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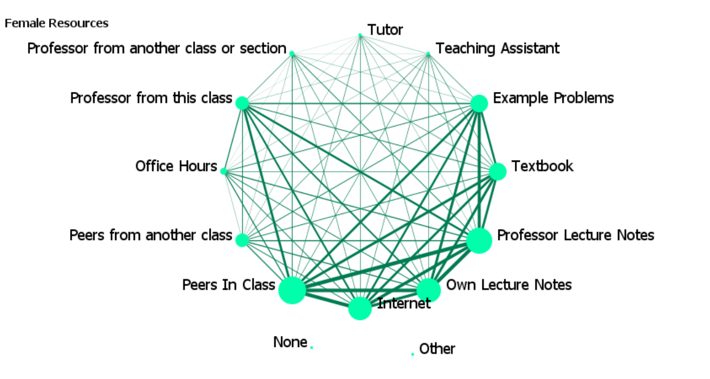
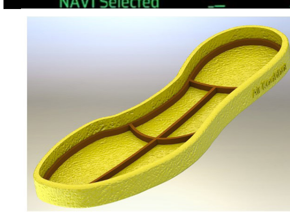
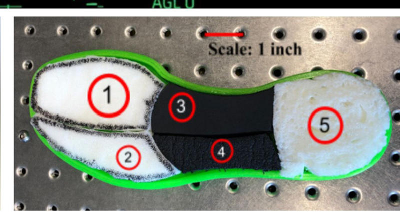
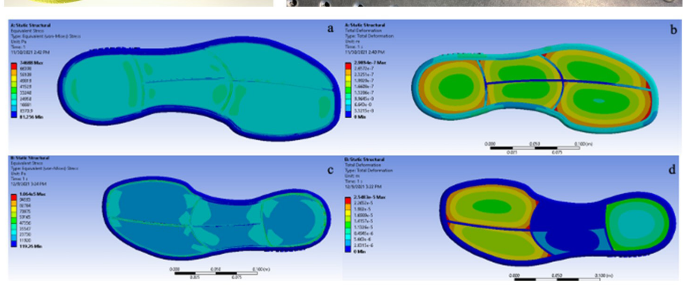
HENRY M. ROWAN COLLEGE OF ENGINEERING









2022 Clinic Showcase Book

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PREFACE

The Engineering Clinic Program is the hallmark of the Henry M. Rowan College of Engineering. Engineering Clinics are a continuous and substantial part of the curriculum and thread the entire four-year undergraduate program.

In first-year and sophomore clinic curriculum, students learn the art and science of design through an interdisciplinary approach. They conceptualize engineering fundamentals into problem-solving best practices while creating an evaluation of projects and final presentation.

During the junior and senior clinic program, students work in small teams under the guidance of faculty and external sponsors to integrate lessons learned from their coursework into engineering problem-solving solutions.

This publication features the meticulous work of 800 students and 122 clinic projects. Our students worked to meet the needs of their communities while pursuing rigorous academic study. These clinic projects reflect the excellence and tenacity of students, the quality of our engineering education and research programs, and the caliber of graduates who leave us.

We hope you enjoy learning about our students and their projects as much as we appreciate sharing them with you.

Sincerely,

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

PROFESSIONAL TRAINING GROUNDS

Junior and Senior Engineering Clinics strive to create engineers that solve real-world problems. In the process they create opportunities for our engineers to practice their entrepreneurial skills and become well-rounded students as they make the transition to being professionals. The last two years of clinics are projects designed to push our understanding and technology forward. The projects are pitched by faculty but the students have a choice of projects to work on. Junior and Senior Engineering Clinics allow students to choose the path based on their interests and ambitions. While solving the technical problems, the clinic projects facilitate practice in professionalism, communication, project management, and team work. In short, these clinics projects become training grounds for our students before they embark on their engineering careers.

Besides exposing our students to engineering practice, clinics are built with innovation at its core. Each project pushes the envelope on the current knowledge and design. Students can work on multiple clinic projects to gain a breadth of experience or dive deep into a single project, if they choose to. Working closely with faculty or external sponsors, and their team, they develop longterm professional relationships. Students also have the opportunity to communicate their work to a range of audiences and media. Based on the variety of projects offered, our students graduate with a broad skill set and are prepared to take on their next challenge. It is not surprising that potential employers use the clinic experience as a distinguishing characteristic of Rowan graduates.

The Engineering Clinic program is a signature program for the Henry M. Rowan College of Engineering. We are proud of its history and proud of the projects presented within this booklet.

Sincerely,

Dr. Smitesh Bakrania
Junior and Senior Engineering Clinic Coordinator

HENRY M. ROWAN COLLEGE OF ENGINEERING

ROWAN UNIVERSITY

1996 2021

25 YEARS

BIOMEDICAL ENGINEERING

3D Printing for Rapid and Affordable Prosthetics

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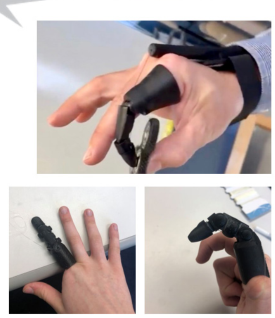
SPONSOR
MedEast Post-Op & Surgical, Inc.



