastal dunes, the largest freshwater dune system in the world, serve as the primary defense against wind-driven erosion and storm impacts [2]. Enhancing dune stability during early restoration stages is essential for improving coastal resilience while minimizing long-term environmental and economic costs. This study evaluated microbially induced calcite precipitation as a biologically driven geotechnical strategy for dune stabilization by testing how targeted bacterial inoculation could improve soil retention and plant performance in American beachgrass (Ammophila breviligulata), a foundational dune-building species [3].

Materials and Methods:

This study used a controlled greenhouse environment to evaluate microbially induced calcite precipitation (MICP) as a dune stabilization strategy. Resources included young Ammophila breviligulata grown within dune sand collected from a shore on Lake Superior. Utilizing two different planting techniques, two microbial inoculation treatments (activated sludge and wetland soil) were applied. Plant performance was assessed through weekly height measurements and surface samples of the soil. Dune stability was quantified using wind tunnel experiments, where soil percent loss was measured under incrementally increasing wind speeds. Shelby tubes were taken at the end of the experiment to assess the calcite production of each sample. Microbial community composition was characterized using 16S rRNA gene sequencing. Community differences were evaluated using Bray-Curtis, Jaccard, and UniFrac distance metrics, with non-metric multidimensional scaling (NMDS) for ordination. Statistical significance was assessed using PERMANOVA and ANOSIM, with dispersion and temporal structure tests conducted to confirm robustness. Calcite content was evaluated from Shelby tube samples to assess potential mineral contributions to soil stabilization.

Results and Discussion:

Microbial community composition differed significantly among treatments, planting techniques, and sampling dates, as demonstrated by PERMANOVA analyses using both Bray–Curtis and Jaccard distance metrics ($p < 0.01$), which collectively explained 21.1% of observed variation. Dispersion tests were non-significant, confirming the robustness of these results. Temporal structure analyses indicated that treatment effects, rather than sampling month, primarily drove community differences. ANOSIM results also showed no significant differences across months, supporting temporal stability in microbial community structure over the experimental period.

Ordination analyses (NMDS and weighted/unweighted UniFrac) revealed partial overlap among microbial communities, suggesting shared taxa across inoculation sources despite statistically significant compositional differences. Functional outcomes aligned with these microbial patterns. Soils inoculated with wetland-derived communities exhibited greater resistance to wind erosion during wind tunnel experiments, withstanding higher wind speeds before soil loss occurred; however, this trend was non-significant ($p = 0.053$), likely reflecting limited replication. Plant height did not differ significantly over time between treatments, indicating that early-stage stabilization effects were more strongly associated with microbial and soil processes than aboveground plant growth. Collectively, these findings support microbial inoculation source as an important driver of early dune stabilization processes and highlight the potential of MICP-informed strategies for freshwater dune restoration.

28. Hierarchical Clustering to Identify Subgroups of Cardiovascular Health and Alzheimer's Disease

Student Presenter: Aili Toyli, Statistics
Faculty Advisor: Weihua Zhou and Qiuying Sha, Medical Imaging and Informatics Lab

Authors: *Aili Toyli*

Introduction:

Alzheimer's disease (AD) and cardiovascular disease (CVD) are two major causes of global death and disability [1]. A growing body of research supports an association between various forms of CVD and AD, highlighting shared risk factors and implicating CVD as a potential interventional target for AD prevention [2]. The correlation between CVD and AD risk is well-established, but despite the broad scope of the literature surrounding the heart-brain axis, studies examining CVD subgroups and AD patients are limited. We sought to identify factors that may explain why certain CVD patients develop AD, while others do not.

Materials and Methods:

We analyzed data from two population-based biobanks: the UK Biobank (UKB) and the All of Us Research Program (AoU). Analyses were restricted to individuals aged ≥60 years. UKB analyses included participants with both cardiac and brain MRI data (n=20,409), while AoU analyses included individuals with linked electronic health record (EHR) data (n=99,956). AD and CVD subtype diagnoses were identified using ICD-10 codes [3], focusing on 11 common CVD subtypes and AD.

Clustering incorporated demographic, diagnostic, clinical, lifestyle, and medication variables in both cohorts. Additional UKB-specific variables included physical activity, depression/bipolar status, cognitive performance, and cardiac and brain MRI features [4] (summarized using principal components). Survey variables were numerically encoded, missing data were input using k-nearest neighbors (k=5), and extreme outliers were excluded.

The optimal number of clusters was selected using silhouette, Davies–Bouldin, and Calinski-Harabasz indices. Agglomerative hierarchical clustering with complete linkage was performed in UKB, followed by ANOVA and chi-squared tests to compare clusters. Due to scale constraints, AoU clustering was conducted on repeated 20% subsamples. Extended clustering in UKB evaluated whether additional imaging and cognitive variables improved insight into heart-brain relationships.

Results and Discussion:

Baseline characteristics differed between cohorts, with UKB participants generally younger, more male, healthier, and having higher socioeconomic status than AoU participants. Hierarchical clustering of UKB data identified four clusters, with a strong imbalance toward a large healthy reference group. The remaining clusters represented distinct disease profiles: (1) high CVD burden with low treatment

utilization, (2) elevated CVD burden with high medication use, and (3) a small cluster containing all individuals diagnosed with Alzheimer's disease (AD). The AD cluster showed elevated CVD prevalence, especially hypertension and hypotension, and lower socioeconomic status.Repeated subsampling and clustering in AoU produced comparable cluster types, including healthy reference, high CVD burden, AD diagnosis, and pulmonary embolism clusters, supporting the robustness and generalizability of the UKB findings across a more diverse population. Some AoU clusterings also included a cluster with notably strong cardiovascular health. Incorporating imaging, cognitive, and behavioral variables in UKB did not substantially alter cluster structure but provided additional biological insight, particularly for the AD cluster.

Key strengths include large sample sizes, replication across cohorts, and the use of hierarchical clustering to capture nonlinear heart-brain relationships. The primary limitation was the substantial case-control imbalance, which may obscure subtler disease subtypes. Future work should leverage more disease-enriched samples and causal methods to identify intervention targets linking CVD and AD progression.

29. Drones and Thermal Imaging for Wilderness Search and Rescue Efforts

Student Presenter: Alexander Barber, Mechatronics
Faculty Advisor: Dr Amna Mazen, Applied Computing

Authors: *Alexander Barber, Dr. Amna Mazen*

Introduction:

This work proposes an integrated system of a thermal-detecting drone and mobile robot for wilderness search and rescue (WSAR). Unlike traditional search techniques, this system uses thermal imaging to enable search through low visibility conditions, meaning that search and rescue efforts can be conducted around the clock. This integrated system is expected to reduce the search and rescue time when people get lost in cold environments, thus reducing risks.

Materials and Methods:

The system is composed of two major components, the drone search algorithm and the human detection with thermal imaging. The drone must be programmed to autonomously search an area in an efficient but thorough manner. There are a number of area covering algorithms that can be used in a given area.

Results and Discussion:

The system is composed of two major components, the drone search algorithm and the human detection with thermal imaging. The drone must be programmed to autonomously search an area in an efficient but thorough manner. There are a number of area covering algorithms that can be used given a complicated concave swath, but for this system, and proposed scenarios, a back and forth cross pattern is sufficient. While the drone is covering its path, it will be processing thermal imaging data, and analyzing it using a YOLOv8 model to detect any lost persons. The detection model was trained on a Wilderness Search and Rescue dataset containing aerial thermal images at multiple heights of lost individuals in forested areas.

30. Characterizing Cardiac Inflammation in a Mouse Model of Hypertrophic Cardiomyopathy

Student Presenter: Amber Howard, Medical Laboratory Science
Faculty Advisor: Dr. Robert Larson, Department of Biological Sciences

Authors: *Amber Howard, Melia Austin, Jenna Disser, Robert Larson*

Introduction:

Hypertrophic cardiomyopathy (HCM) resulting from sarcomere gene mutations is the most common genetic heart disorder, characterized by cardiac hypertrophy, fibrosis, inflammation, and susceptibility to arrhythmias and sudden cardiac death. Our lab previously demonstrated a sensitized cardiac spinal afferent reflex in an alpha tropomyosin (Glu180Gly) mouse model of HCM, yet the mechanism(s) remain unknown. Previous human studies suggest elevated circulating proinflammatory cytokines (PICs) in HCM, which are known to activate cardiac sensory nerves. This study aims to assess mRNA levels of PICs in the heart and characterize cardiac immune cell infiltration in HCM and littermate wild-type (WT) control mice.

Materials and Methods:

We utilized qPCR to quantify PIC mRNA levels in the left ventricle of HCM and WT mice (n=4 mice in each group). Myeloperoxidase (MPO) activity was measured using O-dianisidine dihydrochloride as a substrate in ventricular tissue from HCM and WT mice (n=5 mice in each group). MPO is the primary enzyme in neutrophil granules, and this assay provides an index of neutrophil infiltration. Ongoing studies will measure protein expression of the macrophage markers MCP1 and F4/80 in ventricular tissue from HCM and WT mice via Western blot. Statistical comparisons were performed with paired t-tests and results are expressed as mean±SE.

