Rowan University

HENRY M. ROWAN
COLLEGE OF ENGINEERING

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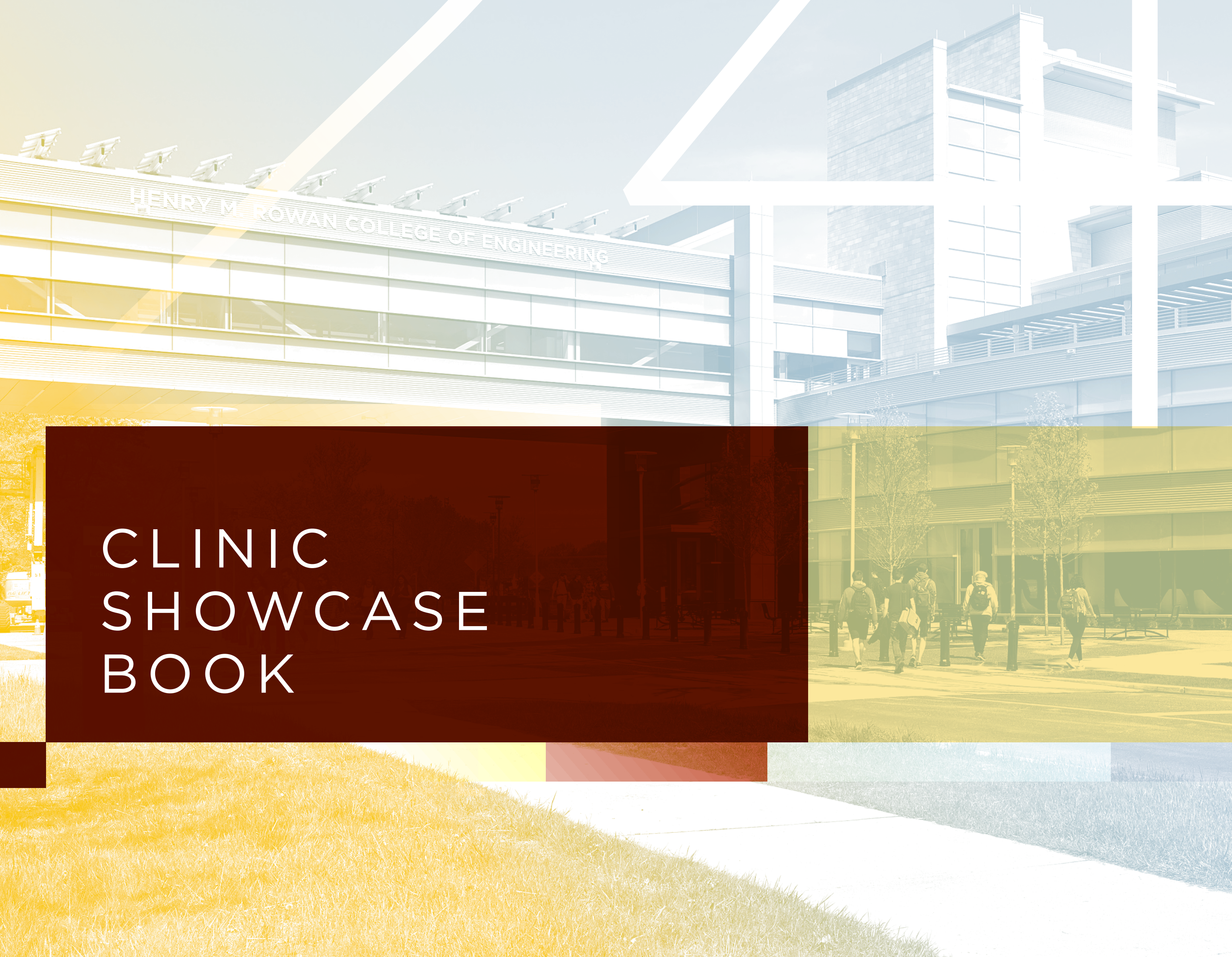

CLINIC SHOWCASE BOOK

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ELECTRICAL & COMPUTER ENGINEERING

EXPERIENTIAL ENGINEERING EDUCATION

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Preface

The Engineering Clinic Program is the hallmark of the Henry M. Rowan College of Engineering. Spanning the entire four-year undergraduate program, Engineering Clinics serve as a vital and continuous component of the curriculum. In the first-year and sophomore clinic curriculum, students acquire a comprehensive understanding of the art and science of design through an interdisciplinary approach. They skillfully translate engineering fundamentals into problem-solving best practices, culminating in the evaluation of projects and final presentations.

Throughout the junior and senior clinic program, students collaborate in small teams under the guidance of faculty and external sponsors to assimilate the knowledge gained from their coursework into practical engineering solutions.

Within this publication, we proudly present the meticulous work of **569 students**, encompassing **135 clinic projects**. These students have actively contributed to the betterment of their communities while engaging in rigorous academic study. Each clinic project serves as a testament to the exceptional talent and perseverance of our students, the remarkable quality of our engineering education and research programs, and the caliber of graduates we produce.

We trust that you will derive as much enjoyment from learning about our students and their projects as we have from sharing them with you.

Sincerely,

Giuseppe R. Palmese, Ph.D.
Dean, Henry M. Rowan College of Engineering

Engineers in the Making

Preparing students to become professional engineers requires more than a solid grounding in theory and fundamentals—though these are certainly crucial. Successful engineers are distinguished by their ability to apply theoretical knowledge to solve complex, real-world challenges. They must operate effectively within team environments, navigating limited information to develop solutions that meet rigorous success criteria. This is where our Junior and Senior Engineering Clinics play a pivotal role. These clinics offer students an invaluable platform to engage in the full spectrum of the engineering profession under the direct guidance of seasoned faculty.

In the final two years of our engineering program, students transition from theoretical study to practical application. Through team-based projects, they are tasked with delivering concrete solutions. Projects are proposed by faculty but selected by students, allowing them to align their work with their interests and career goals. The Junior and Senior Engineering Clinics are designed to enhance not only technical proficiency but also professionalism, communication, project management, and teamwork. These clinics serve as comprehensive training grounds, preparing students for their future engineering careers.

Innovation is at the heart of our clinics. Each project challenges existing knowledge and pushes the boundaries of design. Students can work on up to four different clinic projects, gaining a broad range of experience, or they may choose to concentrate on a single project for an in-depth exploration. Collaborating closely with faculty, external sponsors, and team members, students build lasting professional relationships and gain experience in communicating their work to diverse audiences. The variety of projects ensures that our graduates leave with a well-rounded skillset, ready to tackle new challenges. Consequently, the clinic experience is often cited by potential employers as a distinctive feature of Rowan graduates.

The Engineering Clinic program is a hallmark of the Henry M. Rowan College of Engineering. We take pride in its legacy and the impactful projects showcased in this booklet.

Sincerely,

Dr. Smitesh Bakrania
Junior and Senior Engineering Clinic Coordinator

Biomedical Engineering

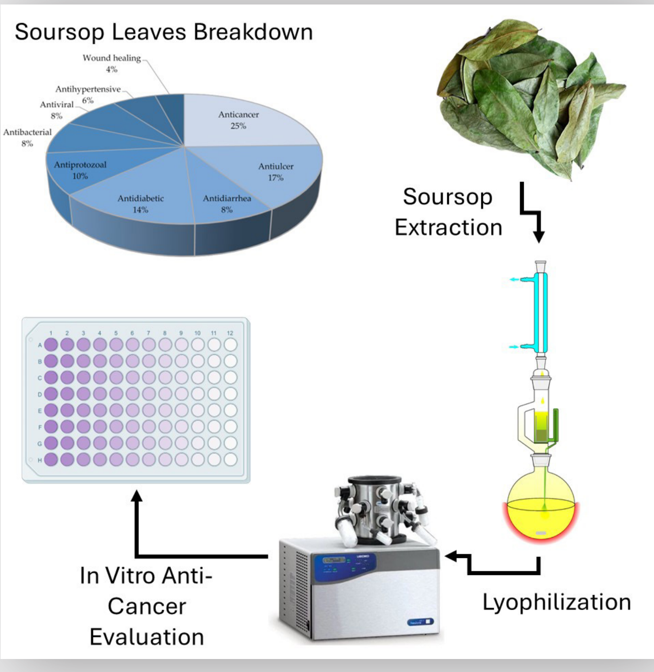
Anti-Cancer Efficacy of Soursop Extracts

TEAM MEMBERS
Joseph Krakowiecki

PROJECT MANAGERS
Dr. Subash Jonnalagadda (Chemistry and Biochemistry & Molecular and Cellular Biosciences), Dr. Manoj Pandey (Cooper Medical School)

SPONSORS
The New Jersey Health Foundation

Triple-negative breast cancer (TNBC) which is the form of cancer that lacks estrogen receptors, progesterone receptors and human epidermal growth factor receptor-2. This variety of cancer accounts for 15-20% of all breast cancer prognosis and only has a five-year survival of 8-16%. This low survival rate is because of its low response to therapeutics and highly metastatic nature. However, some oncologists have noticed that soursop tea has helped shrink the size of the tumors for TNBC. Soursop leaves (Annona muricata Lin) are primarily found in Central America and are commonly used to make tea. From the tea in various studies, it has been observed that it has efficacy against TNBC because of the high abundance of phytosterols, tannins, and flavonoids. This observation has led to the question of what active molecules and what proteins are being impacted. The observation is focusing on anti-apoptotic proteins which when inhibited leads to the death of the cell including Cyclin D1 and Bcl-2. The identification and characterization of the active molecules inside the tea helps to provide a possibility of new treatment avenue for TNBC or combination approach.



Sigma Receptor Modulation as an Opioid-free Approach to Pain Therapy

TEAM MEMBERS
Lauren Spalluto, Shannon Jordan, Kali Pierson

PROJECT MANAGERS
Dr. Thomas Keck (Chemistry and Biochemistry & Molecular and Cellular Biosciences),
Dr. Nathaniel Nucci (Molecular and Cellular Biosciences)

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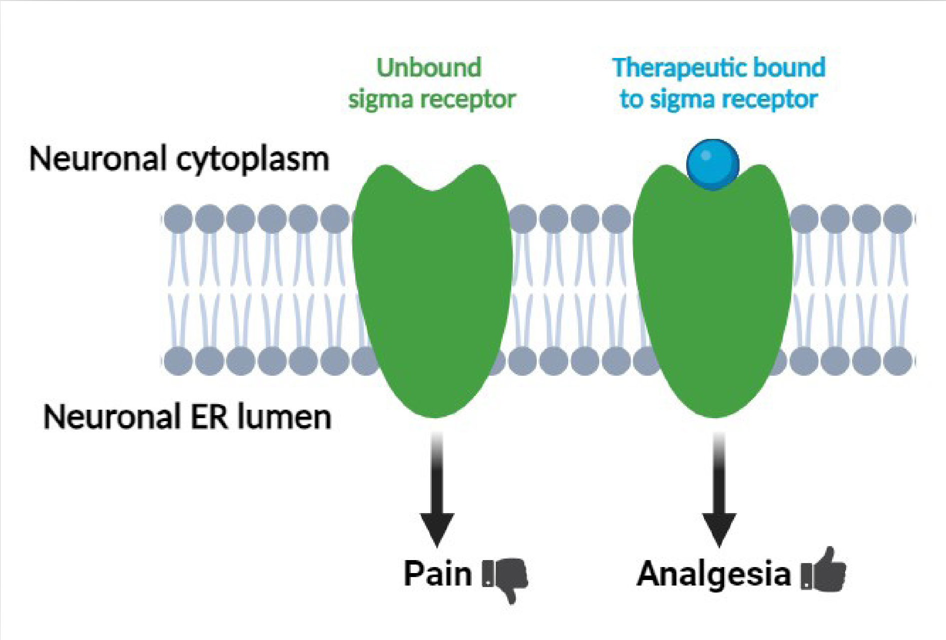
Eshelman Institute at the UNC Eshelman School of Pharmacy

Sigma receptors, particularly σ2, represent promising yet underdeveloped therapeutic targets for pain management, offering potential alternatives to opioid-based medications. Leveraging recent advances in structure-guided drug design and innovative ligand discovery, preclinical leads for σ receptor modulation can be developed for pain treatment. Three novel classes of σ receptor ligands have been identified, distinct from traditional aromatic-containing ligands, offering improved selectivity and reduced side effects. Through a combination of molecular docking, biophysical methods, and iterative compound optimization, the lead compounds for σ2 will be evaluated on their binding affinities, selectivity, and analgesic efficacy in rodent models. In addition, these methods will provide valuable insights into potential binding modes, compound activity, ligand-receptor interactions, and structural dynamics. This research holds promise for advancing opioid-free pain management strategies and addressing the unmet medical need for safer and more effective analgesics.



Effects of Stiffness and HAVDI on Stemness and Matrix Mechanosensing

TEAM MEMBERS
Hayley Jankowski, Tyler Torres

PROJECT MANAGERS
Dr. Sebastián Vega (Biomedical Engineering), Mattias Recktenwald (Biomedical Engineering)

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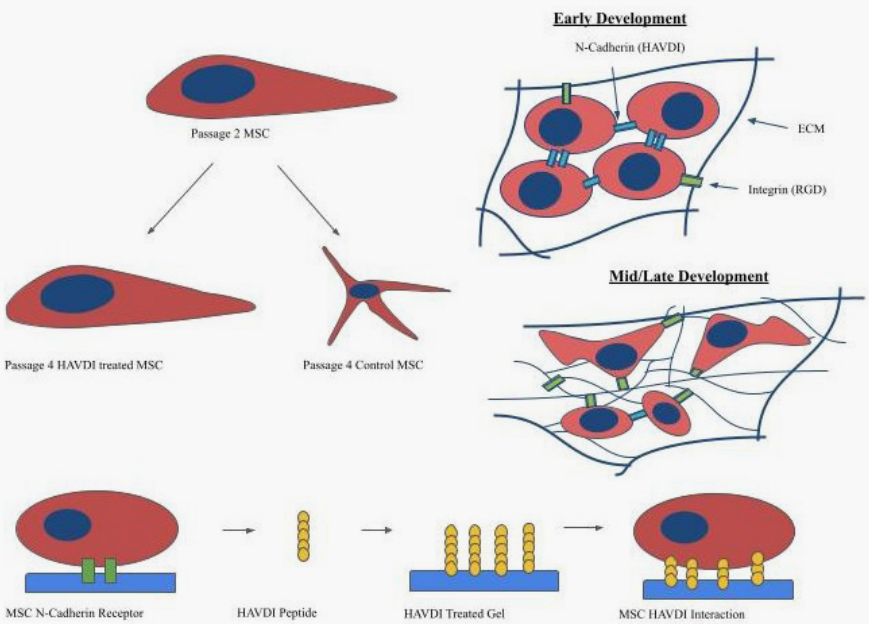
Mesenchymal Stem Cells (MSCs) hold immense potential for cell therapies due to their ability to proliferate and differentiate into musculoskeletal tissue cells including osteoblasts, adipocytes, and chondrocytes. However, their potential for clinical translation is challenged by the inability to expand MSCs in vitro while maintaining their stemness throughout multiple passages. There is a growing consensus that this is due to expanding MSCs on tissue culture plastic, resulting in supraphysiological matrix mechanosensing and a progressive loss in stemness. N-cadherin mediated cell-cell interactions attenuate matrix mechanosensing, and the hypothesis of this work is that MSCs cultured on biomaterials functionalized with N-cadherin mimetic peptides will exhibit a decrease in matrix mechanosensing resulting in the maintenance of their stemness over multiple passages. To test this hypothesis, soft and stiff PetriSoft hydrogels functionalized with N-cadherin mimetic peptides (HAVDI) were used to study how stiffness and the HAVDI peptide influence MSC morphology and the expression of stemness surface markers over time.



Development of a Conductive Hearing Aid on a Flexible Substrate

TEAM MEMBERS
Raaha Kumaresan, Aliyan Aamir, Joseph Rosa, Michael DeMelas, Alyssa Matro

PROJECT MANAGERS
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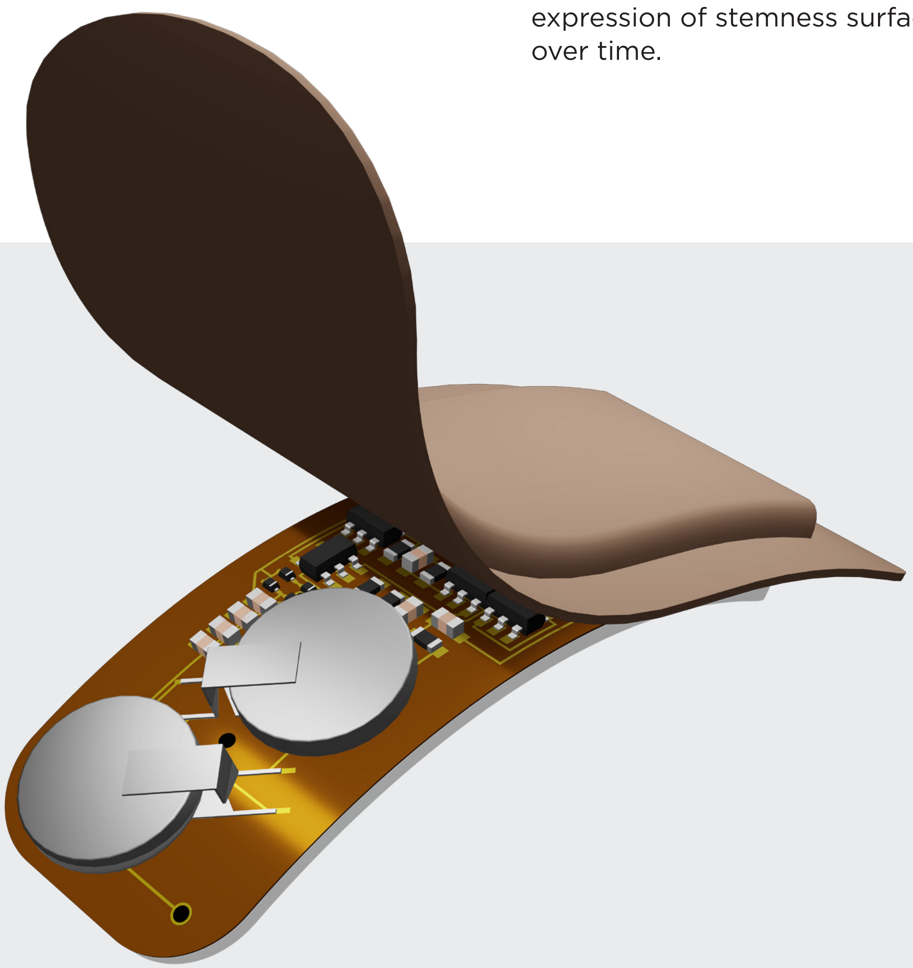
National Institutes of Health

Mesenchymal Stem Cells (MSCs) hold immense potential for cell therapies due to their ability to proliferate and differentiate into musculoskeletal tissue cells including osteoblasts, adipocytes, and chondrocytes. However, their potential for clinical translation is challenged by the inability to expand MSCs in vitro while maintaining their stemness throughout multiple passages. There is a growing consensus that this is due to expanding MSCs on tissue culture plastic, resulting in supraphysiological matrix mechanosensing and a progressive loss in stemness. N-cadherin mediated cell-cell interactions attenuate matrix mechanosensing, and the hypothesis of this work is that MSCs cultured on biomaterials functionalized with N-cadherin mimetic peptides will exhibit a decrease in matrix mechanosensing resulting in the maintenance of their stemness over multiple passages. To test this hypothesis, soft and stiff PetriSoft hydrogels functionalized with N-cadherin mimetic peptides (HAVDI) were used to study how stiffness and the HAVDI peptide influence MSC morphology and the expression of stemness surface markers over time.

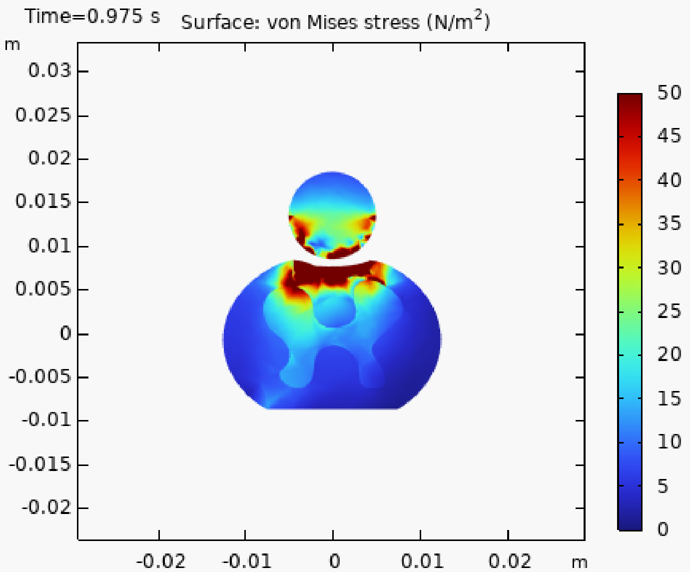


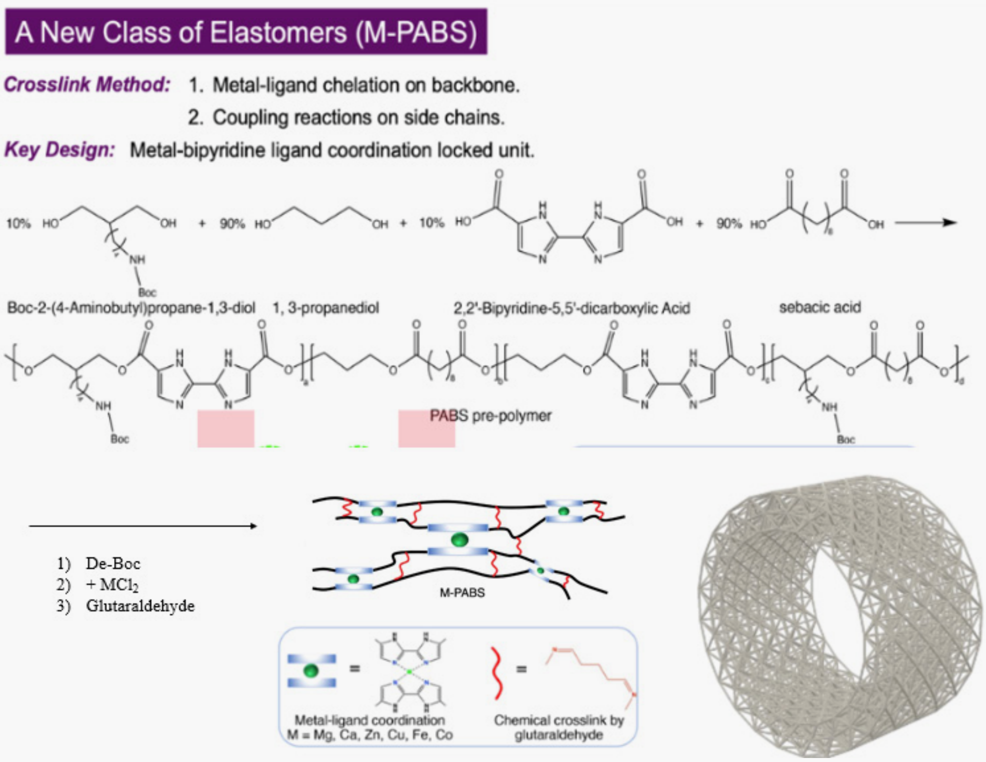
A Model of Spinal Cord Injury

TEAM MEMBERS
Gianna Riviello

PROJECT MANAGERS
Dr. Peter Galie
(Biomedical Engineering)

Injury to the spinal cord can be detrimental to the nervous system. Any impact on the cord leads to stress on both the inside, or gray matter, and outside, or the white matter, domains of the cord. Understanding the mechanics of this injury, especially the relative amounts of stress experienced and where the stress is concentrated, can aid in developing effective treatments and therapies for the spinal cord after it is injured. This project aims to study the impact of spinal cord injury computationally, modeling an indentation performed on a bovine spinal cord in the laboratory. Specifically, a round indenter is pressed into a small section of the spinal cord at a constant speed for a set time so that the force on the cord can be measured; however, this test cannot show where the stress is localized and which sections experience more stress. Therefore, the model aims to show this data. Models of both the spinal cord and indenter are generated in SolidWorks, and they are imported into COMSOL. A time-dependent study is conducted to indent the spinal cord at a constant velocity. The stress of the indentation can be observed on a cross section at specific time points, and values in both the gray and white matter can be sampled for analysis. The results, shown in the image, showed that there is much higher stress in the gray matter than the white matter in the spinal cord, and little stress concentrates in the white matter.





Enhanced Vascular Integration: A Biodegradable Elastomer-Based Arterial Graft

TEAM MEMBERS
Isabella Frangiosa

PROJECT MANAGERS
Dr. Ying Grace Chen
(Biomedical Engineering)

Cardiovascular disease is the leading cause of death in the United States. Prosthetic vascular grafts are used to replace diseased veins or arteries. Current options, primarily Gore-Tex® and Dacron®, don't integrate with the host and have poor biocompatibility in small-diameter vessels (< 6 mm). Biomaterials with proper viscoelasticity, compliance, and biocompatibility may enable use in small blood vessels. Our project focuses on the development of novel metal-ligand coordinated biodegradable elastomers. These materials are designed to offer a range of mechanical properties and bioactivities, making them suitable for the fabrication of small-diameter vascular grafts. Our approach uses melt electrowriting method to create grafts that not only meet the mechanical demands of blood vessel replacement but support cellular integration and tissue regeneration. To assess the efficacy and biocompatibility of our newly developed grafts, we will conduct a series of in vitro and in vivo experiments. These studies will evaluate several key factors, including the mechanical properties, the biocompatibility, the extent of cell infiltration, the rate of polymer degradation and tissue regeneration, and the process of host remodeling. Through this research, we aim to introduce a promising alternative to vascular grafts with the potential to significantly improve outcomes for patients with cardiovascular disease.

Modular Design and Optimization of a Parallel-Track Electrospinning Device

TEAM MEMBERS
Anna Marie McMahon

PROJECT MANAGERS
Dr. Vincent Beachley
(Biomedical Engineering)

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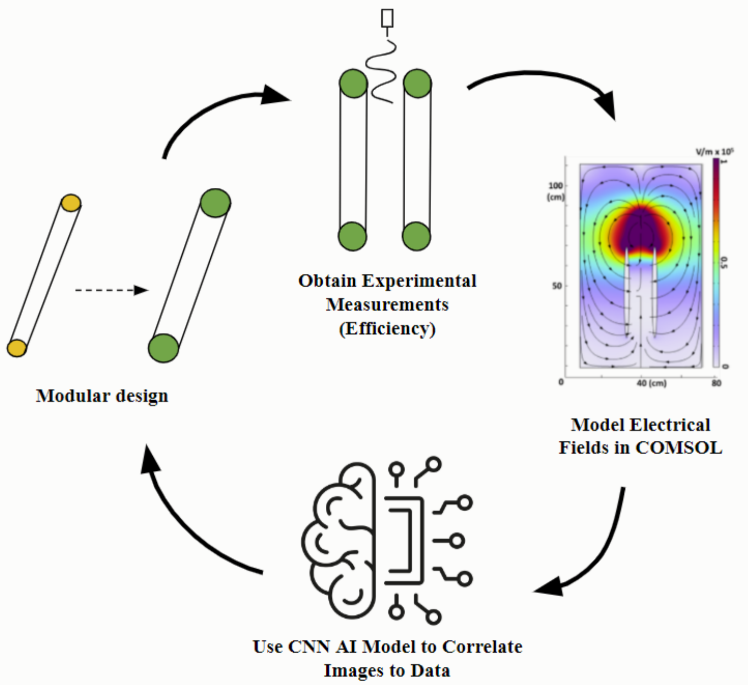
Due to their high surface area to volume ratio, polymer nanofibers are used in a variety of applications, including but not limited to tissue engineering, electronics, and smart textiles. For textile products, long, continuous, aligned nanofibers must be spun into high-strength yarns; but as it is not currently possible to commercially produce continuous aligned nanofibers, these yarns cannot be made on an industrial scale. One promising approach to manufacturing aligned nanofibers is parallel track electrospinning, a technology that is unique to the project. However, previous research has found that the average efficiency of parallel-track electrospinning is low. To optimize this system, different manufacturing designs will first be studied experimentally. Then, electrical field models will be generated for each design using COMSOL, and these will be matched to the respective efficiency of the design. This data will be fed to a convolutional neural network AI model, and the electrical fields will be correlated to the experimental efficiencies. With this model, the efficiency of a manufacturing design can be screened by computer before testing to reduce reliance on physical experimentation, conserving time and resources. These findings will be used to develop an optimal physical design for parallel-track electrospinning, paving the way for commercialization of roll-to-roll aligned nanofibers and ensuring higher efficiency.

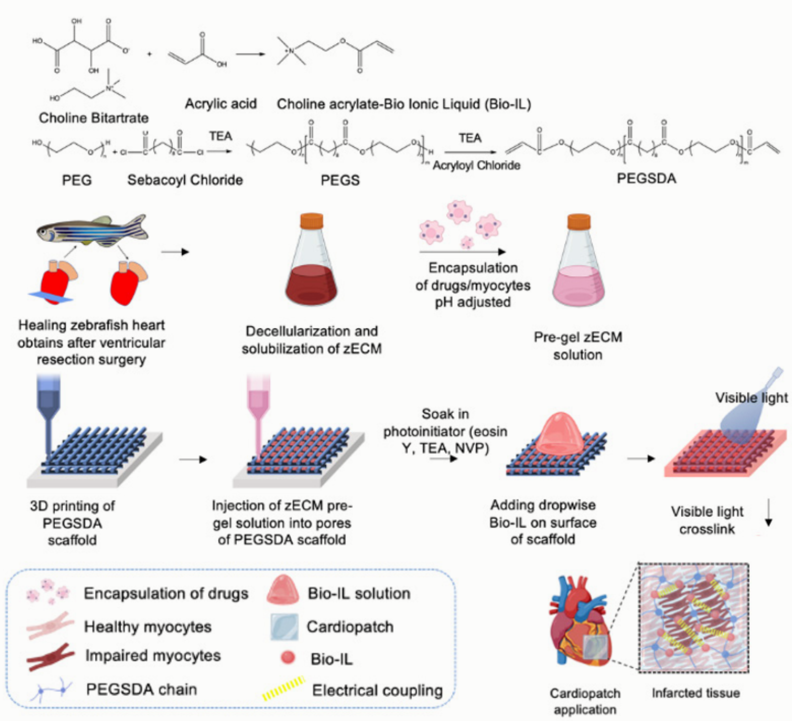


A Novel 3D- Printed Cardiac Patch for Myocardial Repair

TEAM MEMBERS
Jacob Buler

PROJECT MANAGERS
Dr. Ying Grace Chen
(Biomedical Engineering)

Myocardial infarction (MI), commonly known as a heart attack, results from the interruption of blood supply to the heart, causing irreversible damage to the cardiac muscle due to the limited regenerative capability of human myocardium. Our present research introduces a novel cardiopatch scaffold fabricated using Stereolithography (SLA) 3D printing technology, aimed at improving cardiac repair post-myocardial infarction. Inspired by the high myocardial regenerative capacity of zebrafish, our cardiopatch incorporates zebrafish cardiac extracellular matrix (zECM) to promote cardiomyocyte proliferation and cardiac regeneration. The electroconductive scaffold, made of poly(ethylene glycol) diacrylate (PEGSDA) interlaced with a bio-ionic liquid (Bio-IL), adheres to cardiac tissues via electrostatic forces and covalent bonding. These interactions ensure close contact with the myocardium, which is crucial for efficient electrical signal transmission and mechanical support during the healing process. The zECM component of the cardiopatch accelerates myocardial regeneration, aligning the degradation rate of the scaffold with the regenerative process of the tissue. Our approach not only offers a promising solution for heart repair after MI but also suggests a versatile platform for tissue engineering that can be tailored for other organs by altering the ECM source.



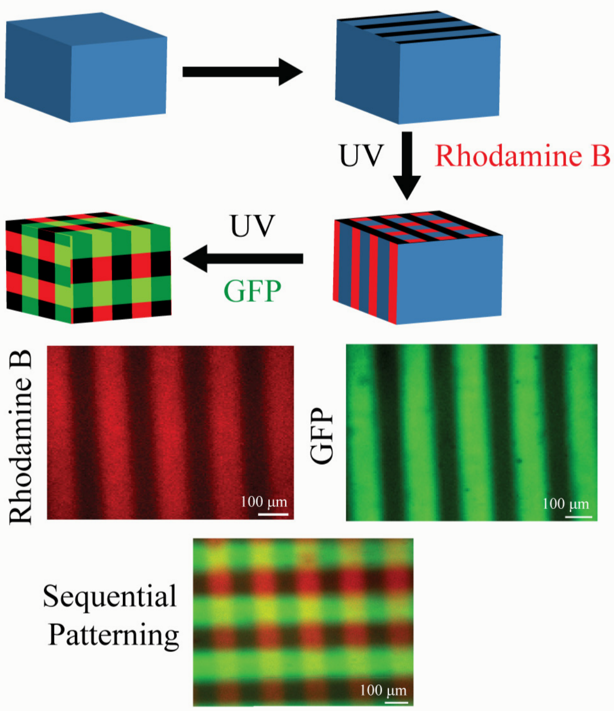
Synthesis and Sequential Photopatterning of Synthetic Thiol-Norbornene Hydrogels

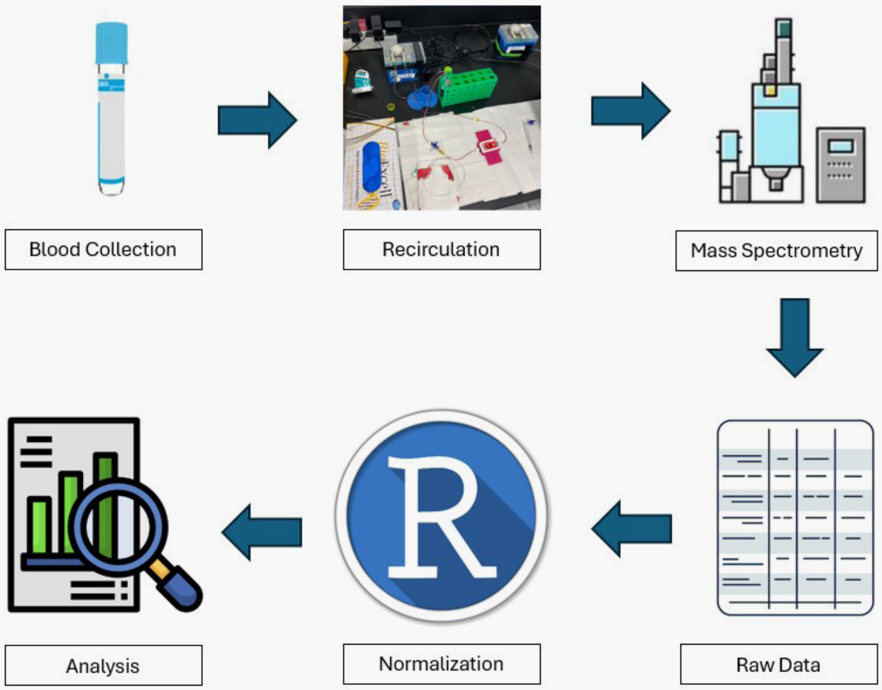
TEAM MEMBERS
Arielle Gsell, James MacAulay, Abigail Madden, Jillian Smith, Luke Siri

PROJECT MANAGERS
Dr. Sebastián Vega (Biomedical Engineering)

SPONSORS
National Science Foundation, National Institutes of Health

Hydrogels are a class of soft biomaterials and the material of choice for various biomedical applications due to their biocompatibility and tunable properties. Macromers derived from natural sources (e.g., hyaluronic acid, gelatin, alginate) can cause off-target cell signaling, motivating our team to explore synthetic macromers such as poly(ethylene glycol) (PEG). Despite advancements in chemical and physical stimuli-responsive strategies, many hydrogels formed oversimplify the characteristics of the native extracellular matrix. However, by using light-mediated click chemistry reactions, hydrogels can be modified after the base hydrogel network is established. Photopatterning base hydrogels with crosslinkers or bioactive molecules provides an in situ approach to modify the microenvironment with spatiotemporal control. This project examines the formation of 8-arm PEG-Nor macromers and di-thiolated dithiothreitol (DTT) crosslinkers into hydrogels amenable to sequential photopatterning with mono-thiolated peptides. To test this hypothesis, hydrogels were formed while retaining functional groups for secondary reactions then photopatterned with bioactive peptides. Base hydrogels were precisely patterned with multiple peptides in a controlled manner throughout the scaffold and confirmed via confocal microscopy. Furthermore, cell studies in 2D and 3D confirmed the hydrogel's biocompatibility and cell adhesion and proliferation.





Proteomic Analysis

TEAM MEMBERS
Noah Goldman

PROJECT MANAGERS
Dr. Peter Galie (Biomedical Engineering)

SPONSORS
National Science Foundation

Hemodynamics have been studied in vitro since the 1930s with Fahraeus using capillaries to determine the effect of diameter on hematocrit. However, the geometries used to study blood flow have yet to significantly progress beyond the glass capillaries. Even recently, researched in vitro systems have been unable to measure whole blood flow dynamics in a deformable, branched network topology. With the advent of digital light processing (DLP), we have been able to create a rigid substrate with complex microvasculature capable of creating complex flow regimes that can be studied in real time. Using this, we have begun investigating drag reducing polymers' (DRP) mechanism of effect on blood flow. DRP's have been proven to show vast medicinal results when added to the blood however there is uncertainty surrounding its mechanism of action. My study investigated resultant changes in protein levels due to DRP addition in accordance with varying flow profiles. After this study's conclusion, I have further worked on proteomic analysis in discovering Alzheimer's Disease (AD) mechanism of action and specification to the varying cohorts of AD.