The cost of a commercial body-powered prosthetic hand can range from $4000 to $10,000, while externally powered ones can reach beyond $75,000. While prices continue to rise as technology advances, prosthetic abandonment rates remain high as patients often find the use of their prosthetic cumbersome.
To better understand the potential benefits of current prosthetics and allow short-term trials at affordable rates, Rowan Engineering students have partnered with MedEast, a leading prosthetic and orthotics provider in the greater Philadelphia area, to create fast, efficient, and long-lasting 3D prosthetics that come at a manageable cost. The team has sought to improve designs through analyses of currently available models and insights from patients at MedEast. They tackled a wide range of prosthetics, from cases unique to specific patients to universal designs per limbs that can be used in everyday life. We pair this research with material testing and utilize several stress techniques to explore whether it suits what our team is looking for. Our goal as a team is to provide MedEast with affordable designs that will provide their patients with life-changing accommodations and help push availability and awareness for prosthetics everywhere.

A Haptic-Surgical System: Trajectory Generation and Force Feedback Model

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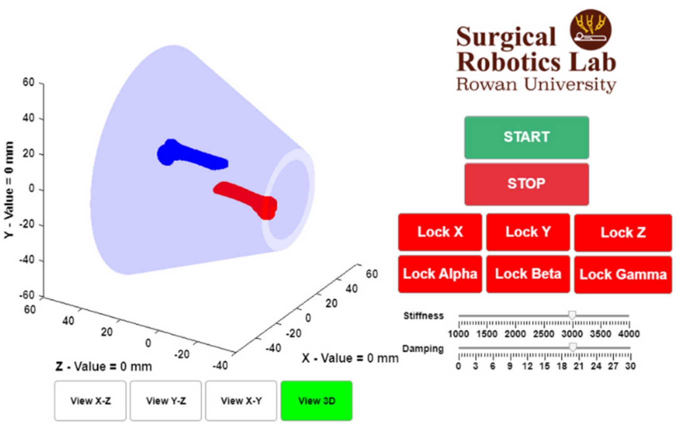
National Science Foundation



This architecture presents a surgical robot, Robossis, integrated with a 7 DOF haptic manipulator, sigma-7, for a more enhanced and intuitive femur fracture surgery. As an alternative to the current manual surgical procedure, the proposed architecture provides the surgeons with a safe and feasible paradigm for aligning broken femur fragments within sub-millimeter accuracy. The proposed architecture includes the unique implementation of the spring-damper force feedback model and spline trajectory generation method. Results illustrate that the force feedback model can restrict the motion of the haptic manipulator to be within the limit of the surgical robot's joints space described by the blue cone-shape surrounding the bone fragments. Furthermore, real-time sampling of the haptic manipulator and trajectory generation for the surgical manipulator can be viewed by the surgeon in real time through the movement of the distal fragment (blue) in regard to the fixed proximal fragment (red). As seen in the panel, different planes are provided to the surgeon to view the bone fragments for optimal alignment. Lastly, the haptic manipulator movement can be restricted to one or multiple axes, translational and/or rotational, and allows for the surgeon to have a more enhanced control of the overall outcome of the surgery.

Acoustic Biometric Device

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ZSX Medical, LLC

ZSX Medical

An early stage medical technology company is developing a biometric device to assist medical professionals in the monitoring and management of chronic conditions. Worn passively, this first generation biosensor is able to provide information about the physiological performance of patients in real-time, extending patient monitoring past what was previously possible. To achieve its full benefit, the device must be worn comfortably by a wide array of patients, without compromising its ability to precisely monitor their condition. However, during late development, the arisal of an unforeseen constraint made it necessary to find an alternative sensor technology. A proposed new sensor could satisfy the constraint, but would require additional development to match the performance of the previous device. Rowan University engineers, in collaboration with Dr. Mazzucco and Dr. Brewer, have investigated the characteristics of the new sensor, and developed the vital components necessary to implement it into the final biometric device.

Adhesion Testing of Additive Assembled Hydrogel Nanofiber Tissue Scaffolds

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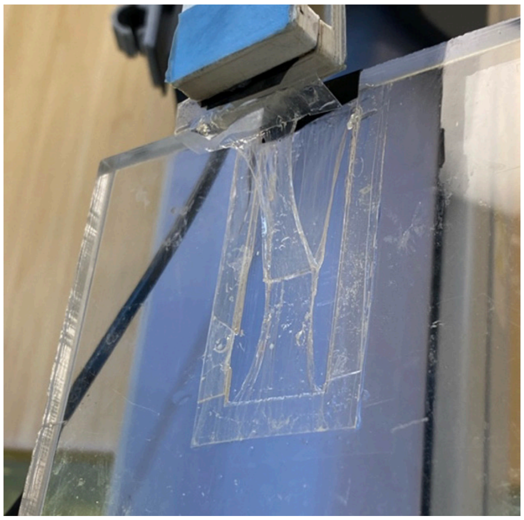

Hydrogel nanofiber engineering is one of multiple approaches used to assemble tissue scaffolds in tissue engineering. In this project, tissue scaffolds for nerve grafts are synthesized from electro-spun nanofibers coated in a hydrogel. A scaffold is then constructed using an additive assembly technique of hydrogel nanofibers. Some of the limitations that exist in this area of research include the ability to correctly test the adhesion of layers in the hydrogel samples. The adhesive forces between each layer in the scaffold is important in understanding the structure of the scaffold, including the structural integrity of the tissue scaffolds and the scaffold's ability to properly function within a living organism. The objective of this project is to develop a sustainable method of testing the adhesion between layers of the additive hydrogel nanofiber structure. Knowing the adhesive forces between the layers of the hydrogel nanofiber scaffold will allow the optimal assembly and function for a tissue graft scaffold.