Results and Discussion:

IL-1β mRNA was significantly elevated in HCM mice (WT 1.00±0.18 vs. HCM 2.64±0.87, $p<0.05$), whereas there was no difference in TNF-α (WT 1.00±0.21 vs. HCM 0.90±0.20, p=0.35), IL-6 (WT 1.00±0.66 vs. HCM 0.97±0.33, p=0.48), or INF-γ (WT 1.00±0.52 vs. HCM 1.27±0.86, p=0.24). There was no significant difference in MPO activity normalized to protein content between HCM and WT mice (WT 5.24±0.29 U per ug protein vs. HCM 4.27±0.56 U per ug protein, p=0.27) suggesting similar cardiac neutrophil levels in HCM and WT mice. In conclusion, IL-1β mRNA levels were increased in HCM mice suggesting that inflammation could be an activator of cardiac sensory nerves in HCM. Our results also suggest there is not excess cardiac neutrophil infiltration in HCM hearts. Further work will quantify monocyte/macrophage markers including MCP-1 and F4/80 in cardiac tissue to determine if they might be contributing to elevated PIC levels in HCM.

31. Methods to Create 3D Co-Culture Models with Macrophages and Ovarian Cancer Cells

Student Presenter: Andrew Shore, Biochemistry and Molecular Biology
Faculty Advisor: Maria Gencoglu, Chemical Engineering

Authors: *Andrew Shore*, Gethyn Evans* & Maria Gencoglu*

Introduction:
This research provides methods to generate ovarian cancer (OC) co-culture spheroids by using relevant models to study the spread of cancer from its primary site to the secondary site. Cancer spheroids, made up of cancer cells, macrophages, and other epithelial cells, are how tumors and other metastatic cancers spread throughout the body. By creating an effective model of metastatic cancer spheroids, we can build a better understanding of how cancer spreads and disseminates to secondary sites. This type of model can be used for biomarker discovery and drug screening experiments.

Materials and Methods:
SKOV-3 and RAW 264.7 cell lines were used to replicate both ovarian cancer (OC) and macrophage cells, respectively. The SKOV-3 and RAW 264.7 were cultured to ~80% confluence. Two types of methods were used to generate co-culture spheroids: the suspension method and the hydrogel method. The ratio of OC to macrophage cell line seeding was optimized to generate spheroids of around 200 μm to replicate the physiological accuracy and to replicate the necrotic core. Cell spheroids were examined under a confocal microscope after 24, 48, and 72 hours of culturing. Images were taken and analyzed at the designated times with the parameters of circularity and diameter with a circularity of 1 and a diameter of 200 μm to be the optimal size and shape. Live/Dead staining was applied to the cells to test cell viability.

Results and Discussion:
We believe that the optimal ovarian cancer to macrophage cell line seeding ratios will typically fall between 5k-10k for the ovarian cancer cells and 1k-5k for the macrophage cells, to form spheroids about 200 μm with the suspension method. The macrophage cell line is at a lower seeding value due to the growth rate of the cell line. With an optimized ratio, we will be able to integrate drug screening experiments within the co-culture model using common platinum-based drugs like paclitaxel. This will provide a better, more physiologically accurate way of determining if certain ovarian cancers are responsive to current chemotherapeutic drugs.

32. Polymer Decomposition of Polylactic Acid and Polyethylene Terephthalate Glycol with Ammonia Hydroxide

Student Presenter: Andrew Brenner, Chemical Engineering
Faculty Advisor: Dr. Rebecca Ong, Chemical Engineering Department, Ong Research Laboratory

Authors: *Andrew Brenner, Dr. Rebecca Ong*

Introduction:

Polylactic Acid (PLA) and Polyethylene Terephthalate Glycol (PETG) are common 3D printing filaments. PLA is a Biopolymer commonly synthesized from starches. PETG is not a biopolymer and is commonly synthesized using polymer condensation. Both PLA and PETG have ester functional groups that can be targeted by Ammonia Hydroxide (NH_4OH). This reaction can break down PLA and PETG into their base monomers for recycling. Because this can cause deformation in the structure of the polymer and make recycling harder, this project will look at the ability to break down PLA and PETG before and after the 3D Printing Process.

Materials and Methods:

For this work, the total decomposition of each polymer was analyzed before and after 3D printing. Using a sealed tubular reactor, the polymers were reacted with NH_4OH to break them down into the base monomers. PLA in the presence of NH_4OH breaks down into lactic acid and ammonium lactate. PETG breaks down into ethylene glycol, terephthalic acid, and ammonia salts. The solid samples are dried, and a mass analysis is correlated to the total breakdown of the polymer. The liquid samples were analyzed to verify that the compounds broke down into the base monomers.

Results and Discussion:

The reaction did break down PLA and PETG into their base monomers. At 25 °C, pure PLA broke down to about 40%, where printed PLA, PETG, and printed PETG broke down <10%. This resulted in a shift in the temperature of the reactor to push towards breaking down the polymers. At higher temperatures, it was found that PLA broke down 70% and printed PLA broke 62%. PETG broke down 22%, and printed PETG broke down 23%. The printed PLA samples had a lower breakdown rate than the pure samples. PETG and printed PETG broke down by a similar amount. Temperature does impact the breakdown of each polymer. Further process analysis at 120°C should be conducted to verify the results of this experiment. Also, liquid analysis through High Performance Liquid Chromatography (HPLC) is used to determine the total amount of monomer recovered in each sample.

33. Prevention of Nanobead Aggregation for High-Resolution Traction Force Microscopy

Student Presenter: Asia Hoehle, Biomedical Engineering
Faculty Advisor: Dr. Sangyoon Han, Biomedical Engineering, Han Lab

Authors: *Asia Hoehle*

Introduction:
Traction Force Microscopy (TFM) is a method that involves coating carboxylated nanobeads onto an amine-treated silicone gel to report single-cell-generated gel deformation and associated traction forces. Dense and uniform bead coating onto the gel surface is crucial for ensuring high spatial resolution of traction forces transmitted by the cells for environmental sensing. However, aggregation of these beads, which is potentially caused by hydrophobic interactions, limits the uniformity of bead coating onto the gel and thus the spatial resolution of traction forces. The goal of this project is to inhibit these nonspecific interactions and improve data resolution through increased bead density.

Materials and Methods:
This research investigates the behavior of 100 nm carboxylated fluorescent (405 nm excitation) beads (FluoSpheres®) seeded onto a silicone gel composed of a 1:1.5 ratio of QGel920A to QGel920B. Three experimental groups were established, each subjected to specialized chemical formulations designed to prevent bead aggregation while promoting bonding to the gel surface. In the control group (CG), beads were suspended in deionized water. The bead solution group (BSG) consisted of beads suspended in a solution of 10 mg/mL 1-Ethyl-3-(3-dimethylaminopropyl) carbodiimide (EDC), 5 mM N-Hydroxysuccinimide (NHS), and 50 mM, pH 6.0 2-Morpholinoethanesulphonic acid (MES). In the bead and buffer solution group (BBSG), the aforementioned bead solution was combined with pH 7.4 phosphate-buffered saline (PBS), 0.1% bovine serum albumin (BSA), 0.01% Tween® 20, and 0.5 M ethylenediaminetetraacetic acid (EDTA). The effectiveness of each bead treatment was evaluated by obtaining images of beads using a confocal microscope and analyzing them for quantification of bead density and aggregation level via a customized MATLAB program.

Results and Discussion:
Preliminary observations indicate that maintaining two minutes of sonication for each solution, the adapted bead-buffer mixture (BBSG) produces bead distributions comparable to the control group and higher than the BSG group. Among all conditions, the BBSG group exhibited the minimum level of aggregation, below both the control and the BSG groups, suggesting that the addition of surfactant and chelator guarantees a more uniform bead coating. Additional experimentation showed a similar high-density, minimally aggregated bead coating for the BBSG group even without solution sonication. These findings suggest that adding a bead buffer that prevents surface interactions between beads facilitates consistent and regular bead coating results. Further experiments will assess whether the modified BBSG approach also enhances the long-term stability of the carboxyl-amine bond by observing bead distribution upon exposure to 10x PBS. In previous trials, fibronectin seeding on bead-treated gels resulted in irregular, honeycomb-like bead patterns, which prevented accurate traction force data from being obtained. If the adapted bead-coating method continues to yield robust bead adhesion and uniform distribution, subsequent optimization will focus on reducing sonication and incubation times. Ultimately, this work demonstrates that proper preparation of the silicone gel substrate is the foundation for investigating cellular mechanobiology.