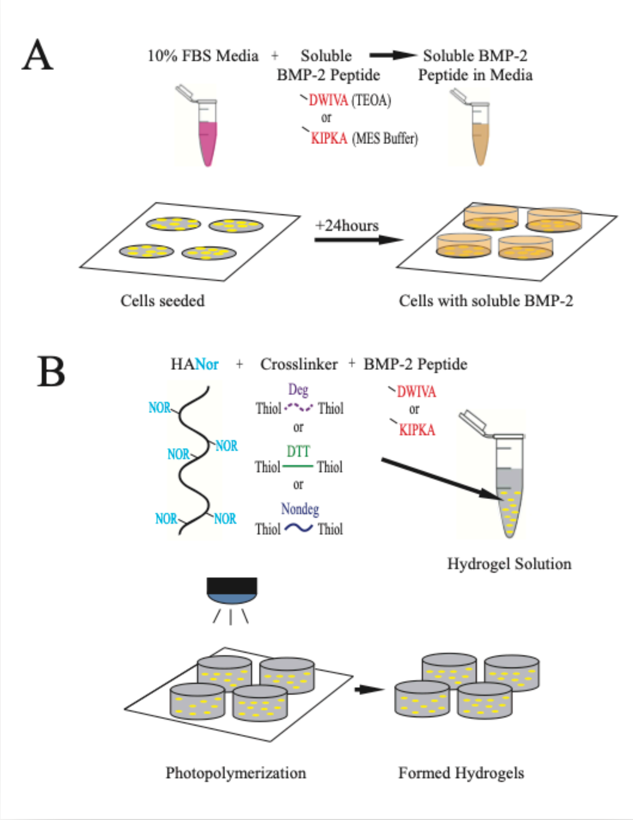
Effects of BMP-2 peptides on mechanosensing & osteogenesis in 3D hydrogels

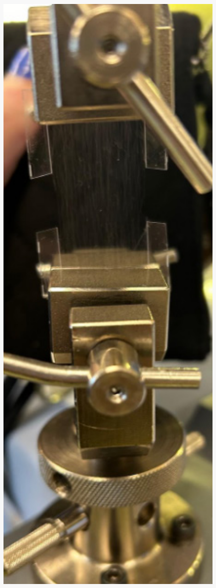
TEAM MEMBERS
Abigail McSweeny, Arielle Gsell, Marissa Pestritto

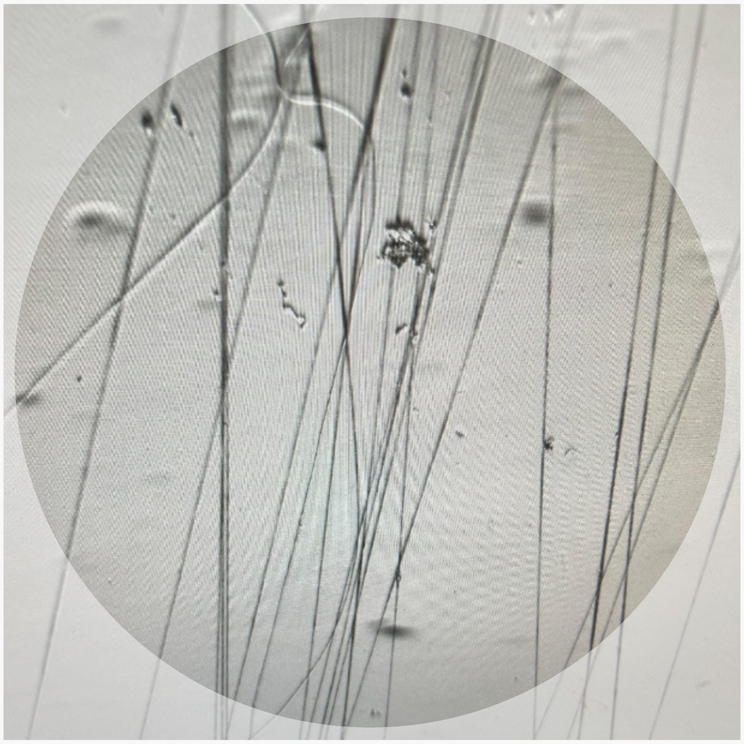
PROJECT MANAGERS
Dr. Sebastián Vega (Biomedical Engineering), Umu Jalloh (Biomedical Engineering), Myranda Sims (Biomedical Engineering)

SPONSORS
National Science Foundation, National Institutes of Health

While bone fractures typically heal with current medical interventions, about 10% of long bone fractures fail to heal. Biomaterials such as hydrogels can augment the healing process, thereby reducing the incidence of nonunions. Bone morphogenetic protein-2 (BMP-2) is a powerful inducer of bone growth, and peptides (DWIVA and KIPKA) that mimic the osteogenic domains of BMP-2 promote MSC (mesenchymal stem cell) bone differentiation. In this project, the individual and synergistic effects of DWIVA and KIPKA peptides on bone differentiation are evaluated in a dose-dependent manner in 2D (Fig. 1A) and 3D (Fig. 1B) MSC cultures. For 3D cultures, MSCs are encapsulated in degradable hydrogels functionalized with BMP-2 peptides. To study the effects of BMP-2 peptides on MSC behavior, samples are stained with biomarkers, imaged with a confocal microscope, and single cells are analyzed with ImageJ software. Specifically, matrix mechanosensing is evaluated by the extent of 3D cellular spreading and nuclear YAP (Yes-associated protein) localization, and osteogenic differentiation is assessed by the amount of nuclear Runx2 (runt-related transcription factor 2) and cytosolic alkaline phosphatase (ALP) in individual MSCs. These findings will guide the design of hydrogels that will be used to maximize bone healing in a preclinical rat femur fracture model.







Laser Treatment and Mechanical Testing of Electrospun Polylatic Acid Nanofibers

TEAM MEMBERS
Abigail Popoff

PROJECT MANAGERS
Dr. Vincent Z. Beachley
(Biomedical Engineering)

SPONSORS
National Science Foundation

Because of their unique properties, nanofibers have a wide range of medical applications. Their large surface areas, similar size to cells, and ability to direct cell alignment make them suited for applications like tissue engineering and drug delivery. To explore potential load bearing use, we want to improve the mechanics of electrospun polymer nanofibers, which are weaker than conventional fibers. Laser-zone drawing, a method of interest, has only been studied on microfibers while nanofibers have only been studied with drawing methods that lack the extreme temperatures laser drawing uses to induce reorganization of polymer chains. We are analyzing the mechanical properties of undrawn and laser-zone drawn polymer nanofibers to establish how and why laser drawing affects mechanical properties. The importance lies in understanding how laser treatments facilitate aspects like diameter thinning, rate of heating and cooling, and molecular alignment to develop an optimized nanofiber material. In this project, electrospun Polylactic acid (PLA) nanofibers are laser-zone drawn at different laser densities, employing the concept that more energy absorbance increases fiber temperature and pliability to allow for more aligned polymer chains during post-drawing. Understanding how laser treatment affects molecular alignment and mechanical properties of nanofibers will begin to display how widely laser-treated nanofibers can be applied.

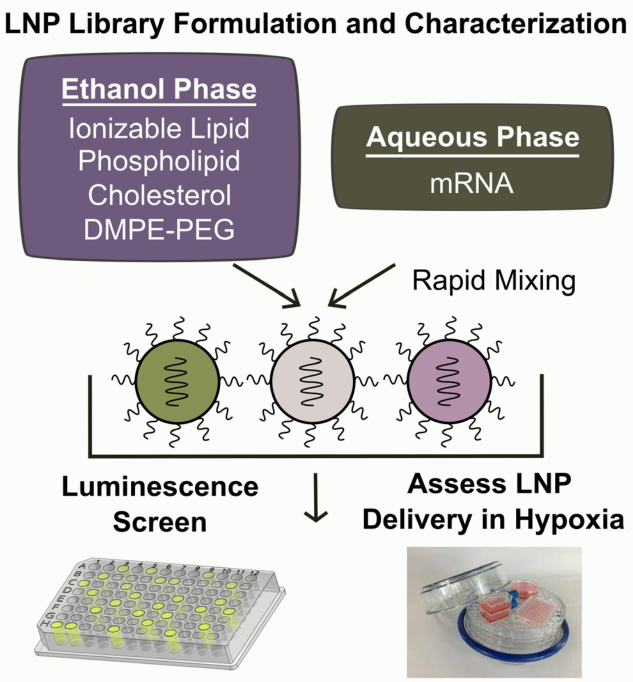
Assessment Of Placental In Vitro Models For Lipid Nanoparticle Delivery

TEAM MEMBERS
Krisha Darji

PROJECT MANAGERS
Dr. Rachel Riley (Biomedical Engineering)

SPONSORS
NJ Health Foundation, Preeclampsia Foundation, National Science Foundation, Engineering Research Initiation

Lipid nanoparticles (LNPs) have been developed by our lab for mRNA delivery to the placenta as potential therapeutics for preeclampsia. LNPs are comprised of RNAs complexed with four lipid components: ionizable lipids, phospholipids, cholesterol, and polyethylene glycol (PEG). LNPs allow for high transfection and low toxicity while protecting the encapsulated nucleic acids against degradation. Appropriate model systems must be utilized to design and study LNPs for maximal mRNA delivery to the targeted tissues and cells. In my clinic project, I am establishing normoxic and hypoxic in vitro models of pregnancy to examine how oxygen levels impact LNP-mediated mRNA delivery to placenta cells, called trophoblasts. In preeclampsia, the placenta is more hypoxic than in healthy pregnancies, and this low oxygen tension leads to impaired uteroplacental blood flow. Thus, it is necessary to understand how hypoxia influences LNP delivery and uptake in the diseased placenta. In my clinic project, I am assessing LNP delivery across three in vitro placental cell lines—HTR8/SVneo (first trimester), JAR (third trimester), and BeWo (third trimester)—cultured in normoxic and hypoxic conditions. I found that as oxygen concentration decreases, LNP uptake decreases across all cell lines. Ultimately, my work will inform future development of LNPs specifically designed for delivery to the hypoxic placenta.



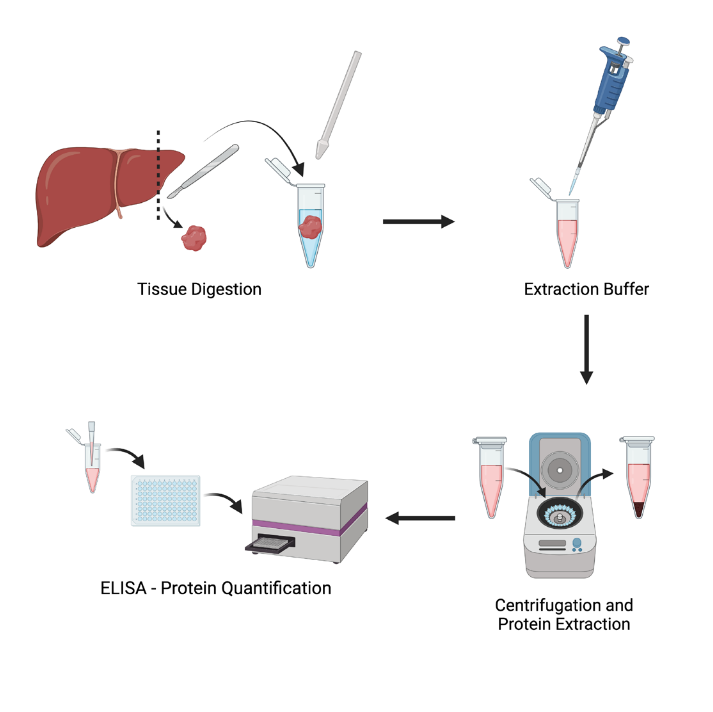
Engineering Immunomodulatory Lipid Nanoparticles for Treatment of Preeclampsia

TEAM MEMBERS
Nia Bellopede

PROJECT MANAGERS
Dr. Rachel Riley (Biomedical Engineering)

SPONSORS
The Preeclampsia Foundation, New Jersey Health Foundation, New Jersey Department of Health, National Science Foundation Engineering Research Initiation

Preeclampsia is a complication of pregnancy in which symptoms, such as high maternal blood pressure and proteinuria, present after Week 20 of pregnancy. While not fully understood, one mechanism underlying preeclampsia onset is aberrant inflammation at the maternal-fetal border early in gestation. Our lab is developing immunomodulatory lipid nanoparticles (LNPs) as a means to study and treat preeclampsia by regulating T-cell and macrophage activity.. The lab has developed LNPs that deliver nucleic acids to the placenta. We are using this platform to encapsulate and deliver cytokine messenger RNA (mRNA), including both IL-4 and IL-13, to control immune cell activity towards a tolerogenic immune state in support of placental development. To evaluate mRNA delivery, LNPs are injected intravenously to pregnant mice via the tail vein. In my clinic project, I digest the tissues to extract the proteins using an extraction buffer and an RBC lysis buffer. I quantify the amounts of IL-4 and IL-13 in these tissue extracts using enzyme linked immunosorbent assays (ELISAs). This work will inform future development of LNPs towards regulating abnormal immune activity in the placenta.



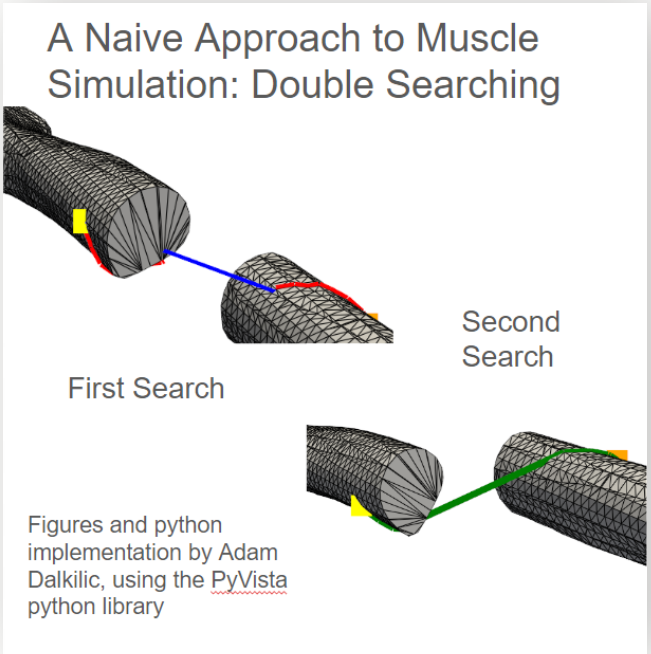
Efficient Graph Searches for Simulating Muscle Geometry During Real-Time Surgery

TEAM MEMBERS
Adam Dalkilic

PROJECT MANAGERS
Dr. Mohammed Abedin-Nasab (Biomedical Engineering)

SPONSORS
National Science Foundation

The shortest polyhedral path from some arbitrary start point to another point in a path filled with some obstacles has many applications in various engineering disciplines, and it has been studied for some time. The case of finding the shortest path within terrains with some change in obstacles' orientations and locations in space has also been studied. The case where obstacles are represented as 3D polyhedral, triangulated meshes is of particular interest in graphics simulations of muscles. Most algorithms that aim to solve shortest path problems among moving obstacles utilize a hybrid of pre-processing and real-time processing. Generating graphs for the static case and repeatedly traversing them for different start and end points is well documented. Generic visibility graphs are also useful for this niche. For moving objects, however, the graph representing connections between vertices may lose validity as some vertices no longer share a line of sight with others, requiring the grid to be reconstructed. For these cases, a more efficient graph representation is needed to minimize the delay in identifying viable connections while objects are moving. In our lab, we discovered a simple, intuitive extension to the traditional concept of a visibility graph, Sinaan's Graph (S-Graph), that is useful for finding the exact shortest path around moving obstacles (which will not be described here because it has not been published yet).



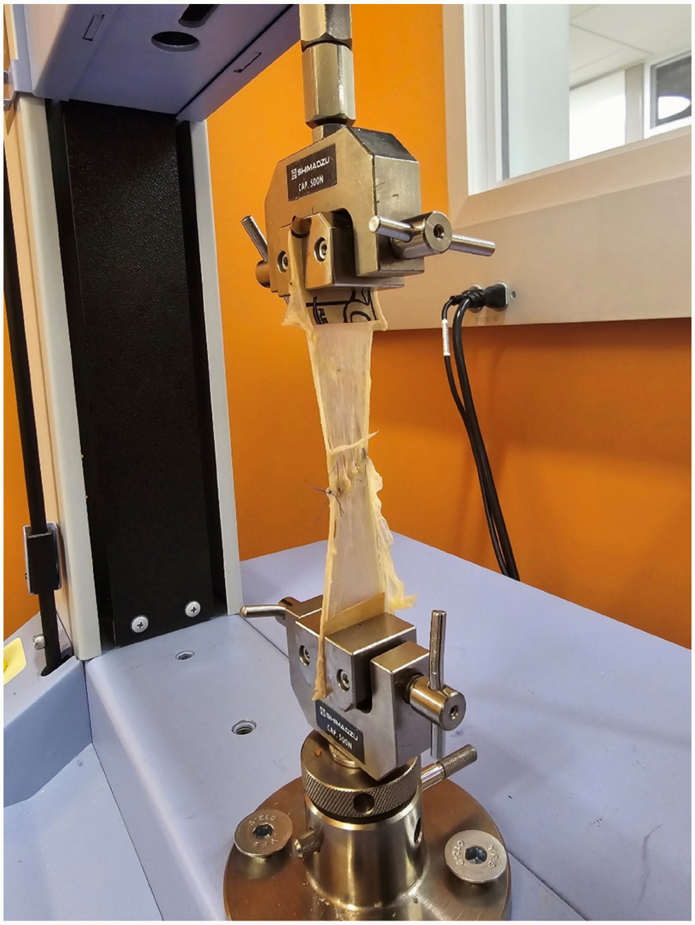
Fascia Clips

TEAM MEMBERS
Audrey Bathurst, Leeza Kumar,
Steven Simonetti

PROJECT MANAGERS
Dr. Daniel Mazzucco (Biomedical Engineering)

SPONSORS
ZSX Medical, LLC.

Abdominal fascia is a layer of connective tissue that surrounds and supports the muscles and organs contained within the abdominal cavity. Abdominal fascia closure following surgical procedures poses challenges due to complications such as incisional hernias which can lead to discomfort and chronic inflammation. The current standard-of-care is to suture the wound closed, but meta-analysis shows incisional hernias to be a common complication of midline laparotomy using this method. This is a compounding issue, with higher incident rates in vulnerable patient groups, and high recurrence rates leading to worse patient outcomes and increased risk of surgical site infection. Our solution aims to approximate and retain tissue without additional trauma and reduce uneven tension, to minimize complications and improve patient outcomes. Our proposed solution is a PLA clip, chosen based on its potential efficacy and compatibility with existing surgical practices. Prototypes have been generated for bench-top evaluation via 3D printing. Ongoing testing focuses on tensile strength of incised tissue when approximated by suture or our prototypes, and follows ASTM recommendations.Future work will refine the design and evaluate its performance using tissue samples for testing. We anticipate that our work, in the context of a broader project, will demonstrate that our device provides adequate tissue retention during healing.



Tensile testing in progress

Hydrogel blends for use in peripheral nerve regeneration scaffolds

TEAM MEMBERS
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PROJECT MANAGERS
Dr. Vincent Z. Beachley
(Biomedical Engineering)

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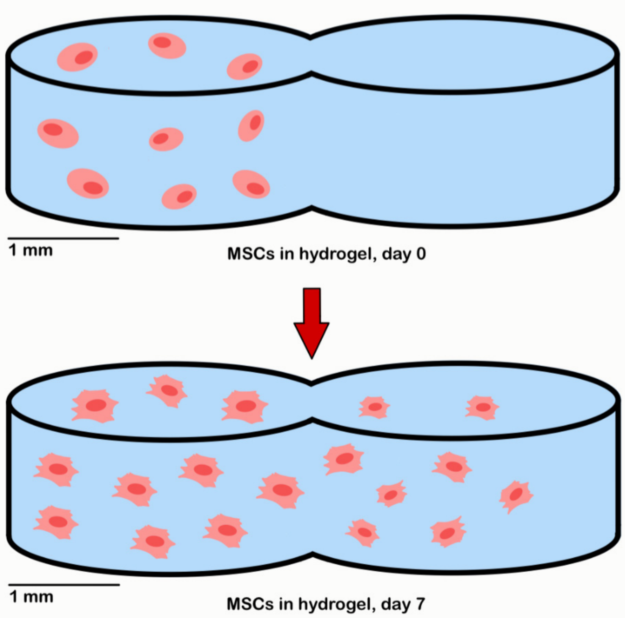
Peripheral nerve tissue damage such as nerve gaps in the limbs typically requires surgical intervention for proper healing. Nerve axons must have directional guidance to grow, leading to a need for scaffolds or grafts to provide structure and alignment in the place of a nerve gap. Allografts and Autografts are the current surgical methods used to assist nerve repair; however, these grafts have drawbacks such as difficulty in obtaining them, and risk of infection. As a result, researchers are investigating implantable scaffolds to facilitate nerve fiber regrowth, such as hydrogel and nanofiber scaffolds. Nanofibers direct cells to align and elongate during regeneration, while hydrogels mimic the natural cellular environment and provide a cell-permeable structure that fixes the aligned nanofiber architecture in a 3D structure. Our lab is developing a composite scaffold combining nanofibers and hydrogels; and specifically is investigating the use of different hydrogels to optimize cell migration and proliferation in these scaffolds. To assess the permeability of different hydrogels such as Gelatin Methacrylate and decellularized extracellular matrix gel, mesenchymal stem cells (MSCs) are seeded and cultured in hydrogels. Cells are seeded in one side of a 3mm by 3mm gel mold, while the other side is only hydrogel. Cells are imaged at days 0, 3, and 7, and the migration distance of cells is measured using the known mold dimensions.



Multimodal Evaluation of Knee and Hip Imaging: MDCT vs. Advanced CBCT

TEAM MEMBERS
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PROJECT MANAGERS
Jenna Roller, PA-C, Director of Clinical Applications (CBAI)

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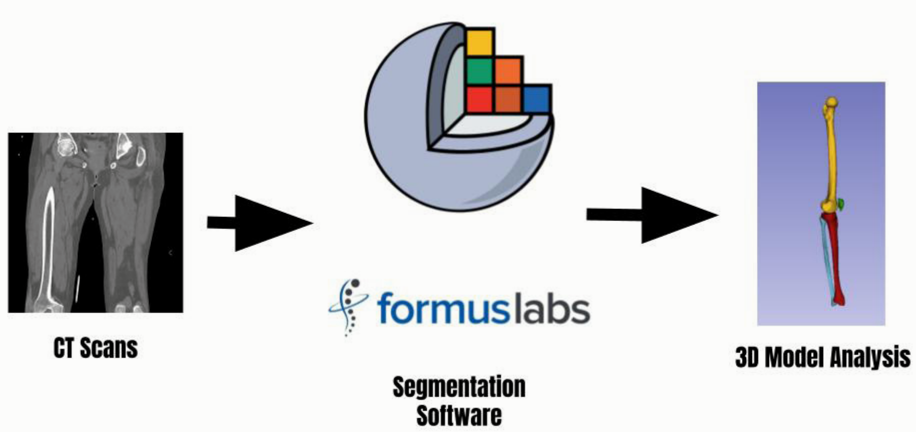
This study presents a comprehensive evaluation of knee and hip imaging modalities through a multimodal approach, comparing Multi-Detector Computed Tomography (MDCT) with Advanced Cone Beam Computed Tomography (CBCT). Four cadavers of varying Body Mass Index (BMI) sizes underwent imaging scans, with MDCT serving as the gold standard reference. The evaluation focused on three key aspects: Image Quality, Radiation Dose, and Segmentability. High-resolution CBCT scans were performed using different protocols to assess their efficacy in comparison to MDCT. Dose reports were gathered and analyzed for both modalities, with expert consultation aiding in dose interpretation. Segmentability was evaluated through manual and automated segmentation processes for knee and hip joints. Results revealed nuanced differences in image quality, radiation dose, and segmentability between MDCT and CBCT, providing valuable insights for clinical decision-making. This study underscores the importance of a multimodal approach in assessing the suitability of imaging modalities for knee and hip evaluations, offering valuable implications for surgical planning and clinical practice.



3D Nanofiber-Hydrogel Composite for Cellular Mechanosensing Analyses

TEAM MEMBERS
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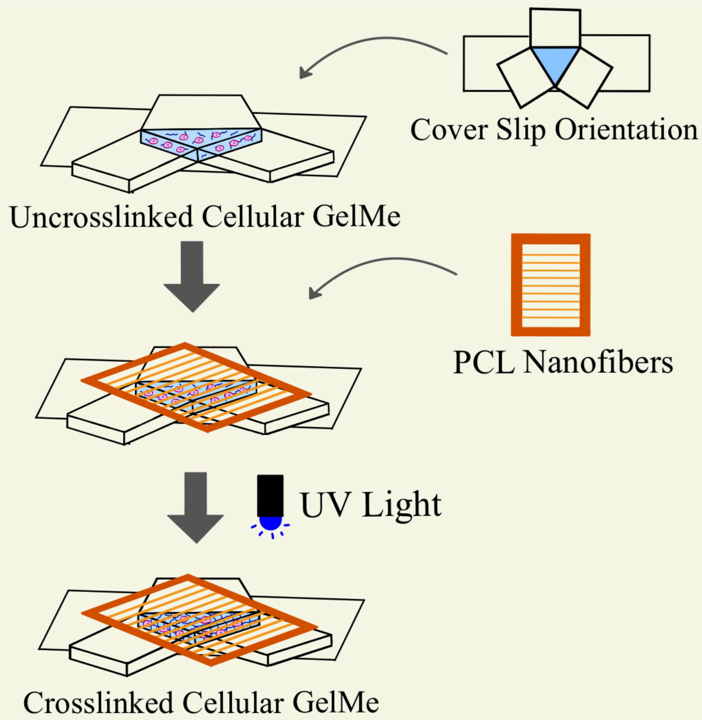
SPONSORS
Department of Orthopaedic Surgery, Cooper Medical School of Rowan University, Camden, NJ

Use of aligned nanofibers into existing peripheral nerve regeneration strategies have been proven to enhance various aspects of nerve regeneration. These enhancements include increased axon alignment and accelerated axon growth, facilitated through the provision of biophysical cues linked to the aligned nanofibers in the cellular microenvironment. Although there are studies supporting the added benefits of aligned nanofibers for nerve regeneration, there is limited data on the specific magnitude of cell nanofiber interactions that occur in hydrogels. The effects of hydrogel spacing between cells and nanofibers were studied, specifically trying to further understand cellular mechanosensing in a 3D environment including the biophysical cues from nanofibers. Hydrogel-nanofiber composites were constructed using layers of 4 wt% gelatin methacrylate (GelMe) and sheets of electrospun polycaprolactone (PCL) nanofibers. By using photo radical polymerization, layers of GelMe (~0.17mm) were crosslinked and stacked in varied amounts, with a sheet of nanofiber being placed at different levels of the composite in each group. At different time points, the composites were fixed and stained for single-cell morphology analyses.
The data collected will provide insight on the critical parameters needed to fine tune current approaches to peripheral nerve regeneration using biomaterials such as hydrogels and nanofibers.



Goniotape: A Wearable Alert System for Post Operative Patients

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Goniotape

Revision surgery of knee, shoulder, and hip arthroplasties occur when complications arise following the initial surgery. While there are several complications that may lead to revision surgery, there is an increased likelihood when patients don't adhere to the post-operative precautions provided by their occupational therapists. The precautions outline the appropriate range of motion for movements during the recovery process, like flexion, extension, abduction, and adduction, and are intended to promote successful healing following surgery. While the risk of arthroplasty revisions is significantly lower when precautions are followed, patient compliance remains a major factor to their poor adherence. Currently, there are no devices on the market that can help patients monitor their range of motion and provide them with feedback. In collaboration with medical device start-up Goniotape, founded by Occupational Therapists, Rowan engineering students are developing a wearable sensor that will solve this problem. Using Inertial Measurement Units (IMU), a microcontroller, and an Arduino IDE, spatial arrangements of each sensor can be determined to alert the patient if they are not adhering to their precautions. The accuracy of this system is verified by comparing the sensor data to values measured by a motion analysis software during dynamic testing to ensure that this design can accurately provide feedback to the patient.

Application of 3D Printing in Personalized Drug-Eluting Stents

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SPONSORS
Virtua Organ Transplant Center

Cardiovascular stents are medical devices used to open narrowed or blocked arteries, promoting improved blood flow and reducing symptoms of coronary artery disease. In particular, drug eluting stents are vital in the treatment of coronary artery disease, designed to release medication over time to prevent restenosis. However, commercially available stents are only available in pre-set sizes and uniform cylindrical shapes. These commercial stents do not address unique, patient-specific cardiovascular architecture, such as irregular geometry and variable length of vessels. 3D-printing of medical devices is an emerging field that seeks to develop customized devices designed on a patient-by-patient basis. However, this work has been limited to benchtop, academic research, with no published data of personalized stents in pre-clinical in vivo studies. To address this, our team, in collaboration with the Virtual Health Organ Transplant Center and their medical residents, are working to develop customizable, 3D-printed, drug-eluting stents, with a long-term goal of demonstrating safety and efficacy in in vivo studies. This year, initial testing has focused on drug release and mechanical testing using a variety of resins. In our work, we aim to achieve greater patient personalization of stents by utilizing 3D printing technology.

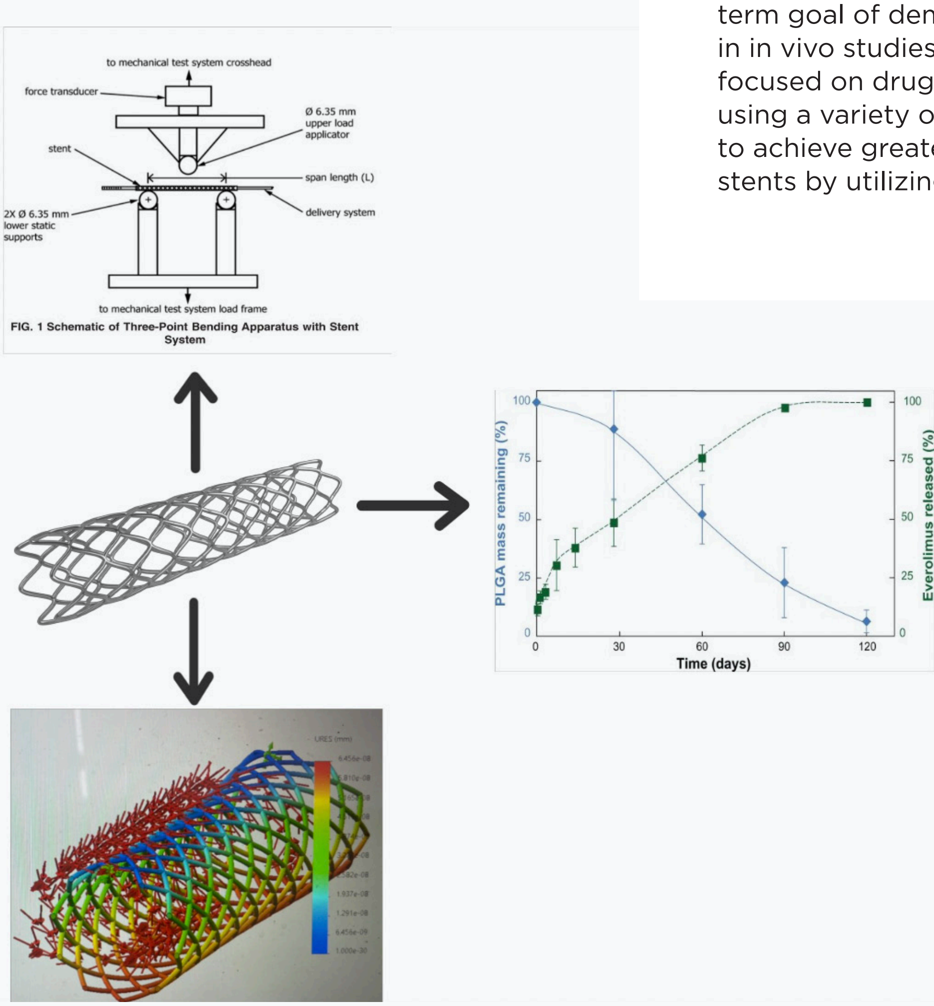
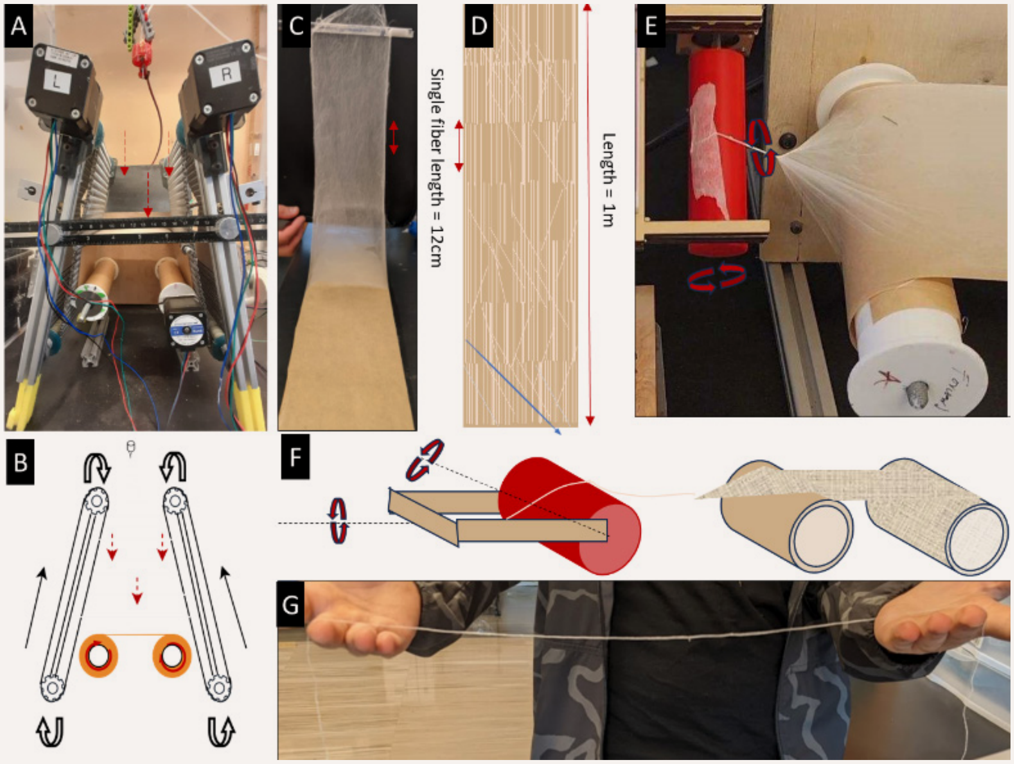


FIG. 1 Schematic of Three-Point Bending Apparatus with Stent System



Electrospinning Polyacrylonitrile (PAN) for Yarn Fabrication and Carbonization

TEAM MEMBERS
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National Science Foundation

Carbon nano yarns are a nanostructured material created by twisting carbon nanofibers into threads to create a yarn-like structure. Carbon nano yarns are used for multiple applications such as increasing the mechanical strength of medical devices, tissue scaffolding, drug delivery, and biosensors. Collections of polyacrylonitrile (PAN) nanofibers can be twisted into continuous yarns and then go through a stabilization and carbonization process to create carbon nano yarns. Current methods used to fabricate carbon nano yarns result in weak and short yarns. The length is limited to ~1m and the weakness is attributed to poor fiber organization in yarns. In our lab, we have an efficient way of electrospinning PAN nanofibers which includes two parallel tracks that collect the fibers onto a roving roll which allows for continuous collection of strong highly aligned PAN nanofibers. These aligned nanofibers are then twisted into continuous PAN nanofiber yarns and are ready for carbonization. With our electrospinning system, we produce highly aligned PAN nanofibers because of the electrical field and strong PAN nanofibers from our ability to use elongation of the nanofibers by adjusting the parallel track angles. The parallel tracks are angled by creating a larger gap at the bottom than at the top causing the elongation of nanofibers, enhancing the molecular alignment and strength.

3D Modeling for Organ Transplant Size Mismatch

TEAM MEMBERS
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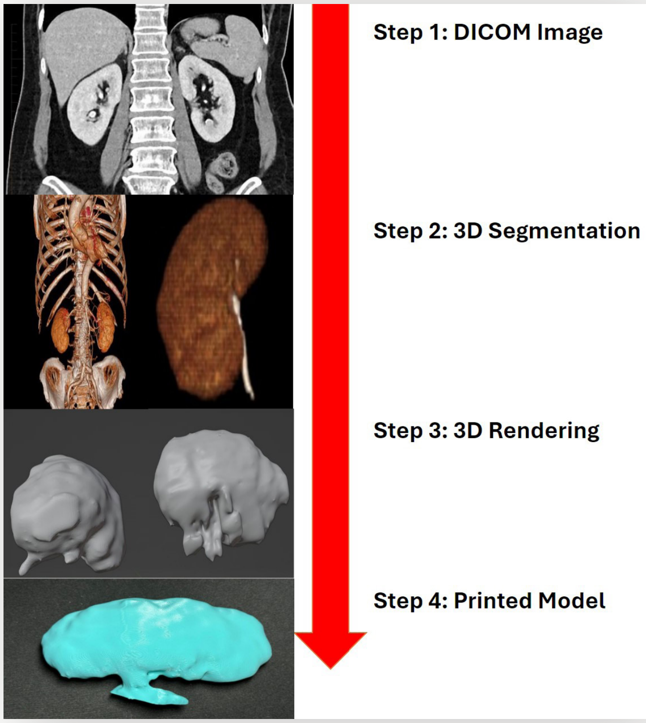
SPONSORS
Virtua Transplantation Team

In transplant surgery, matching organ sizes between donor and recipient is crucial to ensure optimal function and reduce the risk of complications post-operation: For instance, approximately 50% of recipients with small-for-size syndrome (SFSS) have been reported to die of sepsis within 4–6 weeks in liver transplantation. However, to assess the size match between donor and recipients, surgeons currently assess the size of the organ by merely eyeballing the donor and recipient CT/MRI scans. This 2D analysis is often misleading: A retrospective analysis from 2016 evaluated 770 liver transplantation cases and recorded a 19.9% incidence rate of postoperative hemorrhage that necessitated emergent surgical revision. Alternatively, 3D imaging and the use of 3D printing has shown promise in augmenting pre-operative planning in a variety of surgical cases, though its utility in mitigating size mismatching organ transplants remains untested. Therefore, Rowan engineers, in collaboration with the Surgical Transplant team at Virtua Health, have begun exploring the feasibility of using medical imaging for 3D rendering and pre-operative planning of organ transplantation. The teams hypothesize that poorer volumetric overlap between donor and recipient livers or kidneys for transplant surgeries correlates with increased intraoperative length time and increases in various post surgical morbidities.