Automated Dip Drawing Method for Creating Lignin Nanofibers

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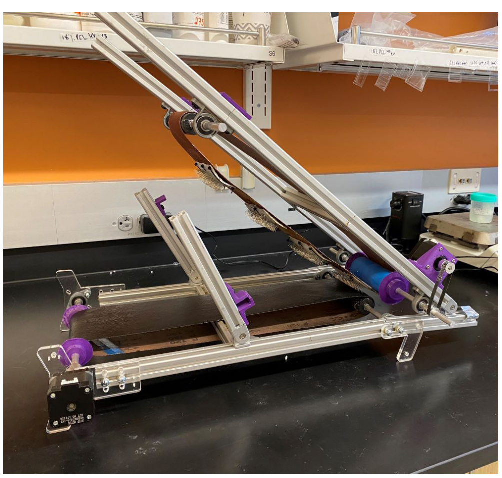

Tissue engineering grafts are needed for the use of regenerating aligned soft tissues. Some of these tissues are nerve, spinal cord and skeletal, smooth, and cardiac muscle. Utilizing aligned nanofibers in the grafts enhances the alignment and elongation of the cells. However, aligned nanofibers are generally tested as 2D films only, which is not appropriate for 3D tissue regeneration. The 2D films do not have the proper geometry to mimic in vivo conditions. and dense fiber packing in the films inhibits cell infiltration. In this project, we utilize a layer-by-layer assembly approach with thin thermo-reversible UV cross-linkable hydrogel films to create a 3D cohesive structure with tunable spacing between aligned fiber arrays that achieves cell permeability. The goal of this study is to determine the relationships between processing parameters and 3D nanofiber architecture and to investigate cells' ability to align within these composites.

Behavioral Effects of Ethanol on Neurodevelopment in Schmidtea mediterranea

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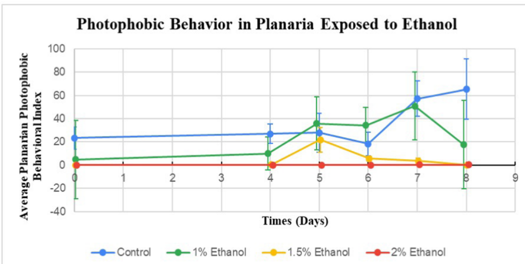

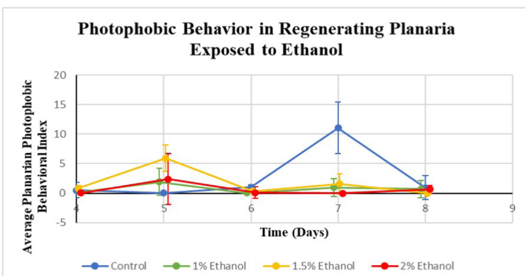

Ethanol has been shown to be detrimental, particularly in neurodevelopment. Although the connection between prenatal consumption and birth defects is widely accepted, ethanol abuse during pregnancy and its effect on fetal neurodevelopment requires further exploration. Schmidtea mediterranea (Smed) planaria have an incredible capacity to fully regenerate their heads within 9 days after decapitation, and demonstrate photophobic behaviors when exposed to light. These animals have primitive central nervous systems. Dopamine transport is important in neuronal function across species, and previous studies have visualized the dopamine receptors (D2) in planaria. However, to the best of our knowledge, no research has been conducted regarding Dopamine Transporter (DAT) in Smed planaria. Here, we examine the effects of ethanol on the head regeneration of planaria. Tests on intact worms confirmed a decrease in the photophobic behavior of ethanol-exposed worms. Behavioral testing of regenerating worms demonstrated abnormal neurodevelopment and an inability to effectively restore neurological function after decapitation. Currently, we are evaluating the DAT expression and localization in planaria to better understand its importance in regeneration, and how alcohol exposure impacts the neuronal development and organization of the central nervous system. Through this work, we aim to characterize the impact of prenatal alcohol exposure.

Cell-matrix interactions of dermal fibroblasts in magnetically active hydrogels

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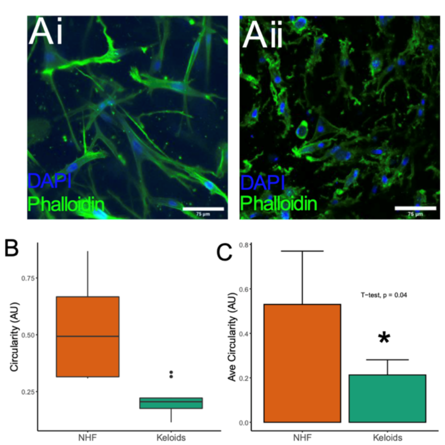

Figure 1: Confocal scans of Keloids (Ai) and NHF (Aii) cells in a 2mg/ml Collagen gel. Morphological distributions (B) and Mean circularity of both cell types (C).

After an injury has healed, thick, raised scars form called keloids, which develop from excess protein deposition in the skin during the healing process. Analyzing cells from keloids is vital for potential therapeutic applications in burn scar healing, specifically hypertrophic scarring that often occurs to burn victims who need to wait extended periods of time to fully heal. Seeding normal human fibroblasts (NHF) and keloid fibroblasts into collagen gels allows them to be monitored in a three-dimensional environment, and incorporating with magnetically active hydrogels provide a means to study the effects of dynamic matrix stiffness on their cell response. In my project, I characterized the behavior of cells seeded into collagen gels. Morphological parameters including circularity and aspect ratio (AR) can be compared between both cell types. Hoechst, phalloidin, anti-lumican, and anti-alpha-SMA staining was used to analyze the expression of fibroblast markers as well as viability and spreading. Representative images of the gels were taken using epifluorescent and confocal microscopy, and the morphology was quantified using FIJI. This work verifies the ability of these cells to attach and spread in 3D environments and sets the foundation for future studies interrogating the effect of a dynamically changing microenvironment.