34. Great Lakes Under-Ice Observatory

Student Presenter: Brady Hager, Mechanical Engineering
Faculty Advisor: Hayden Henderson, Great Lakes Research Center

Authors: *Brady Hager*

Introduction:
The Great Lakes Research Center (GLRC) developed the Under Ice Observatory to better understand the Great Lakes during winter, when data collection is typically limited. Supported by the Great Lakes Observing System (GLOS) with funding from the National Oceanic and Atmospheric Administration (NOAA), this project involved designing, building, and deploying two observatories in the Keweenaw Waterway and the St. Marys River. These systems aim to collect year-round water quality and acoustic data, helping researchers study complete environmental conditions, vessel activity, and ice formation. This work supports long-term Great Lakes monitoring while providing the public with real-time, high-resolution data.

Materials and Methods:
Two Under-Ice Observatories were designed, built, and deployed at separate locations. The primary development system was installed at the Great Lakes Research Center on the Portage Canal, consisting of an H2D hydrophone, a multi-parameter water quality sonde, and a stick PC used to process and stream acoustic data. The system measures key environmental parameters such as temperature, dissolved oxygen, chlorophyll, pH, turbidity, and conductivity, while also using hydrophones to record acoustic activity from ice movement, vessel traffic, and weather. This system was shore-powered, allowing continuous operation and iterative testing.

A second observatory was developed for deployment in Sault Ste. Marie, MI, requiring solar power and autonomous operation. Both systems were deployed in environments with high vessel traffic and configured to collect continuous water quality measurements alongside acoustic recordings. Acoustic data for the Sault Ste Marie location were recorded for later analysis, while water quality data were logged for long-term monitoring. The performance and durability of these systems were continually tested and improved as needed.

Results and Discussion:
The GLRC observatory has been operating continuously since January 2025, temporarily recovered from underwater for calibration and maintenance periods. This system has collected water quality data in the Portage Canal, ranging from the turbid spring-time waters, due to mass snow melts and excessive rain, to the pristine, clear water that gets pushed in from Lake Superior. It has even captured a winter under-ice algae bloom from diatoms inhabiting the underside of ice sheets.

Acoustic recordings also documented ice formation and breakup, snowmobile traffic, and vessel activity, including research vessels, commercial ships, and recreational boats—all for the public to openly listen to on a YouTube channel livestream. There is also work underway to expand this observatory to collect colocated weather data and report both this and the water quality data to GLOS Seagull for use by both weather forecasters and the public.

The Sault Ste. Marie Observatory successfully operated for over three weeks in August 2025, capturing numerous freighter transits through the Soo Locks. These recordings are currently being analyzed and cross-referenced with marine traffic logs to identify vessel-specific acoustic signatures. Together, these results demonstrate the viability of year-round under-ice monitoring and provide new tools for studying winter Great Lakes processes.

35. Humidity-Driven Tunability of Electrospun Nanofiber Scaffolds for Tissue Engineering

Student Presenter: Carter Rodzik, Biomedical Engineering
Faculty Advisor: Dr. Smitha Rao, Biomedical Engineering

Authors: *Carter R. Rodzik, Will Braun, Alan Mendoza Estrada, Mary Bartelli, Maggie Voice, Victoria E. Santillan, & Smitha Rao*

Introduction:

In response to the U.S. FDA's initiative to reduce reliance on animal testing, there is an urgent need for in vitro platforms that more accurately replicate human tissue environments. Biomimetic scaffolds fabricated via electrospinning offer a promising route to achieving this, as their tunable architecture can influence key cellular behaviors, including proliferation, migration, and protein expression [1]. However, while process parameters like polymer concentration and voltage have been widely studied, the impact of environmental conditions, particularly humidity, remains underexplored.

In this study, the influence of humidity on the electrospinning process was explored. By electrospinning at constant values and varying only humidity, the morphology and tissue culture application of these nanofiber scaffolds were investigated.

Materials and Methods:

Polycaprolactone (Mw ≈70,000) was dissolved at 20% (w/v) in chloroform to form a sol-gel. Fibers were electrospun at three controlled humidity levels approximately 10% apart, ranging from 20% to 50% (n = 3), using a dehumidifier and a silica desiccant bag, along with a probe-monitored humidifier that automatically increased ambient humidity as needed. The room temperature was consistently controlled by a dedicated thermostat. Electrospun parameters were maintained constant at 4 μL/min, 11 kV, and 275 rpm. Morphology was characterized by light microscopy and a field-emission scanning electron microscope (FESEM). Surface chemistry was assessed by ATR-FTIR. Mechanical properties were measured using a uniaxial tensile test (ASTM D882)[2]. Young's modulus and ultimate tensile strength were calculated. Electrospun scaffolds were cut into 1 cm² squares and sterilized, and breast adenocarcinoma expressing the green fluorescent protein (GFP) MCF7/GFP (puromycin SC050-G GenTarget Inc.) were seeded on scaffolds (n=3, 10,000 cells/sample). Cells were fixed, permeabilized, and stained with Alexa Fluor™ 594 Phalloidin and DAPI (4',6-diamidino-2-phenylindole) according to the manufacturer's instructions to observe the cytoskeleton and nuclei using a fluorescent microscope (EVOS FL Auto).

Results and Discussion:

By maintaining the same humidity conditions, electrospun nanofibers exhibited three distinct morphologies. Nanofibers electrospun in the 20% range and 50% range formed a honeycomb-like structure, characterized by an abundance of beaded fibers. In contrast, scaffolds electrospun at 40% humidity formed a more organized, aligned structure without bead formation. ATR-FTIR revealed no

differences in surface chemistry across humidity levels. Mechanical testing showed that aligned samples exhibited the highest Young's Modulus and tensile strength, whereas the honeycomb-like fibers exhibited negligible modulus and strength. Cell imaging demonstrated that all scaffolds were viable for cell culture, comparable to a treated tissue culture plate. Cells with an aligned morphology appeared to have their cytoskeletons aligned with the orientation of the fibers.

This study demonstrates the potential of electrospun PCL scaffolds as biomimetic platforms for more physiologically relevant in vitro cancer models, highlighting the role of nanoscale architecture in modulating cellular proliferation. However, the scaffolds remain limited in their ability to mimic the full complexity of the tumor microenvironment. Overall, these findings contribute to the advancement of standardized 3D culture models and support the broader effort to reduce reliance on animal testing by enabling more predictive and human-relevant tissue culture systems.

36. Upcycling Polyethylene Pyrolysis Oil to High-Performance Group IV Base Oils

Student Presenter: Grace Wallis, Chemical Engineering
Faculty Advisor: Dr. Daniel Kulas, Chemical Engineering Department

Authors: *Grace Wallis, Daisy Schwartz, Ryan Wirkkula, David Shonnard, and Daniel Kulas*

Introduction:
Worldwide, 6.30 billion tons of plastic waste have been produced from 1950 to 2015, 80% of which has accumulated in the natural environment [1]. Plastic waste can be recycled via pyrolysis reactions [2], which convert the polyolefin plastic into alkene hydrocarbons. The purpose of this work is to determine the feasibility of producing high-value polyalphaolefin (PAO) base oil from C10-C12 alkenes. Lab experiments were completed using 1-decene and distilled pyrolysis oil to determine the suitability of pyrolysis oil as a PAO feedstock. Financial analysis was completed to determine the commercialization potential of the process.

Materials and Methods:
The oligomerization reaction was completed using a custom reactor at temperatures of 60, 80, and 100℃ for 4 hours. The inerted reactor was loaded with 3 wt% aluminum trichloride catalyst and 300 mL of either 1-decene or distilled pyrolysis oil. The reactor was mixed at about 120 rpm and 10 mL samples were collected every 30 minutes to monitor the reaction progress. The viscosity of samples at 25℃ was determined using a Tuning Fork Vibration Viscometer and the viscosity index was calculated using the viscosity at 40 and 100C.
Financial calculations were performed to determine the net present value of a plant producing 650 lb Lubricant Base Oil/hr with a lifetime of 20 years, depreciated over a 7-yr MACRS schedule. Fixed Capital Investment (FCI) was calculated for the plant using methods from Towler [3]. Utility, equipment sizing, product flow rates, and feed requirements were determined using UniSim simulations.

Results and Discussion:
Experiments with 1-decene confirmed the operating conditions necessary for producing high-value PAO base oil from plastic waste and provided insight into the oligomerization reaction mechanism. Viscosity measurements are used to monitor the reaction progress and the viscosity index is used to determine if the lubricant product is comparable to a high-value group IV lubricant oil. Experiments with distilled pyrolysis oil will be completed to verify its use as an alternative feedstock for PAO production.
Through process modeling in UniSim and the use of a discounted cash flow table, the economic feasibility of the oligomerization process will be determined. Preliminary analysis demonstrates that the main cost driver is process feedstocks. Process gross margin is $1.7 MM/yr, indicating a maximum profitable FCI of $2.2 MM. Market survey results indicate a market size of $10.2 B and a cost of $2.73 M/MT for group IV PAO Base Oils in 2025 [4,5].
Economic results will include net present value of the process and minimum lubricant yield required for economic profitability. These results will provide insight on the ability of lubricant production to improve pyrolysis economics and guide where future research may be directed for press improvements.