Optimizing Lipid Nanoparticle Formulations for siRNA Delivery in Immunotherapy

TEAM MEMBERS
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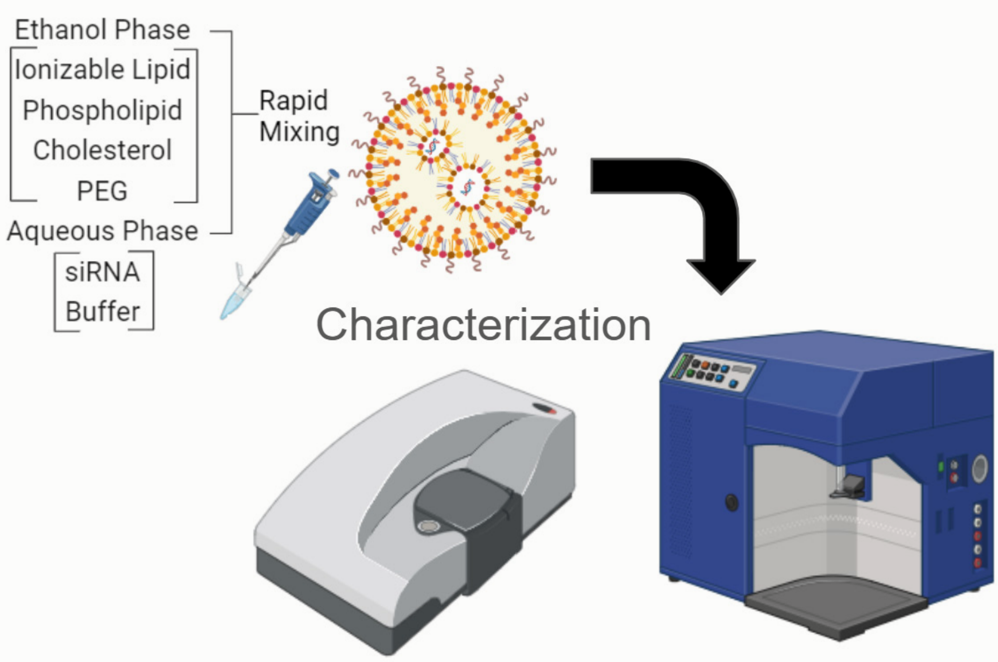
PROJECT MANAGERS
Dr. Rachel Riley (Biomedical Engineering)

SPONSORS
The New Jersey Department of Health,
New Jersey Commission on Cancer Research

Pediatric acute myeloid leukemia (AML) is the second most prevalent cancer in children, with a 70% survival rate and a 25-35% chance of eventual relapse. Current standard-of-care for pediatric AML includes chemotherapy and bone marrow transplantations, but these approaches have limited efficacy and severe adverse side effects. My clinic project is to develop a lipid nanoparticle (LNP) system to deliver therapeutic nucleic acids against pediatric AML. We are using LNPs to deliver small interfering RNA (siRNA) to inhibit WT1 expression, which drives cancer growth and survival, in AML cells. Thus, I hypothesize that silencing WT1 will inhibit cellular growth and survival. My role in this project is to formulate the LNPs, characterize the LNPs, and test siRNA delivery in vitro. I have developed various LNP formulations by changing the types and amounts of each lipid ingredient, and I characterized these formulations by Ribogreen assays for encapsulation efficiency and dynamic light scattering for hydrodynamic diameter. Further, I have conducted flow cytometry to assess LNP uptake in AML cells. These results can yield a new approach to treating pediatric AML by enabling high precision, targeted therapy for improved outcomes in these patients.



Evaluating an Injectable Hydrogel Treatment for Degenerative Disc Disease

TEAM MEMBERS
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PROJECT MANAGERS
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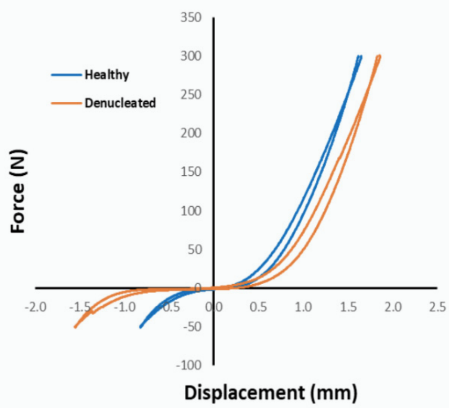
SPONSORS
ReGelTec Inc.

Degenerative disc disease, a common cause of lower back pain, is a condition characterized by the dehydration of the intervertebral disc, leading to diminished biomechanical properties. While spinal fusions are an accepted treatment method, they are highly invasive and can reduce movement capability, especially if multiple discs are afflicted. To address this issue, ReGelTec is developing HYDRAFIL™, a noninvasive injectable hydrogel intended to restore the functions of the intervertebral disc. Therefore, the purpose of this study was to develop a biomechanical test method capable of evaluating the restorative properties of HYDRAFIL™ in a bovine tail model that recreated the effects of degenerative disc disease. Initial studies focused on axial compression testing, using bovine tails subjected to nucleotomies to partially remove disc material, which accurately recreated the biomechanical effects of degenerative disc disease. With the nucleotomies performed on the segments, there was a consistent reduction in both disc height and stiffness. Conversely, after the treatment to these segments with HYDRAFIL™, there was a restoration in disc stiffness and height. This indicates the potential for HYDRAFIL™ to have restorative effects in the spinal disc. Further studies have to be done to verify these results in other types of spinal motion, such as bending and flexion.



Advancing Pediatric Bone-Conduction Hearing Aids

TEAM MEMBERS
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PROJECT MANAGERS
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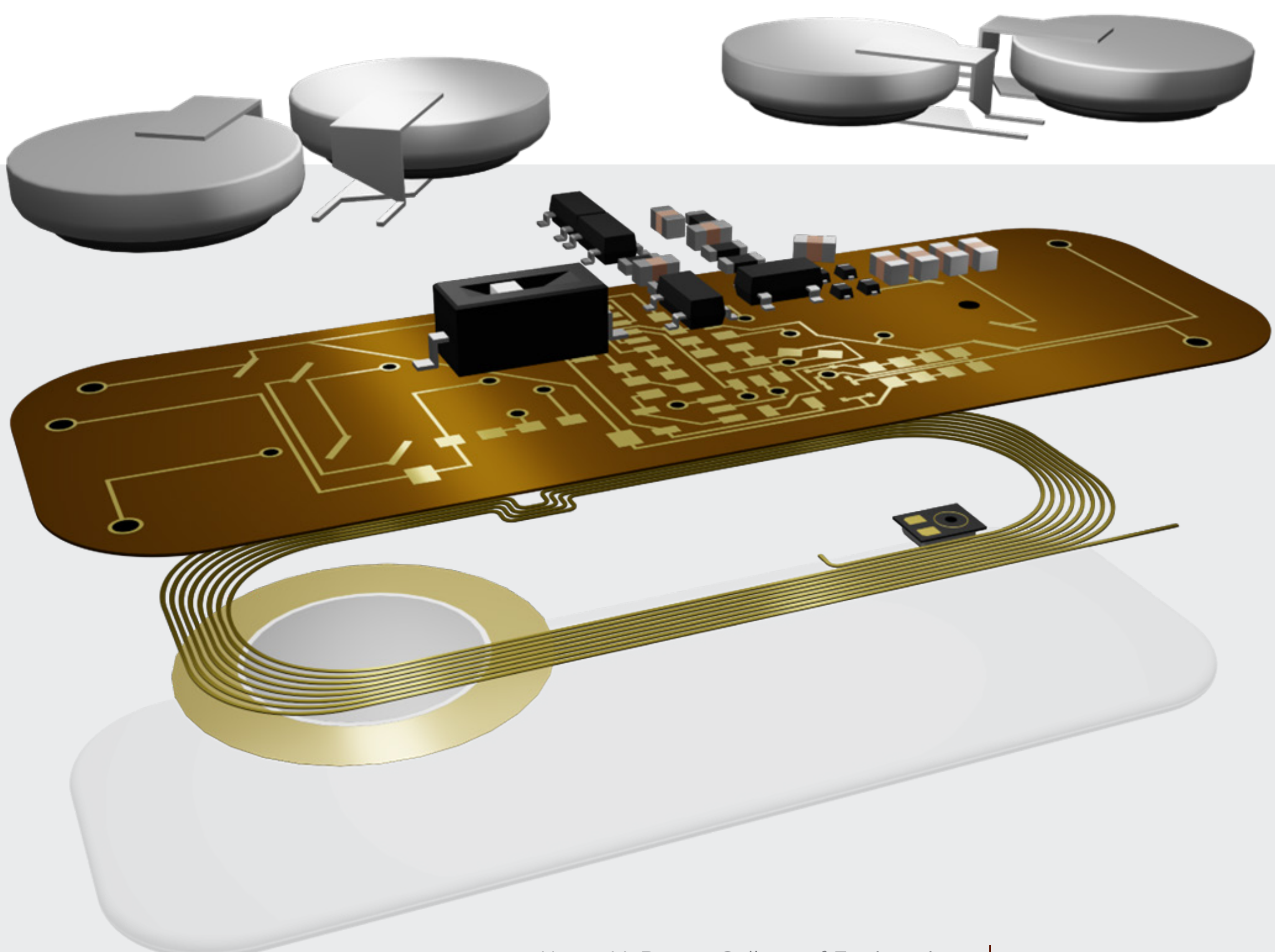
Enosh Lim (Biomedical Engineering)

SPONSORS
National Institutes of Health

Millions of people globally have disabling hearing loss, with a significant portion of those being children. Most children are diagnosed with conductive hearing loss (CHL), in which sound transmission from the external ear to the cochlea is impacted. Surgical options like corrective surgeries and bone-conduction hearing aids are highly invasive and unsuitable for infants, leading to the exploration of non-surgical alternatives. Concerns with existing non-surgical conductive hearing aids are stigma, discomfort, and accessibility. Looking at accessibility, low-to-middle-income countries have a greater prevalence of the factors causing CHL; however, these hearing aids are expensive for most patients. Overall, existing solutions are not suitable for pediatric patients. This research introduces a noninvasive bone-conduction hearing aid on a flexible substrate for pediatric patients. The hearing aid has a Band-Aid®-like design: ultra-thin, unnoticeable, and comfortable. The power management of the device is being improved to extend the lifetime of the batteries and to increase overall convenience. The study's first phase explores ultra-thin batteries and circuit modifications to decrease power consumption. The second phase of this study investigates the incorporation of a wireless charger for convenience and device protection. Finally, these hearing aids are tested to confirm their conformability and effectiveness.



Novel Silicone Hydrogel Contact Lenses for Delaying Myopia Onset and Severity

TEAM MEMBERS
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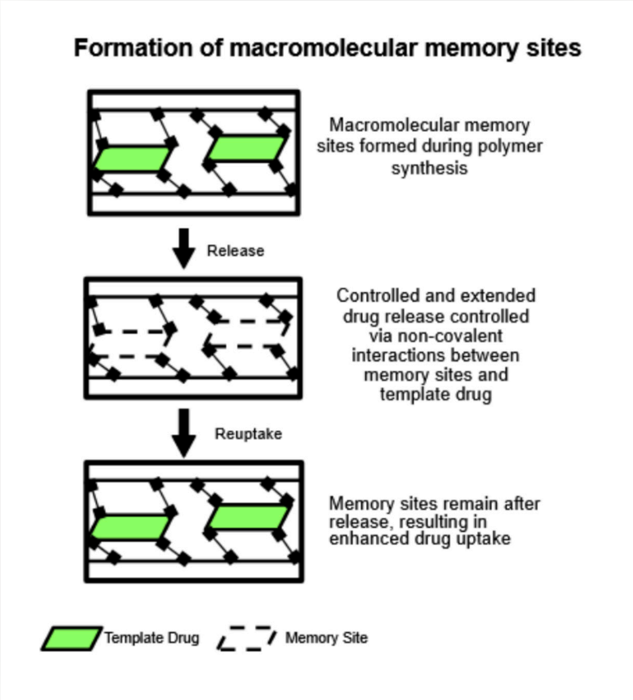
PROJECT MANAGERS
Dr. Mark Byrne (Biomedical Engineering)

SPONSORS
OcuMedic, Inc.

Myopia is an eye disease causing improper light refraction in front of the retina, leading to blurred vision and headaches (in severe cases). Over 30% of the world's population suffers from it, and incidence is rising, with an estimated 50% expected to be myopic in 2050. Myopia is treated with corrective glasses or lenses. Onset and severity can be lessened with topical drug solutions, however, this method has significantly poor bioavailability (only 2-8% reaches the target site). This research focuses on the synthesis of therapeutic silicone-hydrogel extended wear contact lenses that release a therapeutic drug at a controlled and extended rate for the duration of wear. Drug release is controlled via the polymer engineering technique known as macromolecular imprinting, which involves the addition of drug molecules to the prepolymer formulation along with functional monomers that non-covalently bind the drug, resulting in formation of macromolecular memory sites during polymer synthesis. The monomer to drug template ratio can be used to control release rate based on the amount of chemistry within the polymer and degree of memory site formation, resulting in a therapeutic lens with controlled release of drug, having potential for a more efficient and effective treatment.



Robot-Assisted Femur Surgery: Integrating Virtual Fixtures & Haptic Feedback

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Kenechukwu Adibe

PROJECT MANAGERS
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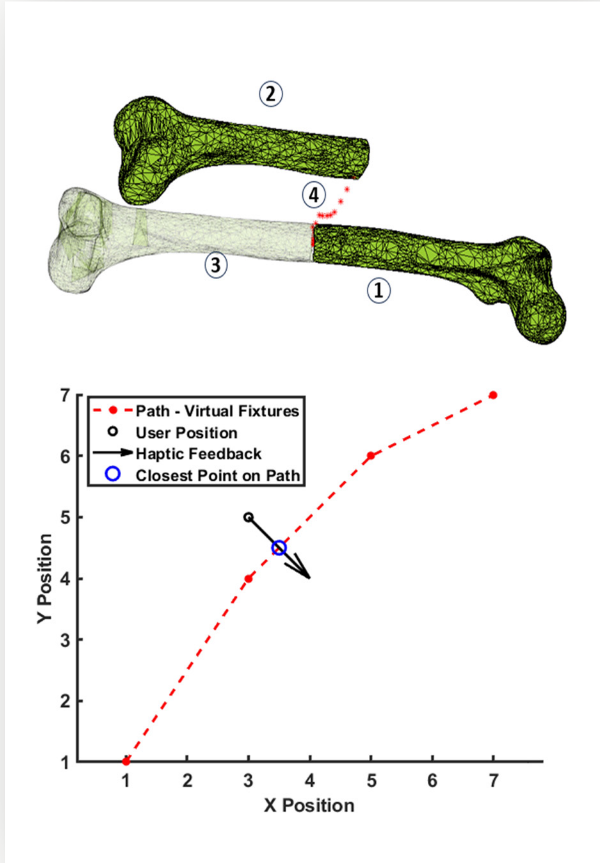
(Biomedical Engineering)

SPONSORS
National Science Foundation

Femur fractures represent a significant challenge within the healthcare system, necessitating advancements in surgical methods to improve outcomes and reduce risks. Standard techniques for reducing femur fractures are manual, and the limitations include high incidences of mal-alignments and high exposure to radiation for the surgical teams. While mitigating risks associated with manual methods, surgical robotics can reduce the surgeon's tactile feedback, essential for intuitive decision-making. This work introduces the development of a haptic feedback method for the realignment of femur fractures. Our system addresses these issues by developing a modified A* search algorithm, virtual fixtures, and haptic feedback. The A* algorithm calculates the shortest path in both the rotational and translational workspace while avoiding bone collisions, improving the precision and accuracy of the femur fracture alignment. The virtual fixtures and haptic feedback provide tactile information, thus bridging the gap between surgeon and robot. We validate the proposed work using theoretical and experimental testing. Our approach promises to improve femur fracture treatment, offering improved accuracy, reduced risk, and a more intuitive experience for surgeons.



Robosis

TEAM MEMBERS
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PROJECT MANAGERS
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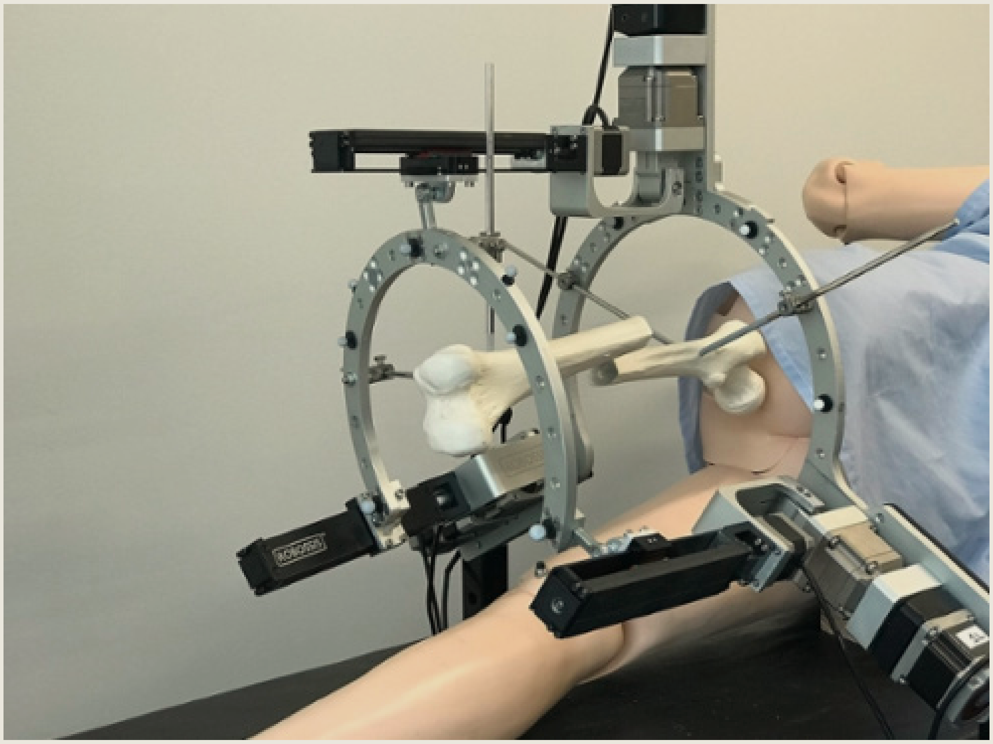
Biomedical Engineering)

SPONSORS
National Science Foundation,
Virtua Willingboro Hospital,
Virtua Our Lady of Lourdes Hospital

Out of all of the bones in the body the femur bone is the strongest in the human body. What happens when the femur bone breaks? The femur bone is situated beneath some of the strongest tissues and muscles that makes it difficult to be put back into place. The process to put the femur bone back into place is a long strenuous and tiring procedure for surgeons to go through. What Robosis is, it is a medical device to help aid in putting the femur back into place. There are three main components to the device: the robot itself, the imaging software, and a haptic device. With these three components it helps the surgeon realign the bone with less physical labor and more efficiently. What Robosis is provided for the surgeon is stronger eyes with the imagining software so teh surgeon can see what is happening on the inside of the leg without opening the leg fully. Also Robosis is providing a stronger hand for the surgeon. The next step of Robosis is to start commercializing Robosis to help more surgeons and patients in the future.



Evaluation of EPDA Receptors in Mammalian Cells via Hydrogel-Peptide Conjugation

TEAM MEMBERS
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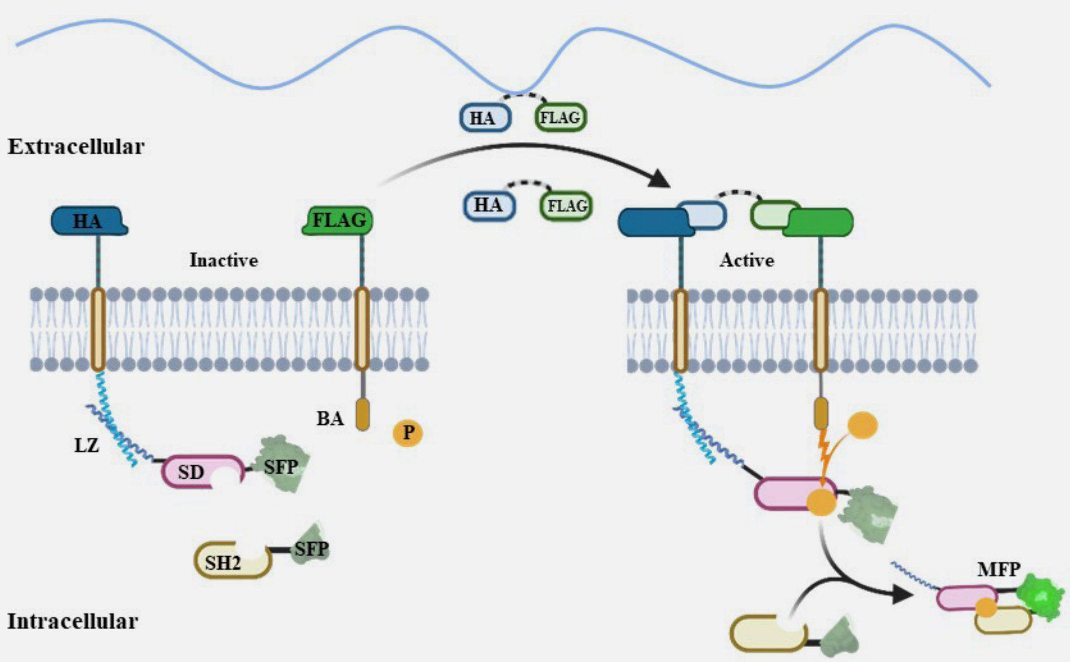
Dr. Sebastián Vega (Biomedical Engineering), Matthias Recktenwald (Biomedical Engineering)

SPONSORS
National Science Foundation

Recent advancements enable mammalian cells to express synthetic surface receptors, yet limited understanding exists regarding receptor interaction with ligands conjugated to artificial materials. This study reports the development and characterization of a novel Extracellular Peptide-Ligand Dimerization Actuator (EPDA) cell-surface receptor system which can activate and deactivate cellular responses based on its interactions with synthetic stimulatory and inhibitory peptide-ligands. The extracellular portion of the system contains binding domains specific to FLAG-HA, an orthogonal epitope tag peptide group. The peptide group is conjugated to the hydrogel via chemical crosslinking, and the extracellular binding triggers a cascade that occurs intracellularly in engineered HEK293 cells that are transfected with EPDA receptors. The intracellular portion features a reversible leucine zipper dimerization domain that recruits a CD3z substrate and a CD3z-sensitive kinase. The kinase phosphorylates following peptide stimulation, leading to the recruitment of a Zap70 SH2 domain which facilitates the assembly of split fluorescent protein halves. The novel engineering of HEK293 cells before encapsulation in hydrogels was followed by viability testing of encapsulated cells with growth serum media cell groups predicted to have higher viability, and promising results demonstrate enhanced efficacy of biomaterial-based therapies.



Hydrogel Clarity for Cataract Posterior Capsule Opacification Treatment

TEAM MEMBERS
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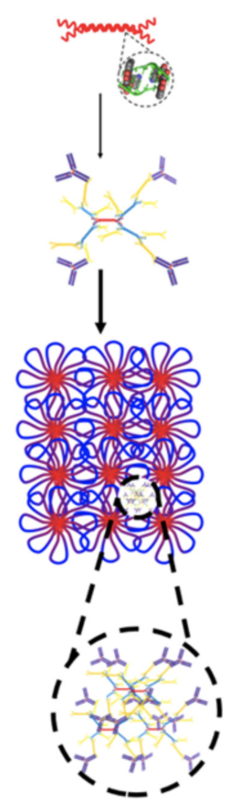
PROJECT MANAGERS
Dr. Mark Byrne
(Biomedical Engineering)

SPONSORS
Cooper Foundation, OcuMedic, Inc.

This report presents an examination of a parametric study aimed at developing self-assembling, injectable hydrogels for sustained drug release of DNA nanoconjugates to mitigate post-capsule opacification (PCO) after cataract surgery. The investigation focuses on the synthesis and characterization of these hydrogels, emphasizing the optical clarity of polymer solutions and its dependence on various formulation parameters. The study explores the impact of solution concentration, particularly of poly(D,L-lactic-co-glycolic acid)-b-poly(ethylene glycol)-b-poly(D,L-lactic-co-glycolic acid) (PLGA-PEG-PLGA) triblock copolymers, poly-L-Lysine (PLL) concentrations, and the inclusion of anionic hyaluronic acid (HA). Solutions were prepared with varying concentrations of PLL and HA, along with different sizes of HA molecules, to assess their effect on optical clarity and release kinetics. Key findings reveal an inverse relationship between triblock copolymer concentration and optical clarity across a broad spectrum of wavelengths, indicating a consistent trend. Surprisingly, the presence and concentration of HA and PLL show minimal influence on optical clarity. This highlights the significance of triblock copolymer concentration as the primary determinant of optical properties in these hydrogels.



DNA Conjugated Gold Nanoparticles for Controlled Chemotherapeutic Drug Delivery

TEAM MEMBERS
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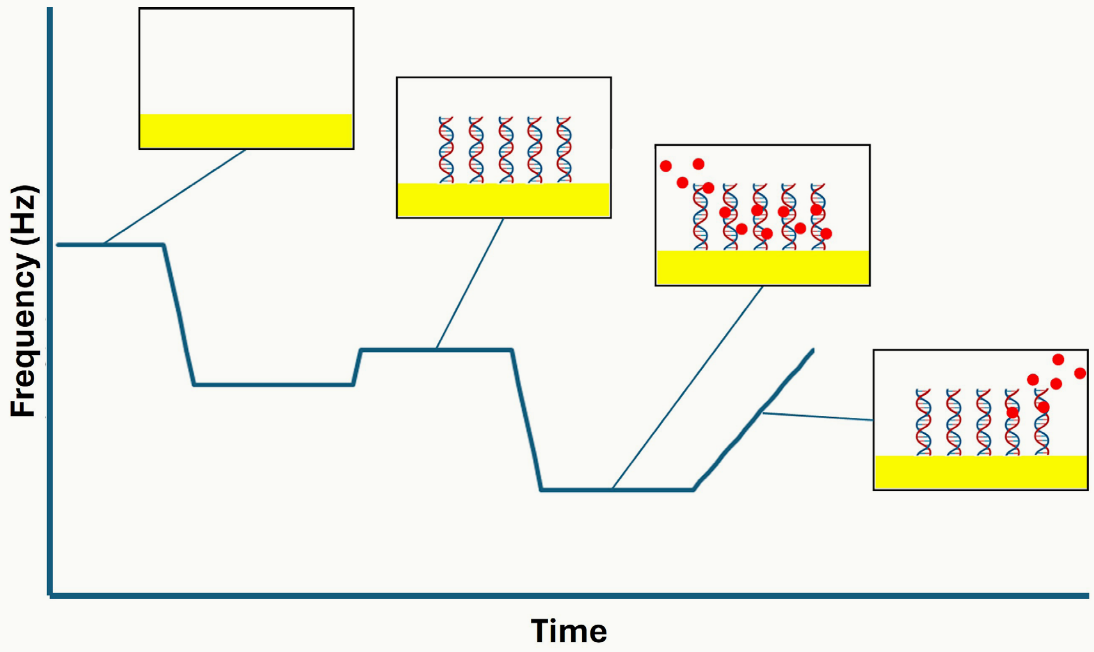
Dr. Mark Byrne
(Biomedical Engineering)

SPONSORS
Goldwater Foundation

Cancer is a highly varied collection of diseases that inflicts a tremendous economic and physical burden on patients around the world. Acute Myeloid Leukemia (AML) is one such disease associated with high financial burdens and degradations in health following chemotherapeutic regimens and the course of the disease itself. However, despite what patients sacrifice for a better quality of life, clinical outcomes for AML remain poor. These factors highlight the need for novel chemotherapy delivery platforms that augment the effectiveness of small molecule drugs through passive targeting while minimizing toxic effects via controlled drug release. This research focuses on the design and optimization of a novel drug delivery platform featuring gold nanoparticles conjugated with DNA oligonucleotides that are loaded with daunorubicin hydrochloride, a drug often used in treating AML, for controlled drug release. Nucleic acid (NA) strand composition, length, density, and architecture have been varied to control drug release for durations of days to weeks. Recent efforts to characterize and optimize this method of drug delivery have involved quartz crystal microbalance with dissipation monitoring (QCM-D) to fully elucidate the role of DNA oligonucleotide architecture on gold surfaces in drug release. Fully understanding the mechanisms that govern release from this platform is imperative for its success in various treatment strategies.



Universal Hitch Attachment for Strollers, Shopping Carts for a Blind Veteran

TEAM MEMBERS
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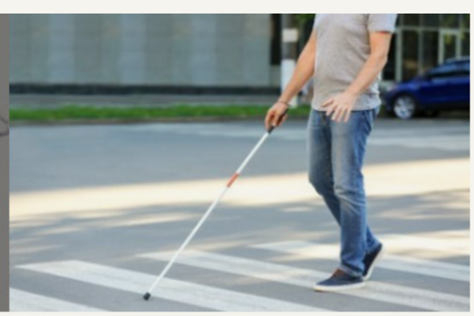
PROJECT MANAGERS
Dr. Erik Brewer (Biomedical Engineering)

SPONSORS
Quality of Life Plus

United States Army veteran Mike Nelson, visually impaired due to injuries sustained during his military service, faces the daily challenge of maneuvering a stroller while utilizing his white cane. To address this challenge, our team at Rowan University, partnering with Quality of Life Plus (QL+), is designing an attachment that enhances Mr. Nelson's mobility without compromising safety or comfort of the stroller or impairing the use of his white cane. The stroller attachment, designed to meet ASTM F833-21 safety standards applicable to all strollers, features an extendable platform with wheels, allowing Mr. Nelson to pull or push the stroller while maintaining alignment and ease of use with his white cane. This innovative design is intended to be compatible with a variety of stroller models, ensuring its universal usability. By incorporating feedback from Mr. Nelson and consulting with industry experts such as Occupational Therapists and Mobility Specialists, we aim to create a solution that not only meets Mr. Nelson's specific needs but also provides a template for addressing similar challenges faced by visually impaired individuals. This project exemplifies the application of engineering principles to improve the quality of life for those facing unique mobility challenges.



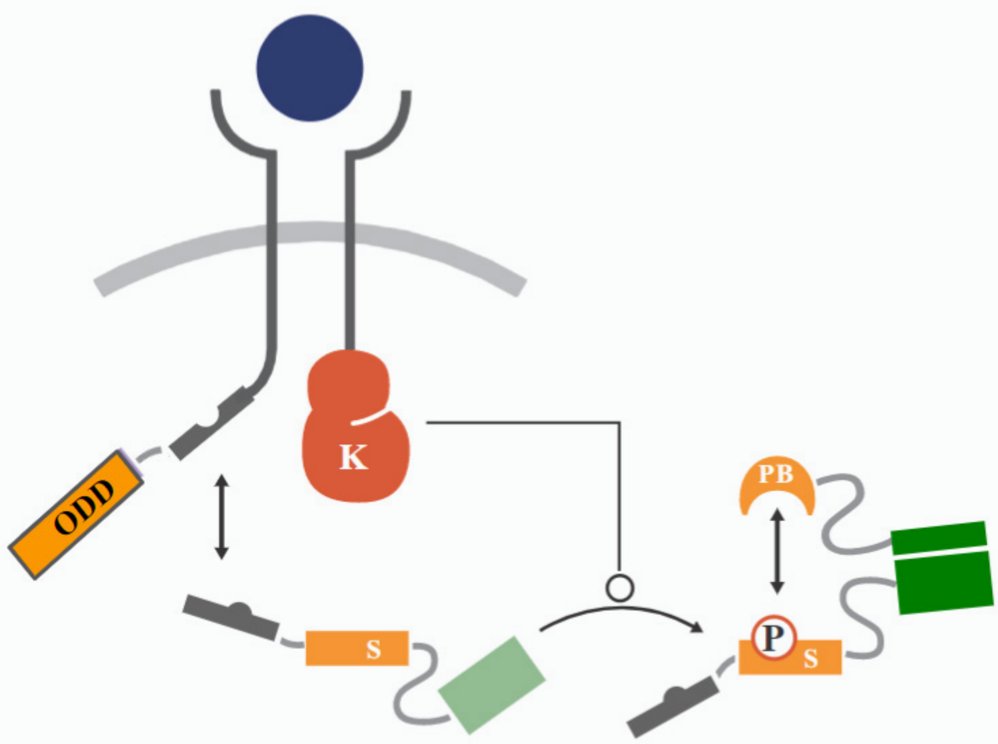
A Novel Approach to Hypoxia Sensing: a HIF-Based Genetically Encoded Biosensor

TEAM MEMBERS
Madeline Dunsmore

PROJECT MANAGERS
Dr. Mary Staehle
(Biomedical Engineering)

SPONSORS
National Science Foundation

The dynamic and hostile tumor microenvironment (TME) of solid tumors stands as a significant barrier to the efficacy of targeted therapeutic interventions. Hypoxia, a prevalent feature of the TME, drives cancer progression through angiogenesis, metabolic alterations, and increasing metastasis, while impairing the effectiveness of conventional treatments. Cellular responses to hypoxia are predominantly governed by hypoxia-inducible factors (HIFs), which offer promising therapeutic targets. We propose leveraging HIFs to address hypoxic conditions in the TME, harnessing them as tools for cell-based therapeutics. To elucidate the dynamics of HIF-1a and HIF-2a, we developed a constitutively-active intracellular biosensor with portions of the oxygen-dependent degradation domains (ODDs) of HIF-1a and HIF-2a. The activation of this biosensor triggers an orthogonal phosphorylation cascade, culminating in the reconstitution of a split fluorescent protein. This circuit enables real-time monitoring of HIF dynamics via analyzing mean fluorescent intensities, offering insights into their potential manipulation in cancer therapy. We have observed increased functionality of HIF-2a compared to HIF-1a in severe hypoxic conditions (1%). This 11-fold change in activation of the HIF-2a ODD, compared to the 3-fold change in activation for HIF-1a, underscores HIF-2a's potential for utilization in therapeutic applications for targeting solid tumors.

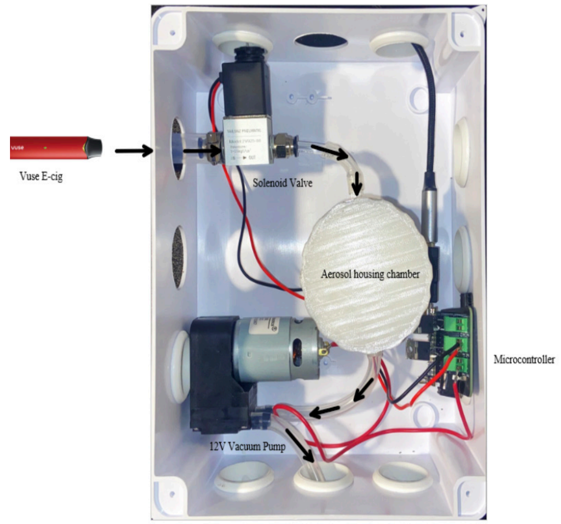


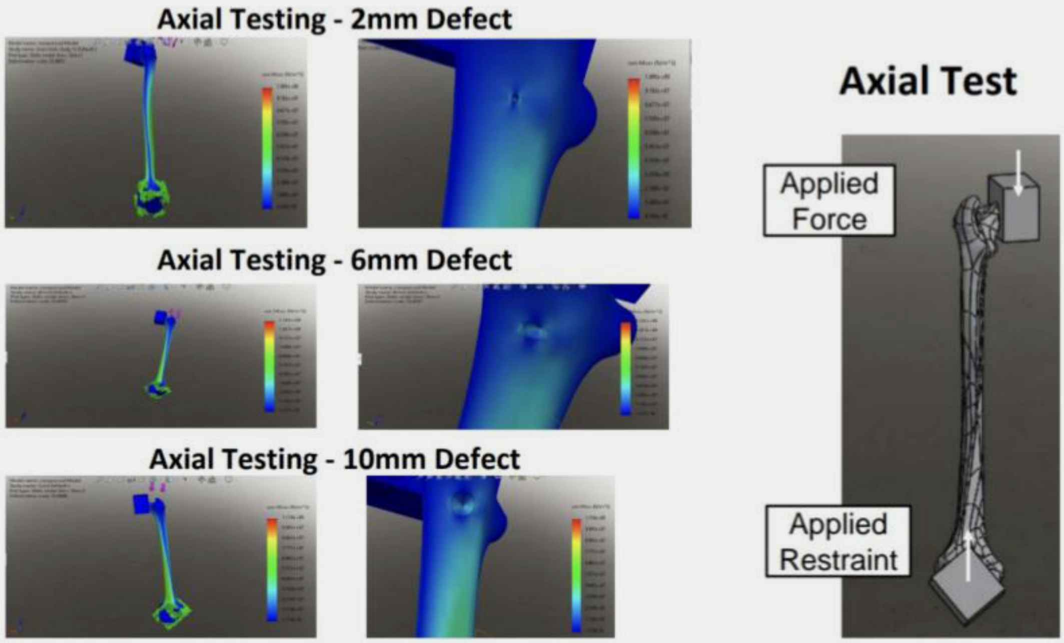
Aerosol Cell Culture Chamber

TEAM MEMBERS
Edward Davis, Jesus Martinez Sosa

PROJECT MANAGERS
Dr. Erik Brewer
(Biomedical Engineering)

While cigarettes and other forms of tobacco use have been extensively researched using decades of clinical records, there is little data available to test the relative safety of e-cigarettes compared to other forms of tobacco use. Furthermore, there are no accepted in vitro lung models to evaluate these. Therefore, molecular biologists have contracted Rowan engineers to develop a cell culture chamber capable of pulling aerosolized smoke from vape pens, while further recreating natural respiratory patterns. The chamber aims to house the lung cell culture model and allow for direct interaction with the vapor coming from e-cigarettes, using programmed vacuum draws to mimic repeated pulls from the e-cigarette. The programmed vacuum also allows for fresh air intake, clearing the cell culture chamber. By varying the amount of the programmed e-cigarette pulls, along with intervals of fresh air intake, the cell culture chamber will be able to assess a variety of e-cigarette exposure regiments. As a result of this work, cell biologists will be able to assess geno- and cytotoxic effects of e-cigarettes in a robust benchtop model.





Investigating Fracture Risks Associated with Corticotomies in Femoral Bones

TEAM MEMBERS
Ansh Patel, Alexa Warren, Sierra Finn

PROJECT MANAGERS
Dr. Christina Gutowski, MD, MPH (Cooper University Healthcare),
Alison Blumstein (Cooper University),
Evan Derector (Cooper University),
Dr. Erik Brewer (Biomedical Engineering)

Within orthopedic surgery, the manipulation of bone structures, notably via corticotomies, is required for accessing the internal bone canals. Yet, the repercussions of such interventions on bone integrity, especially in patients with osteoporosis, are poorly understood. This investigation, employing Finite Element Analysis (FEA) and mechanical testing, hypothesizes that corticotomies jeopardize the strength of femoral bones, escalating the risk of postoperative fractures. In collaboration with Cooper University, we aim to evaluate how surgical factors—such as corticotomy configuration, size, and placement—affect fracture susceptibility in healthy and osteoporotic bones. Using a two-phase approach, we initially applied FEA to a detailed femur model reconstructed from a CT scan, simulating stresses under varied loading conditions—axial (to mimic walking) and lateral (to simulate a fall). Subsequently, mechanical testing was conducted on synthetic bone models to assess mechanical responses post-surgery. Initial observations indicate a correlation between cortical defect size and heightened local stresses, indicating a notable decline in bone strength following corticotomy. By explaining the biomechanical implications of corticotomies, our study contributes to establishing standardized surgical protocols and enhancing the utility of FEA in orthopedic investigations.