Cellular spheroid size on mechanosensing and migration in 3D hydrogels

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SPONSOR
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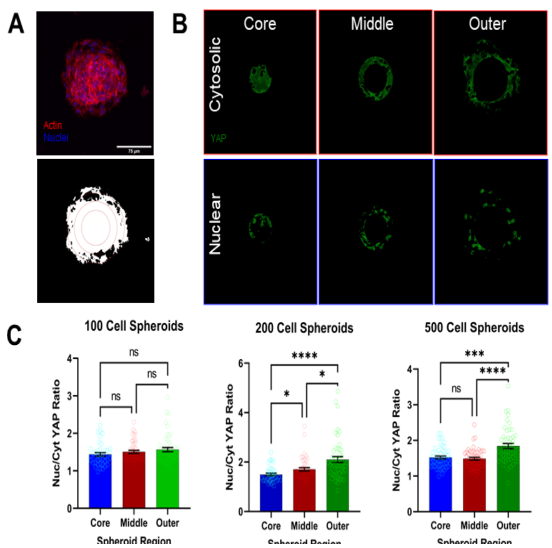

Norbornene-modified hyaluronic acid (HANor) hydrogels serve as a tunable platform to study and model disease. In this study, cellular spheroids were used to mimic rhabdomyosarcoma tumors of varying sizes. 100, 200, and 500 MSC spheroids were formed using AggreWell plates, encapsulated in 3D degradable HANor hydrogels, and stained for actin (red), nuclei (blue), and YAP (green) (Figure 1A-B). Yes-associated protein (YAP) is a mechanosensitive protein that travels from the cytoplasm to the nucleus based on feedback from extracellular signals (e.g., cell-cell and cell-hydrogel interactions). To quantify zonal differences in nuclear YAP localization, spheroids were split into three regions: core, middle, and outer. Using ImageJ software, cytosolic and nuclear YAP intensity was determined in spheroid regions that expose cells to cell-cell (core, middle) and cell-hydrogel (outer) interactions (Figure 1B). Results indicate a progressive nuclear YAP increase in outer section cells, suggesting that cell-cell interactions have an inhibitory effect on cellular mechanosensing (Figure 1C). Overall, these in vitro results facilitate better understanding of the metastatic potential of cancer cells based on tumor size and YAP signaling. Currently, HANor hydrogels functionalized with cell-cell mimetic peptides are being used to evaluate whether engineered cell-cell signals can prevent migration of outer region cells.

Characterization of the 10MAG/LDAO Reverse Micelle System

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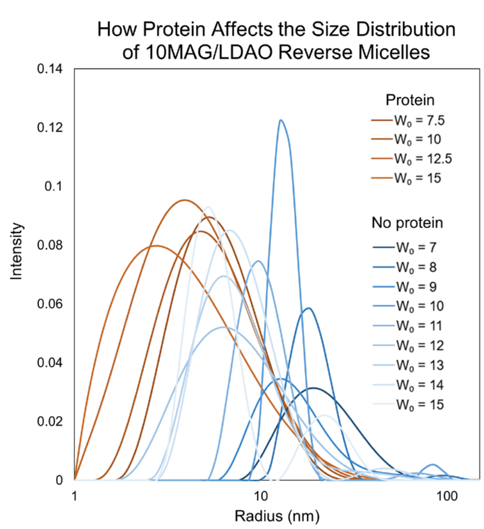
National Science Foundation,
American Chemical Society Petroleum Research Fund



Reverse micelles (RMs) are spontaneously organizing nanobubbles composed of an organic solvent, surfactants, and an aqueous phase that can encapsulate biological macromolecules. Reverse micelles can facilitate novel biophysical studies, especially studies of confinement and interfacial interactions on protein thermodynamics. The 1-decanoyl-rac-glycerol (10MAG) and lauryldimethylamine-N-oxide (LDAO) system provides long-term protein sample stability without precise optimization of RM size. In other commonly used surfactant systems, RM size is dictated by the ratio of water to surfactant, known as water loading, W0. However, 10MAG/LDAO RMs saturated with protein demonstrate RM size that is W0-independent. This unique property of 10MAG/LDAO was investigated with dynamic light scattering (DLS) and diffusion ordered nuclear spectroscopy (DOSY) to characterize the RM size distribution. We found that this surfactant system differs greatly from the traditional, monodisperse RM population model. Proteins seem to drive the thermodynamics of the mixture, encapsulating at their optimal RM size, while a second nonspherical population is proposed to act as the water reservoir in the system. These findings are important for developing thermodynamic models to complement applications of 10MAG/LDAO RMs for studying protein stability and water dynamics in the nanoconfined space.

Children’s Hospital of Philadelphia (CHOP) Adjustable Powered Wheelchair

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75 million people worldwide require wheelchairs with over 124,000 American users under 21. Powered wheelchairs provide mobility for children as young as 18 months with mobility impairments. However, the number of powered chair training sessions necessary to obtain an insurance approval for a personal chair is limited by a lack of power chair accessibility in rehabilitation centers. In collaboration with Dr. Keenan at CHOP, Rowan Engineering students propose designing and manufacturing an adjustable powered wheelchair where one chair adjusts easily to fit multiple patients. This solution allows more people to receive the insurance approval that covers the cost of a personal powered wheelchair. The team at Rowan University is working with Dr. Keenan to create a prototype, and later a permanent solution, that meets the needs of these facilities. Along with input from multiple doctors in the rehabilitation space, the team has developed an adjustable frame compatible with adult-sized chairs but capable of fitting patients aged 2-18. The chair’s size changes to accommodate the patient by adjusting hand brakes and sliding components. The team is in the prototyping stage and plans to obtain an IRB to gain further feedback on the design.