37. Single Network Acrylic Hydrogels Using the Fenton Reaction to be Used for Double-network Hydrogels

Student Presenter: Gwendolyn Frolich, Biomedical Engineering
Faculty Advisor: Dr. Bruce P. Lee, Biomedical Engineering Department

Authors: *Gwendolyn Frolich, Vedika Khare*

Introduction:
Double-network hydrogels have been studied for wound healing due to their increased strength and versatility. These hydrogels consist of a strong, rigid first network and a more ductile second network. Combining two single-network hydrogels into a double-network has been shown to increase fracture strength and optimize properties. Free-radical polymerization was used to synthesize both acrylamide and poly (ethylene glycol) diacrylate, and can be initiated by the Fenton reaction, where ferrous ions and hydrogen peroxide react chemically to produce the hydroxyl radicals. The second network consists of 8-arm poly (ethylene glycol) functionalized with 6-hydroxydopamine, as it has autoxidative and adhesive properties.

Materials and Methods:
The main objective was to optimize the first network with varying materials, concentrations, pH, crosslinkers, and Fenton reaction initiators. Polymerization of acrylamide was observed with changes in the following: crosslinker methylenebisacrylamide concentration; pH range of 4.5-6.5; iron sources of Fe^{2+}, Fe^{3+}, and Fe_3O_4 nanoparticles; PEG-DA polymerization was observed with varying molecular weights, H_2O_2 concentration, and iron sources under the same pH range as acrylamide. Curing time was determined by inversion of the vial until flow was no longer observed. Swelling tests were performed on PEG-DA, where the gels were injected into molds and allowed to cure before being punched into discs. They were soaked in a PBS buffer, rinsed with deionized water, blotted dry, and the swollen mass was recorded. The dry mass was determined following lyophilization.
4- and 8-arm PEG-DOPA-OH were synthesized and characterized by 1H NMR, FTIR, and UV-vis spectroscopy. These materials can be used for the second network and as a source of hydroxyl radicals for autoxidation and free radical polymerization of the first network. Previous research has been conducted in the Lee Lab on 8-arm PEG-DOPA-OH and is not thoroughly highlighted in this research.

Results and Discussion:
The Fenton reaction usually only occurs at acidic pH. At higher pH, the ferrous ions precipitate into ferric hydroxide, inhibiting the reaction and decreasing the amount of available iron. Acrylamide was only able to cure at pH 4.5 and 5 with crosslinker concentrations of 0.5 and 1.0 wt%, averaging around a minute to fully cure. Fe^{2+} was found to have the fastest curing times with PEG-DA, while Fe_3O_4 had unpredictable curing times. The increase in molecular weight of PEG-DA decreased the curing compatibility at pH levels higher than 4.5. At the lower pH, Fe^{2+}, Fe^{3+}, and Fe_3O_4 were all able to cure PEG-DA; at the higher pH of 5.5, Fe^{3+} and Fe_3O_4 were still able to cure, with decreasing success as the molecular weights of PEG-DA increased. As the concentration of H_2O_2 increased in these tests, the curing time decreased for all PEG-DA and iron source combinations. These results show the variable success of the Fenton reaction at mildly acidic pH. The curing times must be fast and consistent, and rely heavily on the concentrations of the free-radical polymerization initiators. Further research must be conducted to optimize the first network in a double-network hydrogel.

38. Methods to Create 3D Co-Culture Models with Macrophages and Ovarian Cancer Cells

Student Presenter: Gethyn Evans, Chemical Engineering
Faculty Advisor: Dr. Maria Gencoglu, H-STEM Building, 3Disease Lab

Authors: *Andrew Shore, Gethyn Evans, Maria Gencoglu*

Introduction:
This research provides methods to generate ovarian cancer (OC) co-culture spheroids by using relevant models to study the spread of cancer from its primary site to the secondary site. Cancer spheroids, made up of cancer cells, macrophages, and other epithelial cells, are how tumors and other metastatic cancers spread throughout the body. By creating an effective model of metastatic cancer spheroids, we can build a better understanding of how cancer spreads and disseminates to secondary sites. This type of model can be used for biomarker discovery and drug screening experiments.

Materials and Methods:
SKOV-3 and RAW 264.7 cell lines were used to replicate both ovarian cancer (OC) and macrophage cells, respectively. The SKOV-3 and RAW 264.7 were cultured to ~80% confluence. Two types of methods were used to generate co-culture spheroids: the suspension method and the hydrogel method. The ratio of OC to macrophage cell line seeding was optimized to generate spheroids of around 200 μm to replicate the physiological accuracy and to replicate the necrotic core. Cell spheroids were examined under a confocal microscope after 24, 48, and 72 hours of culturing. Images were taken and analyzed at the designated times with the parameters of circularity and diameter with a circularity of 1 and a diameter of 200 μm to be the optimal size and shape. Live/Dead staining was applied to the cells to test cell viability.

Results and Discussion:
We believe that the optimal ovarian cancer to macrophage cell line seeding ratios will typically fall between 5k-10k for the ovarian cancer cells and 1k-5k for the macrophage cells, to form spheroids about 200 μm with the suspension method. The macrophage cell line is at a lower seeding value due to the growth rate of the cell line. With an optimized ratio, we will be able to integrate drug screening experiments within the co-culture model using common platinum-based drugs like paclitaxel. This will provide a better, more physiologically accurate way of determining if certain ovarian cancers are responsive to current chemotherapeutic drugs.

39. Image Quality Enhancement of Ultrasound Training Data for AI Identification of Congenital Heart Disease

Student Presenter: Hugh Lubenow, Biomedical Engineering
Faculty Advisor: Jingfeng Jiang, Biomedical Engineering

Authors: *Hugh Lubenow*

Introduction:

Congenital heart disease, or CHD, is the heart's abnormal structure or function affecting the blood flow throughout the heart. The use of ultrasound technology for noninvasive imaging techniques allows for the viewing of internal structures and observation of function. The use of AI to perform identification of CHD indicators has begun to help increase the sensitivity of this diagnosis as opposed to sonographers, as a study performed in 2004 to find acquisition of view and correct diagnosis of CHD rates between different levels of experience in sonographers reported a 52% rate for experienced sonographers while inexperienced were 32.5% [1].

Materials and Methods:

To achieve the goals of improved sensitivity in AI diagnosis of CHD, I used a methodology of image enhancement through two aims and then performed ablation experimentation to evaluate their impact. First was a method of direct image enhancement outlined in [2]: cliplimit, a maximum value of contrast to avoid overamplification of noise and artifacts and brightness addition, then maximum variance in sharpness of the contrast image are extracted from the image, then a consistent procedure for each image was followed. This procedure first gaussian blurred to mitigate noise, then performed contrast to a specified cliplimit, then brightness was adjusted according to brightness addition, then saturation arithmetic was applied to prevent changing of image data values too much before alpha blending with the original image. Secondly, a method of selecting best fit images with key features identifiable was chosen, where Harris corner identification [3] was performed on the images to look for key shapes to be present within the image. Those presenting them proceeded to analysis. After completing enhancement on four data sets (a control with no changes, a set with only method 1 or method 2 applied, and a set with both methods), the results were analyzed.

Results and Discussion:

Through the use of the two methods, I was able examine how each method impacted an AI's ability to identify the four-chamber view of a fetal ultrasound. After the completion of the AI autosegmentation of the four datasets, it was found that the control dataset had the largest completed segmentation quantity of fetal heart chamber, with the feature detection method dataset having the largest completed segmentation rate. The results of the CLAHE enhanced images, while often incomplete or incorrectly segmented, were much clearer or sharper than the unaltered datasets. Of the four datasets, however, the final feature detected and CLAHE enhanced images contained the least autosegmented fetal heart chambers. However, this research continues to explore refined ways to improve the results of AI

identification of fetal heart chambers in ultrasound and I find the results provoking that each method may have potential to be useful if implemented in the correct manner.

40. Comparative Assessment of Nitrogen, Phosphorus, and Metal Removal Across Wastewater Treatment Facilities with Differing Operational Designs in Michigan's Upper Peninsula

Student Presenter: Halie Eiken, Environmental Engineering
Faculty Advisor: Ishi Keenum, CEGE

Authors: *Halie Eiken, Zachary Elmore, Dr. Ishi Keenum*

Introduction:
Wastewater treatment facilities vary due to population demands, local industry, end-use, and geographic constraints. Lagoon systems are used in rural areas, due to their simplicity and low cost. The objective of this study was to assess the treatment effectiveness of two lagoon-based wastewater treatment facilities in Michigan's Upper Peninsula for pH, DO, nitrogen, phosphorus, and metal removal. Metals analyzed include: ^{7}Li, ^{23}Na, ^{24}Mg, ^{27}Al, ^{29}Si, ^{31}P, ^{39}K, ^{44}Ca, ^{47}Ti, ^{51}V, ^{52}Cr, ^{54}Fe, ^{55}Mn, ^{59}Co, ^{50}Ni, ^{65}Cu, ^{66}Zn, ^{75}As, ^{88}Sr, ^{111}Cs, ^{112}Sn, ^{137}Ba, ^{208}Ba, ^{103}Rh, and ^{193}Ir. It is hypothesized that greater population variability leads to variability in constituent removal.