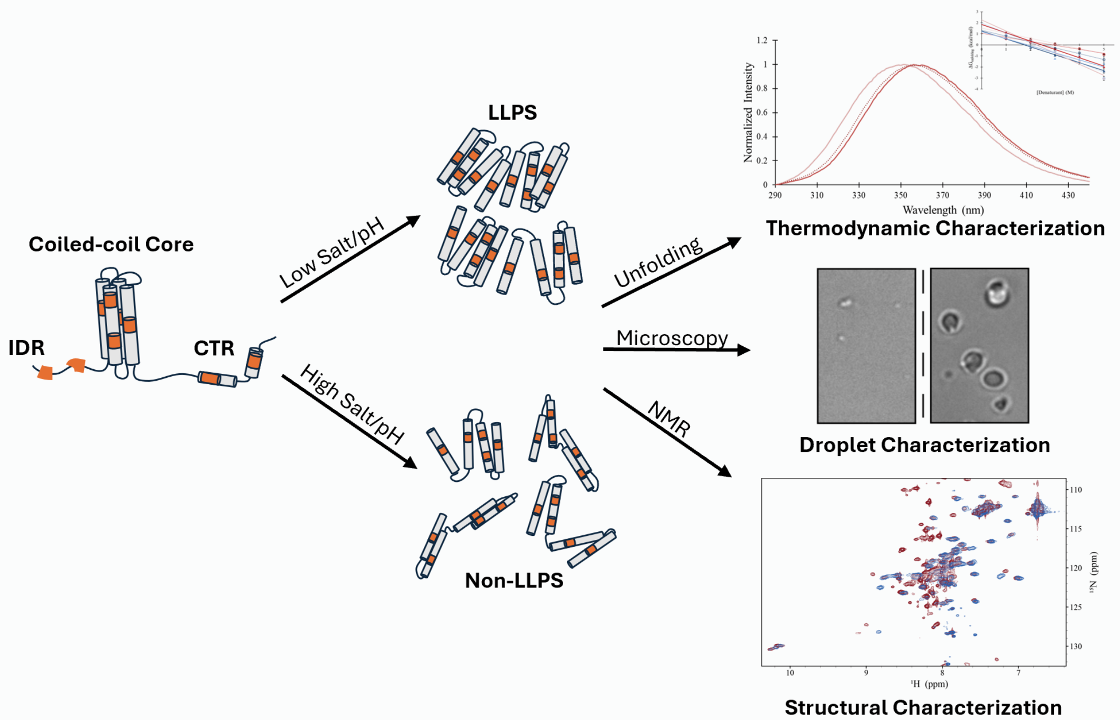
Structural characterization of liquid-liquid phase separating protein, McdB

TEAM MEMBERS
Heather Tejeda, Kali Pierson

PROJECT MANAGERS
Dr. Nathaniel Nucci (Molecular and Cellular Biosciences),
Dr. Anthony Vecchiarelli (University of Michigan)

SPONSORS
National Science Foundation, The American Chemical Society Petroleum Research Fund, U-RISE@Rowan

Liquid-liquid phase separation (LLPS) occurs when a homogenous solution experiences a change in conditions that causes two coexisting liquid phases. LLPS has recently been observed to have a crucial role in cellular organization and the formation of bacterial microcompartments. Dysregulation of LLPS has been associated with pathological protein aggregation linking it to neurodegenerative diseases, further emphasizing its importance in cellular functions. LLPS-forming polymers are a new potential avenue for developing drug delivery platforms. Generally, LLPS-forming proteins are either disordered or composed of large, coiled-coil domains. Maintenance for carboxysome distribution protein B (McdB) is a model system with both an intrinsically disordered region and a coiled-coil core domain that is capable of driving LLPS in a pH- and salt-dependent way, though the structural changes associated with this change are unknown. Using native tryptophan fluorescence, circular dichroism (CD), and nuclear magnetic resonance (NMR) spectroscopy, we show that the core domain undergoes a transition from a more well-defined state at low pH, with a loss of tertiary and secondary structure at high pH, and that the unfolding of both states lack cooperativity. By characterizing the structural hallmarks associated with LLPS-formation, we aim to inform intentional design of engineerable LLPS systems.

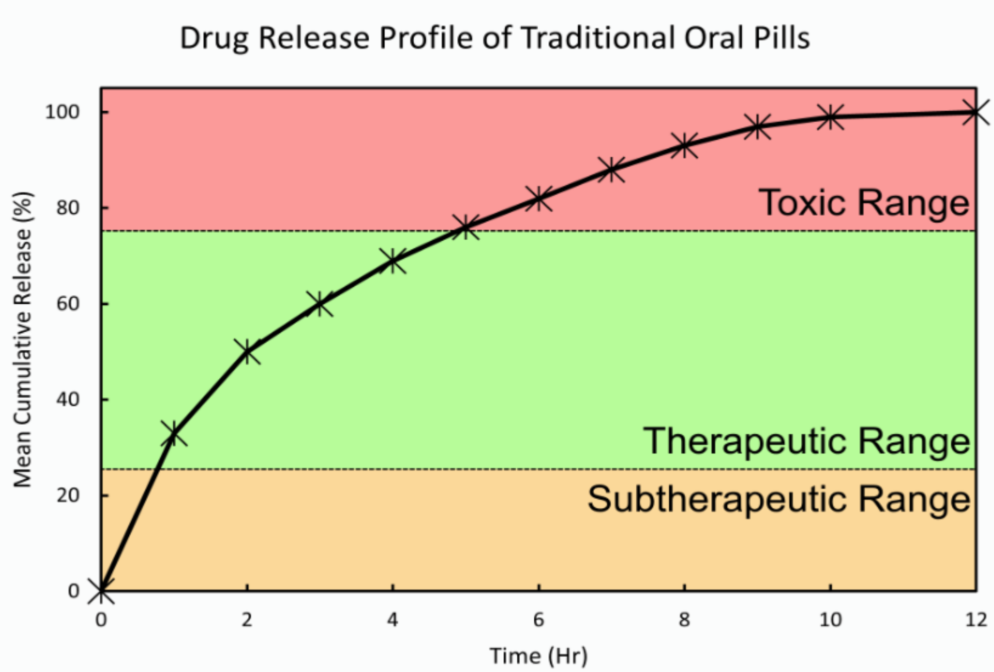


Ameliorative Effects of Nanoparticles on Liver Toxicity

TEAM MEMBERS
Nick Carney, Connor Thomas

PROJECT MANAGERS
Dr. Sophia Orbach
(Biomedical Engineering)

Liver toxicity and other liver-related failures are leading causes of death worldwide. Chemotherapies and other cancer treatments are known to induce liver toxicity in a high percentage of patients. Despite strong medical advancements, limitations continue in the treatment of liver toxicity which can often lead to liver failure and the withdrawal of therapy. Currently, the primary treatment for liver failure is an organ transplant. However, more patients are waiting for a liver than there are available. Alternative therapies need to be considered as there is no guarantee that a patient will receive a successful transplant. Furthermore, often cancer patients cannot withstand the strain from surgery. Nanoparticles are a highly promising alternative technology that support controlled release and improve targeted drug delivery. Their use has been shown to successfully bypass some of the toxic side effects from cancer therapies. However, early nanoparticles were composed of biomaterials, such as silver and gold, that accumulated in the liver and induced liver-specific toxicity. Our clinic project focused on writing a review paper that outlines the recent advancements in nanoparticles and their potential applications in treating liver toxicity which could have myriad applications in cancer treatment.

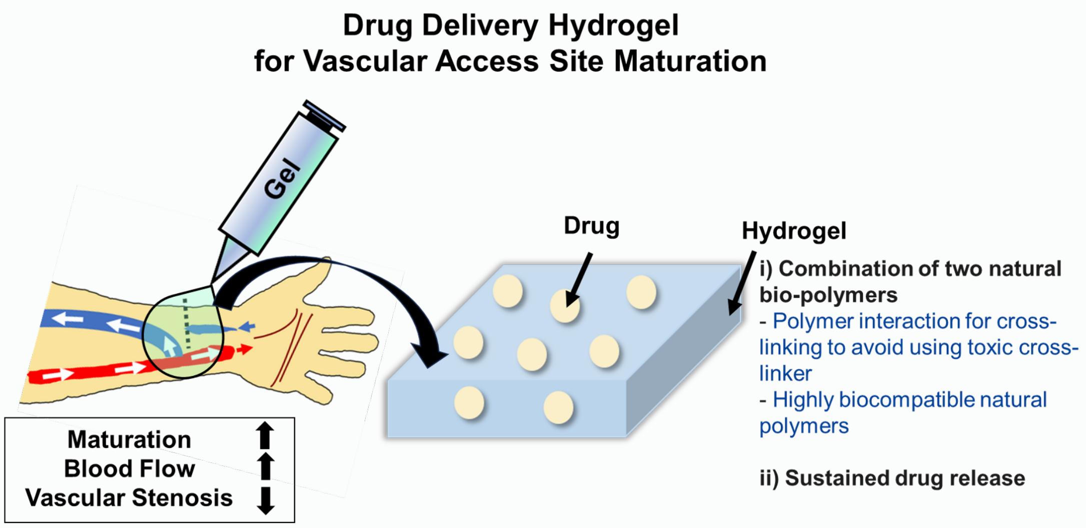


Drug-releasing Hydrogel Development for Dialysis Vascular Access Site Healing

TEAM MEMBERS
Hartej Hundal, Sania Aamir

PROJECT MANAGERS
Dr. Patrick Hwang
(Biomedical Engineering)

Worldwide, hemodialysis remains a need for around 2 million patients who require a well-functioning vascular access for this procedure. However, arteriovenous fistula (AVF), known as the gold standard of vascular access, frequently encounters complications. With a staggering 60% failure rate in maturation due to insufficient blood vessel dilation and intimal hyperplasia, AVF often leads to compromised efficacy.
To improve AVF maturation, we developed a bio-polymer hydrogel that gradually releases molecules for vessel maturation. We used Biomaterials A and B to create this hydrogel through cross-linking. To tailor the gelation properties, we prepared three gels with varying concentrations of Biomaterial A. Each gel underwent characterization for its properties through rheology and injectability tests. In rheology, the gel with the highest concentration of Biomaterial A showed the greatest storage modulus, indicating its robustness. The injectability tests confirmed that all three gels could be administered effectively. Currently, we are assessing porosity and measuring drug delivery kinetics to refine the hydrogel further, aiming to enhance AVF maturation in dialysis patients.

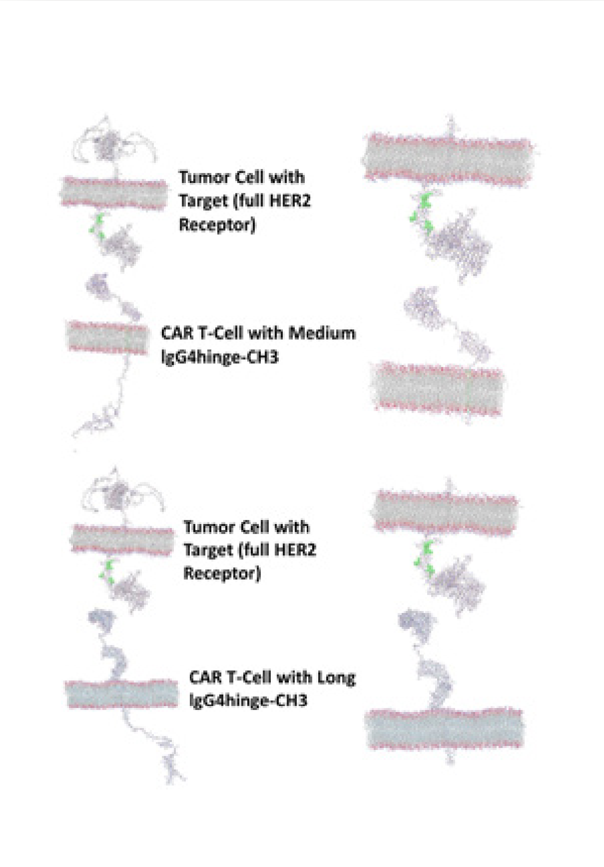


Computational Synthetic Receptors

TEAM MEMBERS
Shruti Dalwadi

PROJECT MANAGERS
Dr. Mary Staehle (Biomedical Engineering),
Leah Davis (Biomedical Engineering)
Dr. Nichole Daringer (National Institute of Biomedical Imaging and Bioengineering)

Despite recent advances in cancer technology, targeting solid tumors remains a challenge. Current treatment methods lack precision and induce cytotoxic side-effects due to off-targeted activation and poor control. Potential for cancer relapse also poses a risk from these conventional treatments. In blood-derived cancers, chimeric antigen receptors (CARs) have been successful in reducing such negative off-targeted effects because of their regenerative nature and clinical administration of immunoglobulin replacement therapy. However, solid cancers create their own tumor microenvironment (TME) to suppress the immune system. The selective pressure and overall nature of the TME results in many functional challenges for cancer treatment, like antigen heterogeneity. Methods to optimize and predict CAR function would help to improve therapeutic efficacy. Utilizing computational techniques, including protein modeling and protein-protein docking, provides an alternative avenue for refining CAR structures and forecasting their effectiveness. Here, we use Schrodinger Maestro to model an anti-HER2 CAR along with the full length HER2 in order to design the best structure and optimize therapeutic potential.

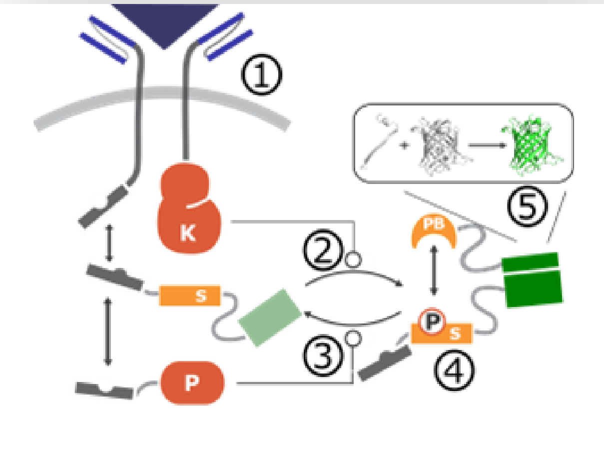


Engineering Post-Translational Circuits with Phosphatases for Solid Cancer Uses

TEAM MEMBERS
Samarth Patel

PROJECT MANAGERS
Dr. Mary Staehle (Biomedical Engineering),
Leah Davis (Biomedical Engineering),
Dr. Nichole Daringer (National Institute of Biomedical Imaging and Bioengineering)

SPONSORS
National Science Foundation



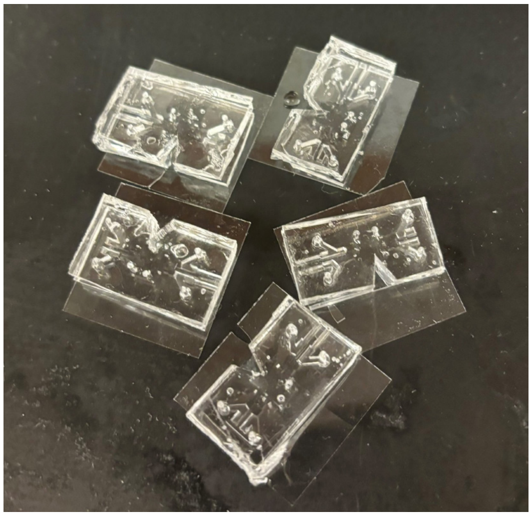
Cancer is the second leading cause of death in the United States and is highly studied, and yet the same five solid cancers have remained at the highest mortality rate for the past thirty years. The fields of synthetic biology and immunoengineering aim to decrease cancer deaths by engineering native human cells to better target cancer. Chimeric antigen receptor (CAR) T-cells are the gold standard for cell-based cancer therapy with seven FDA-approved CARs for lymphomas, leukemias, and one melanoma target. However, CAR T cells are limited by the requirement for specific tumor markers and their lack of controllability. This project focuses on engineering receptors with a novel synthetic receptor, called a post-translational circuit (PTC), to address these limitations. PTCs can be designed to activate in response to soluble extracellular proteins secreted by solid tumors, such as interleukins, and engineered to better control the immune response to prevent toxic side effects. Specifically, this study uses split fluorescent proteins and phosphatases to investigate the mechanisms for controlling the immune response and prevent off-targeted activation to improve cell-mediated therapies for solid cancer applications.

Creation of silicone-based PDMS Microfab Devices for Eventual Use in Cells

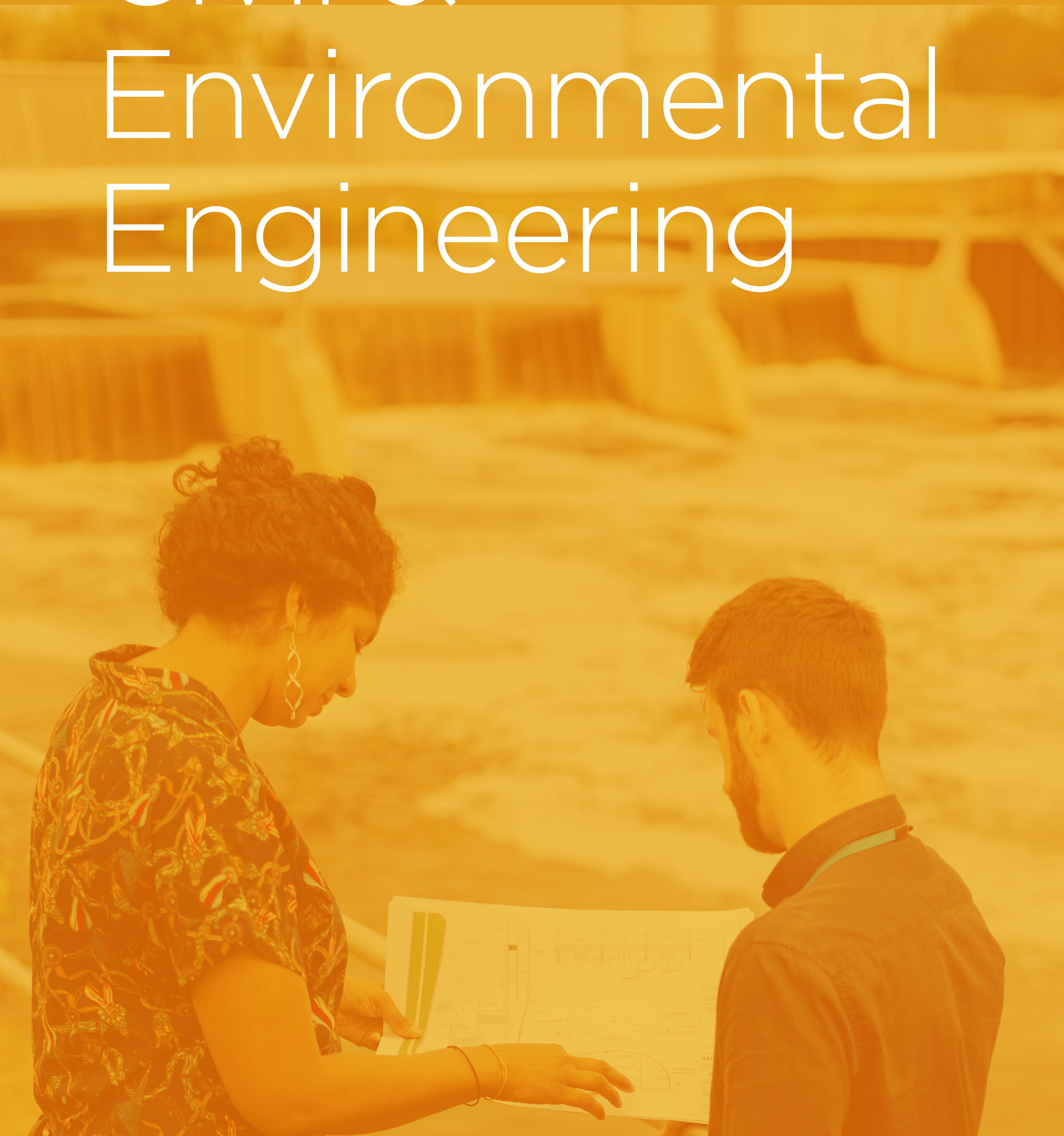
TEAM MEMBERS
Roger Fricke, Srivalli Valluri, Adam Boberick

PROJECT MANAGERS
Dr. Peter Galie
(Biomedical Engineering)

Artificial blood vessels hold great promise for medical research. Compared to traditional methods that rely on animal studies, artificial blood vessels can be made with human cell lines, offering a more physiologically relevant platform for various experiments. Moreover, this kind of platform can offer faster and alternative ways to develop or test emerging treatments. It can also eliminate ethical issues concerning animal studies. Herein we are introducing a silicone based microfluidic PDMS device that mimics an artificial blood vessel. The device was made using a multi-step procedure which included enzyme-based polymerization to create the PDMS base. An acid-etching method was then used to achieve the desired design. A collagen-based solution is injected to represent an extracellular matrix and following polymerization, cells can be injected. The silicone based PDMS platform is now ready for further experiments. This exciting platform is already being used with our collaborators at Temple and Cornell Universities.



Civil & Environmental Engineering

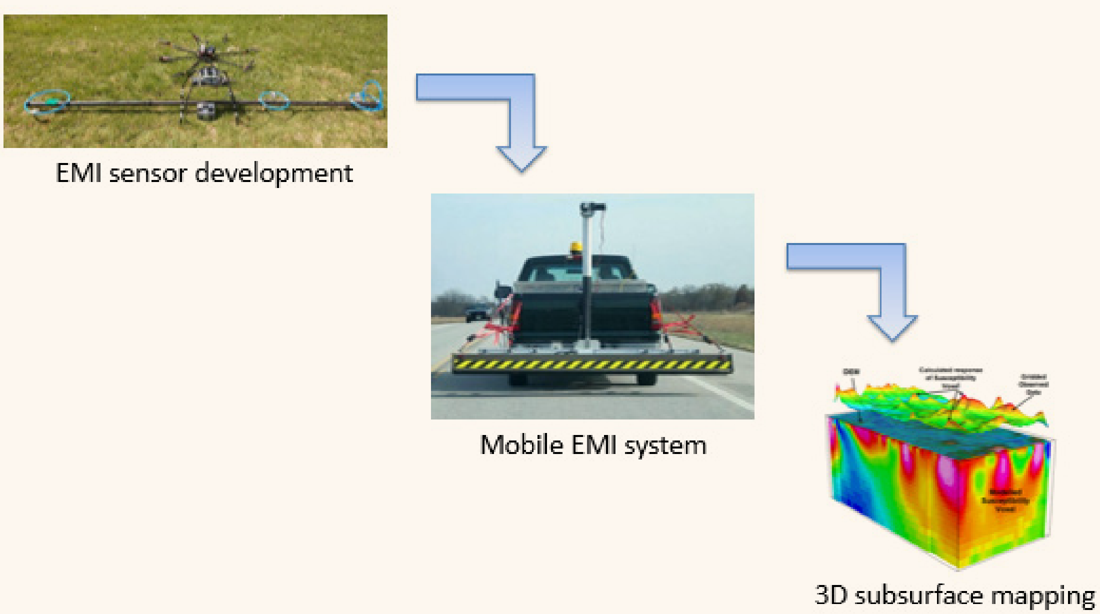


iFrost Mapper

TEAM MEMBERS
Agatha Seretni Uchi, Matthew Barna, Megan Downey, Weiling Cai

PROJECT MANAGERS
Cheng Zhu, John Schmalzel

With the accelerating rate of global warming, permafrost regions are gradually turning into the seasonally frozen ground. The freeze-thaw cycling of frozen soils is known to be the cause of various engineering failures of infrastructure in cold regions. To better conduct construction in cold regions, ground investigations on soil profile distribution and properties of frozen soils are essential. Researchers found that geophysical methods outperform traditional investigating methods in the ground survey of frozen soils for their greater convenience and cost-effectiveness. This research intends to combine the electrical resistivity measurement and the high-frequency electromagnetic induction (HFEMI) to investigate the properties of frozen soils. A series of laboratory experiments are conducted to determine the relationship between soil electrical resistivity and soil geotechnical properties such as initial water content, bulk density, and pore fluid concentration under freeze-thaw conditions. Then, the control experiment is performed to calibrate the HFEMI test results with the electrical resistivity measurement results with soil properties remain the same. The findings of this study are expected to help to develop an automated ground surveying process in the future.



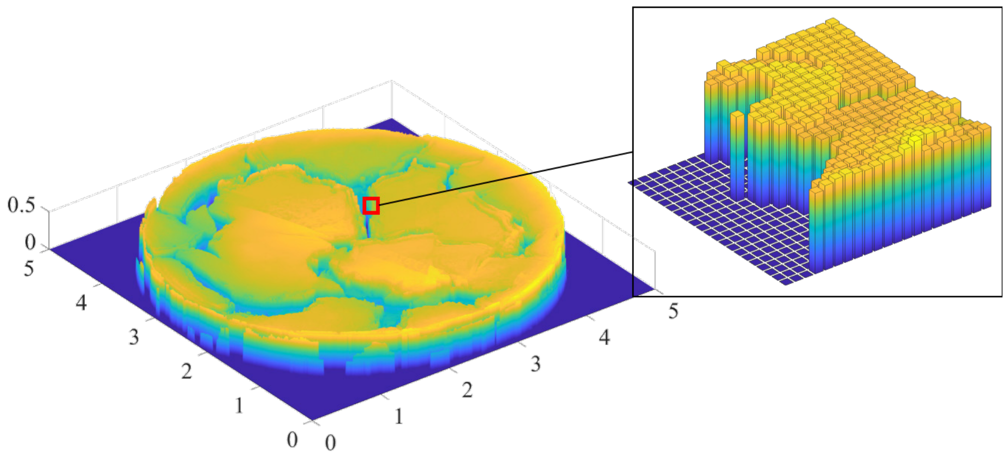
Bio-soil

TEAM MEMBERS
Sean Denny, Colin Hubler,
Luniva Pradhanang, Kaniz Roksana

PROJECT MANAGERS
Cheng Zhu, Melissa Montalbo-Lomboy

SPONSORS
UTC

This project aims to continue to explore the possibility of using bio-mediated technique to reinforce Jersey shore soil for better coastal erosion resistance. Students work in groups on soil experiments, crack image analysis, and other exciting soil characterization techniques such as microscope, 3D surface scan, SEM and X-ray CT. Laboratory-scale soil erosion test indicated the effectiveness of bio-cementation technique in soil reinforcement.



AISC/ ASCE Steel Bridge

TEAM MEMBERS
Connor Trautweiler, Ryan Leeds, Thomas Logan,
Kelly Favato, Katherine Kaniewski,
Alex Soderman, Tyler Jones, Richard Brown

PROJECT MANAGERS
Doug Cleary

SPONSORS
AISC

The steel bridge is an annual competition. The team designed and fabricated a 20' steel bridge. The bridge was judged on construction speed, strength, stiffness, and aesthetics while meeting all of the requirements of the RFP. The design considered all of the constraints of the RFP as well as the ease of fabrication and construction with the goal of an economical design. All of the fabrication was performed by the student team members.

ASCE Concrete Canoe Leadership Team

TEAM MEMBERS
Jake Block, Greg Gladis, Wyatt Anderson, Nick Hui, Zack Martinho

PROJECT MANAGERS
Doug Cleary

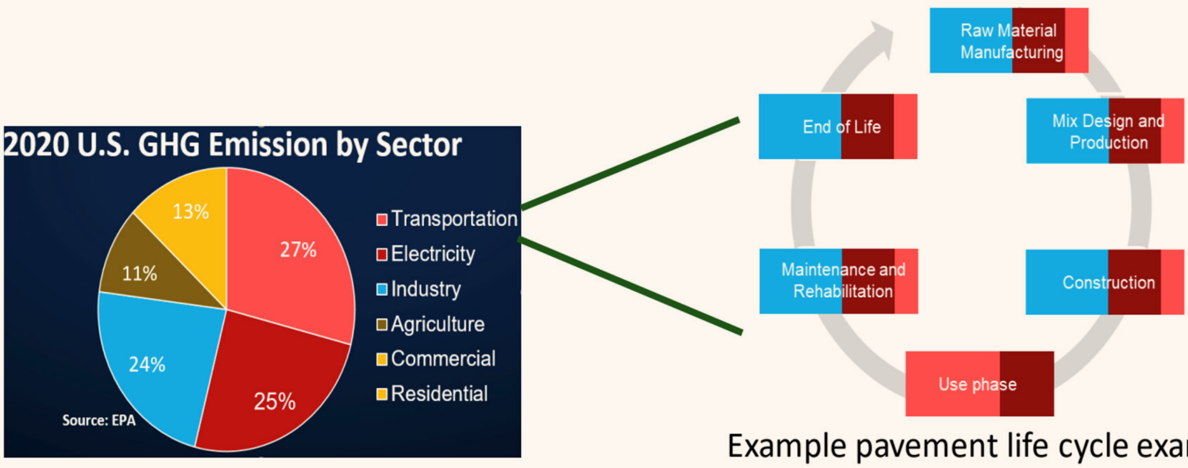
This team provided the leadership and most of the work for design and manufacture of the concrete canoe for the competitions. This included mix design, form design, materials testing, construction planning, display development, project proposal response, and presentation. The leadership team also organized all of the outside help provided by other students. The team qualified for the National competition for the second year in a row.

Enhancing Road Sustainability in New Jersey

TEAM MEMBERS
Luca Mosco

PROJECT MANAGERS
Dr. Yusuf Mehta and
Dr. Surya Teja Swarna

The environmental impact of road construction and maintenance accounts for a substantial portion of global emissions. Traditional methods of road construction focus primarily on immediate economic and functional needs without sufficient consideration of environmental and long-term sustainability. This research addresses the need for more sustainable road construction practices by focusing on comprehensive Life Cycle Assessments (LCAs) and Environmental Product Declarations (EPDs). This study presents an in-depth analysis of the road life cycle, emphasizing the substantial emissions not just from vehicle use but also from the production, maintenance, and end-of-life stages of road infrastructure. The key findings of this clinic project include the disproportionate impact of the use stage, which can emit up to a thousand times the greenhouse gases compared to construction stages. The research also highlights the limited scope of existing Product Category Rules (PCRs) in the U.S., which currently cover only initial life stages (A1-A3) of materials. Recommendations are made for expanding PCRs to encompass full life cycle impacts, particularly the use stage, which involves maintenance, repair, and operational emissions. By developing and implementing comprehensive LCAs and EPDs, this project contributes to the body of knowledge required to enhance the sustainability of road infrastructure in New Jersey.



Example pavement life cycle example

NJDMAVA Energy and Water Use Audits

TEAM MEMBERS
Nathan Andrianto, Emma Benkovic, Edward Coyle, Rajorn Elliot, Natalie Greene, Jordan Jeffers, Payton Keblish, , Matthew Mastej, Owen Power, Lesley Perez, Sarah Remick, Brian Scala, Thomas Torney, Gus Van Walsen (Grad)

PROJECT MANAGERS
Jess Everertt, Mac Haas, Jie Li, William Riddell, Adriana Trias

SPONSORS
NJ DMAVA

Student teams made site visits to six different NJ DMAVA buildings throughout the state. At these visits, students measured indoor air temperature, air quality, and lighting levels; took thermal images of the building envelope; identified devices that use electricity and water; and studied the HVAC system. In addition to the site visit, the teams investigated building plans and utility bills. These observations allowed the students to create building simulations to analyze and model both energy and water use. Based on familiarity with the building, students identified candidate measures to reduce energy and water use, as well as opportunities to generate clean energy on site through solar power. The models for energy and water use were then used to evaluate each candidate design for potential savings, C02 emission reduction, and return on investment. These recommendations help NJ DMAVA to operate their facilities in an efficient manner, and design improvements to infrastructure.

Structural System Analysis

TEAM MEMBERS
Thomas Gassaway, Nicolas Gerace, Diminga Gomez, Christian Varrato

PROJECT MANAGERS
Dr. Seyed Hooman Ghasemi

This educational module, led by S. Hooman Ghasemi, equips students with the foundational skills to model various building and structural frames using industry-standard software such as ETABS and SAP2000. The course analyzes two primary types of structural frames: Moment Frames and Braced Frames, each subdivided into several classes based on seismic response and architectural demands. Students are tasked with selecting appropriate frame types, simulating structural responses across different seismic zones, and building geometries, enhancing their understanding through practical application. By completing this module, students gain a robust theoretical understanding and acquire hands-on experience in structural modeling, preparing them for complex engineering challenges in the real world. This comprehensive approach ensures a profound grasp of structural dynamics, which is essential for future professionals in civil engineering.

Building Information Modeling (BIM)

TEAM MEMBERS
Kieran Breen, David Lopez, Meet Patel, Ronan Swanson

PROJECT MANAGERS
Jess Everett, Will Riddell, Adriana Trias, Jason Muermann, Cedric Jankowski

SPONSORS
New Jersey Department of Military and Veterans Affairs (NJDMAVA)

The Sustainable Facilities Center (SFC) at Rowan University manages various engineering and facilities management projects for the New Jersey Department of Military and Veterans Affairs (NJDMAVA), including Building Information Modeling (BIM). BIM serves as a digital representation of building or infrastructure characteristics, offering data for NJDMAVA to enhance building operations efficiency. This encompasses facilities management, maintenance, construction management, and energy modeling to reduce energy usage and carbon footprint. Four students collaborated this academic year on creating BIM models for four NJDMAVA buildings, totaling around 200,000 square feet. These models incorporate exterior and interior elements like walls, windows, doors, roofs, stairs, and heating, ventilation, and air conditioning (HVAC), plumbing, electrical, and fire protection systems. NJDMAVA plans to utilize these models to modernize fire evacuation plans, previously hand-drawn due to building age (dating back to 1899), and to obtain more precise square footages and room dimensions for leasing purposes, which were previously manually calculated.

Sustainable Facilities Management

TEAM MEMBERS
Anthony Alliegro, Payton Keblish, John Malaszecki, David Miller, Kieran Murphy, Richard Rivera, Sarah Remick

PROJECT MANAGERS
Jess Everett, William Riddell, William Johnson

SPONSORS
Dr. Seyed Hooman Ghasemi

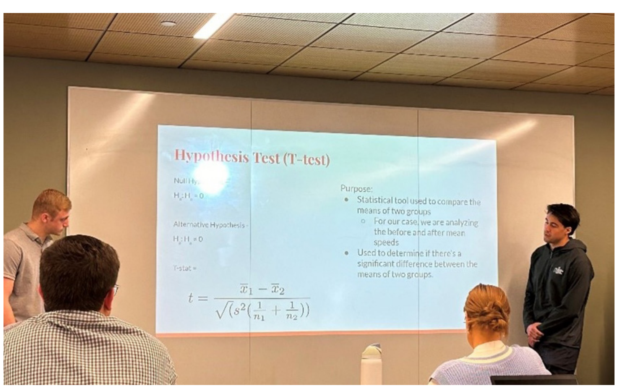
Students help the New Jersey Department of Military and Veterans Affairs (NJDMAVA) and New Jersey Army National Guard (NJARNG) manage ~ 250 buildings on 1,200 acres. They use FacilityDude CMMS and USACE's BUILDER SMS software to optimize maintenance and repair. They apply their education and experience to help NJARNG and NJDMAVA maintain mission readiness by creating level II planned maintenance reports for building systems and equipment that can extend the service life of NJDMAVA assets and assist with repair vs. replacement decisions. The students formulate planned maintenance recommendations that encompass the building's structural, HVAC, plumbing, fire protection, and electrical systems, along with various other facility equipment.

Safe Route to School

TEAM MEMBERS
Paul Riter, Steven Castlegrant, William Anskis

PROJECT MANAGERS
Mohammad Jalayer

SPONSORS
NJDOT through Rutgers University



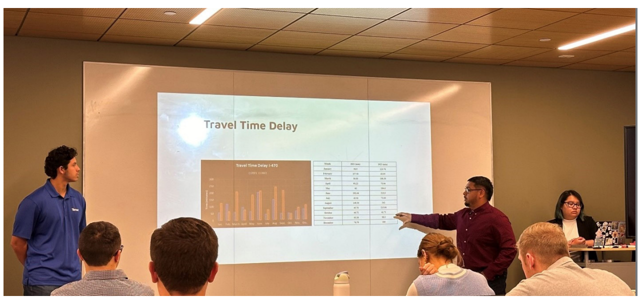
The safety of children traveling to school is a top priority for NJDOT, particularly in areas with mixed traffic. Despite ongoing efforts with Safe Routes to School projects, the evaluation of their effectiveness is not consistently practiced. This clinic focuses on evaluating the impact of traffic calming measures by examining changes in speed profiles before and after their implementation. Extensive research has been conducted, encompassing traffic calming case studies and the implementation of regulations, to assess the effectiveness and feasibility of various measures in school zones. Additionally, a specific analysis was performed on a sidewalk implementation project funded by Safe Routes to School grants. Data was collected on vehicular speed at one-minute intervals, and statistical analysis, including one-sample t-tests, was conducted to assess mean speed changes during weekdays, weekends, peak hours, and off-peak hours in both directions. Appropriate recommendations to enhance the safety of school zone areas were suggested based on the analysis of results.

Evaluating the Effectiveness of Truck Safety Alert System

TEAM MEMBERS
Jesus Rivera, Daniel Olaya, Catherine Abacan

PROJECT MANAGERS
Mohammad Jalayer

SPONSORS
ODOT through Cleveland State University



Commercial vehicles pose a significant safety risk in the United States, particularly on rural interstate routes, where deadly accidents have been on the rise. This trend becomes evident when these vehicles are forced to decelerate abruptly due to congestion caused by major crashes, leading to inefficient responses and subsequent secondary accidents. The lack of early warnings about downstream events significantly contributes to these future crashes. While traditional methods such as dynamic message signs (DMS) and Electronic Logging Devices (ELDs) have been utilized, modern in-cab safety technologies like Drivewyze offer a more interactive experience. Partnering with Drivewyze, the Ohio Department of Transportation (ODOT) aims to enhance Commercial Vehicle Safety Alerts. However, research on the effectiveness of these in-cab safety systems remains limited. To address this gap, this clinic project aims to evaluate the impact of Drivewyze on Ohio's transportation infrastructure. It will analyze travel time data, estimate delays, and investigate changes in congestion costs over a two-year period, conducting a before-and-after comparison. The findings from this study will be valuable for authorities assessing the effectiveness of ELD devices and considering their inclusion in future research endeavors.

Additive Construction

TEAM MEMBERS
Tia Donovan, Austin Werner, David Sibor, Tyler Tran, Tyler Ortzman, Ryan de la Cuesta, Mike Brown, Andrew McGlynn

PROJECT MANAGERS
Islam Mantawy, Jenna Migliorino, Anthony Mackin, Aly Ahmed, and Zaid Hanoun

SPONSORS
Department of Education

Clinic goal is to get familiar with operation of the large-scale concrete 3D-Printers and envision and print next generation of structures.

Metal Additive Manufacturing

TEAM MEMBERS
Etseoghena Alieme, Zaid Mazahreh, Michael Moschella, Mike Waldron

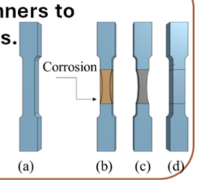
PROJECT MANAGERS
Islam Mantawy, Hamdy Farhoud

SPONSORS
Department of Transportation

The goal of this clinic is to educate the students on two emerging technologies. Cold spray additive manufacturing (CSAM) and metal additive manufacturing (MAM). The application for CSAM is repair of corroded steel elements. The application for MAM is for resiliency of structures.

1

Develop 3D-point cloud protocol using LiDAR scanners to assess the section loss of corroded steel elements.
a) Fabricate steel dog bone.
b) Corrode the specimens
c) Remove corrosion
d) Cold spray the losses



Develop CSAM techniques capable of successful repair of corroded steel elements

2

3

Verify successful repair technique through experimental testing.
a) Tension testing
b) Fatigue testing
c) Additional corrosion testing)

Electric Curing of Conductive Concrete

TEAM MEMBERS
Taylor Manning, Daniel Lynch, Nick Gentile, Connor Ammann, Mason Kennedy

PROJECT MANAGERS
Islam Mantawy, Shahriar Abubakri, Alyssa Sunga

SPONSORS
Department of Defense

The goal of this clinic is to develop concrete mixes conductive enough to facilitate electric curing for concrete casting in freezing and sub-freezing temperatures. The students worked on different concrete mixes with different doses of conductive fibers (steel and carbon fibers) and conducted extensive testing protocol to ensure concrete properties and conductivity.