Control Theory in Synthetic Receptor Systems

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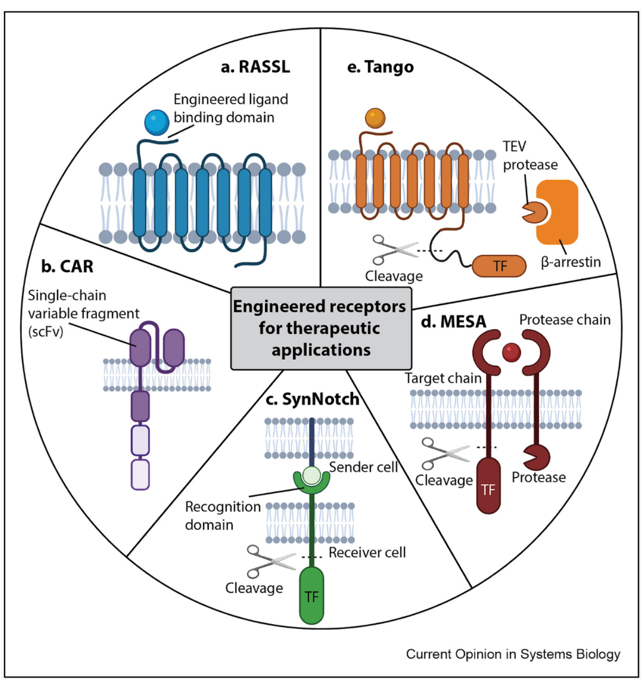

Synthetic receptor systems are a rapidly advancing topic within the field of synthetic biology. Synthetic biology is an interdisciplinary area between molecular biology and engineering that utilizes the knowledge and tools of systems biology and genomics to manipulate cellular behavior. Recent advances in this field have produced sensitive approaches to understanding elusive cellular interactions. Some of the major classes of synthetic receptors include the receptor activated solely by a synthetic ligand (RASSL), designer receptor exclusively activated by a designer drug (DREADD), chimeric antigen receptor (CAR), Tango receptor, modular extracellular sensor architecture (MESA), and SynNotch receptor. Although these receptors, along with their derivatives, show great promise for immunotherapies, theranostics, diagnostics, and other biosensing applications, methods to control and predict them are needed for clinical applications. By implementing control theory concepts to these receptor systems, they may be able to be refined to allow for the development of precise receptors that limit background activation and off-target effects. Our work focuses on analyzing current methods of control that have been applied to different synthetic receptor systems, allowing us to clearly define future opportunities within the intersection of control theory and synthetic biology receptor systems.

Deep-Learning Pipeline for the Detection and Segmentation of Aortic Aneurysms

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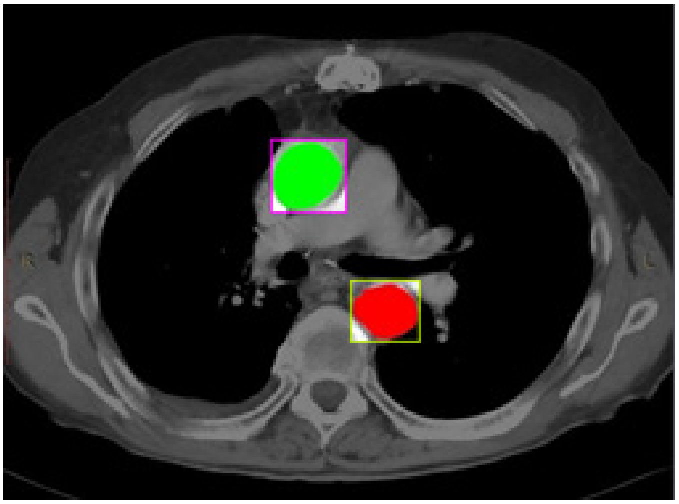

Aortic aneurysms are the most common and deadliest type of aneurysms. These aneurysms are classified as the increase in diameter of the aorta by 50%, a result of the weakening of the walls surrounding the aorta. When ruptured, there is roughly an 80% mortality rate and is more susceptible to an older population. We develop a novel deep-learning pipeline that will help doctors diagnose, monitor, and treat aortic aneurysms. An ensemble deep-learning model, consisting of FasterRCNN and YOLO architectures, as well as a U-Net segmentation model are used. Segmented regions of the ascending and descending aorta are generated which provide a 3D reconstruction of the aorta. Centroids are calculated for all segmented regions which will act as a set of points in a spline interpolation process that will construct the centerline of the aorta. Cross-sectional planes determined by gradients along the centerline allow for diameter measurements of the aorta. True positive detection accuracy scores for FasterRCNN and YOLO are 94.2% and 100.0%, respectively. IOU scores of the U-Net model is 78.9%. Accuracy scores show that our current pipeline can serve as a useful tool that physicians can use to help diagnose and monitor aortic aneurysms.