Materials and Methods:
Wastewater samples were collected at two lagoon-based facilities. Samples were taken at influent, primary, secondary, and effluent stages, along with field blanks. Each facility utilized lagoon treatment. However, one had additional aeration to facilitate nitrogen removal.

The facility influenced by seasonal tourism operates with continual discharge and utilized two lagoons. The primary lagoon is divided into three baffled sections with aeration in the first section. The secondary lagoon was separated into two sections by a baffle with floating wetland mats.
The newly renovated location serves a stable population and performs seasonal discharges every few months. It consists of a deep primary lagoon performing aerobic and anaerobic treatments and three secondary lagoons used for aerobic and UV disinfection processes.

Samples were collected in autoclaved 1-L bottles, with 50 mL set aside in sterile containers for nutrient and metal analysis. Nutrient samples were frozen prior to analysis. Nitrogen and phosphorus were quantified using laboratory test kits from Neci, and a HACH Spectrophotometer. Metal samples were filtered, acidified, and analyzed using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) at Virginia Tech University. The ICP-MS quantified 26 dissolved metals for each sample. Results will allow comparison of concentrations across treatment stages and between facilities.

Results and Discussion:
Research is ongoing and expected to be completed prior to the Undergraduate Research & Scholarship Symposium. Differences in overall nutrient and dissolved metal removal efficiencies are anticipated between the two facilities. These differences are expected to reflect variations in lagoon design, aeration strategies, discharge practices, and population demand.
The results are expected to improve the understanding of how operational design and population fluctuations influence treatment performance in lagoon facilities. This research may be used for future infrastructure improvements and regulatory compliance strategies as nutrient and metal discharge limits become more stringent.

This study also contributes to the nutrient and metal concentrations within the Great Lakes watershed. Beyond these focus facilities, this analysis could be used to further understand the effects of tourism on water treatment design and effectiveness in rural communities. This assessment may help support the development of more adaptive and resilient treatment strategies.

41. Quantifying the Effects of Glossy Buckthorn on Swedetown and the Impacts Goat Browse Has on Invaded Sites

Student Presenter: Haniya Frayer, Applied Ecology and Environmental Science
Faculty Advisor: Dr. Sigrid Resh, Keweenaw Invasive Species Management Area

Authors: *Haniya Frayer, Sigrid Resh*

Introduction:
Woody invasive species such as glossy buckthorn (Frangula alnus) are among the most detrimental forest health issues. Due to their shade tolerance, they form dense thickets in forests, impeding the growth of native species and negatively impacting plant diversity and native wildlife (Burkhart et al. 2009 &, Narango et al. 2018). These species threaten the function and resilience of our local ecosystems. As an alternative to chemicals, goat herbivory was tested as a novel management strategy. Extensive sampling was conducted throughout the three-year project to quantify the impacts of glossy buckthorn and the goats themselves on the vegetation communities.

Materials and Methods:
The goat browse study was designed and implemented by Dr. Sigrid Resh. The research sites, located in Calumet, MI on the Swedetown Trails, include: a reference site (minimally invaded by glossy buckthorn) a control site (heavily invaded); a goat browse site (heavily invaded and browsed once per summer for three years); and a 2x goat browse treatment, (goat browse simulated an additional time per summer). Each research site contained 2 randomly located upland and lowland areas except the 2x goat treatment, which only had 1 upland and lowland area. Circular nested plots were used for vegetation sampling in the upland and lowland areas of each site. The largest sample area (11.3 m radius) was used to measure and record the species and DBH of all live trees with DBH $\geq$ 15.2 cm. The medium plot (5.6 m radius) was used to measure and tally the species of all live tree/shrub stems with height >2.4 m and DBH < 15.2 cm. The four smallest plots (0.84 m radius) were used to obtain percent cover of herbaceous species. PC-ORD was used to analyze changes in the vegetation communities over time and across research sites.

Results and Discussion:
Statistical analysis for this project is still ongoing. The desired outcomes were to determine: 1) the impacts of glossy buckthorn on vegetation communities, and 2) whether goats are effective as a buckthorn management treatment by quantifying their impacts on vegetation communities. The goal of the goat treatment was to reduce the dominance of glossy buckthorn and increase the diversity and cover of native species, in turn, helping to restore the native ecosystems of Swedetown. The reason behind a three-year treatment is so the goats can repeatedly remove carbon from the glossy buckthorn through browsing and inhibit regrowth, ultimately killing the buckthorn. The results will show whether this timeframe and intensity can kill glossy buckthorn as well as help restore the native ecosystem.

Research such as this is important in helping managers find ecologically sustainable tools for managing woody invasive species, which is time consuming and expensive. Most treatment options currently require some degree of manual removal as well as chemical application or shading to combat re-sprouts. Goats present a new management approach. They could be more effective at tackling large infestations of woody invasive species and do not require the use of pesticides, which can harm native species.

42. Mentors as Graders: Reconsidering the Power Dynamic in Student Assessment

Student Presenter: Harley Russell, Electrical Engineering, Concentration: Biomedical Applications, Minor: International Spanish
Faculty Advisor: AJ Hamlin and Amber Kemppainen, Engineering Fundamentals Department

Authors: *AJ Hamlin, Amber Kemppainen, & Harley Russell*

Introduction:
This research studies how grading responsibilities affect the power dynamic between near-peer mentors (NPM) and their student mentees. Similar programs prevent their leaders from grading any student work, in efforts to eliminate any perceived control over student success and prevent this power dynamic from forming. However, this instructional model did not meet the needs of the first-year engineering courses at our university, as we needed a role that combined the responsibilities of a peer mentor (since they build student connections while providing assistance) and a teaching assistant, with a grading component and personal understanding of individual student comprehension.

Materials and Methods:
During the semester, two instructors co-taught three classes of ENG1101 students. Each section had an assigned NPM. Seven of the NPMs graded their student's work (Grading Group), while another seven did not (Non-Grading Group). To gather feedback from our students and leaders, an anonymous Canvas survey was given at the end of the semester containing questions from the Teacher Power Use Scale (TPUS). This assesses a variety of teaching behaviors and classifies them into five different subscales of power use: coercive, legitimate, expert, referent, and reward. We held a focus group for each group of NPMs (grading and non-grading) and the results were analyzed using inductive, open coding to identify and develop themes identified from the focus groups. We independently coded the non-grading focus group transcript, confirmed the codes, grouped the codes into themes, and developed our codebook which was used to complete the analysis of both the focus group transcripts. The codebook is organized into four primary themes: Relationship, Preparation, Being a NPM, and Grading. For this paper, we focused primarily on the first theme (relationship) with respect to the power dynamic that emerged between NPMs who graded their students' work and those that did not.

Results and Discussion:
Statistically significant differences between the student groups did not appear. However, we were able to see how students ranked their NPMs perceived power in the classroom. The most common type of instructional power reported by both groups was expert, followed by referent, and then reward. These rankings make sense, as NPMs have successfully completed the first-year engineering courses, so the students should perceive them as experts in this field. Referent power details approachability and personal relationship building, which also makes sense as NPMs commonly express interest in the well-being and learning outcomes of their students. Furthermore, reward power fits as students are provided with a positive learning environment, frequent feedback, and extrinsic motivation from their NPMs during class.

43. Effects of Resolvin D1/FPR2 Activation on Inflammatory Cytokine and Chemokine Expression in ADPKD

Student Presenter: Jaden Schneider, Human Biology
Faculty Advisor: Yan Zhang, Biological Sciences

Authors: *Jaden Schneider, Nicholas Detterman, Aiping Wei, Yu Xu, & Dr. Zhang*

Introduction:

Autosomal Dominant Polycystic Kidney Disease (ADPKD) is a genetic disorder resulting in fluid-filled cysts and chronic inflammation, eventually leading to renal decline and failure. Resolvin D1 (RvD1) is a recently discovered specialized pro-resolving mediator (SPM) known to resolve inflammation without compromising immune defense. This lipid provides a promising approach to inflammation, yet its potential to reduce the inflammatory burden in ADPKD renal cells remains unclear. The two aims of this study are to determine the expression of FPR2 in primary renal epithelial (PRE) cells, and to determine the effects of RvD1 on pro-inflammatory markers in PRE cells.

Materials and Methods:

Primary renal epithelial (PRE) cells were isolated from the kidneys of PKD-model mice. The kidneys were then minced and digested with collagenase IV to help collect primary renal epithelial cells (PRE) for seeding. To confirm receptor expression, FPR2 levels were assessed via immunocytochemistry (ICC) and quantitative PCR (qPCR) using PRE cells, as well as RAW 264.7 macrophages as a positive control. The impact of Rvd1 on PRE cells inflammatory markers was then tested. PRE cells were similarly cultured and treated with RvD1 at varying concentrations vs vehicle control for 26 hours. Total RNA was extracted using Trizol reagent. Then, mRNA expression levels of pro-inflammatory markers, specifically monocyte chemoattractant protein-1 (MCP-1), interleukin-1 beta (IL-1β), and tumor necrosis factor-alpha (TNF-α) were quantified via qPCR to assess the downstream impacts of Rvd1 on inflammatory markers.