Watershed Visual Assessment

TEAM MEMBERS
Thomas Gassaway, Aidan Mcilhenney, Jillian Peslak, Ryan Riddle, Christopher Cavalieri

PROJECT MANAGERS
Dr. Zhiming Zhang, Dr. Kauser Jahan, Michael Hartshorne

SPONSORS
New Jersey Department of Environmental Protection (NJDEP)

A watershed represents a dynamic interconnected system comprising land, water, air, flora, fauna, and various other elements. Maintaining the health and equilibrium of watersheds is paramount for environmental sustainability. As part of the U.S. Environmental Protection Agency's watershed management strategy, watershed visual assessment serves as a fundamental tool for conducting comprehensive watershed evaluations. In collaboration with Princeton Hydro, our team undertook a visual assessment of the Chestnut Branch Watershed. This assessment encompassed an evaluation of channel conditions, bank and shoreline stability, overall ecological health, and the presence of stormwater infrastructure. Additionally, students collaborated with Princeton Hydro to propose stormwater best management practices for potential field sites within the watershed. These field assessments and recommendations are instrumental in generating maps and data delineating existing conditions. This information serves as a valuable resource for stakeholder education and informs decision-making regarding watershed management practices.

Project E3: Energy, Environment and Education

TEAM MEMBERS
Jessica Carroll, Jillian Jankowski, Philip Sedalis, Vincent Volpi

PROJECT MANAGERS
Dr. Zhiming Zhang, Dr. Kauser Jahan

SPONSORS
U.S. Environmental Protection Agency (USEPA)

The escalation of climate change, driven by greenhouse gas emissions, has precipitated a surge in extreme weather occurrences and sea-level elevation. The imperative shift towards renewable energy sources is pivotal in forging a sustainable and future. This project is dedicated to fostering environmental literacy among upcoming generations, with a specific emphasis on renewable energy and climate change. Team members have cultivated an understanding of the root causes and ramifications of climate change, including its localized impacts on South Jersey, and the viable prospects offered by renewable energy, such as tidal energy, through a combination of literature review and hands-on experiential learning. The team is actively engaged in crafting comprehensive learning modules encompassing four key themes: 1) climate change; 2) air quality monitoring; 3) renewable energy; and 4) decision-making for low-carbon communities. By interfacing with local K-12 students, educators, college cohorts, and community stakeholders, the team endeavors to raise public consciousness and comprehension regarding climate change and renewable energy. Moreover, this initiative seeks to instill a sense of environmental stewardship and cultivate the requisite skills for sculpting a sustainable and low-carbon future.

Engineers Without Borders

TEAM MEMBERS

Patrick Kuchnik, Erin Kennedy, Nate Hitchner, Austin Andrews, Julia Fiorentino, Karly Amandeo, Seamus Johnson, Seth Steward

PROJECT MANAGERS

Dr. Jagadish Torlapati, Dr. Yusuf Mehta

Rowan University's Engineers without Borders (EWB) Chapter is a multidisciplinary engineering student team coordinating with faculty and applying their curriculum to solve real-world problems locally and internationally. The Ambuela community in Ecuador experiences water supply shortages throughout the year. During the dry season, the community purchases water from the capital, which is delivered monthly. Our team conducted an assessment trip to the community on January 17, 2023, to test for water quality, identify potential new water sources, and conduct in-home surveys. We are planning an implementation trip for Fall 2024 to improve the water source that provides clean drinking water to the community. EWB also works with nonprofit organizations to improve community gardens. We have partnered with CROPS NJ to build new raised garden beds to improve accessibility for the disabled community. In addition, we also built new community garden beds for the Gloucester County Boys and Girls Club and a new irrigation system for the Cooper Sprouts community garden.

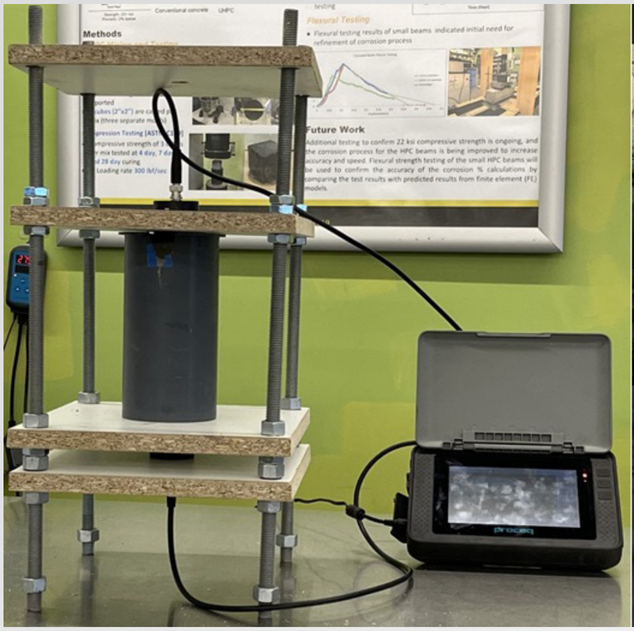
Self-Consolidating Concrete

TEAM MEMBERS
Tyler Abate, Kevin Colligan, John Smith, Austin Schuhrer, Dalton Corte, Brian Inclan, Chase Tinges

PROJECT MANAGERS
Gilson Lomboy, Aljhon Morana

SPONSORS
ERDC/CRREL

Self-consolidating concrete (SCC) refers to concrete that has no resistance to flow and can be placed and compacted under its own weight. SCC must have low yield and high viscosity values. To balance deformability and stability, the amount of fine materials is typically high. In some cases, a viscosity-modifying admixture is used to stabilize the concrete mixture. Polycarboxylate-based high-range water reducers are typically used to plasticize the mixture and lower the yield value. This project aims to develop an SCC and measure the setting times using ultrasonic pulse velocity (UPV). Setting time measurements requires six to eight hours of observation using a standard penetrometer. Using the UPV makes data collection continuous and unmanned. The SCCs are tested for flowability properties, temperature, air content, strength, elastic modulus, and electrical resistivity. The setting times are measured with the UPV and the penetrometer. Measurements will be at 10, 20, and 30 °C.



Concrete Shrinkage Cracking

TEAM MEMBERS
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PROJECT MANAGERS
Gilson Lomboy

Modern concrete mixtures used in transportation infrastructure can have a high risk of shrinkage cracking because of the high cementitious content, finer portland cement, low water-to-cementitious material ratio, and various admixtures in the concrete. The study's overall goal is to improve the longevity and performance of transportation infrastructure by reducing the concrete shrinkage and cracking potential, which will prevent the ingress of water and other deleterious substances into the concrete. High-performance concrete mixtures' autogenous shrinkage, drying shrinkage, and restrained shrinkage cracking were measured. Concrete mixtures with high shrinkage and cracking potential are will be treated with shrinkage reducing admixture, shrinkage compensating admixture, surface coating, internal curing, fibers to mitigate the shrinkage and cracking of concrete in the lab. The hardened concrete properties, such as compressive strength, modulus, splitting tensile strength, and creep are also being tested. Mixtures with optimum dosages of admixtures will be tested under field conditions.

Bridge Vertical Clearance

TEAM MEMBERS
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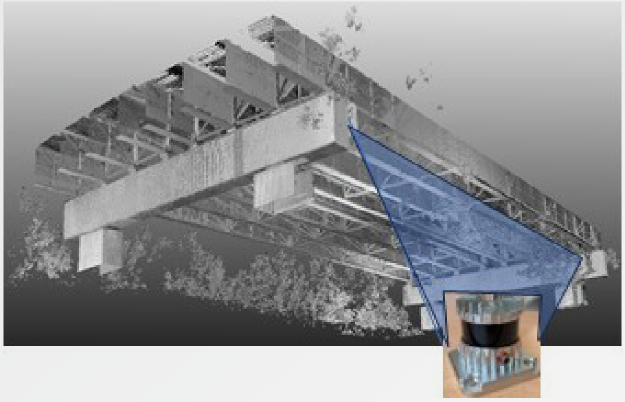
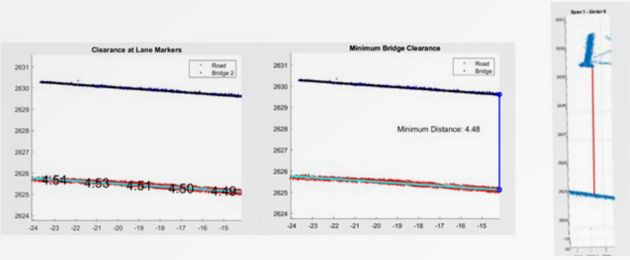
PROJECT MANAGERS
Adriana Trias Blanco

SPONSORS
NJDOT

The Bridge Vertical Clearance clinic focuses on automating the estimation of the under-clearance of operating New Jersey bridges to report the existing available truck height and avoid collisions. For this purpose, the team collected data by deploying a mobile LiDAR sensor to capture the entire geometry of the structure and of the under-crossing roads. The data collected conforms to what is called a point cloud, which is a 3D representation of millions of points containing coordinates that can then be translated into dimensions and distances. These point clouds were processed and analyzed via CloudCompare and MATLAB to identify key components, such as girders and road lanes, to measure the required distances following the criteria established by the New Jersey Department of Transportation (NJDOT), which consists of calculating the vertical clearance at each lane for each bridge girder and reporting the shallower distance per lane. The minimum vertical clearance in NJ is 14 ft. 6 in. for county roads and 14 ft. 9 in. for state roads. This clinic project was able to identify the aforementioned key components within the point clouds and automate the estimation of the vertical clearance with an accuracy of 1.15%.





Structural Assessment of Offshore Wind Turbines Using Remote Sensors

TEAM MEMBERS
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PROJECT MANAGERS
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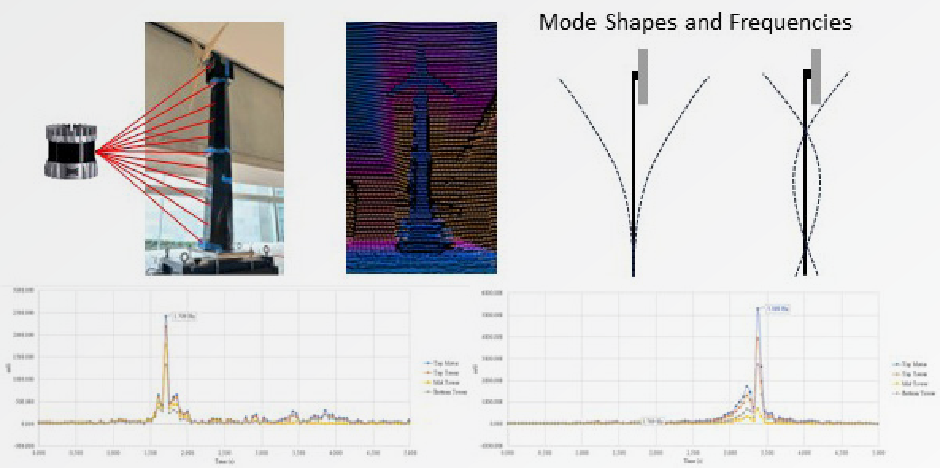
SPONSORS
NJEDA

Wind turbines provide 10.2% of the total U.S. utility-scale electric energy (U.S. Energy Information Administration, 2022), and their growth has been exponential in the last 20 years. Therefore, engineers are constantly working to improve the maintenance of these structures to ensure they can operate at total capacity throughout their service life. The deployment of structural health monitoring (SHM) systems to supervise wind turbines is becoming increasingly necessary to ensure the stability of all structural components. Existing SHM systems incorporate the use of (a) acoustic emissions, (b) thermal imaging, and (c) ultrasonic methods, which are focused on the detection of cracks, delamination, corrosion, and internal deterioration of the structural elements, while (d) strain gauges and (e) accelerometers, evaluate the structural performance and responses at local scale. This clinic implemented a mobile LiDAR sensor to capture the vibrating shapes of a wind turbine model, scaled at 3 ft tall, to evaluate the innovative application of this technology to monitor and evaluate the structural responses of the tower. The tower was vibrated through a shaker at 1, 2, 2.7, 3, and 4 Hz, and the results provided promising outcomes for the continuation of this application.



Work Zone Capacity Changes with CAVs

TEAM MEMBERS

Joseph Lloyd Nadolny, Joseph Mackin, Abbie Coen, Adam Williams

PROJECT MANAGERS

Fahmida Rahman

Work zones face challenges like delays, flow breakdowns, capacity reductions, and bottlenecks, affecting roadway efficiency. Connected and Automated Vehicles (CAVs) can help by reducing delays and bottlenecks while increasing overall capacity in work zones. However, limited studies have explored CAVs' impact on work zone capacity. This study aims to quantify their influence across various market penetration rates. We considered two freeway work zone configurations: one-lane closure and two-lane closure. We simulated CAVs interacting with traditional vehicles using VISSIM software on a 1-mile stretch of California's I-10 EB corridor. By gradually introducing CAVs from 20% to 100% penetration rates, we observed significant trends in work zone capacity. Notably, the benefits of CAVs were minimal at lower penetration rates but increased substantially, as rates rose. Specifically, the benefits doubled for one-lane closure and quadrupled for two-lane closure after reaching a penetration rate of 60%. This threshold marked a significant shift in capacity recovery grade, suggesting that CAVs' effectiveness in minimizing work zone challenges notably increases beyond this point. Furthermore, our findings indicated that achieving 100% CAV adoption in both one-lane and two-lane work zone configurations could result in capacity recovery equivalent to that of one lane.

Assessment of Self-Healing Potential of Highly Elastic Asphalt Binders

TEAM MEMBERS
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PROJECT MANAGERS
Yusuf Mehta, Arunkumar Goli

SPONSORS
Cold Regions Research and Engineering Laboratory (CRFREL), Department of Defense

Asphalt pavements in cold regions, such as Alaska, face extreme weather conditions and is subjected to load and non-load associated loads throughout their service life. Asphalt binders are more susceptible to various forms of failure at low temperatures, including fatigue cracking, and thermal cracking, often aggravated by heavy traffic loads. To mitigate these distresses, researchers are exploring "Highly Elastic Asphalt Binders (HEBs)," proven to enhance asphalt binder performance in low temperatures. In general, when cracking occurs it can undergo a phenomenon called self-healing if it experiences a period of rest. During self-healing, microcracks are essentially filled in and repaired. This mechanism significantly influences the fatigue resistance of asphalt binders and hence is essential to assess their self-repair capabilities. HEB's due to its high polymer content with softening agents can possess superior self-healing characteristics than conventional asphalt binders which is essential when used in cold regions. Therefore, this study evaluates the self-healing characteristics of HEBs. Results showed that the HEB's possess an enhanced self-healing capability up to six times than the conventional asphalt binder. HEB's exhibit instantaneous self-healing capabilities and less susceptible to fatigue load damage levels.

Commercial Motor Vehicle Crashes in New Jersey

TEAM MEMBERS
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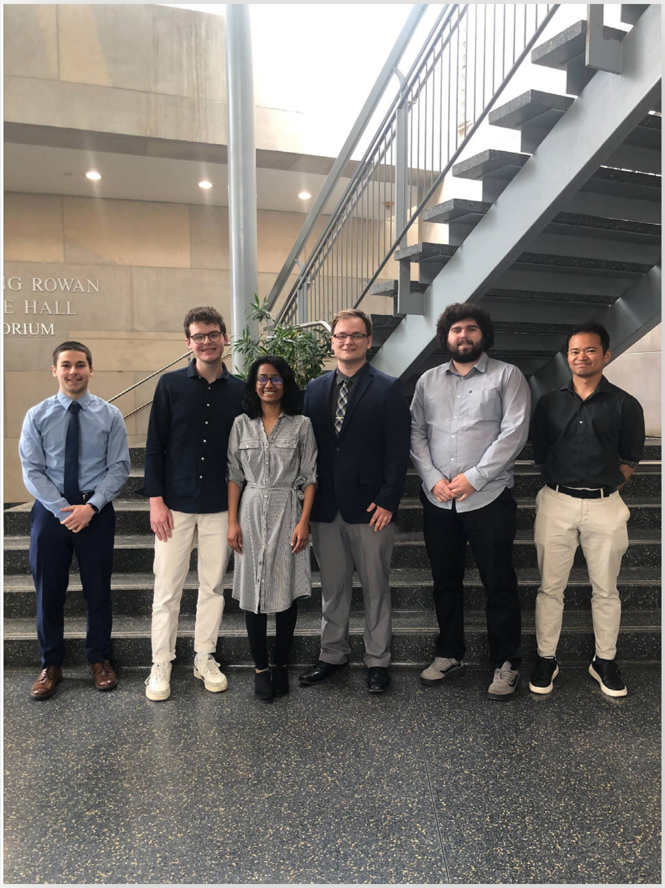
PROJECT MANAGERS
Fahmida Rahman

The escalating presence of commercial motor vehicles (CMVs) on roads, driven by the surge in online commerce, has led to a corresponding increase in large-truck crashes, some resulting in fatalities. This study focuses on investigating factors of CMV crashes specific to New Jersey and identifying countermeasures to reduce these crashes based on an extensive literature review. Data from the Federal Motor Carrier Safety Administration (FMCSA) was collected and analyzed to compare the CMV crash statistics of New Jersey to the national average. The comparison helped to identify the critical factors specific to the state. These include presence of median, license class, signage for hazardous materials, restraint usage, traffic violations, etc. A detailed literature review was performed to identify various countermeasures associated with these factors. The countermeasures include improving roadway medians with rumble strips and barriers, implementing safety management techniques for license classes, increasing the display of hazardous materials signs, providing safety education and training on alcohol usage, enhancing roadway conditions with delineators and variable speed limits, enforcing restraint usage with consequences for non-compliance, and increasing police enforcement for traffic violations.



Sustainable Drinking Water

TEAM MEMBERS
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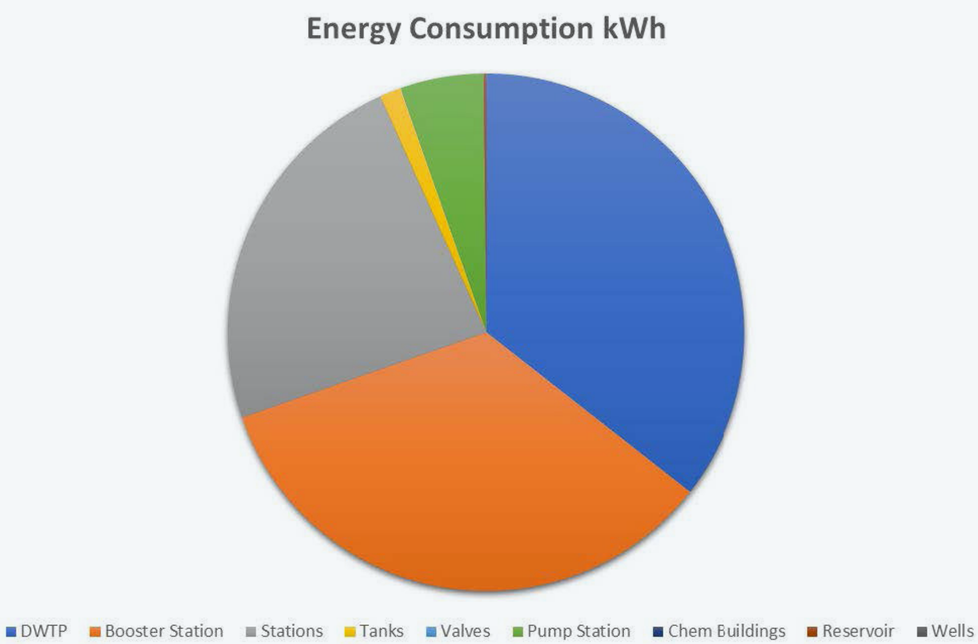
PROJECT MANAGERS
William Riddell, Jess Everett, Jagadish Torlapati, Kirti Yenkie

SPONSORS
New Jersey American Water

The objective of the project is to help NJ American Water to improve the energy efficiency of drinking water extraction, treatment and delivery. In this first year of the project, we have focused on analyzing drinking water systems in New Jersey to allow us to develop models for process and analyze energy use throughout these systems. In addition, we have performed a literature review to identifying key performance indicators (KPIs), such as energy required per cubic meter of delivered drinking water, and other benchmarking techniques that have been used to evaluate drinking and wastewater treatment systems, and the results that have been found for facilities throughout the U.S. and the world. Energy use for every facility within three NJ American Water drinking water systems, and organized energy use by type and activity of the facility. Furthermore, the energy use per cubic meter of treated water were determined for four drinking water treatment plants within the three systems, and compared to values found in the literature. These preliminary results will be used to identify specific facilities for more detailed study in the next phase of the project.



Reflective Cool Pavements

TEAM MEMBERS
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Caitlin Purdy, Dr. Abhary Eleyedathl

PROJECT MANAGERS
Dr. Yusuf Mehta

The urban heat island (UHI) effect causes an increase in temperatures for cities compared to surrounding countrysides, negatively impacting energy consumption, air quality, and water quality. A significant factor influencing UHI is the solar energy absorbed by pavement surfaces, which is radiated as heat to the surrounding environment. Previous studies have found that lightening the pavement surface color can reduce the pavement temperature. However, the indiscriminate solar reflection caused glare issues for drivers and temperature increases in the surrounding structures. Since solar radiation is comprised of about 50% NIR light (non-visible), Titanium Dioxide and Silicon Dioxide, which reflect NIR light, have been proposed as potential pavement additives to mitigate these issues. This research aims to develop a cool pavement strategy to reduce UHI effects by adding these compounds into slurry seal, a common pavement maintenance technique. Slurry seal samples meeting local design requirements will be added as a coating to asphalt samples with embedded thermocouples to monitor temperature after sunlight exposure. The mechanical performance of the slurry seal before and after introducing the additives will be characterized. It is anticipated that adding these reflective compounds will improve reflectivity and reduce pavement temperature without compromising the stability of the pavement surface.

Bioremediation of hydrocarbons in Cold Regions

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PROJECT MANAGERS
Dr. Jagadish Torlapati, Dr. Yusuf Mehta, Dr. Kirti Yenkie

SPONSORS
Department of Defense

The cryosphere, encompassing all things frozen, is integral to sustaining life functions on planet Earth. The cryosphere has many critical responsibilities, such as regulating global temperatures. One of the vital components of the cryosphere is the permafrost, which is the frozen ground existing in the high northern and southern latitudes. As anthropogenic factors cause global temperatures to rise, permafrost has been thawing at an alarming rate. The primary goal of this study is to evaluate the potential pathways for the bioremediation of carbon present in the permafrost to preserve the resiliency of the ecosystems present in the Arctic region. Experiments were conducted to investigate the bioremediation of naphthalene at room temperature and cold temperatures (5° C). Our experimental studies showed that bioremediation is negligible at cold temperatures, whereas 88% removal of naphthalene was observed in room-temperature experiments. Future experiments involve optimizing cold temperature experiments by adding cryophilic bacteria and nutrients.

Food Waste Pathways

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PROJECT MANAGERS
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SPONSORS
New Jersey Department of Environmental Protection

Approximately 30% to 40% of food produced is wasted, necessitating a shift in outlook and disposal practices. Many nations have responded with food waste laws to reduce waste and improve disposal methods. In this clinic project, students investigated global food waste management practices, disposal techniques, and regulatory frameworks to evaluate their impacts on public health and the environment. This project aims to enhance the knowledge of local regulatory agencies and the recycling and solid waste industries by providing a clearer insight into the processes involved in the disposal and recycling of food waste. Food waste poses significant environmental challenges, contributing to water and air pollution through various disposal methods like landfilling and incineration. While emissions from food waste treatment are studied, research on water pollution remains limited, requiring deeper investigation. The project seeks to bridge this gap by examining food waste management's legal aspects to better understand its effects on public health and the environment.

Chemical Engineering

Enhancing Lithium Ion Battery Cathodes and Performance

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PROJECT MANAGERS
Ken Lau, Joe Stanzione

Although widely used in electronics and electric vehicles, lithium ion batteries (LIBs) suffer from limited energy and power densities. This leads to insufficient battery charge and long charging times. To overcome these limitations, research in this engineering clinic project is pursuing higher capacity LIB cathode materials based on transition-metal oxides. However, these materials are very reactive and prone to degrade over time. To protect these materials from degradation, our project is further pursuing conducting polymer coatings to protect the LIB cathodes. Our work to date has shown that the coated cathode materials have higher capacity and are able to retain their capacity for longer, which implies that they are more stable. By enhancing the performance of LIBs, there is promise in advancing batteries as a viable energy storage technology for a sustainable energy future. This clinic project engages four junior Chemical Engineering students, and they have been trained by a Ph.D. student mentor to fabricate and test lithium ion battery coin cells using a wide range of state-of-the-art battery-related tools, including an inert glove box, doctor-blade film coater, coin cell crimper, and battery cyclers.

Jet Fuel from Coffee Waste

TEAM MEMBERS
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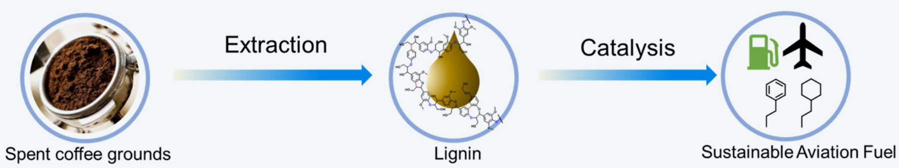
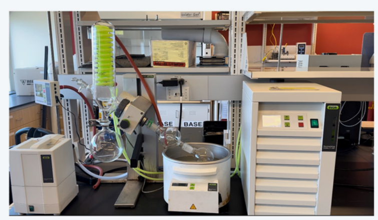
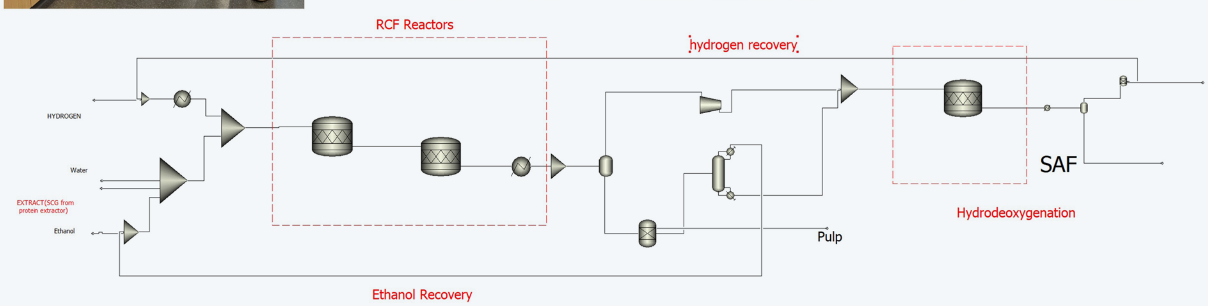
PROJECT MANAGERS
Jun Hee Jang

The implementation of decarbonization strategies for aviation fuel is crucial to addressing the carbon emission problem within the aviation sector. Accordingly, the U.S. government has announced a plan to produce 35 billion gallons of sustainable aviation fuel by 2050. In this Clinic, we propose spent coffee grounds as waste feedstocks to produce jet fuel blendstocks. Lignin, one of the major components of spent coffee grounds, can be catalytically converted into aromatics and cycloalkanes, which accounts for up to 40% of jet fuel composition. First, we developed a closed-loop process model consisting of multiple steps including lignin extraction, depolymerization, hydrogenation, and hydrogenolysis. In the lab, we used two different types of coffee waste. Lignin oil was successfully extracted from coffee waste through tandem solvolysis, depolymerization, and stabilization.







Mixing Phenomena in Stirred Vessels

TEAM MEMBERS
Austin Colon, Maria Logothetis

PROJECT MANAGERS
Robert Hesketh, Arthur Etchells III

In industry, various mixing techniques are used to achieve desired process results. However, there is typically a lack of understanding of geometric arrangements and their effect on mixing phenomena. Specifically, there is a lack of depth in quantitative modeling used when designing mixing vessels. In this ongoing work, various geometric parameters are chosen, varied, and their effects are studied. The end goal of each investigation is to discover novel phenomena & quantify these effects. In the past, mixing times in baffled and unbaffled vessels were studied and correlated, and in unbaffled vessels the vortex (depth, point of aeration, etc) was characterized. In the future, it is hoped that this clinic will continue to perform novel work, and discover mixing phenomena that benefits industry and academia alike.

Roadmap for Efficient Processes in Petroleum Pipelines

TEAM MEMBERS
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PROJECT MANAGERS
Dr. Kirti Yenkie, Dr. Robert Hesketh, Dr. Stewart Slater, Dr. Mariano Savelski, Barnabas Gao

SPONSORS
ExxonMobil-NJ and US Environmental Protection Agency

ExxonMobil Lubricants Oil Blending Plant (LOBP) in Paulsboro NJ is Company's 2nd largest facility in the world performing oil blending and filling operations at multiple scales. Because of the growing number of unique blend compositions/ formulations and properties, the plant uses an existing manifold system to perform multiple blending and filling operations. Since products are greater than connections, lines must be reused for multiple formulations. This requires certain lines to purge leftover products from previous operations before the next task. This is cost-intensive and utilizes a significant amount of pure product to perform purging operations. Thus, the goal of this project is to reduce the amount of flush oil produced during the flushing of blending and filling lines. This will be accomplished by understanding issues with inline flushing at Paulsboro LOBP and identifying alternatives through the integration of chemistry, process design, and optimization.

learn more:

Machine Learning for Sustainable Chemicals

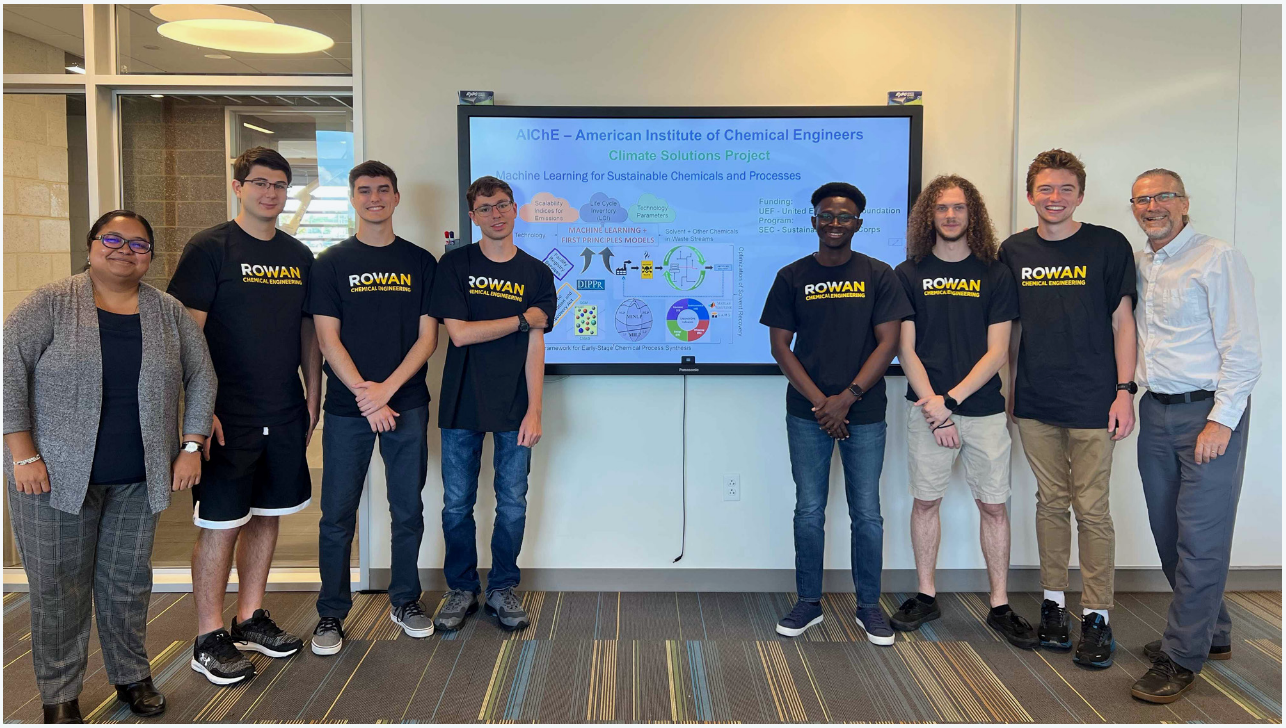
TEAM MEMBERS
Matthew Conway, Jared Longo,
John Pazik, Milo Barkow

PROJECT MANAGERS
Dr. Kirti M. Yenkie, and Dr. Robert Hesketh

SPONSORS
AstraZeneca and
US Environmental Protection Agency

learn more:

This project intends to advance the state of knowledge in sustainable chemical and process design through the development of novel Machine Learning models. Currently, access to physical and chemical properties, separation mechanisms, environmental impacts, sustainability metrics, and the life cycle of novel chemicals, such as bio-based solvents, alternative chemicals, and APIs, can be very difficult since there is very little to no information available in the literature. However, these are required to accurately determine if the novel chemicals can provide an eco-friendly and safer substitute for more commonly used chemicals. To this end, this project integrates machine learning approaches with traditional process synthesis and modeling methods to find common environmental and sustainability indicators. On the whole, the ML-based predictive algorithms for LCI, Scalability Index, and Technology parameter estimation developed as a part of this project will enable engineers and chemists to quickly assess how sustainable and cost-effective new chemicals and process technologies are when compared to their traditional counterparts.



PEKK Composites for Aerospace

TEAM MEMBERS
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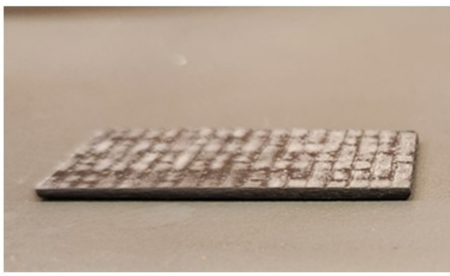
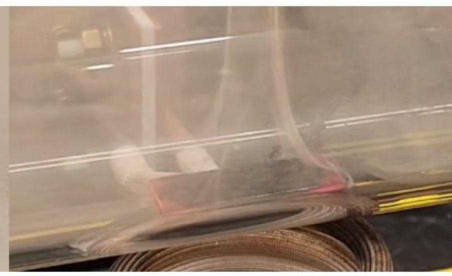
PROJECT MANAGERS
James Newell, Joseph Stanzione,
Mattew Schwenger

SPONSORS
Department of Defense

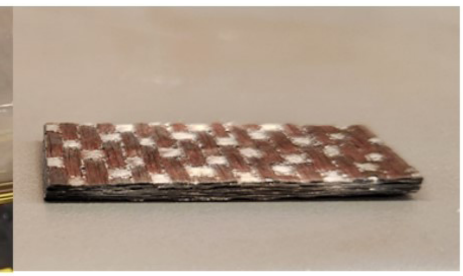
PEKK (Polyether Ketone Ketone) shows great promise as a precursor material for the manufacture of carbon-carbon composites. This study evaluated the ability to control the crystallinity of the polymer, and therefore, the order that remains after carbonization by controlling the temperature and duration of soak of the material. We were able to show that crosslinking and carbonization were competitive and tunable reactions.



Before carbonization



Onset of pyrolysis by induction



After carbonization

High-Performance PBO-based Composite Materials

TEAM MEMBERS
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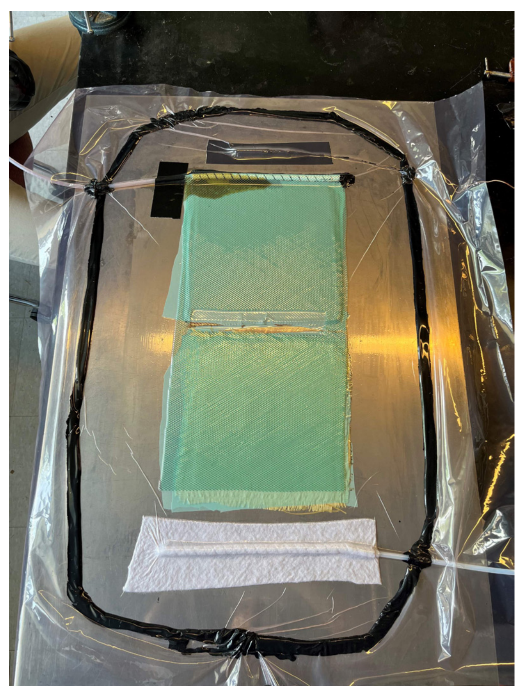
Cole Johnson, Joshua Shafer, Matthew Weinstein

PROJECT MANAGERS
James Newell, Joseph Stanione,
William Beck, Casey Barrett

SPONSORS
Department of Defense



High performance PBO composites were constructed using Vacuum-Assiisted Resin-Transfer molding (pictured). These composties showed exceptional mechanical properties including tensile and recoil compressive strength, toughness, hardness, and flexural modules. The resultant composites could be used as produced or subsequently carbonizaed to form high-performance carbon-carbon composites for aerospace applications.

Polymer Cold Spray Modeling

TEAM MEMBERS
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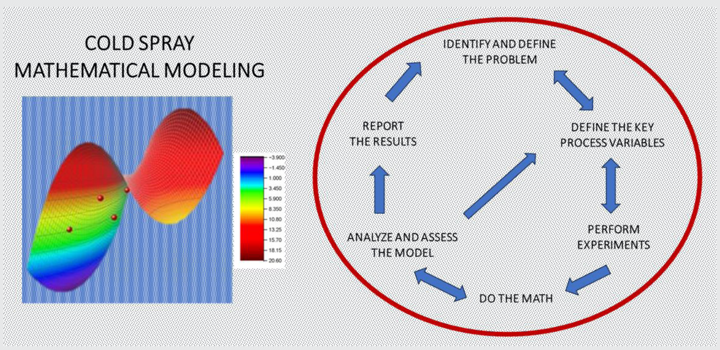
PROJECT MANAGERS
James Newell, Joseph Stanzione, Okikiola Agbabiaka

SPONSORS
Department of Defense

Although the use of cold spray in metals is widespread, its use for polymers is more limited because of the complex viscoelastic behavior of polymers. This project developed a mathematical model that predicted deposition efficiencies based on a variety of process conditions, then recommended near optimal spray conditions. This model serves as the first step towards a larger effort to predict optimal conditions for previously unsprayed polymers based on five key physical parameters - melting temperature, molecular wright, crystallinity, particle size, and particle shape.