Effects of 3D Spreading and BMP-2 Mimetic Peptides on Stem Cell Differentiation

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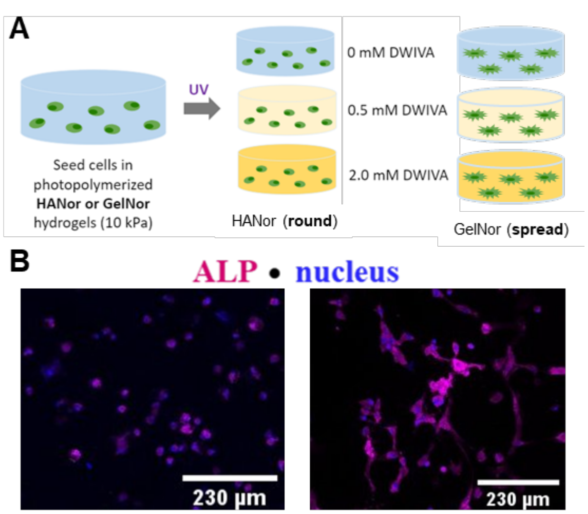

Hyaluronic acid (HA) and gelatin are macromolecules present in native tissues and due to their biocompatibility these polymers have been explored as biomaterials for 3D stem cell culture. Hydrogels consist of highly hydrated polymer networks, and stem cells encapsulated in crosslinked HA hydrogels remain round, whereas stem cells in 3D gelatin hydrogels spread over time. Bone morphogenetic protein 2 (BMP-2) is a growth factor that signals stem cells to differentiate into osteoblast (bone) cells. DWIVA is a short peptide sequence that mimics the bioactivity of BMP-2. In this study, the effects of biophysical (cellular spreading) and biochemical (bone-activating peptides) cues on the osteogenic differentiation of human mesenchymal stem cells (MSCs) was investigated. MSCs were encapsulated in either norbornene-modified HANor (restricts cell spreading) or GelNor (allows cell spreading) with low or high concentrations of DWIVA (Figure 1A). After 7 days in culture, hydrogels were stained for alkaline phosphatase (ALP, magenta) and double-stranded DNA (nucleus, blue) (Figure 1B). MSCs in high DWIVA-HANor hydrogels remained spherical while MSCs in high DWIVA-GelNor hydrogels were spread and had higher ALP expression. These results show that spreading is an important prerequisite for 3D osteogenic differentiation and that DWIVA promotes osteogenic differentiation in a concentration-dependent manner.

Engineering A Synthetic Mammalian Cell-Based Serotonin Biosensor

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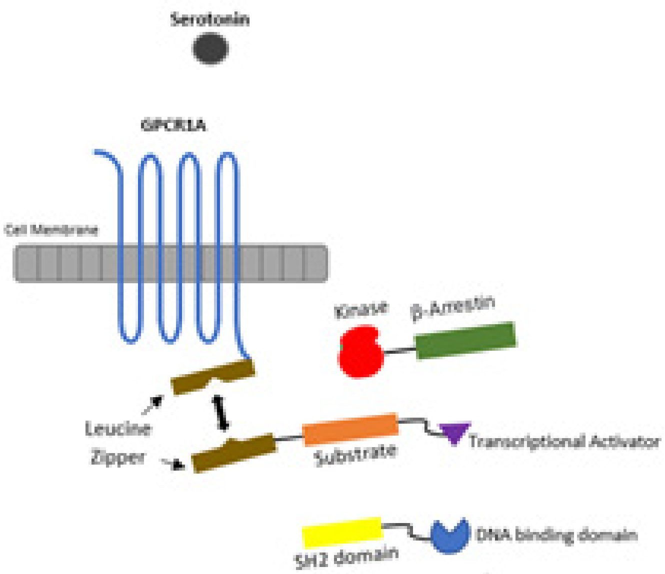

It is estimated that 35% of all approved drugs target G-coupled protein receptors (GPCRs) due to their control over a wide variety of physiological functions. Synthetic receptors are novel transmembrane receptors that mimic native signal transduction pathways but are completely orthogonal. A post-translational circuit (PTC), a novel type of synthetic receptor, relies on receptor heterodimerization to activate the receptor and induce an intracellular mechanism similar to phosphorylation. Typically, PTC's encode a single-chain fragment variable (scFv), specific to the type of target ligand, as the ectodomain. However, PTCs have not been adapted to use with GPCRs, limiting their therapeutic implications, especially within the brain where most receptors are GPCRs. In this study, a biosensor that targets serotonin is being developed by expanding upon the PTC. To do this the scFv and transmembrane domain will be replaced with the serotonin GPCR 1A by molecular cloning. The application of Dr. Daringer's PTC is optimal for this design due to its ability to record real-time downstream signals at the fast speed necessary for neurons to process. Following preliminary testing in HEK-293 cells, testing in neurons will be conducted in collaboration with the Solesio lab at Rutgers University.

Evaluating nanoparticle transport through the placenta

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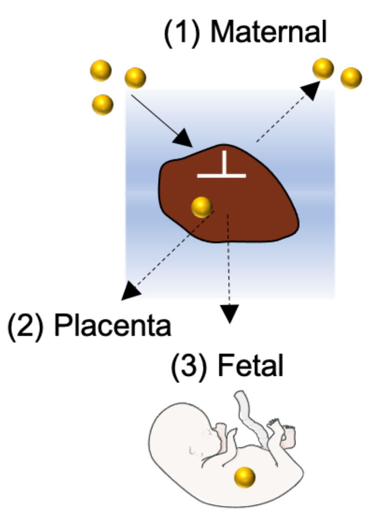