Results and Discussion:

We successfully confirmed the presence of the FPR2 receptor in ADPKD renal epithelial cells. qPCR analysis and ICC staining demonstrated clear FPR2 expression in PRE cells, though at lower levels than macrophage positive controls. Quantitative analysis revealed that RvD1 treatment holds promise for downregulating pro-inflammatory gene expression. Specifically, treatment with RvD1 demonstrated the capacity to reduce the expression levels of MCP-1, IL-1β, and TNF-α mRNA levels relative to vehicle controls. Higher doses of RvD1 showed variable efficacy, suggesting an optimal therapeutic range for intended RvD1 activity. These findings indicate that ADPKD epithelium is responsive to RvD1, likely mediated through the identified FPR2 receptor. This suggests RvD1 could offer a low-toxicity therapeutic strategy to dampen chronic inflammation in ADPKD. Future work will utilize receptor antagonists to definitively confirm the FPR2-dependent mechanism.

44. Toward Knowledge-Guided AI Assistants for Porous Acoustic Metamaterials

Student Presenter: Jennifer Celeste, Mechanical Engineering
Faculty Advisor: Bhisham Sharma, Mechanical and Aerospace Engineering

Authors: *Jennifer Celeste, Bhisham Sharma*

Introduction:

Noise pollution causes serious health impacts, including hearing loss and cardiovascular disease [1]. While porous acoustic metamaterials offer a lightweight, high-performance solution for noise mitigation in aerospace and architecture, their vast design space complicates manual discovery. Although Large Language Models (LLMs) can accelerate material innovation, general-purpose models often lack the specialized depth required for complex acoustics. This research investigates whether a compact, domain-adapted language model can effectively retrieve specialized knowledge in porous metamaterials. By adapting a lightweight model to acoustics literature, we examine if domain-specific training yields a reliable technical assistant or merely mimics surface-level terminology.

Materials and Methods:

This study employed a targeted domain-adaptation pipeline centered on the GPT-2 XL architecture (1.5B parameters) [2]. The model was selected to facilitate the diagnosis of failure modes in smaller, specialized systems. The methodology comprised three primary phases: corpus assembly, continual pretraining, and supervised fine-tuning. The curated Acoustic Porous Material (APMR) corpus aggregates literature on empirical models (e.g., Johnson-Champoux-Allard-Lafarge), classical designs, and modern metaporous architectures [3]. This database was used to form the training corpus. We performed continual pretraining on this corpus to adapt the model's vocabulary to acoustics-specific notation and equations. Finally, since no specialized QA dataset existed, we utilized knowledge distillation. A larger teacher model generated synthetic question-answer pairs, which were manually validated against authoritative literature to ensure ground-truth accuracy. This bootstrapped dataset was used for supervised fine-tuning, teaching the model to respond to technical inquiries within the porous acoustic metamaterials domain.

Results and Discussion:

Testing of the adapted 1.5B parameter model revealed a stark divergence between linguistic pattern matching and physical reasoning. While the model successfully internalized acoustics-specific terminology and recalled equation fragments, evaluations demonstrated that this knowledge was superficial. Structured testing revealed three primary failure modes: recall without comprehension, where the model provided validity ranges or measurement procedures instead of requested coefficients; an inability to synthesize concepts, resulting in contradictory outputs; and hallucination when prompted with queries outside its narrow training window. Quantitative evaluation using an "LLM-as-a-judge" framework further highlighted the limitations of current benchmarks. ChatGPT and Gemini gave scores to the model of 50% and 15% respectively. This confirms that the model failed to learn causal relationships, such as how geometric parameters affect acoustic mechanisms or how to reason through

coupled design constraints. Ultimately, these results indicate that while domain adaptation transfers vocabulary, it does not instill physical grounding.

45. Testing and Characterizing the Effects of Skid Geometry on Power Draw Efficiency

Student Presenter: Julian Hong, Mechanical Engineering
Faculty Advisor: Paul van Susante, MAE

Authors: *Julian Hong*

Introduction:

The Tethered-permanently shadowed Region EXplorer (T-REX) was designed to roll into craters and lay down tether to transfer power and communications [1]. The research team, due to scope, was unable to determine what correlation existed between skid geometry on power efficiency. A formal study on skid design and its impacts on efficiency would increase the capability of future rovers like T-REX to traverse the lunar terrain.

The main objective of this research was to characterize the impact the skid design has on T-REX's power efficiency, and propose modifications to the design based on the results obtained from testing.

Materials and Methods:

The study design involves five types of tests to run. T-REX is to drive 1 meter at 0.1 m/s at various slopes and regolith (lunar dirt) simulant densities. T-REX is to drive down a 45 degree decline, down up a 15 degree decline, up a 15 degree incline, and on flat terrain. The two types of flat tests incorporate densely packed or loosely packed regolith. Each of these tests will have T-REX's power draw measured, which will be analyzed afterwards in MATLAB. After analyzing these test results, we can see in what situations T-REX is most power-hungry. Furthermore, we can juxtapose this analysis with film, and draw conclusions about the way the skid interacts with the terrain.

Results and Discussion:

Currently, all testing has been completed, including MATLAB analysis of each category testing. The 45 degree decline used the lowest amount of power, at 28.9 W. The flat data had a wattage of 34.1 W for the dense regolith and a wattage of 37.8 W for the loose regolith. For the 15 degree incline, the rover uses 36.4 W, while for the 15 degree decline, the rover uses 31.2 W.

The differences between the dense and loose regolith can be anticipated, as with looser regolith, the regolith gets between the grousers and more torque is required from the motors.

The electrical performance drastically improves with angle; thus the original intent of the skid to maximize power efficiency while driving down a slope has been achieved. The next steps are to determine what changes could be made to the skid to be more efficient driving uphill or on flat ground, as that is where most of the inefficiencies lie.

46. Utilizing Wastewater-Based Surveillance to Monitor Borrelia sp. for the Detection of Lyme Disease in a Nonendemic Region of the United States

Student Presenter: Jacob Schmidt, Environmental Engineering
Faculty Advisor: Ishi Keenum, Civil, Environmental, and Geospatial Engineering

Authors: *Jacob Schmidt, Aimee Marceau, Raul Gonzalez, & Ishi Keenum*

Introduction:
Tick-borne pathogens (TBPs) like Borrelia sp., the causative bacteria of Lyme disease, are a major public health concern because of their variable occurrence and limited existing monitoring methods [1]. Wastewater-based surveillance (WBS) has emerged as a way to monitor pathogen concentrations in near-real time [2]. Traditional Lyme surveillance methods use clinical surveillance monitoring human cases after symptoms present. Data is then distributed to public health officials, creating a lag in reporting [1, 3]. This project expands existing efforts to monitor TBPs using WBS. Our preliminary study establishes the feasibility for monitoring Borrelia using WBS, potentially providing a revolutionary way to understand disease burden [4].

Materials and Methods:
Weekly 24-hour wastewater influent samples were collected from March 2024 – March 2025, following sterile sampling protocols, from the Portage Lake Water and Sewer Authority wastewater treatment plant in Houghton. Wastewater samples were filtered in triplicate. DNA was extracted from the filtered samples using the FastDNA™ SPIN Kit for Soil. Digital droplet PCR (ddPCR) was used to measure variations in Borrelia prevalence. Targeted assays were multiplexed for B. burgorferi fliD and Borrelia 16S rDNA to amplify specific genetic markers. Genomic DNA standards (ATCC 35210DQ) and no-template controls were used for data validation. Borrelia detections were normalized using two methods: influent human fecal load and 24-hour wastewater flow rate.

Data visualization was conducted with R Studio using the ggplot2 package. Statistical analysis was conducted to compare WBS detections with reported cases of Lyme disease by the Michigan Department of Health and Human Services, Google Search trends, and companion animal Lyme disease rates.

We are currently assessing our limits of detection and quantification (LOD/LOQ). Future expansions include expanding testing to different communities with more public health data and Sanger sequencing to confirm assay performance.

Results and Discussion:
We have successfully measured Borrelia using two assays and published our results in Environmental Science and Technology Letters (Dec 2025) [4]. ddPCR results for WBS show consistent positive results for both grab and 24-hour composite influent samples, validating method feasibility for detection using WBS. The WBS data collected was compared to Houghton County Lyme Disease cases, as reported by

the Michigan Department of Health and Human Services, with an inconclusive correlation found. WBS data lagged clinical data by 11.5 weeks at its strongest correlation point. Further analysis is needed to address the lack of clinical data available to validate our WBS findings. Due to the high uncertainty associated with Google Search trend and companion animal Lyme disease rate data sets, their correlation with WBS data was not assessed; visual analysis suggests a similar pattern to our WBS data during the spring and summer months.

The successful implementation of TBP monitoring using WBS could enable proactive public health interventions and control measures. The potential to shift the procedures for TBP monitoring processes allows public health officials to focus on implementing risk assessments, prioritizing resource allocation, and guiding policy development, greatly improving the public health response to TBPs and beyond.