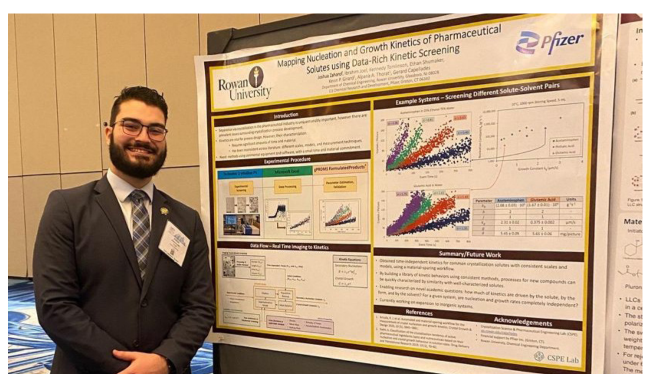
Crystallization Kinetics

TEAM MEMBERS
Joshua Zaharof, Kennedy Tomlinson

PROJECT MANAGERS
Gerard Capellades

SPONSORS
Pfizer

Crystallization is used as a separation process to purify pharmaceuticals and to isolate those with the right solid-state properties for a target medical function. However, the development of crystallization processes is time and material intensive. In this clinic, we developed a set of automated methods to screen crystallization kinetics of common pharmaceuticals, and created a nucleation and growth library that serves as a reference for the development of processes for new compounds.



Dyeing Pharmaceuticals

TEAM MEMBERS
Claire Schleper, Abigail Martin, Anne Nong, Ricardo Otake, Gavin Trutzenbach

PROJECT MANAGERS
Gerard Capellades

SPONSORS
National Science Foundation

In this clinic, we seek to understand how impurities from a manufacturing process end up in pharmaceutical products, and how the consequences of that entrapment go beyond the potential toxicity of the impurity on the patient. To study the general behaviors of impure crystals while also being able to track the distribution of those impurities inside the crystal, we use dyes as model impurities and incorporate them in common pharmaceuticals. Results show how those impurities affect both the fragility and the dissolution profile of the pharmaceutical crystals.

Design a Crystallization Laboratory

TEAM MEMBERS
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PROJECT MANAGERS
Gerard Capellades

SPONSORS
The Kern Family Foundation

This clinic involved the development of two parallel crystallization laboratories: a traditional experiment utilizing industrially-relevant equipment and a closed manual, and a crystal growth competition based on optimizing a crystallization toy. Both deal with the same general concepts, but probe different aspects of student learning from building technical skills to building an entrepreneurial mindset. After running both laboratories in parallel, student performance was compared both in technical proficiency but also on the demonstrated levels of curiosity, building connections between concepts, and understanding of how those skills can be used to create value.

Advanced Composite 3D Printing

TEAM MEMBERS
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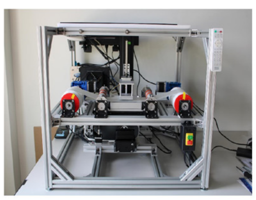
PROJECT MANAGERS
Dr. Joe Stanzione, Karl Dyer, Elias Timmons

SPONSORS
U.S. Army Research Laboratory

This Clinic project pushed the envelope of advanced composite additive manufacturing for high performance and military applications. Students were asked to tap into their creative engineering, innovation, and teamwork skills to ideate, design, machine, code, and ultimately manufacture custom digital light projection (DLP) 3D printers capable of fabricating fiber reinforced polymers of both simple and complex geometries. Systems engineering and convergent and disruptive manufacturing were central to this project. Students worked closely with folks in the Sustainable Materials Research Lab (SMRL) in the Chemical Engineering Department at Rowan University as well as with Rowan University's Advanced Materials and Manufacturing Institute (AMMI).


Custom Composite DLP 3D Printer


Advanced 3D Printed Parts

Birch Bark Extract Polymers

TEAM MEMBERS
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PROJECT MANAGERS
Dr. Emre Kinaci, Dr. James Newell, Dr. Joe Stanzione, Nesrine Abbouz, Heather LaFrance

SPONSORS
National Science Foundation

This Project examined the production of thermoset polymers from material extracted from birch trees growing on campus. The students collected the bark, extracted both ethanol and chloroform soluble fractions using a Soxhlet extraction technique, and were able to develop polymeric materials, including coatings, from the product of these extractions. The polymers were characterized in terms of both their thermal, mechnical, rheological properties. Ultimately, the goal of the project was to develop polymers from completely renewable materials that possess physical and rheological properties that would enable them to replace petroleum-based polymers in commercial applications.


Fossil Park Birch Trees


Promising Coating

&


Promising Polymer

Sustainable Betulinic Polymers

TEAM MEMBERS
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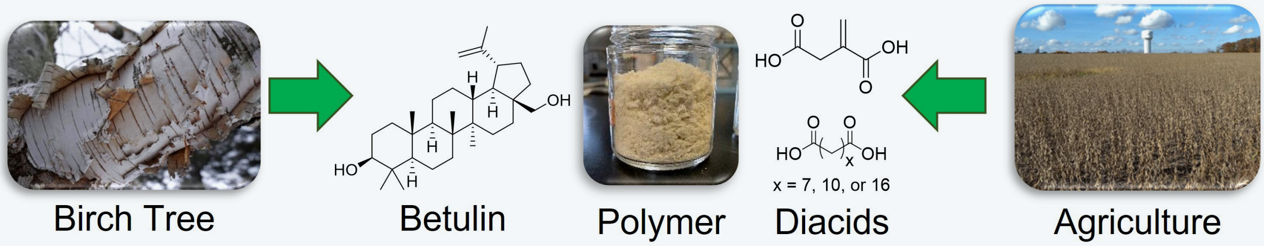
PROJECT MANAGERS
Dr. Emre Kinaci, Dr. James Newell,
Dr. Joe Stanzione, Alexandra Lehman-Chong

SPONSORS
National Science Foundation

The potential harmful health and environmental effects of monomers used during a polymer's manufacturing stage are important yet often disregarded considerations when evaluating sustainability of synthetic materials. Betulin is an inherently nontoxic chemical that can be extracted from birck bark. Itaconic acid (IA) is a nontoxic chemical commercially produced from agricultural waste. Here, betulin was used to synthesize fully biosourced polyesters with tailored amounts of unsaturation. The melt flow behavior of thermoplastics without IA was analyzed at multiple temperatures to identify ideal conditions for filament extrusion. Tensile testing was used to determine the mechanical properties of these thermoplastics. Polyester thermoplastics both with and without IA were incorporated in polyester-methacrylate (PM) resins. The unsaturated thermoplastics were able to participate in photopolymerization, transforming them into thermosets. Cured PM resins with unsaturated polyester content exhibited crosslinking behavior, resulting in polymers with better chemical resistance and thermal stability. Overall, the saturated betulin-based polyester thermoplastics have potential applications as filament for 3D printing, and the PM resins have potential UV-curable applications. This Project demonstrated that bioderived, benign chemicals can be used to synthesize polymers for safer manufacturing processes.



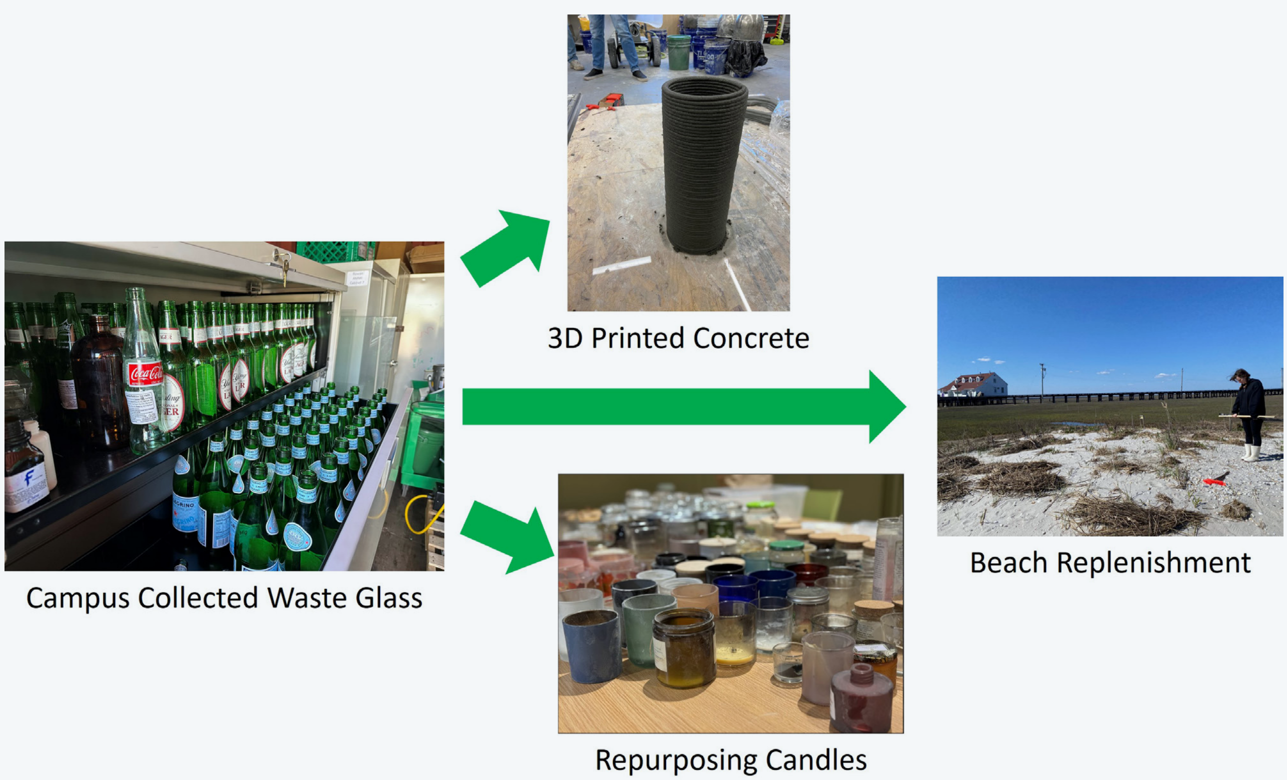
“Re-Glassing” Glassboro

TEAM MEMBERS
David Bauer, Samuel Sotelo-Flores, Eric Tanzosh

PROJECT MANAGERS
Dr. Lily Pfeifer, Dr. Joe Stanzione, Justin Elko

SPONSORS
New Jersey Department of Environmental Protection

In the Glassboro area there is an opportunity to improve material waste systems and build a model for circularity by focusing on common glass material. This Clinic team, in collaboration with Bottle Underground, a Philadelphia non-profit glass recirculation organization, targeted research and development of a semi-pilot scale glass processing program. The team’s goal was to recirculate the waste glass generated on campus, and slightly beyond its borders, and connect the supply to campus and the local economy. An initial semi-pilot scale glass collecting and processing facility located on Rowan’s West Campus was established through Rowan’s Advanced Materials & Manufacturing Institute (AMMI). The team worked across campus forming a multidisciplinary cohort (e.g., with Art, Engineering, Geology, Geography, and Communication Studies) and began redirecting waste glass from landfills and repurposingit for both upcycled and downcycled applications. Research related to all aspects of developing this semi-pilot scale glass collecting and processing facility, including data science and the incorporation of processed glass sand and cullet in advanced composites, 3D printing concrete formulations, and beach replenishment sands, were accomplished. Ultimately, this Project demonstrated the willingness of community stakeholders to engage in improving our sustainability as well as providing advanced technical solutions for waste glass.



Electrical & Computer Engineering

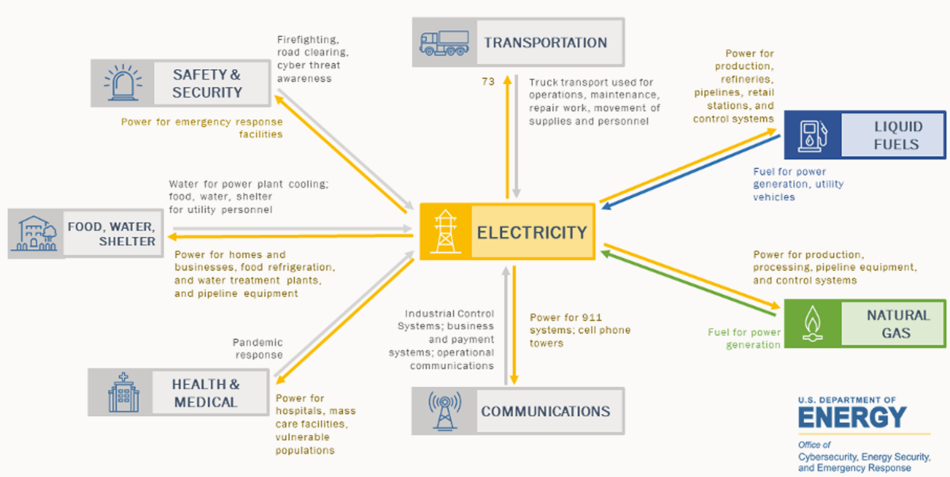
New Jersey State Energy Security Plan (SESP)

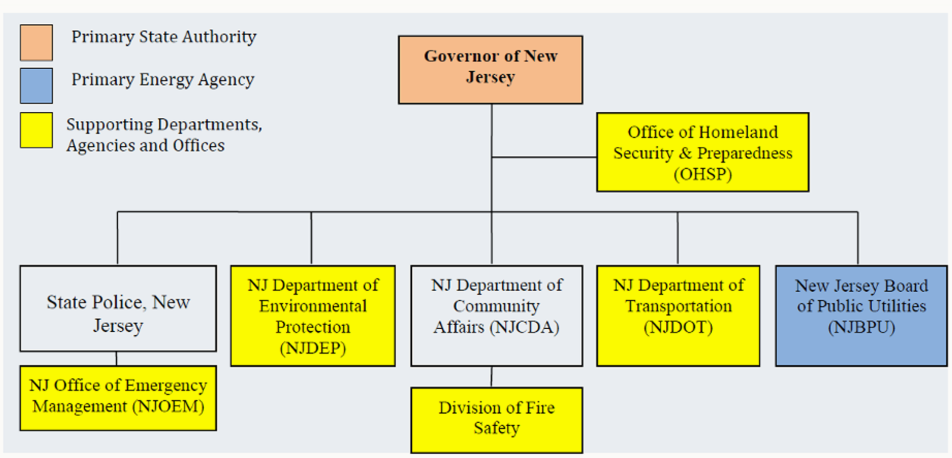
TEAM MEMBERS
Adam Kinsley, Aysha Sohail, Lauren Eckert, Daniel Bindas, Donovan Brown

PROJECT MANAGERS
Jie Li, Ethan Cantor (Ph.D. student)

SPONSORS
NJBPU

The objective of this project is to furnish NJBPU with a comprehensive plan for the development of an overarching State Energy Security Plan (SESP), encompassing all aspects of Energy Security and Resilience activities within the State of New Jersey. The purpose of the New Jersey SESP is to assess the existing energy situation in the state and propose methods to secure energy infrastructure against physical and cyber threats, mitigate the risk of energy supply disruptions, enhance the response to and recovery from energy disruptions, and ensure a reliable, secure, and resilient energy infrastructure to meet the six elements outlined in Section 40108 of the bipartisan Infrastructure Investment and Jobs Act (IIJA). The New Jersey SESP is specific to the critical energy infrastructure security, including the electricity, natural gas, and liquid fuel sub-sectors, which are uniquely critical, as all other critical infrastructure sectors depend on power and/or fuel to operate. The developed SESP, while consolidating the State's existing energy emergency response plans, is expected to serve as the baseplan for all energy emergency-related initiatives and activities, as well as all monitoring and response actions.





Dreamscape Learn at Rowan

TEAM MEMBERS
Troy Cognigni, Gavin Ritter, Anthony Alliegro, Johnathan Schiede, Jillian To, Matthew Zmuda

PROJECT MANAGERS
George Lecakes, Amanda Almon

Rowan University has partnered with Dreamscape Learn, to bring immersive virtual reality into classrooms. This initiative redefines education by integrating free roam VR experiences that have been tailored for course curriculums. Dreamscape uses the Unity game engine as the foundation to create these VR experiences. This clinic collaborated with Dreamscape to develop customized VR tools for Rowan University educators. Leveraging Dreamscape technology, our aim is to enhance traditional learning with interactive, engaging experiences. Working with the Department of Biological Sciences at Rowan, the team was instructed to construct a Dreamscape version of the “Fish Evolution” freshman lab where students could explore the diverging evolutionary traits of fish that were collected and 3D scanned in Alaska.

FAA VR & 3D Scanning

TEAM MEMBERS
Ally Bazikos, Brandon Tibbitt, Carly Iverson

PROJECT MANAGERS
George Lecakes, Amanda Almon

SPONSORS
FAA

Airspace is a continuously expanding industry, and its demand surpasses the limited supply of professionally trained pilots and ATC operators. Today, training programs have an insubstantial pool of training equipment that is effective, affordable, and accessible to aviation students. Pilot and ATCO programs are searching for alternative solutions that will enable a higher generation of qualified personnel without jeopardizing the proficiency of current training practices. The clinic team recognizes virtual reality as a holistic approach towards experiential learning experiences, and has a long-term vision to develop immersive training platforms that are available to a greater range of students in aviation.

Mixed Reality Battlefield

TEAM MEMBERS
Kristian DelSignore, Ferdinando Gismondi, Michael Morgan, Gwenn Maxinne Abano

PROJECT MANAGERS
George Lecakes, Amanda Almon

SPONSORS
Picatinny Arsenal, US Army

Rowan, in partnership with Picatinny Arsenal, is working on AI that can detect drones and their intentions to save the lives of soldiers who are left vulnerable to the future threat of drones on the battlefield. The concept of drones in combat is a new development. Drone warfare is being deployed worldwide, used to drop payloads, of either supplies or explosives. Very few data sets exist of real-world drones for AI training for intention detection. Our team repaired a drone to a functional condition and recorded footage of various flight patterns to cultivate a dataset to help develop AI algorithms to increase situational awareness for soldiers. This is achieved by flying the drone in multiple environments and perspectives so a separate team can utilize this varied real-life data to back up their simulations to develop this algorithm. By having this data, we can ensure greater knowledge of how to combat drones on the battlefield, by being able to predict and mitigate their harm to our soldiers, resulting in preserving more lives.

VR Landfill & Water Rescue

TEAM MEMBERS
Andrew Wilson, Cheyenne Ajebe

PROJECT MANAGERS
George Lecakes

SPONSORS
USDA, US EPA

Virtual Reality (VR) has allowed for learning to be an engaging experience. This project's goal was to create two interactive VR experiences, WaterCAVE and VR Landfill. WaterCAVE is an innovative approach to engaging and educating K-12 students on the daily routines of water and wastewater facilities workers. VR Landfill is an interactive experience to teach the importance of landfill safety to prevent landfill disasters. The project has been continued over consecutive semesters with the current one focusing on creating the VR Landfill experience. The collection of research and reference images backed the production of the VR experience landscape. The project focuses on four landfill disasters located in the United States that can offer a wake-up call to the users who experience the tragedies in the VR world.

VR Parent & Doctor Training

TEAM MEMBERS
Mahtab Amzad, Jacob Boyle, Samuel Kilsdonk, Andrew Mazurek, Moshier Rawy

PROJECT MANAGERS
George Lecakes, Amanda Almon

SPONSORS
NJ Department of Health

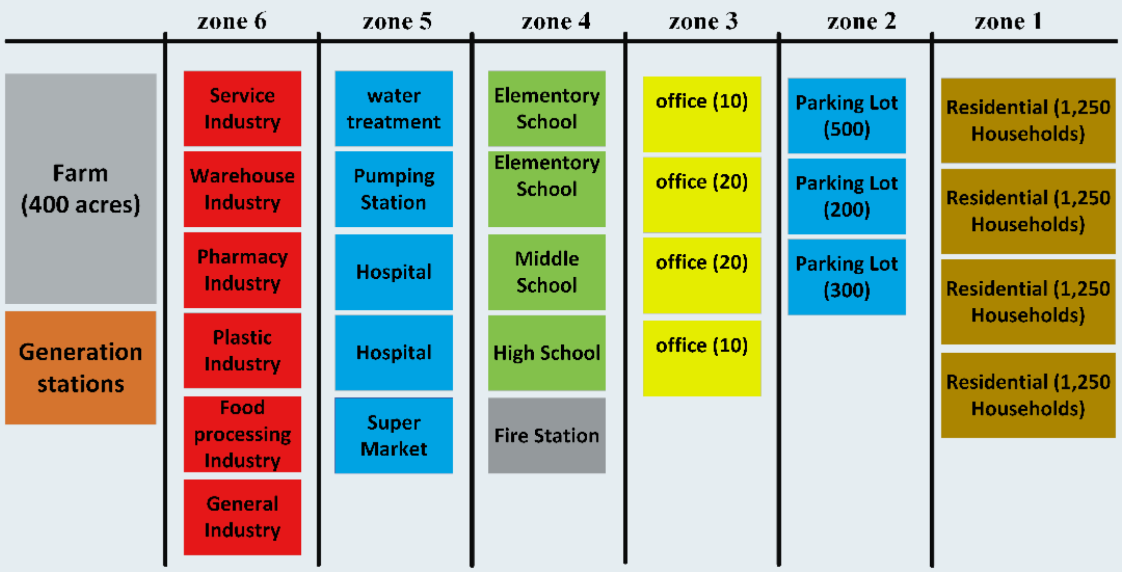
Children with autism spectrum disorder (ASD) frequently engage in severe destructive behavior (e.g., self-injury, aggression, property destruction) that presents significant risks to themselves and others, poses substantial barriers to community integration, and results in high familial and societal financial burden. Physicians and parents lack training related to children with ASD and in how to manage these destructive behaviors. With more patients being diagnosed with ASD, efforts must be made to mitigate destructive behavior and increase compassionate care of children with ASD. This project seeks to utilize educational modules within VR to help train parents on the best methods of engaging children with ASD. These methods include teaching them when it is appropriate to request something from the parent, such as attention, an object or even a break as well as the correct way to ask for them. The Doctor trainer is meant to give physicians an accurate virtual reality (VR) depiction of what treating a patient with ASD might entail. The doctor must run through a routine checkup while respecting the patient's extreme behavior. This includes abrupt outbursts, refusal to cooperate, and long tangents.

Self-Sustainable Microgrid for the Future using Renewable Energy

TEAM MEMBERS
Brandon Tran, Aiden Gumpper, Gershon Mokom

PROJECT MANAGERS
Dr. Yashwant Sinha

The demand for clean energy is increasing due to growing concerns about land, air, or sound pollution. The rationale is to design a sustainable microgrid using only renewable energy resources (RES) wind, solar, hydro, and pumped hydro. This is to promote environmental conservation and offer a more decentralized solution to meet energy needs. To achieve this, we are looking at designing a new setup for community consisting of residential areas, schools, hospitals, offices, parking lots, farmland, and industries. We are aiming to estimate the power demand of such community from futuristic viewpoint (2050) and design renewable energy based power solution to meet the demand of this community on a sustainable basis on a daily, monthly, and yearly basis. This study is likely to impact develop self-sustainably powered communities and meet power demand for our futuristic society without making significant impact on the environment.



Novel Power Generation—Harvesting Energy from Railways

TEAM MEMBERS
Alex Ordoveza, Evelyn Lliguicota, Anthony Chicketano, Braden Waller

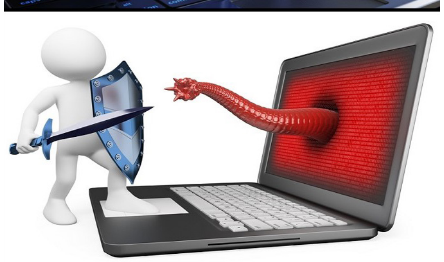
PROJECT MANAGERS
Dr. Yashwant Sinha

Commercial railroad tracks experience displacement and vibrational forces which has significant energy content. In this project we are looking to harness and store this energy for potentially other applications. Our initial investigations have used piezoelectric devices which converts force to electricity. The initial results have shown promising results which we will take forward. However we are also investigating other technologies and strategies to harness such energy.

Adversarial Machine Learning

TEAM MEMBERS
Aidan Sharpe

PROJECT MANAGERS
Robi Polikar



With the proliferation of AI/machine learning controlling seemingly endless aspects of our lives, a new cybersecurity threat has been posed. Not only are traditional cloud-based threats risk, such as denial of service attacks, but AI services are also at risk of being sabotaged by adversarial attacks. In this project, we focus on image recognition-based applications (such as object identification by autonomous systems), and propose a pipeline that applies denoising image filters to circumvent image based adversarial attacks before they reach the AI model. In doing so, the goal is to remove, or at least reduce the impact of, adversarial attacks. We find that in cases where data is particularly high contrast, certain image filters can maintain the classifying accuracy of the model even at high attack strengths.

Teaching Language Models How to Act

TEAM MEMBERS
Chaz Allegra

PROJECT MANAGERS
Robi Polikar

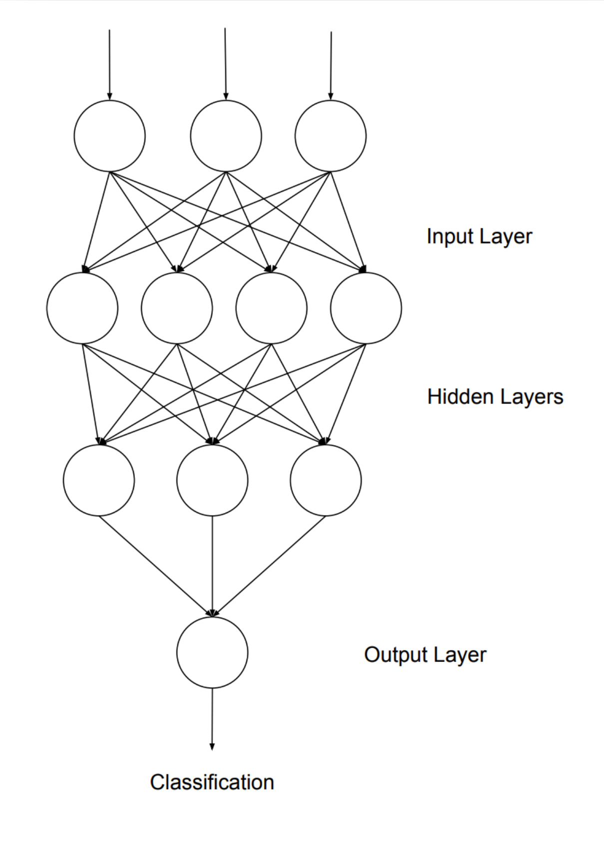
Visual language models acting as “brains” to embodied agents (such as smart robots) is a new frontier for robotics tasks, but the data required to train such models is costly and inaccessible for most researchers and practitioners. In this project, we show how simply understanding the nature of our agent’s action space can yield us ”free” training data, providing wider access to those interested in working in this new field, which was previously inaccessible. We call this method Action Question Answering (AQA), which is the act of teaching a language model how to operate their newfound physical body based on what they already know about language. In our case, for a car that has a throttle, brake, and steering for each action, we were able to generate 45,000 action-description pairs, without collecting a single piece of data, and utilizing them for both language and action response tasks yielding 90,000 data samples. Our tests show that pre-alignment of the action space greatly improves the effectiveness of the model. Finally, we see that AQA makes fine-tuning of the agent with a limited amount of gathered data feasible, improving the data efficiency and stability of training these models.

Early Detection of Alzheimer's Disease using Machine Learning

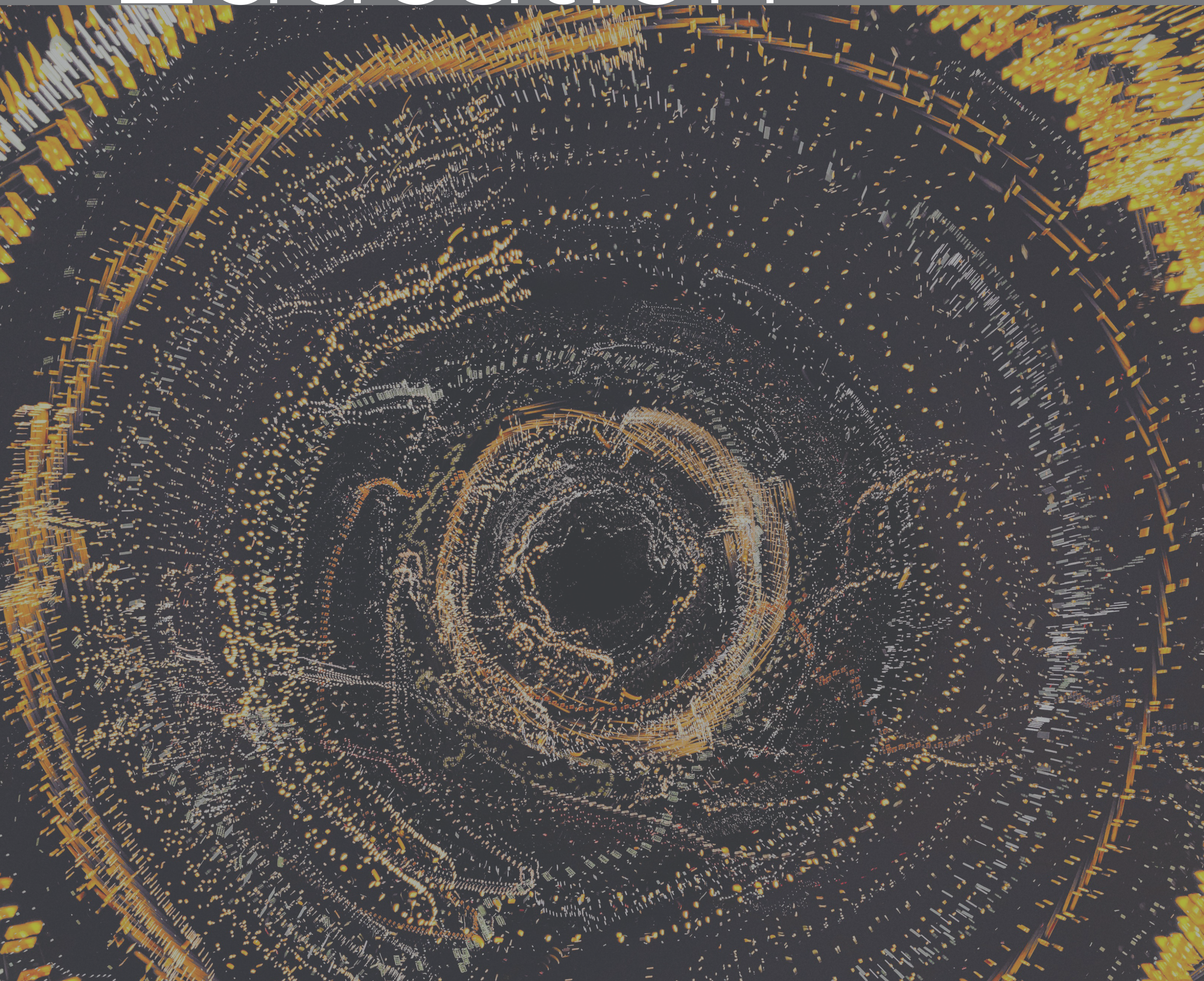
TEAM MEMBERS
Ohm Sharma

PROJECT MANAGERS
Dr. Robi Polikar
(Electrical and Computer Engineering),
Dr. David Libon
(New Jersey Institute for Successful
Aging School of Osteopathic Medicine)

Alzheimer's disease is an incurable illness with no definitive method of diagnosis besides during an autopsy. Clinicians currently rely on a variety of diagnostic tools to evaluate symptoms of Alzheimer's, such as dementia. The Clock Drawing Test (CDT) is among these assessments where patients are asked to draw a clock. The resultant drawing is analyzed to determine the stage of dementia. However, this is a subjective and sensitive assessment that is open to misinterpretation. Instead, machine learning can be used to objective;y predict the severity of Alzheimer's Disease using numerical data from CDT. This approach may not only increase the diagnostic accuracy of Alzheimer's Disease, but also allow for timely interventions and patient care.



Experiential Engineering Education

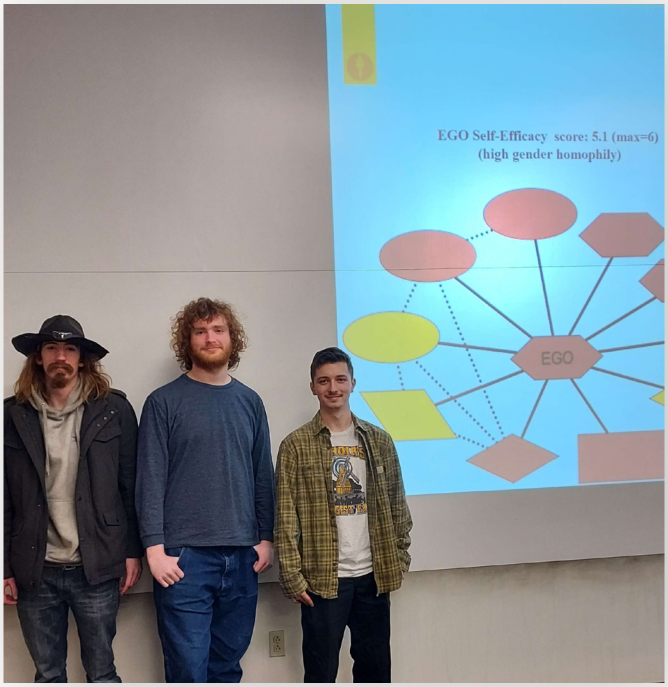


The Effect of Ego Network Structure on Self-Efficacy in Engineering Students

TEAM MEMBERS
David Myers, Luciano Miletta, Matthew Currey

PROJECT MANAGERS
Kaitlin Mallouk, Darby Riley

Engineering students' self-efficacy—a self-judgment of capability in a given field—is an accepted predictor of college success. Many factors affecting self-efficacy have been identified in previous research, such as positive performance in classes, practical experiences, and access to mentors. Previous studies have also found that many of these factors are affected by aspects of students' social circles, namely homophily and social capital. Students with more homophilous networks (networks with greater similarity between the student and the people in their network) tend to demonstrate higher performance and may feel a greater sense of belonging in engineering as a whole. Homophily most typically explores similarities in gender and/or race. Students seek people similar to themselves and feel more inclusion making social connections with people of the same gender and/or race. Social capital also plays a vital role in friendships and education, affecting social outcomes and academic achievement, including improved grades, test scores, and overall performance. Social capital is a measure of the resources a student has access to within their social network. For example, a student who has friends performing higher than themselves can leverage these friendships as resources while studying for exams or working on a final project.

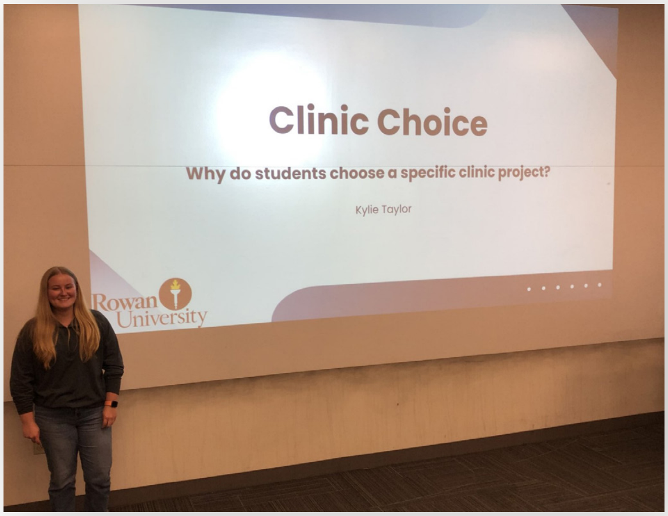


Exploring Students' Clinic Choices

TEAM MEMBERS
Kylie Taylor

PROJECT MANAGERS
Cassandra Jamison, Smitesh Bakrania

This project explored the processes by which students at Rowan make decisions about which clinic projects to engage with and how their engagement supported their professional development. Data collected were from a series of interviews with current and former Rowan engineering students. The student lead on the project joined at the conceptualization phase of the project, contributing to the IRB preparation and approval process, interviewing fourteen total participants including Rowan alumni, and learning new qualitative data analysis approaches in order to identify initial patterns in how students make decisions about clinic projects. Key findings illuminated the unique role friends had in narrowing down choices during the decision-making process, gaps in students' understanding of the clinic structure when entering clinics for the first time, and the value of talking to faculty to understand clinic projects. The work completed this year will be used to inform changes in the clinic match process and support future research to understand how the clinic structure already supports and can better support students' professional development in the future.



Narratives of Food Access

TEAM MEMBERS
Dylan Letcher, David Lentz,
Anthony Madonna, Adam Amaefuna

PROJECT MANAGERS
Dr. Justin Major

SPONSORS
New Jersey Office of the Secretary of Higher Education

Food insecurity is rampant on college campuses and greatly impacts the success of affected students. Rowan University is no different. In fact, a significant number of Rowan students, including engineers, experience food insecurity and there is increasing evidence that such experiences impact their mental health, GPA, and retention. As part of a grant funded by the New Jersey Office of the Secretary of Higher Education, students in this clinic explored food insecurity on college campuses and constructed stories of engineering student food insecurity based on real accounts from Rowan engineering students. The analysis is ongoing, but evidence from their work suggests that food insecurity impacts engineering students in a variety of ways including its impacts on their energy and time.

SHOP Check-out and Inventory System Design

TEAM MEMBERS
Anne-Marie Zamor, Layane Neves, James Sunbury, Brian Dalmar, Solimar Soto, Nik Leckie, Erick Ayala-Ortiz, Emmy Sagapolutele, Allison Garfield, Juan Palacios (Clinic Consultant), Cole Cheman (Clinic Consultant)

PROJECT MANAGERS
Dr. Justin Major & Nick Bovee

SPONSORS
New Jersey Office of the Secretary of Higher Education

Food insecurity is rampant on college campuses and greatly impacts the success of affected students. Rowan University is no different. In fact, a significant number of Rowan students, including engineers, experience food insecurity and there is increasing evidence that such experiences impact their mental health, GPA, and retention. As part of a grant funded by the New Jersey Office of the Secretary of Higher Education, students in this clinic addressed inventory and check-in issues at the Rowan University food bank, The SHOP, using engineering design. Specifically, the team of engineers designed a hardware and software setup that would allow The SHOP to manage its inventory and collect data on students to better its ability to address food insecurity in the future.

Student Familial Inequality

TEAM MEMBERS
Anne-Marie Zamor, John Borden

PROJECT MANAGERS
Dr. Justin Major

Resource inequity deeply impacts students' ability to access an equitable engineering education. To make matters worse, access is not always equal across raced and gendered lines. Furthermore, the mechanisms by which it impacts students are not completely understood. In this project, students explored resource access in the home and school and explored how inequitability impacted engineering students' development of engineering identity and belonging. Engaged students learned to use the programming language R and conducted statistical analyses using methods such as linear regression. Specifically, they explored how engineering identity measures differed by differential access to resources. Students identified that access to different categories of resources impacts engineering identity differently.