Treating diseases and pre-existing conditions during pregnancy is challenging due to potential risks to the fetus, altered pharmacokinetics due to increases in blood volume and flow, and the constantly developing placenta. The placenta plays critical roles during pregnancy including the transport of blood, oxygen, and nutrients to the fetus and the removal of waste products from the fetus. In this project, we are studying how the placenta can be used as a biological barrier for selective drug delivery to the fetus to treat fetal diseases, to the placenta for placenta-related diseases, or gestational carrier to treat maternal diseases. By selectively delivering therapeutics, we can maximize therapeutic impact to the desired tissues while minimizing adverse off-target effects to the fetus. To do this, we are developing an ex vivo placenta perfusion model to study drug transport during pregnancy. This model consists of inlet tubes that act as the maternal blood supply and outlet tubes connected to the fetal side of the placenta. Using this perfusion model, we can evaluate the transport of drug delivery vehicles, called nanoparticles, through human placenta tissue. Ultimately, this project will provide new lipid nanoparticle technologies that are designed to selectively deliver therapeutics to maternal tissues, the placenta, or fetal tissues while minimizing off target toxicities to the fetus during pregnancy.

Expanding Sensing Capabilities of Synthetic Receptors Using Synthetic Biology

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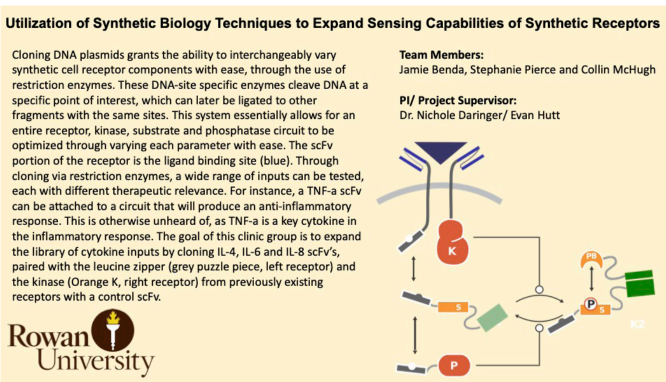

Cloning DNA plasmids grants the ability to interchangeably vary synthetic cell receptor components with ease, through the use of restriction enzymes. These DNA-site specific enzymes cleave DNA at a specific point of interest, which can later be ligated to other fragments with the same sites. This system essentially allows for an entire receptor, kinase, substrate and phosphatase circuit to be optimized through varying each parameter with ease. The scFv portion of the receptor is the ligand binding site (blue). Through cloning via restriction enzymes, a wide range of inputs can be tested, each with different therapeutic relevance. For instance, a TNF-a scFv can be attached to a circuit that will produce an anti-inflammatory response. This is otherwise unheard of, as TNF-a is a key cytokine in the inflammatory response. The goal of this clinic group is to expand the library of cytokine inputs by cloning IL-4, IL-6 and IL-8 scFv's, paired with the leucine zipper (grey puzzle piece, left receptor) and the kinase (Orange K, right receptor) from previously existing receptors with a control scFv.

Hydrogel and Nanofiber Composite Scaffold Viability

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Rowan University,
National Science Foundation

The overall objective of this project is to create a hydrogel and nanofiber composite scaffold which can be used to accelerate the healing process of peripheral nerve damage. The scaffold is constructed using an additive manufacturing process in which layers of fibers created through polycaprolactone (PCL) electrospinning are dipped in gelatin methacrylate (GelMe) and are then layered on top of each other and crosslinked to create a cohesive combination of fiber and gel. The goal of this study is to see determine how different concentrations of GelMe affect the efficiency at which cells will burrow into the scaffold and align on the fibers. It is hypothesized that a lower concentration of GelMe will create a less structured matrix in which cells can more easily navigate to locate fibers. However, too low of a concentration will result in the loss of the structural integrity and failure of the composite. Different amounts of UV crosslinking time also change the physical properties of the hydrogel and are being studied similarly. An ideal range of GelMe concentration and UV crosslinking time will be determined through conditions in which cell burrowing and alignment are observed at the highest and most efficient rates.

Inhibition of secondary flows at bifurcations using drag-reducing polymers

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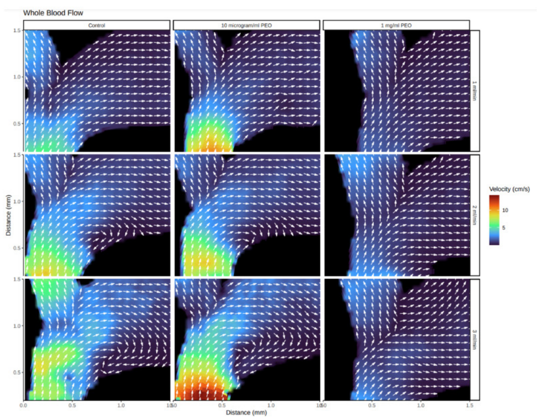

Figure 1: At flow rates of 1, 2, and 3 ml/min, addition of drag reducing polymer shows the reduction of secondary-flow and more evenly distributed velocity gradients.

Recirculation and secondary-flow regimes are areas where backflow occurs under laminar flow. Recirculation occurs in the body at areas of blockages as well as in bifurcations in vasculature. This recirculation is hypothesized to be an area of increased likeliness for cancer metastasis due to the low shear stress magnitude and augmented shear gradient in this area. Addition of drag reducing polymers (DRPs) to blood has been studied to have benefits regarding leukocyte-cancer cell interactions as well as oxygen diffusion. However, the ability of DRPs to dampen recirculation in secondary flows has yet to be investigated. We have designed a bifurcation vascular topology that achieve srecirculation at a flow rate of 2 mL/min as predicted by computational fluid dynamics of whole blood flow. Viscometry was used to characterize the non-Newtonian properties of whole blood, which was incorporated into the computational model. We used microparticle image velocimetry (μPIV) to measure the flow profile at several flow rates and at several concentrations of drag-reducing polymers. The results indicate that addition of the drag-reducing polymers inhibit recirculation, likely by reducing gradients in velocity within the blood. This research provides new insight into the mechanisms underlying the effects of drag-reducing polymers on improving cardiovascular health.