47. Assessing Vitamin D-Polymer Interactions Using UV-Vis to Optimize Electropolymerized Molecularly Imprinted Polymers

Student Presenter: Karenine Ornevil, Chemical Engineering
Faculty Advisor: Dr. Adrienne R. Minerick, Chemical Engineering

Authors: *Natalia Krakhaleva, Dr. Yixin Liu, Dr. Adrienne Minerick, & Karenine Ornevil*

Introduction:

Vitamin D is an often overlooked yet crucial supplement to the human body. Deficiencies of the supplement have been linked to numerous health conditions, including osteoporosis and cancer. Insufficiency is often unrecognizable until a medical assessment has occurred, most often by a blood test, limiting many individuals' access to immediate care. Tears serve as a feasible alternative to blood serum collection, as they are a less-invasive sample by means of collection and reduce complexity of analysis preparation. A Molecularly Imprinted Polymer (MIP) has been designated as a unique sensor for Vitamin D3, further enabling access to care.

Materials and Methods:

Preparation of the vitamin D-polymer (pPD) is completed via serial dilution, completing 5 samples of the solution from one concentrated stock. Combinations of Vitamin D and pPD were previously prepared in 70% methanol solution and will be reproduced by addition of PBS to the methanol solution before addition of the vitamin D and pPD combinations. A comparative analysis between Vitamin D's performance in both solutions will follow. Extensive usage of pipettes and pipetting techniques are used for sample preparation, and UV-Visible spectroscopy is continuously used to measure the sample's light absorption as it ages.

Results and Discussion:

Research is ongoing; however preliminary findings utilizing UV-Vis analyses have concluded that pPD and Vitamin D peak between 215 and 270 nm and decrease over time. Peak ratios of vitamin D have a trend of increasing over time, while those of pPD have a trend of decreasing over time. A pPD peak greater than 270 nm has a tendency to decrease over time. With Phosphate Buffer Solution (PBS) not expected to affect UV-Vis' absorption abilities, similar results are expected with the addition of the salt to the solution. Completion of this analysis will enable determination of the optimal Electropolymerized Molecularly Imprinted Polymer.

48. Drug Screening of a Novel Drug Probe in Ovarian Cancer

Student Presenter: Maria Tessin, Chemical Engineering BS, Chemistry BA
Faculty Advisor: Maria Gencoglu, Chemical Engineering

Authors: *Maria Tessin, Andrew Shore, Reeba Reji, Marina Tanasova & Maria Gencoglu*

Introduction:

Ovarian cancer is the leading cause of gynecological cancer mortality due to lack of symptoms, late diagnosis, and resistances to first-line therapy (carboplatin/paclitaxel). This study investigates a novel probe. The preclinical drug screening utilizes a two-dimensional (2D) cell culture system providing a reproducible method for evaluating the drug's efficacy while optimizing experimental conditions, such as drug concentration, cell densities and incubation time. To understand the probe's effectiveness, it will be screened against first-line therapy.

Materials and Methods:

Human ovarian cancer cell lines (SKOV-3) were cultured under physiological conditions. The cells were plated into a 96 well plate at a density of 5 thousand, 10 thousand, 50 thousand, and 100 thousand cells per well. Drug treatment was added in 1:3 or 1:10 serial dilutions after 24 hours. Cells were incubated with the drug for 48 hours, 72 hours or 96 hours. Dimethyl sulfoxide was used as vehicle control. Cell viability was assessed using the Cell-Titer Glo Luminesce Assay, which measures ATP activity and is directly proportional to the number of cells alive in the culture. Drug response curves and parameters were calculated with Prism Software.

Results and Discussion:

We have found that the optimal cell density is 5 thousand cells per well. The optimal incubation time for the probe in cells is 96 hours. We have found the IC50 to be 1.44E-5 µM for the novel probe, which is considered an extremely potent value for an inhibitor. This means that the drug is very effective at low concentrations, which allows for less drug to be needed to inhibit the growth of cancer. Eventually this can lead to a lower dosage needed in cancer treatments. Further testing needs to be done regarding the specificity of the probe to cancer cells versus stromal cells. This will be done with three-dimensional (3D) coculture models. Further testing will also be done to assess the probe's effectiveness against first-line therapy.

49. Using Fatty Acid Analysis to Evaluate the Effects of Human-Altered Landscapes and Sex on the Nutritional Status of Black Vultures

Student Presenter: Mara Sorensen, Ecology and Evolutionary Biology
Faculty Advisor: Dr. Jill A. Olin, Biological Sciences, Great Lakes Research Center

Authors: *Mara Sorensen, Hunter C. Roose, & Jill A. Olin*

Introduction:

Black vultures (Coragyps atratus) facilitate the flow of nutrients through food webs by consuming carcasses and removing decaying materials [1-2]. As a monomorphic species, black vultures exhibit few differences in appearance and behavior [3]. However, diet and nutrition may differ between males and females. Fatty acids are essential components of normal growth and development. Essential fatty acids are used as tracers for spatial and temporal consumer resource use [4].

Materials and Methods:

From January to March, 2025, black vultures (n = 32) were euthanized in the southeastern United States by the USDA's Animal and Plant Health Inspection Service. Samples were collected from the pectoral muscle, liver, and adipose tissue of 13 males and 19 females. Lipids were extracted from freeze dried tissues, derivatized, and quantified with gas chromatography. R was utilized for subsequent data analysis.

Results and Discussion:

Initial analysis of the pectoral muscle tissue identified no significant difference in fatty acid composition of males and females (PERMANOVA: 999 permutations, F = 1.928, $R2 = 0.060$, p = 0.102). Indicator species analysis identified linoleic acid (18:2n-6), omega-6 (n-6) and polyunsaturated fatty acids (PUFA) as strongly associated with female pectoral muscle fatty acid profiles. Myristic acid (14:0) was strongly associated with male pectoral muscle fatty acid profiles. Research is ongoing, and analysis of liver and adipose tissue will offer further insight, as different fatty acids represent different timescales of nutrient assimilation.

50. Longitudinal Psychological Readiness Trajectories Following Anterior Cruciate Ligament Reconstruction

Student Presenter: Micaela Geborkoff, Medical Laboratory Science
Faculty Advisor: Dr. Erich Petushek, Department of Psychology and Human Factors

Authors: *Dr. Erich Petushek, Dr. Matthew Harkey, Dr. Gregory Myer, Allie Lugin, & Micaela Geborkoff*

Introduction:
Return-to-sport (RTS) decisions following anterior cruciate ligament reconstruction (ACLR) rely on both physical and psychological factors (1). Psychological barriers like fear of reinjury and underconfidence in their knee prevent many individuals from returning to preinjury levels despite adequate physical recovery (4,5). Psychological readiness (encompassing fear of reinjury, confidence, and emotional readiness) is a key determinant of RTS (2,3) which is commonly assessed using the ACL-Return to Sport after Injury (ACL-RSI) scale (6). Although ACL-RSI strongly predicts RTS, prior research largely assumes homogeneous recovery. This study used latent growth and mixture modeling to identify distinct psychological readiness trajectories and characterize clinical subgroups.

Materials and Methods:
Data were drawn from multisite prospective registries of patients undergoing anterior cruciate ligament reconstruction (ACLR). Participants completed assessments of psychological readiness at 3, 6, 9, and 12 months post-ACLR. Psychological readiness to return to sport was measured using the Anterior Cruciate Ligament–Return to Sport after Injury (ACL-RSI) scale.

Longitudinal trajectories of ACL-RSI scores were examined using latent growth and mixture modeling to identify distinct patterns of change over time. Models with increasing numbers of latent classes were estimated and compared using the Bayesian Information Criterion (BIC) and additional model fit indices to determine the optimal class solution.

After class assignment, trajectory subgroups were described and compared on key demographic, sport-related, and clinical characteristics, including sex, age, sport participation level, and graft type, to aid in the interpretation and clinical characterization of identified subgroups.

Results and Discussion:
Data from multisite prospective ACLR registries have been successfully imported, merged, and prepared for longitudinal analysis. Based on prior work and clinical observations, we anticipate identifying a three- to four-class solution reflecting distinct trajectories of psychological readiness over the first year following ACLR, including patterns of rapid improvement, delayed recovery, and persistently low readiness.

Identification of these trajectory subgroups has important clinical implications. Early detection of individuals demonstrating stagnation or decline in psychological readiness may allow clinicians to identify patients at risk for protracted recovery, disengagement from rehabilitation, or delayed return to sport, even when physical recovery appears adequate. Such insights could support earlier, more targeted psychological or educational interventions.

Ongoing and future analyses will examine how psychological readiness trajectories relate to functional outcomes to more fully characterize biopsychosocial recovery patterns following ACLR. Integrating psychological and functional trajectories may help inform more precise, individualized return-to-sport decision-making and intervention strategies, moving beyond one-size-fits-all rehabilitation timelines.