Measuring Engineering Teamwork

TEAM MEMBERS
Dylan Letcher, David Lentz, Anthony Madonna

PROJECT MANAGERS
Dr. Justin Major

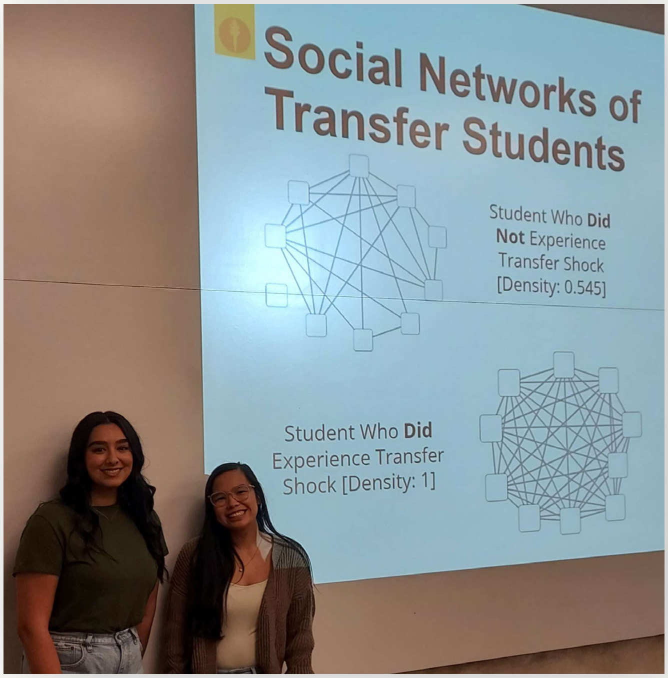
Engineering teamwork is an important skill for all engineering students to develop throughout their engineering educations. Teamwork effectiveness is greatly understood, how students develop engineering skills is not. In Fall 2023, a survey of teamwork attitudes and skills was developed and administered at two mid-atlantic universities, over 600 students responded. As part of this clinic, engaged students learned to use the programming language R and conducted statistical analyses using methods such as linear regression. Specifically, students explored how different attitudes and skills predicted conflict on engineering teams. Students identified that team leadership, team makeup, and other factors greatly influenced the degree to which students experienced conflict on their engineering teams.

Transfer Students' Social Networks and their Experience of Transfer Shock

TEAM MEMBERS
Noor Aulakh, JoyLynn Torelli

PROJECT MANAGERS
Kaitlin Mallouk, Darby Riley

This project investigated the social networks of lateral and vertical engineering transfer students to understand their integration and how it affects transfer shock, a GPA decrease experienced by transfer students. Two research questions were addressed: 1) How do the social networks of these transfer students differ? 2) What's the correlation between their social network and transfer shock? A survey was sent to engineering transfer students at a Mid-Atlantic university, covering demographics, GPA, and social network details. Social network analysis using Cytoscape focused on homophily, social capital, and network density. The results of this study showed that there was little difference between the social networks of lateral and vertical transfer students in terms of network density. However, there was a statistically significant relationship showing that the more interconnected a student's network, the more likely they were to experience transfer shock. Additionally, students who experienced transfer shock reported that they spent more social time with friends outside of class than those who did not experience transfer shock. Combined, these results suggest that there is a "sweet spot" between socializing and academics. As such, the researchers recommend that universities implement programs that aim to support transfer students in finding this balance quickly.



Modules for learning Acoustics

TEAM MEMBERS
Steven Weinstein, Joshua Justin Rosa

PROJECT MANAGERS
Juan M. Cruz, Chen Shen

SPONSORS
National Science Foundation

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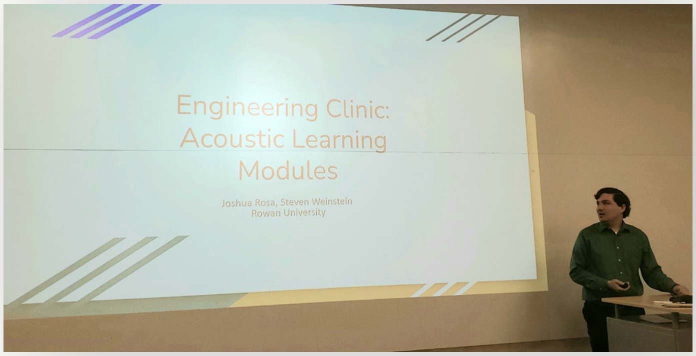


Introductory Videos for the Rising Doctoral Institute (RDI)

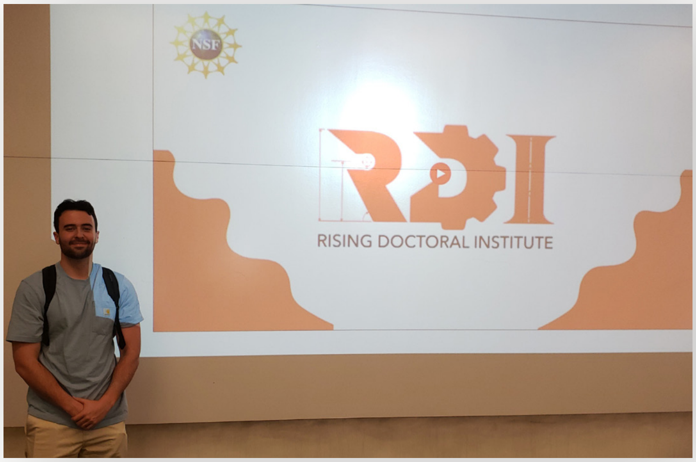
TEAM MEMBERS
Roman Leone, Benjamin Olitsky

PROJECT MANAGERS
Dr. Juan M. Cruz

SPONSORS
National Science Foundation

The RDI is an intervention directed at first-year engineering doctoral students. It consists of a series of workshops focused on five common struggles affecting most new doctoral students; safe spaces for small group discussions; and an evaluation to assess the impact of the RDI on students' success. The purpose of this clinic project is to create introductory videos aimed at inviting change agents from engineering colleges nationwide to participate in the initiative. After developing a script and storyboard, students integrated royalty-free multimedia material and AI-generated voiceovers to create two videos.

These videos were published on YouTube and the RDI website **therisingdoctoralinstitute.com**



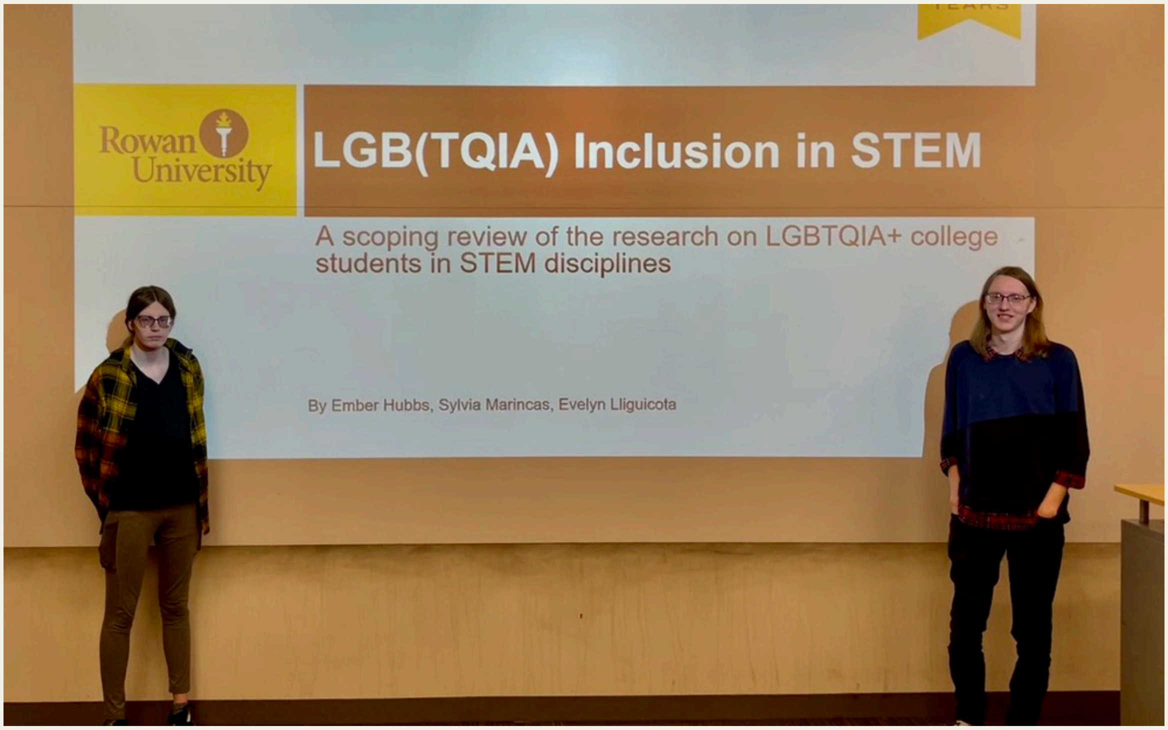
learn more:

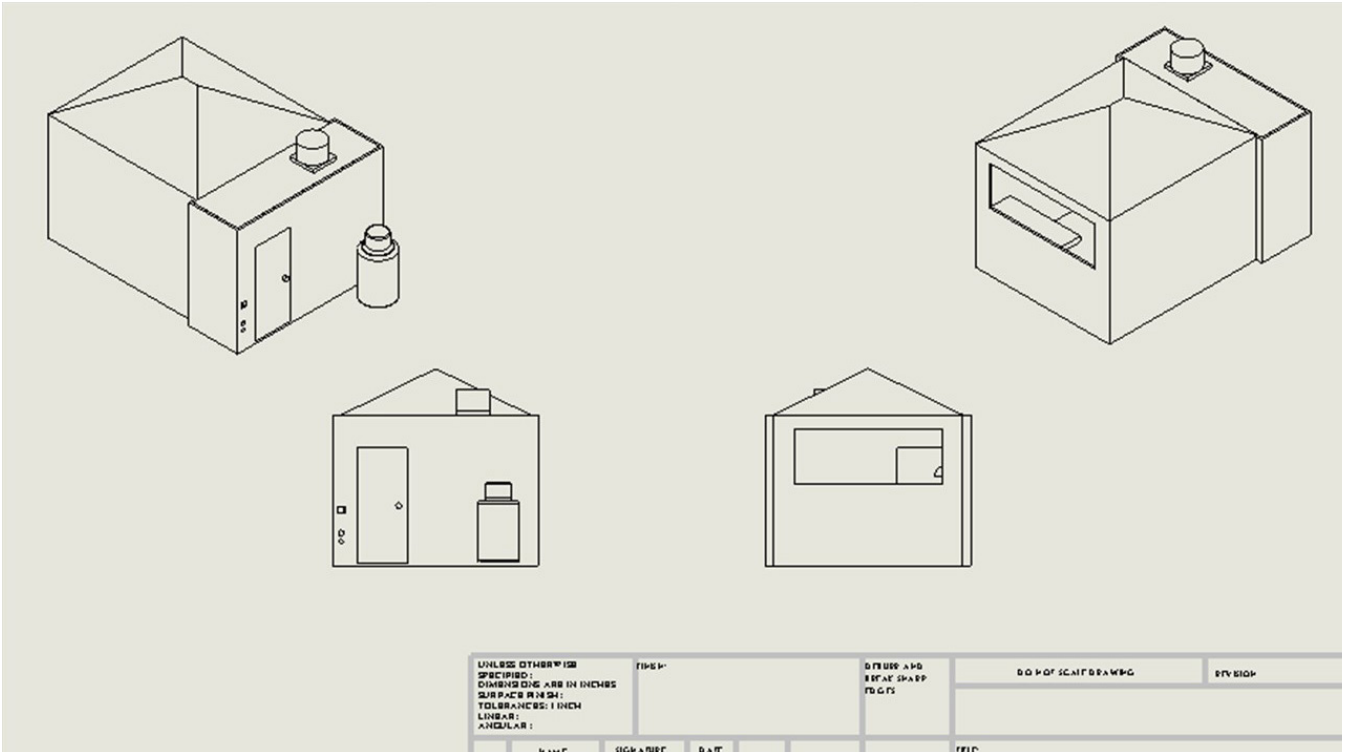
LGB(TQIA) Students in STEM: A Scoping Literature Review

TEAM MEMBERS
Ember Hubbs,
Sylvia Marincas, Evelyn Lliguicota

PROJECT MANAGERS
Stephanie Farrell, Keith Bowman

Research on the experiences of LGBTQIA+ individuals in STEM has been emerging gradually over the last 15 years, starting with the publication of two studies in 2009 focused on the experiences of lesbian, gay and bisexual (LGB) faculty and students. To our knowledge, only a few studies have focused on the experiences transgender and gender nonconforming individuals in STEM, and this research reveals a hostile STEM environment that can be even more challenging than it is for LGB folks. Our work uses a scoping literature review to assess the current state of knowledge regarding the narrow subset of the LGBTQIA+ community that includes transgender, intersex and asexual (TIA) individuals in STEM higher education worldwide. The findings will help to reframe the current approach to the study of gender in STEM, and to establish an agenda for research that will advance our understanding TIA college students in STEM disciplines.





Design Thinking: Community Engineering Applications

TEAM MEMBERS
Kaitlyn Riggs, Angelo Coiro

PROJECT MANAGERS
Dr. Michael Dominik

SPONSORS
Rowan Accelerate South Jersey Program / Truist Foundation

This Design Thinking clinic featured engineering fieldwork done for a disadvantaged minority community entrepreneur (client) who is sponsored by the Rowan University Accelerate South Jersey program. The project featured development design options for relocating and configuring her food trailer enabling her to use it as a place of business. The students applied the Design Thinking Principle of empathy by meeting with the client in her setting to understand her needs and challenges. Students satisfied client needs by developing structural relocation options and designing a food-safe water intake and disposal system.

Mechanical Engineering

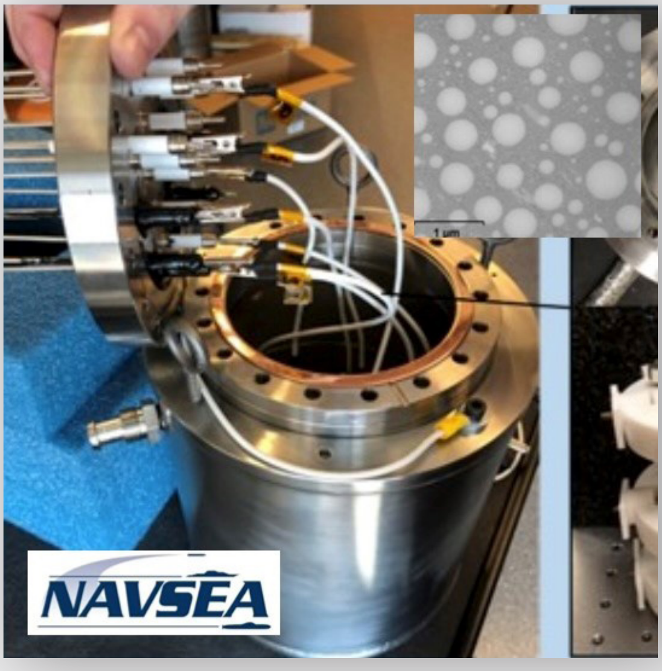
Polymer Composites for Navy Applications

TEAM MEMBERS
Jared Ericksen, Michael Smith, Joseph Marshina, Logan Allison, John Terifay, Nicholas Insinga, Benjamin Olitsky, John Hayes, Matthew Olivo, Madeline Seybold

PROJECT MANAGERS
Wei Xue

SPONSORS
Office of Naval Research

This project, sponsored by the Office of Naval Research, aims to study novel nanocomposite-based insulation materials for high-temperature superconducting (HTS) energy and power systems. These HTS systems operate at cryogenic temperatures between 20 to 100 K. The compact, lightweight, and efficient power transmission characteristics offered by the HTS technologies have demonstrated a high power-to-volume capacity, more than 200 times of those from standard copper conductor systems. Our clinic team aims to investigate various nanocomposites, including polymer-silica nanoparticle and polymer-POSS composites, as cryogenic dielectrics. The clinic students have focused on two key areas of research and development in this project, including (1) designing, operating, and optimizing a custom-built cryogenic testing system, and (2) preparing and testing novel composite dielectric materials. The students have utilized their engineering skills in design, manufacturing, instrumentation, materials research, material characterization (both electrical and mechanical), and data analysis. The preliminary results collected by these clinic students show that the nanocomposites are promising material candidates for cryogenic applications, especially in high-energy and high-power systems.



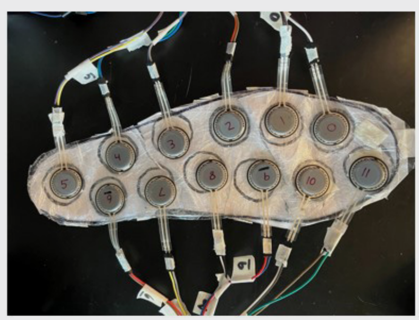
Property Adjusted Shoe Soles

TEAM MEMBERS
Carl Pantano, Andrew Solarski

PROJECT MANAGERS
Behrad Koohbor

SPONSORS
New Jersey Health Foundation

The goal of this two-year clinic project has been to create shoe midsoles with tunable mechanical properties. A shoe outsole and its corresponding model were designed using data collected from a foot pressure map and then fabricated using a silicone mold with inserts of different inserts. The clinic team designed and created several sections to house 3D-printed foam inserts inside the outsole. The placement of different inserts with adjustable stiffness was determined based on their mechanical properties which were characterized independently under compressive loads. The embedment of force sensors was done to help measure the local plantar pressure at different locations of the foot. The midsoles designed and developed in this work were tested by human subjects during walking (slow and fast) and running conditions with a treadmill. The design strategy proposed and implemented in this clinic can be an alternative to expensive custom orthotics for athletes and patients with specific foot and ankle issues.



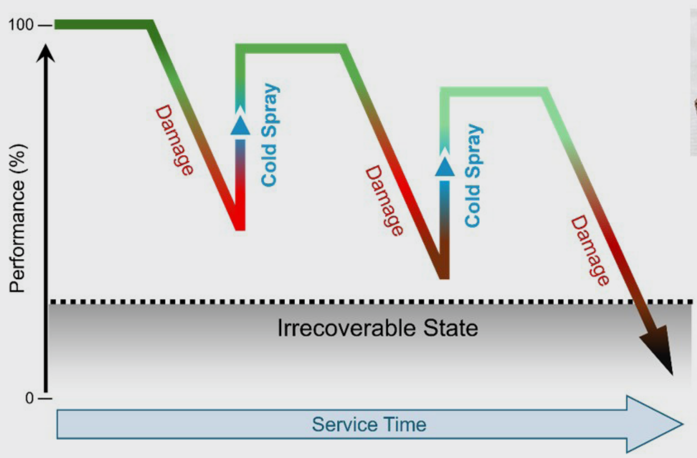
Repair of Composites by Cold Spray

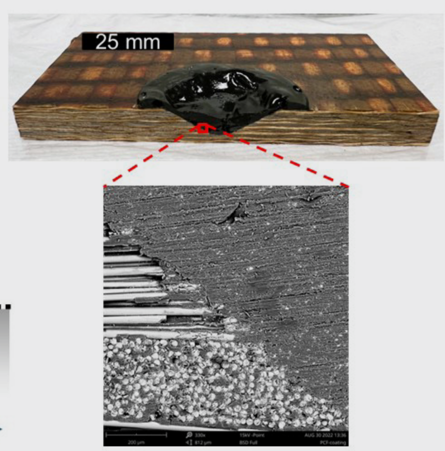
TEAM MEMBERS
Margaret Barrasso, Stephen McClain

PROJECT MANAGERS
Behrad Koohbor, Ibnaj Anni

SPONSORS
Army Research Lab

A significant challenge in the application of composite materials is the maintenance and repair of a damaged composite. This project aims to investigate the application of polymer cold spray technology as an innovative and effective alternative for repairing damaged composite panels. The project involves the intentional and controlled imposition of impact-induced damage to fiber-reinforced polymer composites to replicate the service damage (e.g., due to debris or projectile impact), followed by a repair protocol that is based on the cold spraying of thermoplastic polymeric powders. The impact-induced damage is generated using a custom-designed gas gun with the capability to shoot a wide range of projectiles at velocities as high as 15 m/s. The recovery of the lost structural properties (due to damage) is evaluated experimentally using three-point bending tests. The results indicate that the polymer cold spray can substantially recover the mechanical properties of the repaired product at a significantly reduced time, cost, and energy compared with traditional repair methods. Furthermore, the investigated "repair by cold spray" process can be used for on-site damage repair, leading to the development of high adhesion strengths and stiff coatings, while requiring minimal pre/post-processing.





SAMPE Student Bridge Contest

TEAM MEMBERS
Lawrence Agostini, Caylei Hoffman, Alan Kwok, Jason Lee, Zachary Steelman, Gloria Villagomez

PROJECT MANAGERS
Behrad Koohbor, Nicholas Mennie

The Bridge Contest is an annual international competition at the SAMPE conference. SAMPE has hosted this competition for student members to design, analyze, build, and test a miniature structural bridge using various composite materials in accordance with a set of well-defined rules. The main objective is to design and build a composite bridge using an assortment of pultrusions, cores, fabrics, and other materials, such that the strength-to-weight ratio of the fabricated bridge is maximized. Following the successful establishment of the SAMPE student chapter at Rowan in 2022, the Bridge Contest Clinic was initiated with the idea to form teams of students who compete internally, and upon selection, would represent Rowan University at the annual SAMPE meeting.

sampe
North America

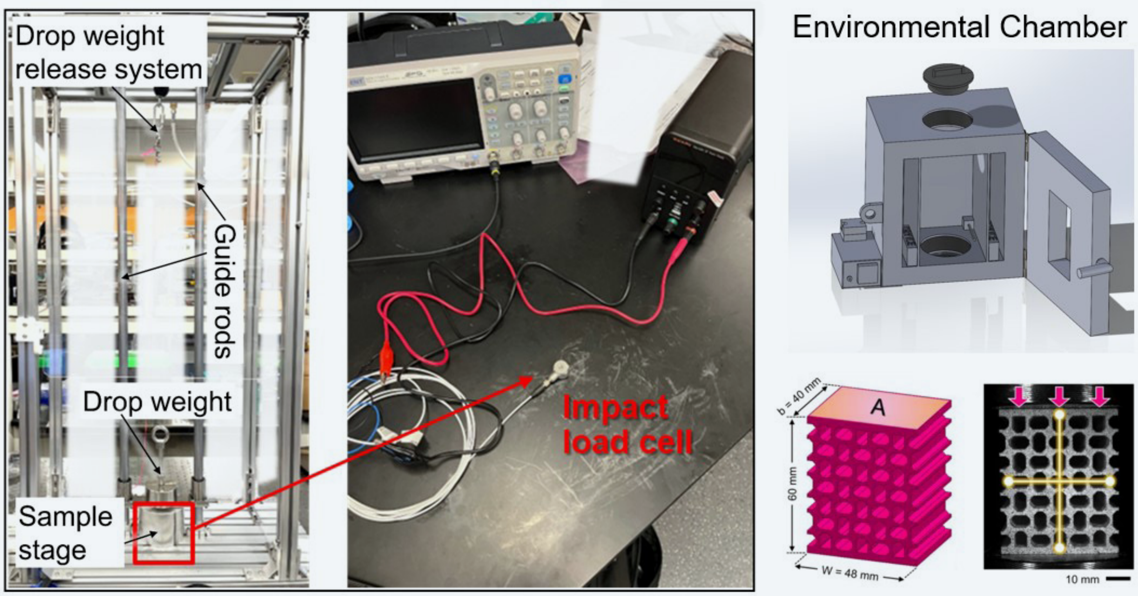
3D Printed Foams

TEAM MEMBERS
Matthew Heras, Rylan Krikorian, Richard Nasuti, Andrew Nguyen

PROJECT MANAGERS
Behrad Koohbor

SPONSORS
National Science Foundation

This Clinic project involves the design, fabrication, and characterization of 3D-printed cellular structures for impact mitigation applications. Continuing from previous semesters, this project included the design and fabrication of 3D printable flexible structures that resemble the mechanical properties of foams. Sample fabrication was done by stereolithography 3D printing. To enable testing of the 3D-printed structures at high strain rate conditions, the team also worked on upgrading the existing drop tower impact tester by making it taller. Additionally, the team designed a temperature-controlled environmental chamber to enable the testing of materials and structures at cold and elevated temperatures. Finally, by combining the upgraded test instrument with high-speed photography, digital image correlation analyses were performed on structures to understand their deformation response under a wide range of loading conditions, including high-speed impact.



Exoskeleton—
Fall Prevention

TEAM MEMBERS
Adil Khaleeli, Adrian Segovia, Ferdinando Gismondi, Edward Rosa, Alessio Sainato, Erick Ayala-Ortiz, Nicholas Andrianto, Ryan DiGiacomo, Joseph Rosa

PROJECT MANAGERS
Dr. Mitja Trkov

SPONSORS
National Science Foundation

Existing exoskeleton devices are often specifically designed to aid with a targeted task, such as level-surface walking or stair climbing. The ability of an exoskeleton device to assist during walking with gait perturbations still presents a challenge. The goal of this project was to design a hip exoskeleton device to assist with medio-lateral foot placement that can augment human bipedal gait capabilities and enhance safety during gait perturbations. Improvements of the existing prototype were made to enhance the functionality of assisting with hip abduction. Bench tests were performed and improvement in electronics to precisely control the air cylinders actuation.

BAJA SAE Junior Clinic

TEAM MEMBERS

Brayden Bruseo, Addison Deckert, Hunter Givone, Ryan Hussey, Lorenzo Linarducci, Susannah Llugani, Sebastian Maslach, Erin Miklencic, Briana Roman, Christopher Spicer, Ethan Struble, Anthony Tramontana, John Truitt John Truitt, Edgar Velazquez, Ilinca Vilceanu, Jason Wheeler

PROJECT MANAGERS

Anu Osta

SPONSORS

Gene Haas, Polaris, Penske, HMS Motorsports, KHK, Metlab, Summit Racing

The Society of Automotive Engineers (SAE) hosts yearly competitions in which a single-seat, all-terrain vehicle is designed by a team of students in compliance with the rules set forth by the SAE Baja Collegiate Design Series. The goal of participating in Baja SAE is to compete in various static and dynamic events, in which the design and assembly of the car is rigorously put to test.. Design of the Rowan Motorsports 2025 Baja Car began in the summer of 2023 with the goal of producing a lightweight car without sacrificing strength or reliability. The 2025 car will compete in the regional SAE Baja competitions in 2024 and 2025. They will test, identify design flaws and redesign the systems. The Baja team consists of the following sub-systems: frame, transmission, front suspension and steering, rear suspension, brakes and throttle, safety, and data acquisition. The primary design objective of the car is reliability while still maintaining weight savings. The weight reduction and overall design choices are tailored toward increasing long-term performance in the endurance challenge.

BAJA SAE Senior Clinic

TEAM MEMBERS
Vincent Gallo, Ryan Connors, Anthony Kuczynski, Kaitlyn Hines, Jake Bobrowski, Brian Deady, Nicolas Fink, Christian Garabo, Matthew Hewitt, Noah Jager, Joshua Lewbart, Maureen O'Brien, Evan Parker, Brenden Prefer

PROJECT MANAGERS
Anu Osta

SPONSORS
Gene Haas, Polaris, Penske, HMS Motorsports, KHK, Metlab, Summit Racing

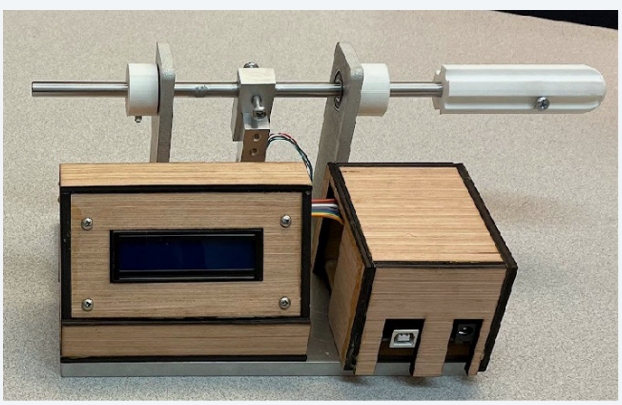
The Society of Automotive Engineers holds an international Baja competition every year where student teams are tasked with building and testing a single seat, all-terrain vehicle. As part of the Rowan University clinic experience, an off-roading vehicle 'Goblin' was designed and manufactured in compliance with the rules set out by the Society of Automotive Engineers as per the BAJA collegiate design series. The Fall semester of 2023 and Spring of 2024 was focused on the completing manufacturing of Rowan's third 4WD vehicle, as per new SAE BAJA rules. The vehicle was designed and tested for acceleration, maneuverability, endurance, hill climb, and pull. This team participated in Épreuve du Nord 2024 in Canada in February. They will be participating in Baja SAE competition at Williamsport, PA in Summer 2024.

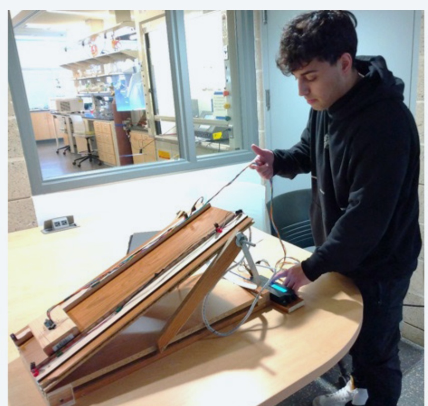
Educational Hardware Modules

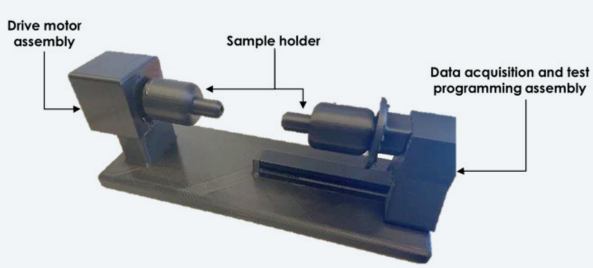
TEAM MEMBERS
Marcus Sosa, Shane Vostenak

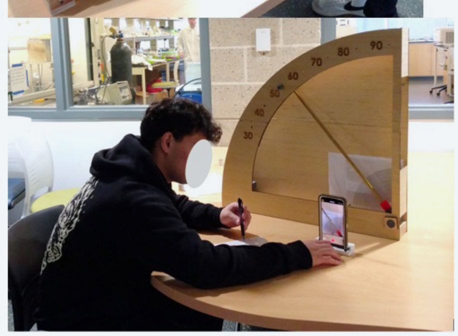
PROJECT MANAGERS
Anu Osta

In this clinic, students crafted in-class demonstration and laboratory modules centered around utilizing a variety of design and manufacturing tools. These tools included 3D printing, CNC machining, PLC and Arduino micro-controller programming, laser and waterjet machining, electronic design, and robotics. Through a blend of manufacturing processes, students created kit components, integrated them with off-the-shelf electronics, and utilized programming languages and computer-aided design (CAD) modeling. These lab modules were tailored to courses such as Advanced Manufacturing, Machine Design, Dynamics, Material Science, Manufacturing, and Strength of Materials. The primary aim was to equip students with hands-on experience in operating CNC machines, robotic manipulators, programming logic controllers, and additive manufacturing equipment such as SLA and FDM 3D printers.









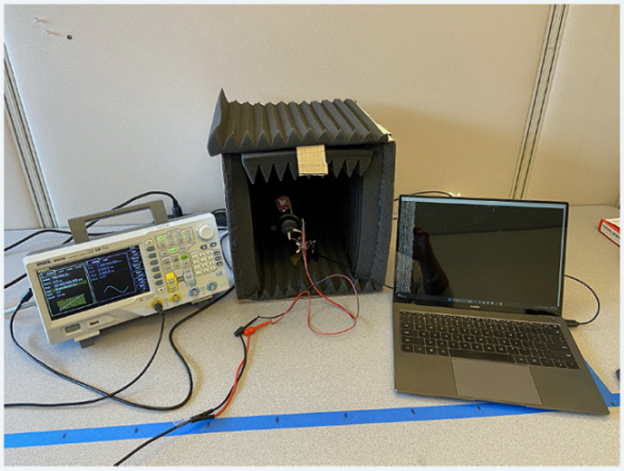
Sonic Guns for Drones

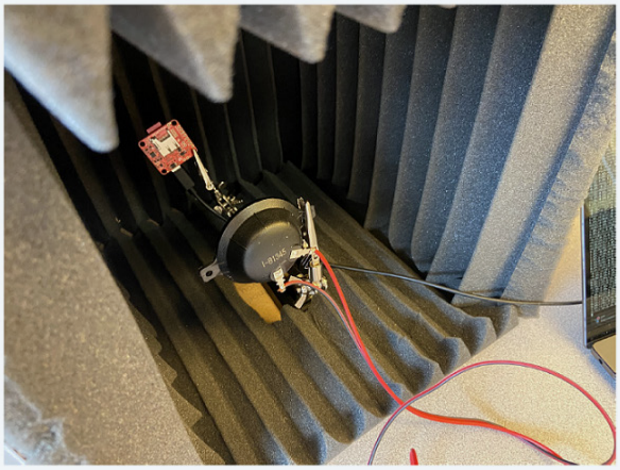
TEAM MEMBERS
Argenis Rodriguez, Vincent Vernacchio, Jason Blanda, Ivan Anderson

PROJECT MANAGERS
Dr. Chen Shen, Corey Churgin, Ali Zabihi

SPONSORS
National Science Foundation

The attitude of a drone is controlled by its electronic sensors, whose output can be impacted by sound waves. When the sound waves match with the resonance frequency of the sensors, strong vibration can be created, which will corrupt their output. Such a scenario can be leveraged for a sonic “gun” that can knock drones off from the sky in a remote manner. In this project, we will design such a sonic “gun” with all the supporting electronics and programs and test its implementation on real drones. The idea was validated on a drone module in the first semester, where the output signals from the module are affected when the sound frequency is carefully adjusted to match with its resonance frequency. In the second semester, the team continues to experiment with this concept using real drones. Several improvements are implemented with additional measurements using a laser Doppler vibrometer to confirm the resonance frequency of the sensors. The ultimate goal is to create a reliable and automated drone attacking scheme for certain applications.





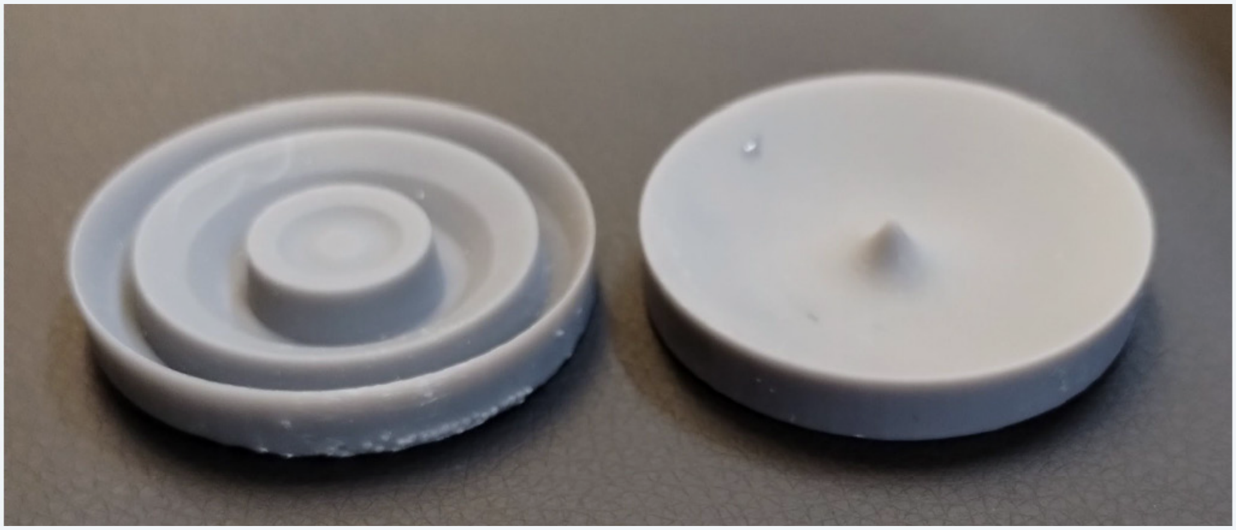
3D Printed Ultrasound Lenses

TEAM MEMBERS
Milton Rivera, Aidan Kayes

PROJECT MANAGERS
Dr. Chen Shen, Chadi Ellouzi

SPONSORS
New Jersey Health Foundation

The objective of this project is to design 3D printed ultrasound lenses and test their abilities to generate different wave patterns in water. Depending on the shape and configuration of the lens, the incoming ultrasound waves can be modulated, and various sound fields can be created based on the interference at the far field. In this project, an underwater acoustic field acquisition system is built, which can map the acoustic pressure distribution in a 3D manner in a water tank. Several ultrasound lenses have been designed and tested, including ultrasound focusing devices, bottle beams, or acoustic vortex beams that have various applications in engineering and healthcare. The lenses are fabricated using stereolithography 3D printing, facilitating their manufacturing and implementation. Part of the results are documented in a journal publication in APL Materials, a leading journal in applied physics.



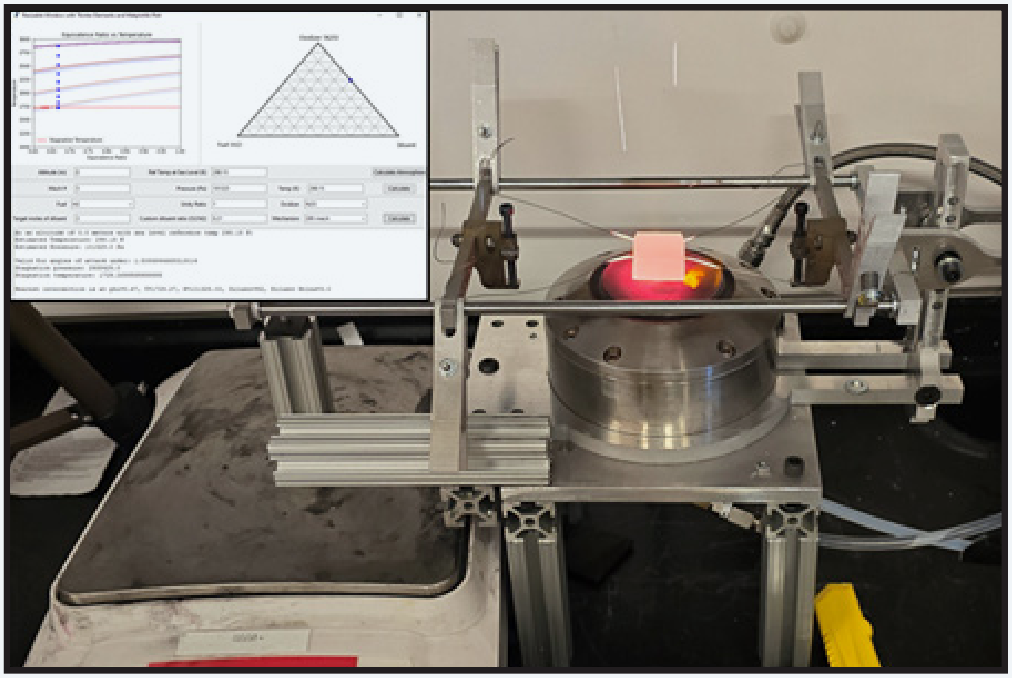
High Temperature Materials Testing

TEAM MEMBERS
Michael Scarduzio, Luke Vargas

PROJECT MANAGERS
Francis Haas
(with support form Logan Klingler)

SPONSORS
US Army Research Lab

This Clinic team developed two facilities for testing materials survivablility under specific types of extreme conditions: (1) an ASTM D3801-inspired testing enclosure for relative flammability screening of novel material developed in the Rowan CHE department and (2) a flat-flame burner facility to serve as a flexible alternative to the ASTM E285 oxyacetylene ablation test. Key design challenges for Apparatus 1 included preserving essential respect for the ASTM testing method while considering cost minimization and site-specific space/utilities needs. Development of custom Apparatus 2 involved integration of an off-the-shelf McKenna burner as the source of a high temperature, radical-rich materials testing environment, an IR camera and laboratory balance for real-time sample monitoring, and requisite supporting infrastructure. Computational tools developed for this effort include a flame calculator to enable facile estimation of inputs to achieve a desired post-flame environment as well as a tool for estimating atmospheric conditions —particularly temperature and oxygen partial pressure - behind normal shock waves associated with high speed atmospheric travel. The associated image, part of Apparatus 2, shows a block of graphite oxidizing/ablating in the environment behind a lean hydrogen flame, with representative flame calculator output provided in the inset.

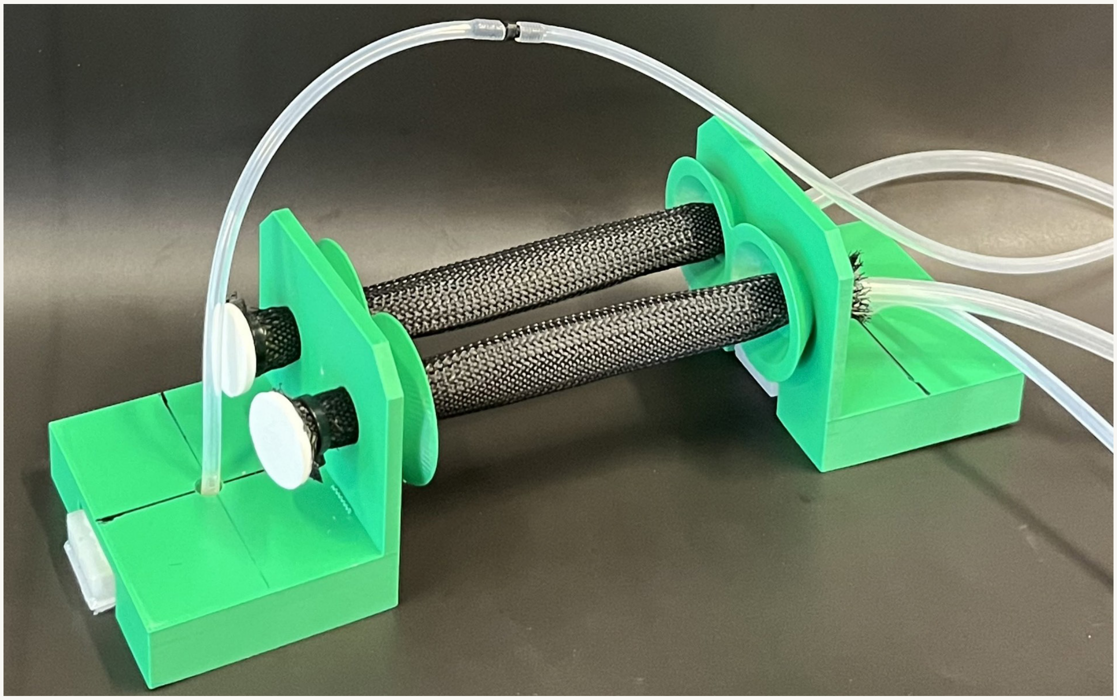


Soft Robotic Actuators

TEAM MEMBERS
Aidan Ritter, Julian Porras Arcos, Christopher Zupko, Andrew Razze, Matt Olivo, Gloria Villagomez, Connor Mahon, Dani Marincas

PROJECT MANAGERS
Dr. Mitja Trkov

The purpose of this project was to design and develop a soft robot to enter the competition at the 2024 IEEE International Conference on Soft Robotics (RoboSoft). In this year's competition, soft robots must show resilience, body compliance, delicate contact, and deformability. There were several tasks that robots must overcome, and our team focused on locomotion. Therefore, the specific tasks of this project were to design a soft robot that could efficiently perform locomotion and steering, while demonstrating its deformability. Students redesigned a previous version to construct a new robot, named Incher. The Incher has extended capabilities that include steering and improved contact interactions.



Rowan AIAA/ DBF 2024

TEAM MEMBERS

McCarthney, Forrest Lee Wang, Daniel W Gupta, Manas Pezzuti, Griffin Paul Saccomanno, Nicholas Mathew Giordano, Noah John Forbes, Caleb E. Schweiger, Brett Wilson, Nicholas P. Marchev, Alfred Joseph Favato, Kelly Brockunier, Keith C. Tindall, Cory David Burns, Harrison Marcel

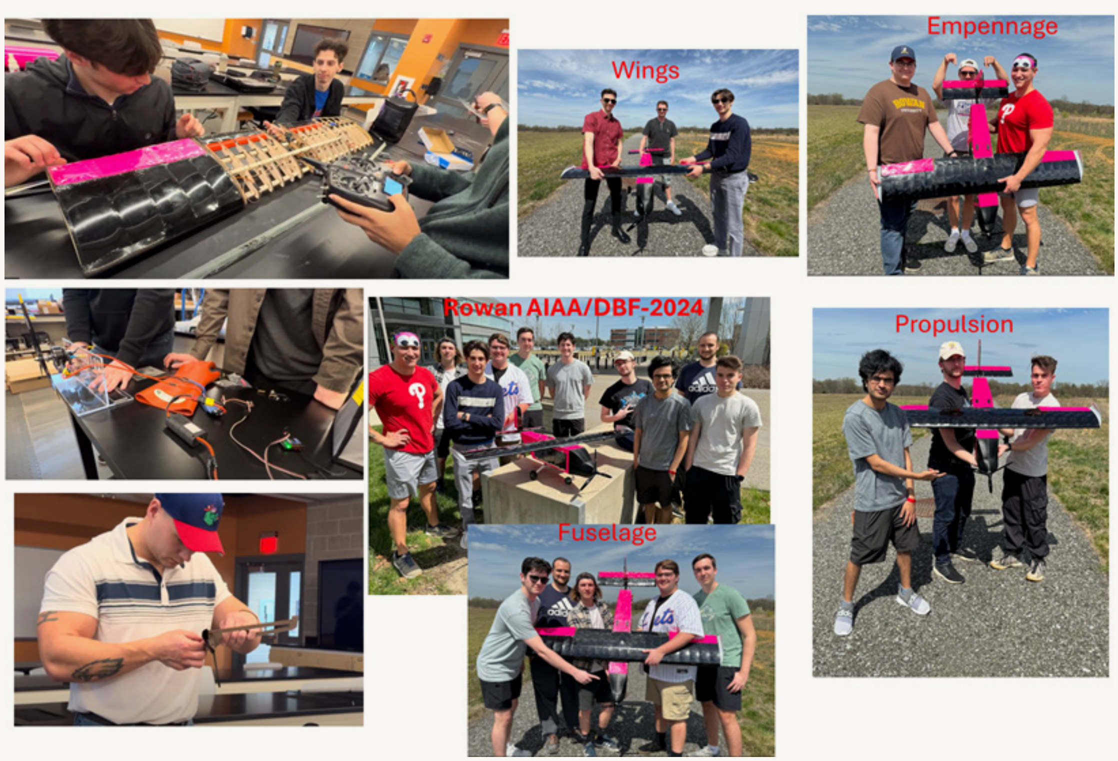
PROJECT MANAGERS

Dr. Nand Kishore Singh and Dr. Paromita Nath

SPONSORS

AIAA club

The American Institute of Aeronautics and Astronautics (AIAA) hosts an annual competition called Design/Build/Fly (DBF) where university students from around the world compete to build an aircraft for a specific design challenge. The contest provides a real-world aircraft design experience for engineering students by giving them the opportunity to validate their designs. The Rowan student team will design, fabricate, and demonstrate the flight capabilities of an unmanned, electric-powered, radio-controlled aircraft that can best meet the specified mission profile. The goal is a balanced design possessing good demonstrated flight handling qualities and practical and affordable manufacturing requirements while providing a high vehicle performance. The team focuses on design & analysis in the Fall semester, followed by fabrication and testing in the Spring semester.



Cultivate Soft Robotics

TEAM MEMBERS
Kathy N. Trieu, Joseph R. Midiri, William Y. Heil-Heintz, Matthew D. Longstreth, Jacob J. Wojcicki, Vincent N. Sambucci, Alexander T. Siniscalco, Douglas Snyder, Matthew Mastej, Jason Merrill, Cole Ludwikowski

PROJECT MANAGERS
Trkov/Bakrania/Jamison/Xue

SPONSORS
National Science Foundation

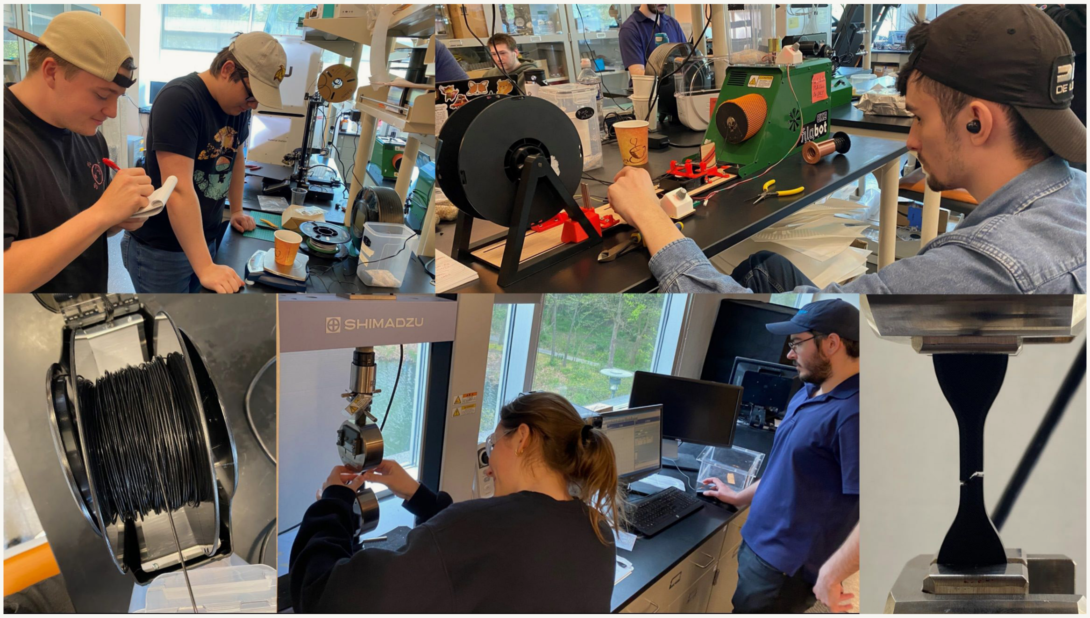
Soft robotics is an emerging field that envisions soft-bodied robots to accomplish everyday tasks. It has gained momentum in industry and academia; however, soft robotics education has yet to catch up to the research advancements in this field. This project was designed to create opportunities for students to directly engage with this field and create student-generated soft robotics educational modules to impact the learning and interest in soft robotics. Several hands-on lab modules were developed that include physical prototypes examples and detailed documentation for instructors. These learning modules are aimed for a broad adoption and implementation in mechanical engineering curriculum.

Sustainable 3D Printing

TEAM MEMBERS
Zachary Tucker, Emma Benkovic, Jeremy Reilly, Shayne Michot, Richard Brown

PROJECT MANAGERS
Dr. Paromita Nath, Dr. Najah Mhesn

Polylactic acid (PLA) is widely used for 3D printing due to its ease of processability, low manufacturing cost, and abundance. In order to lessen the environmental burden associated with the production, disposal, and poor recyclability of plastics, the team investigated the feasibility of recycling PLA. However, recycling polymers can change their properties, thus affecting the strength of the 3D-printed parts manufactured using the reprocessed filaments. In this work, neat PLA filament was reprocessed via extrusion, followed by 3D printing for five cycles. Effects of reprocessing on the thermal properties of the filament and 3D printed parts were assessed via thermogravimetric analysis and differential scanning calorimetry respectively, and mechanical properties were studied via tensile testing. The team aims to implement sustainable 3D printing on campus using the knowledge gained from this clinic project.

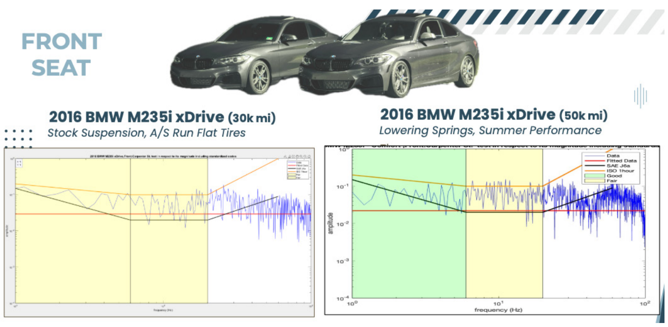


Too Much Rim?

TEAM MEMBERS
Arber Llugani, Gianna Cava, Jack Thorpe, Nicholas Pilla, and Ryan Zheng

PROJECT MANAGERS
Dr. Bhatia

The goal of this project was to use a smartphone, and its internal accelerometer, to study the ride quality, noise, and vibration characteristics of automobiles. A test procedures was developed and MATLAB code written to analyze accelerometer data in order to develop a grading system so a consumer could easily and quantitatively compare vehicles to one another, and assess the effect of modifications (like suspension changes or wheel/tire package changes). All of the results, code, test procedures, and data were then converted into a consumer-focused website for public use.

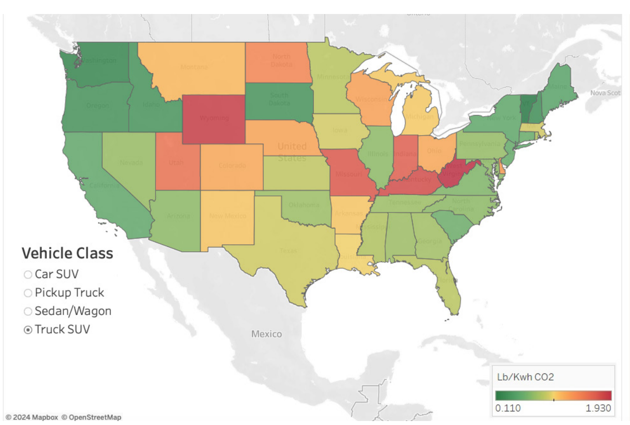


EV Emissions and Cost Analysis

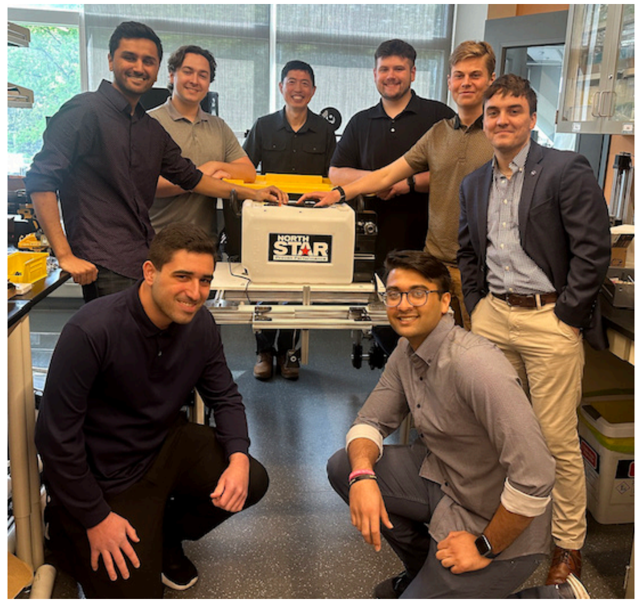
TEAM MEMBERS
Marc Scalera, Arthur Anenberg, Noah Carey, Joshua Rosa

PROJECT MANAGERS
Dr. Bhatia

The goal of this project was to analyze electric vehicle cost and upstream electricity production emissions on a state-by-state level and compare them to traditional gasoline and hybrid vehicles. Localized state electricity CO2 emissions and gasoline prices were utilized. This analysis was conducted for several common classes of vehicles (i.e. trucks, sedans, crossover SUVs, etc). This data was then converted into an easy to use, interactive map-based, interface to help buyers make choices. All of the results and data were then converted into a consumer-focused website for public use.



Improve the chassis of a farming robot



TEAM MEMBERS
Benjamin Busler, Nicholas Cella, Richard Kurczeski, Masumkumar Patel, Sujay Patel, Evan Selzer, Nicholas Zanowicz

PROJECT MANAGERS
Dr. Hong Zhang

With the shortage of labor, farming robots are the ideal substitute to work in the field. The Rowan Farming Robot team is to develop a modular robot platform that will recognize the weed and crop using AI based machine vision, calculate the speed of itself using the image flow, and spray herbicide or fertilizer to the corresponding targets on the move. In this academic year, the Jr/Sr engineering clinic team worked to improve the second generation of the robot with aluminum chassis, brushless motor and chain drive, and other upgrades. The robot is now reaching over 200lb payload and capable of remotely controlled driving.

Development of paste application apparatus for GGB

TEAM MEMBERS
Dylan Hanni, Matthew Longshaw, Kyle Clark, Thomas Moderski

PROJECT MANAGERS
Hong Zhang

SPONSORS
GGB by Timken

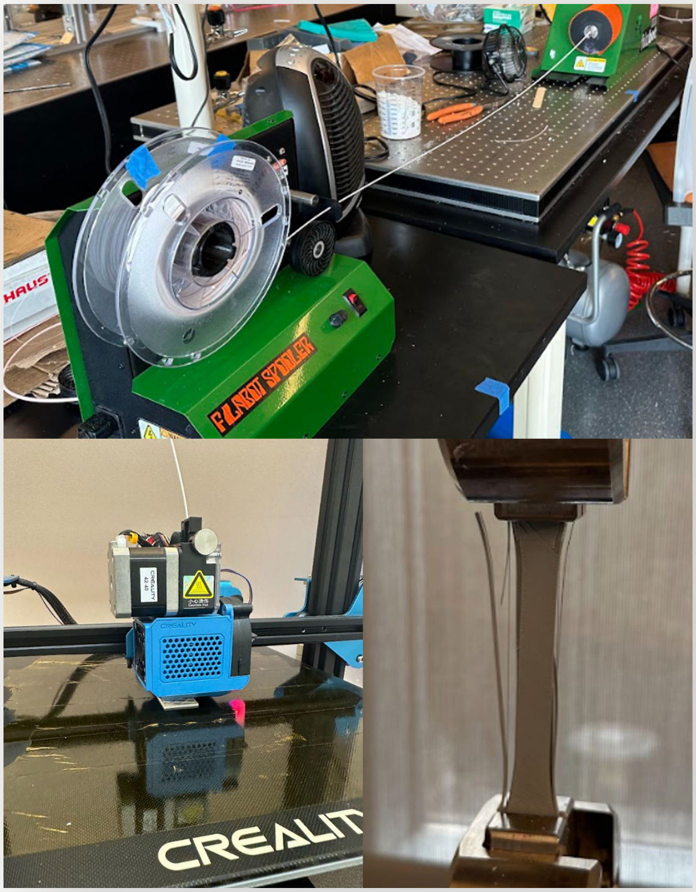
GGB, a bearing manufacturer, had developed a new product by applying a proprietary paste to their bushings. The current procedure of applying the paste is manual and tedious. Rowan Jr/Sr. engineering clinic team was tasked to develop an apparatus and an operational procedure to streamline the process and reducing the application time from 5 minutes to 30 seconds. The student team and the GGB engineers worked together to analyze the existing procedure and develop the technology. After several iteration, an initial solution was provided and is under testing by the company for both the efficiency of the device and quality of the product.

Fabrication of Metal Filaments for 3D Printing

TEAM MEMBERS
Aaron Raio, Dominic Kresge,
Joshua Schofield, Yashdeep Singh

PROJECT MANAGERS
Dr. Paromita Nath and Dr. Nand Singh

Fused filament fabrication with metal filaments provides a cost-effective and accessible method for 3D printing metal components. This clinic focused on customizing metal filaments to produce parts with a wide range of mechanical properties. Filament was fabricated by mixing powdered aluminum alloy with polylactic acid (PLA). The percentage of aluminum was varied from 0 to 5% by volume, allowing for the creation of a range of composite filaments. Specimens were then printed using these customized filaments. Finally, tensile testing was conducted to characterize the mechanical properties of these new filaments. This customization of filaments with multiple volume fractions of metal and polymers allows for the creation of 3D printed parts with varied mechanical properties, catering to specific design requirements and application needs.

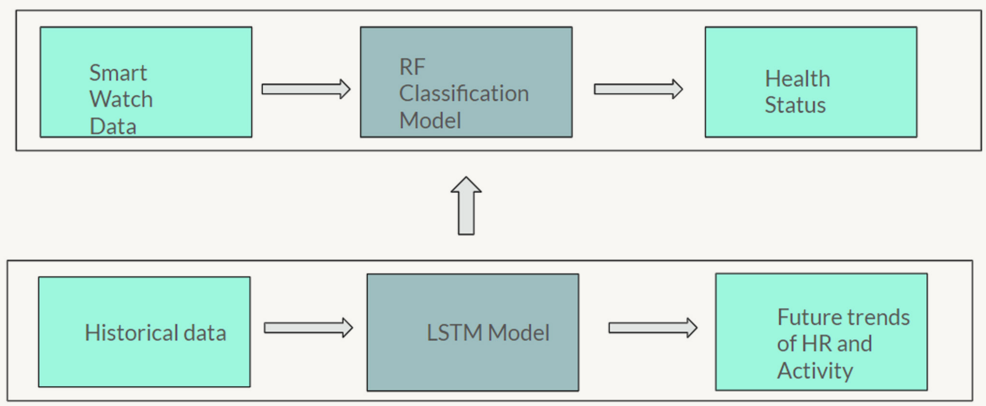


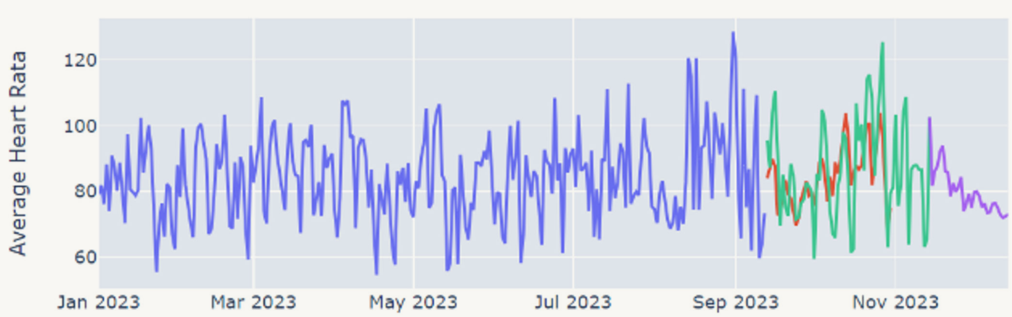
Smart Health Monitoring System

TEAM MEMBERS
Gabrielle Fiore, Garrett LaRaus

PROJECT MANAGERS
Dr. Paromita Nath

This clinic has been working on advancing healthcare using passive monitoring technology. In the previous semester, the team conducted literature reviews on commercially available smart watches and their use in healthcare. The preliminary analysis included comparing the data on heart rate, steps/distance, activity levels, etc. from different smartwatches. This semester the team focused on the development of an LSTM (Long Short-Term Memory) model and a classification model aimed at predicting an individual's health status. Leveraging data collected from smartwatches, a forecasting model using LSTM was trained to predict future heart rates and steps. Subsequently, a random forest classification model was employed to predict the health status of individuals. This project is an important step towards creating a digital twin for patient monitoring and timely intervention from clinicians.



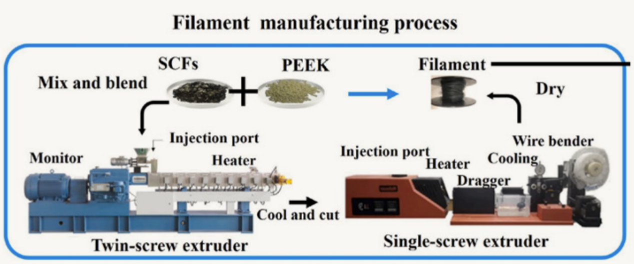


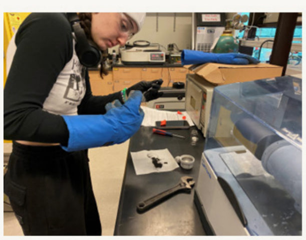
PSP Relationship for 3D Printing Using Fiber—Reinforced Polymers

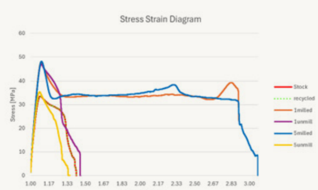
TEAM MEMBERS
James Nguyen, Jason Merrill, Christian Frank, Eve Guttman, Zach Lis, Kaitlyn Riggs

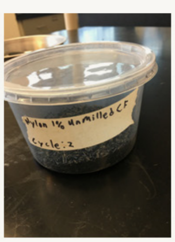
PROJECT MANAGERS
Dr. Paromita Nath and
Dr. Nand Kishore Singh

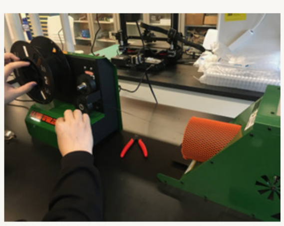
This clinic studied the process structure-property relationship for 3D printing carbon fiber reinforced nylon with milled and unmilled carbon fibers, which required filament extrusion, printing, and testing. The materials, before they were combined, needed to be processed separately. Some of the carbon fiber needed to be put through a cryo-mill. This fiber-reinforced plastic (FRP) was intended to be 3D printed into tensile test samples to observe the differences between Nylon versus Nylon reinforced with milled and unmilled Carbon Fiber at varying volume fractions. This team creates different volume percentages and tests all of them using a tensile test machine. Outlined in this report are current methods for the creation and testing of these filaments, as well as recommendations for researchers in future experiments.









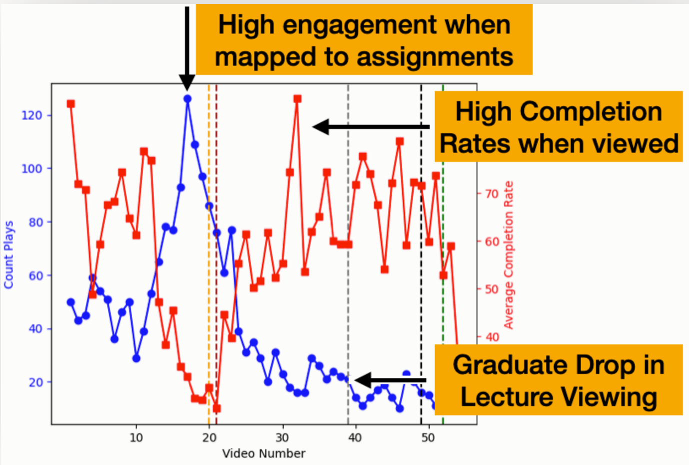


Learning Analytics

TEAM MEMBERS
Owen Power, Andrew Blaylock

PROJECT MANAGERS
Dr. Bakrania, Dr. Nath

This study explored the challenge of gauging student engagement in online courses, where instructors lack the real-time cues available in face-to-face settings. We investigated the potential of remote course data to address this gap. Students analyzed anonymized data from two Mechanical Engineering courses to identify patterns linking lecture video viewing behaviors with student performance. The two courses were co-taught by the same professors to ensure the comparisons do not add any unwanted biases. Utilizing Python, the analysis explored how teaching styles, assessments, and assignments influence viewing habits. Attempts to generalize the tools to apply to other such courses were hindered by the limitations placed by the learning management system. The findings aim to inform the design of online learning environments that foster deeper engagement, ultimately enhancing the student experience.

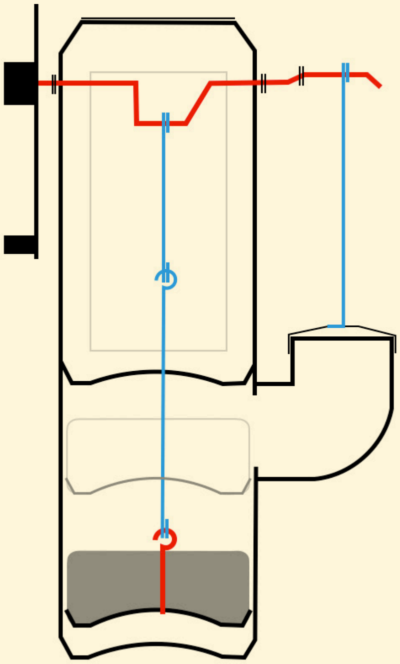


Stirling Engine Design Project

TEAM MEMBERS
Rowen Christianson, Logan Allison, Jason Repmann

PROJECT MANAGERS
Dr. Bakrania

Hands-on project allow students to engage with the concepts taught in courses in a tangible and a meaningful way. Thus a new project that applied thermodynamic concepts was recently introduced for the Introduction to Thermal-Fluid Sciences (iTFS) course. This project allowed students to experience how heat (thermal energy) can be converted to work using a simply thermodynamic cycle. The project required students to build a soda can Stirling Engine and perform thermodynamic efficiency analysis using the concepts taught. However, producing a functional engine proved challenging. Building a functional engine required both theoretical understanding and practical skills. Only 30% of the students achieved success initially. This team was asked to revisit this project and propose a better approach. The revised approach involved creating a detailed guide, evaluating heating sources, measuring engine power input and output, and validating the procedure with volunteers. Implementation in Spring 2024 demonstrated significant improvement in student success. Future work will refine the procedure and explore more effective output power measurement methods.



Novel Power Generation using Land and Water Based Plants

TEAM MEMBERS
Gryphon Arey, Austin Felixbrod, Alessio Sainato, Brenna Packer

PROJECT MANAGERS
Dr. Yashwant Sinha

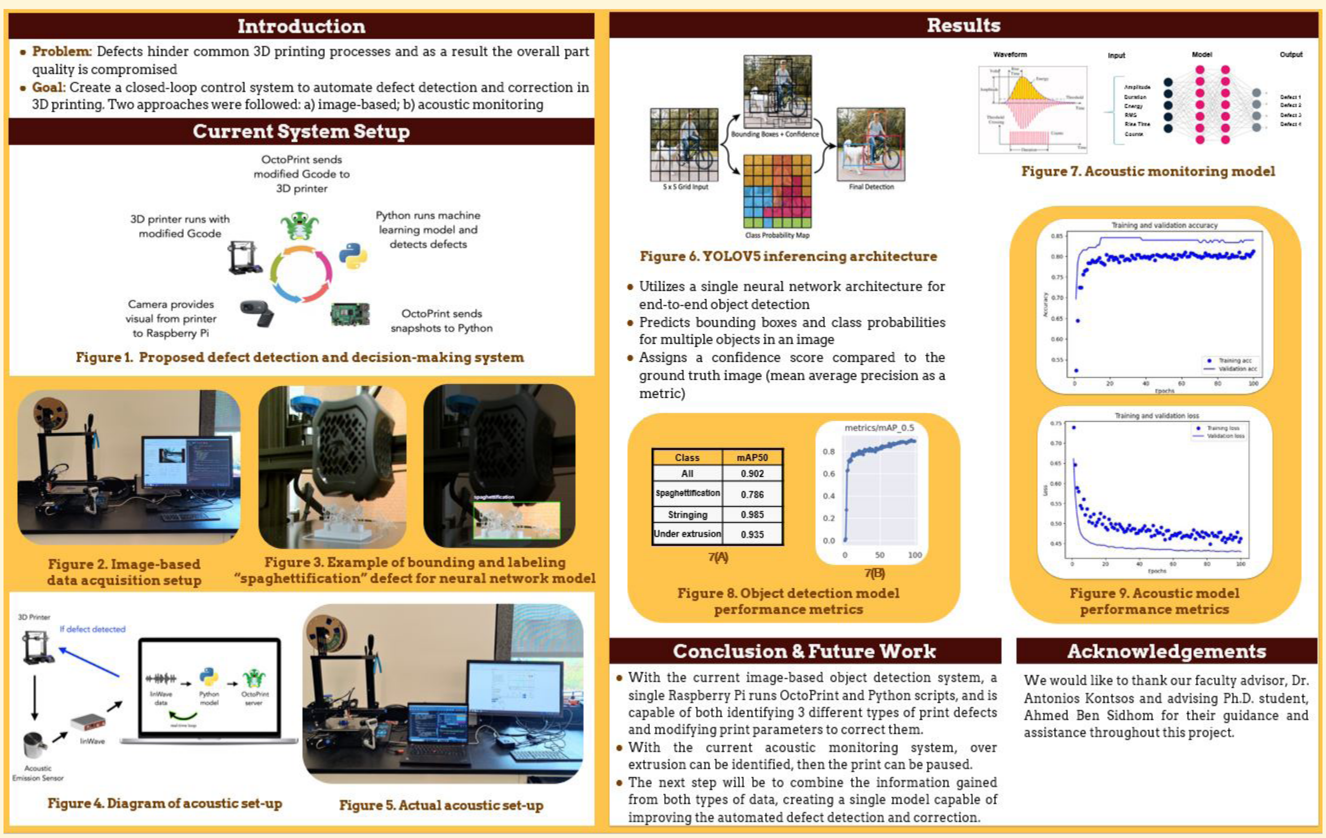
There is a potential to harness power from plants—both on land and water-based plants. Our preliminary investigations have demonstrated that plants do generate small amount of voltage and and now we are exploring technology to modulate and enhance such signals for different applications—street light, nanorobots, signal amplification, and street lighting in remote areas.

3D Printing Defect Monitoring System

TEAM MEMBERS
Aaron Raio, Joshua Schofield, Dominic Kresge, Yashdeep Singh, Anthony Tarchichi

PROJECT MANAGERS
Antonios Kontsos

This project presents a novel approach to enhance the quality control process in polymer 3D printing by combining image analysis and acoustic emission sensing techniques, while leveraging the power of machine learning. Images were captured during the printing process to detect purposely created defects by altering the G code, then the collected data was used to train an object detection model YOLOv5s, enabling real-time identification of defects. Upon detection, commands were sent through OctoPrint installed on a RaspberryPi to adjust printer settings dynamically, ensuring optimal print quality. Furthermore, acoustic emission signals generated during the printing process were captured and analyzed to identify patterns associated with various defects. Feature extraction techniques were applied to the acoustic data, and a dense neural network was trained to classify those defects. This classification model was also deployed in real time which makes both approaches not only capable of identifying defects but also contributing to the closed-loop control of the printer in real-time applications. By integrating the two modalities and using both computer vision and time series, this approach demonstrates excellent performance, enabling automated adjustments to optimize print quality and minimize production errors.



AI-assisted Generative Design

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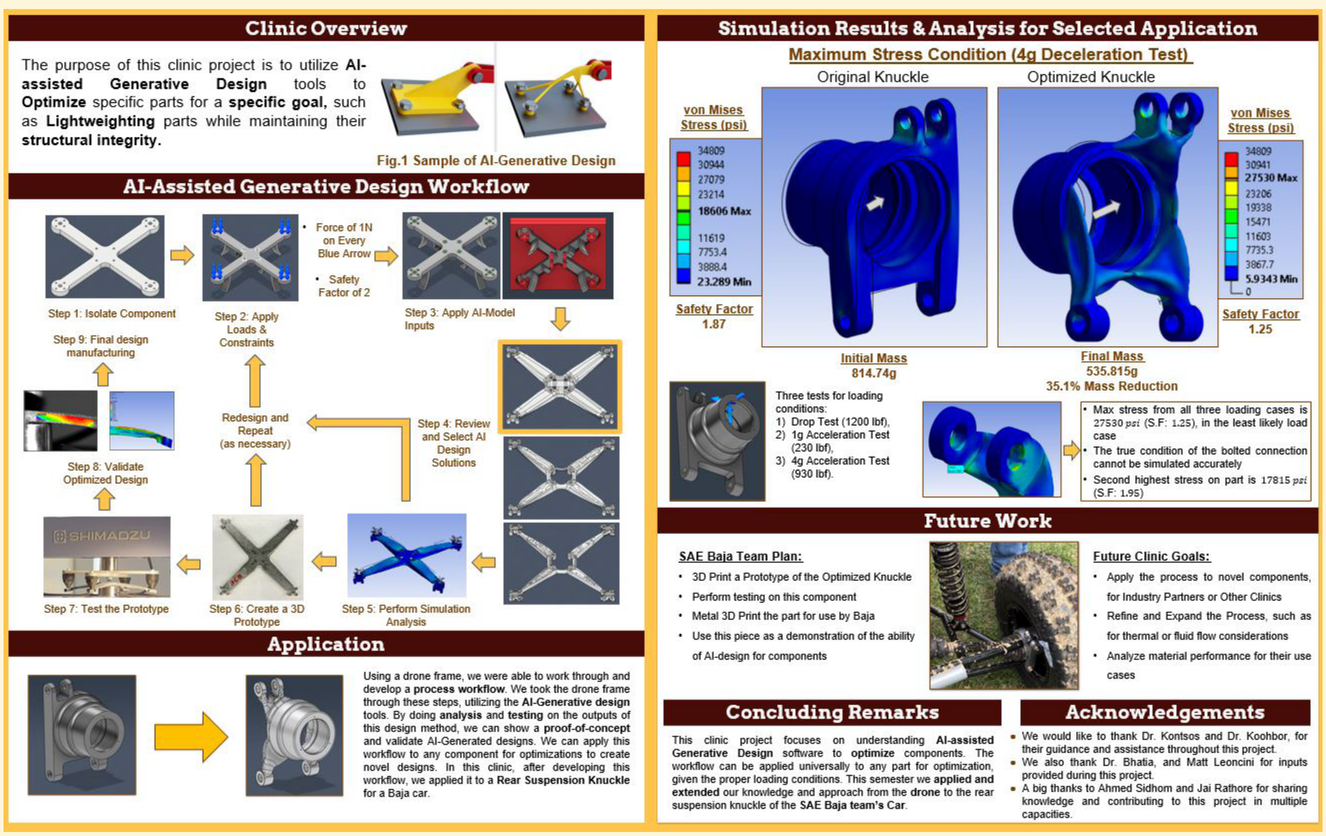
Generative Design in the context of geometry design, proceeds through many iterations produced by Artificial Intelligence (AI) in which an optimum geometry for a given set of conditions can be computed while satisfying material, geometry, and manufacturing constraints, set by the designer. To demonstrate this novel design approach, students in this clinic used a drone frame to demonstrate geometry optimization for strength to mass ratio, which resulted in 74% mass reduction. The optimized geometry was then fabricated and mechanically tested until failure, while collecting full field optical metrology data that was then compared with Finite Element Analysis (FEA) analysis results. This optimization process was then implemented on the rear suspension knuckle on the light-weight off-road Baja team vehicle. The loading on the knuckle was produced through a proposed 6ft drop test, 1g acceleration test and 4g deceleration test. The individual loading conditions, preserved geometry, obstacles, constraints, and material were set for analysis, resulting in an optimized geometry with 35.1% mass reduction while preserving an acceptable safety factor. In the near future the optimized geometry will be produced by metal additive manufacturing methods.



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