51. Investigating the Origin of the Huron Mountains Mafic Intrusions through Their Rock-Magnetic Properties

Student Presenter: Miah Mol, Applied Geophysics and Geology
Faculty Advisor: Aleksey Smirnov, Department of Geological and Mining Engineering and Science, Earth and Enviornmental Magnetism Lab

Authors: *Miah Mol, Gabriel Ahrendt, Aleksey Smirnov*

Introduction:
Mafic dikes can be used to determine the geologic history of Precambrian Era tectonic plates. The age and location at formation can be determined from the direction of Natural Remanent Magnetization (NRM) acquired by these intrusions. The dikes within the Huron Mountains are believed to belong to either the Marathon Large Igneous Province or the Keweenawan Midcontinent Rift System. Both possibilities would have exciting implications for our understanding of the regional tectonic history. The hypothesis will be tested by comparison of paleomagnetic directions and rock-magnetic characteristics of the Huron Mountains dikes with those of the Marathon and Keweenawan dikes.

Materials and Methods:
The process starts with field work, where we drill out core samples, usually around 10 per site, and orient them in the field. The cores are then taken back to the lab and prepped into smaller cores to be used for measurements. These smaller cores are measured in a 2G superconducting magnetometer, which measures remanent magnetization (i.e., a fossilized signature of the Earth's magnetic field). We then slowly demagnetize the cores by heating them up to different temperatures and remeasuring them between each temperature step so we can observe how they demagnetize and at what temperature they demagnetize. This slowly gets rid of the accrued magnetic signatures of the past 2 billion years and leaves us with the true magnetic signature from the time of formation. Then we graph and interpret all of our data to determine the magnetic orientation, direction, and strength of the rocks' NRM. Then we take one core from each site and crush it up into a powder to be measured in our Kappabridge. This machine measures thermal-dependent susceptibility, and the resulting data can be used to determine the dominant magnetic-carrier minerals in the rocks. This lets us know whether our orientation data is correct and trustworthy.

Results and Discussion:
Results are still forthcoming, but we hope to use the magnetic orientation data to help us better understand the tectono-magmatic history of the North American Plate in this region. Thus far, our data points to these mafic dike swarms having mixed origins and possibly represent two to three separate magma pulses from either the Kenora-Kabetogama (KK) or the Marathon Large Igneous Provinces (LIP).

The thermal-dependent susceptibility data shows us that our magnetic directions are stable and trustworthy for 80 percent of our measured sites, whereas around 20 percent underwent some form of magnetic alteration. Broadly speaking, these are the first measured samples of the KK and Marathon LIP dike swarms in this region, and help us trace the evolution of the North American Plate from 2.2-2.11 Ga.

52. Effects of Various Timber Harvesting Methods on the Ratio of Single Stem to Sprout Cluster Origin in Trees of the Northern Hardwood Forest Type

Student Presenter: Paavo Nurmi, Natural Resource Management
Faculty Advisor: Chris Webster, College of Forest Resources and Environmental Science

Authors: *Paavo Nurmi, Chris Webster*

Introduction:

This project is important for several reasons. The results of this study can serve to assist in managing and possibly change the best management practices for the northern hardwoods forest type. By discovering the effects of harvest methods on the abundance of sprout clusters in regeneration, that allows for the ability to optimize management to support single stem recruitment, producing healthier forests and higher yielding forests in industry.

Materials and Methods:

For this study we utilized the existing Northern Hardwoods-Silvicultural Experiment to Enhance Diversity (NH-SEED) located at the Ford center in Alberta, MI. We sampled Single Tree Selection, High Residual Shelterwood, and Low Residual Shelterwood, all of which were also sampled for a control and scarified post-harvest treatments. Plots were 1/1000th acre fixed radius plots, generated randomly within the study are using ArcGIS. Data was analyzed using Excel and MiniTab.

In the field, data points were collected over a variety of environmental conditions, including a BAF10 plot of mature trees taken from each plot, the canopy density, primary and secondary ground cover types. Each plot had all trees located within the plot sampled, identified as a cluster or single stem, and height class, # of stems in cluster (if applicable), and DBH (in >= 2 cm) recorded for each individual.

Results and Discussion:

Results are forthcoming.

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53. Growth of Galeopsis tetrahit (Hemp Nettle) in Disturbed Forest Floor Areas

Student Presenter: Sara Meikle, Wildlife Ecology and Conservation
Faculty Advisor: Julia Burton, College of Forest Resources and Environmental Science. Ford Center Forest.

Authors: *Sara Meikle*

Introduction:
This study explores the effects of disturbance on the presence and success of Galeopsis tetrahit, an invasive species that is known to succeed in disturbed environments. Other than the knowledge that Galeopsis tetrahit is often found in disturbed habitats, there is not a lot known about this plant and not a quantitative proof of this correlation. This could just be a case of most invasive species being commonly present in disturbed areas, which is why this study's goal is to prove this correlation and present information for other studies to build off of.

Materials and Methods:
A field crew resampled a system of permanent plots and subplots in Alberta, Michigan, at the Ford Research Property. It took place on Julia Burton's Adaptive Capacity Through Silvicultural site, a project to study climate change through silviculture on 80 acres of land, eight units, each undergoing one of the treatments. At each subplot a 1-meter squared sample zone was laid, within this zone each species rooted and hanging in the zone was given a cover class. This subplot was also given a disturbance class from zero to three based on the U.S. Department of Agriculture's Soil-Disturbance Field Guide (zero being undisturbed soil surface, one being slight disturbance, two being moderate disturbance, and three being major disturbance). Due to the low number of class threes being recorded, an additional protocol was created. This protocol started with mapping out skid trails on the ACTS site to find more disturbed locations, then finding areas on them that were class two or three. In these areas a pen was thrown to make plot center and to maintain a random sample. Subplots were then made at the cardinal directions. The protocol for data collection in each of these subplots is the same as above.

Results and Discussion:
Due to the large about of data collected for this study the entry has not been completed yet but soon will be. The planned analysis is to compare the overall distribution of Galeopsis tetrahit before treatment and after treatment across the entire site. The disturbance data can only take place this year because there is no pre-treatment data for disturbance levels. This means that a small subset of each class will be randomly selected and correlation will be looked for between the cover class of Galeopsis tetrahit and disturbance class. Based on field observations it is expected that there will be some correlation but not an extreme one, as the species seemed quite prominent almost everywhere. The treatment-by-treatment Galeopsis tetrahit presence data will be helpful to look at, as some units seem to have more present than others. Especially with the mid-winter thaw during harvest treatments, only some units experienced this. It is predicted that Galeopsis tetrahit's distribution will indicate this. This

research project's aim is to create baseline data to provide a good platform to build Galeopsis tetrahit control methods off of. It is anticipated that it will be successful in doing so.

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54. Left Atrial Appendage Double-blinded Study

Student Presenter: Sydney Trzebiatowski, Biomedical Engineering
Faculty Advisor: Hoda Hatoum, Biomedical Engineering Department

Authors: *Sydney Trzebiatowski, Hailey LaBonte, Ahmad Bshennaty, Ghasaq Saleh, Mohamad Alkhouli, and Hoda Hatoum*

Introduction:

The patient scans provided to us contained samples that had atrial fibrillation, stroke, both, or neither. The double blind implies that we were unaware of which combination of these the patient scans had. We aimed to run a fluid dynamics simulation on all of these patients and "diagnose" them based on the findings. We then share these results with the clinicians to see how many "diagnoses" were correct to the actual clinical diagnosis provided by the doctors. These comparisons help us validate the accuracy of our simulations.

Materials and Methods:

In order to complete research on this topic, computed tomography (CT) scans of heart patients were provided from the Mayo Clinic under an Institutional Review Board (IRB) approved study. Patient-specific 3D geometry was created by importing the CT scans into Mimics Research 23.0 (Materialise Belgium) and then segmenting them to build the atrium from the scan. Then, to smooth out the exterior geometry of each of the segmented models, 3-matic software (Materialise, Belgium) was used. The models were imported into Ansys Workbench (Canonsburg, PA) where calculated extensions were added to each pulmonary vein and the mitral valve. Next, the geometry was meshed in preparation for the computational fluid dynamics (CFD) simulations. The boundary conditions are found from the echocardiographic waveforms extracted for each patient from Mayo Clinic. The simulations yielded needed data and contour plots that show the distribution of time-averaged wall shear stress (TAWSS), blood velocity against the atrial wall, Relative Residence Time of the atrium wall (RRT), Oscillatory Shear Index of the atrium wall (OSI), and streamlines inside of the atrium. These values were turned into images that are displayed with a legend.

Results and Discussion:

As of right now, the research is being completed, and the final results of our simulations are being evaluated. Once all the patients are evaluated, we will provide our simulatory "diagnosis" back to the clinicians on each patient. This allows direct results from studies to be given without any conclusion biasing toward a preconceived diagnosis from the clinicians. This study will provide results to clinicians on these patients, in hopes that the results are conclusive with the clinically provided results from the doctors. These comparisons will help us validate our simulations if they are on par with the diagnosis.