Injections Pressures of a Novel Hydrogel for Low Back Pain

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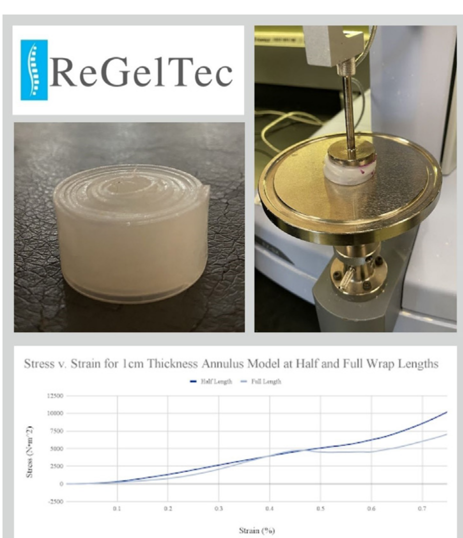
ReGelTec, Inc.



Lower Back Pain is one of the leading causes of disability in adults aged 45 to 65 and is usually induced by Degenerative Disc Disease (DDD). DDD is characterized by a loss of hydration in the disc's interior nucleus pulposus which results in the loss of disc height and increased stress on the outer annulus of the disc, causing the outer annulus to wear down over time. ReGelTec has developed a hydrogel spinal disc implant (HYDRAFIL) that solves problems associated with current treatment methods for DDD such as effectiveness, cost, and invasiveness of the surgery performed. HYDRAFIL provides a non-surgical alternative that can reverse the effects of DDD and consequently reduce lower back pain. The goal of this project is to create a model where HYDRAFIL can be used to survey and record its effectiveness on the human spine using bovine cadaver tails which have similar biomechanical properties to human intervertebral discs. Initial steps taken to achieve this goal are to characterize a correlation between pressure injected into the disc's nucleus pulposus and the compressive force the disc experiences via mechanical testing. Additionally, exploring the stiffness of the disc pre and post injection of HYDRAFIL to measure the effectiveness of the treatment.

Interpreting the Cognitive Implications of Planarian Responses to Light Stimuli

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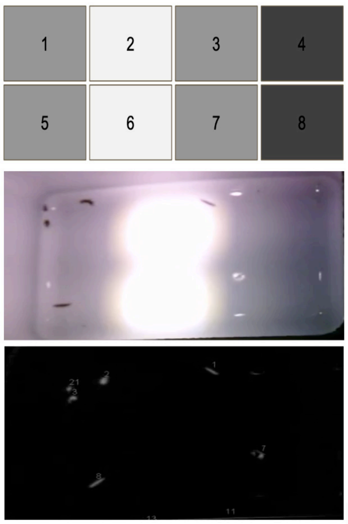

Planaria are aquatic organisms that are recognized for their regenerative capabilities. With a nervous system strikingly similar to humans and simple cerebral eyes, planaria are often used to study neurological function, neurological regeneration, and eye regeneration. Notably, there are often conclusions drawn on planarian cognitive abilities based on the efficiency of their innate photophobic behavior - their ability to avoid light. However, relatively little is understood about planarian photophobic behavior, and a more comprehensive understanding is critical before assuming this behavior is an appropriate metric of cognition. Many organisms respond to stimuli without cognition, including chemokines that express chemotaxis, and bacteria that express thigmotaxis. Our experiment utilizes a high-throughput device that provides a light stimulus to planaria and records their behavioral photophobic responses. We hypothesize that if we engineer appropriate light stimuli and analysis metrics, we can determine whether planaria flatworms aimlessly swim away from light (photophobia) or actively seek the dark (nyctophilia), and thereby we can characterize the amount of cognition used in this behavioral response. These results will provide an improved understanding of planarian behavior and an essential platform for interpreting planarian light avoidance behavior in the assessment of cognition.

Modeling the Human Annulus Fibrosus Using a Wrapped Silicone Design

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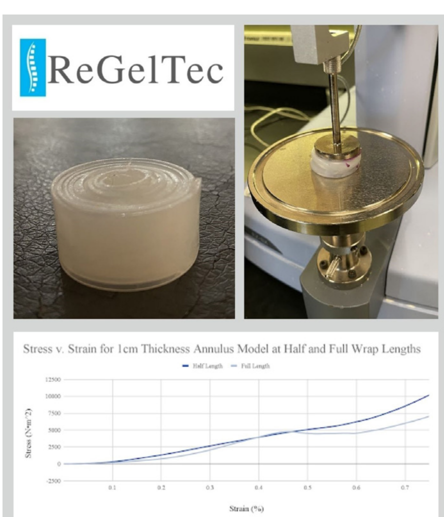

Lower back pain causes more disability around the world than any other condition, according to the CDC, and one of its leading causes is degenerative disc disease (DDD). While the ReGelTec HYDRAFIL implant is a promising experimental DDD treatment, a valid in vitro testing model for the material is yet to be attained. A valid design should replicate the compressive mechanics of the human physiological structure, including proper stiffness, buckling behavior, and chord modulus values. In order to test the utility of the HYDRAFIL injectable hydrogel for the restoration of lumbar discs, we propose a silicone model to replicate the structure and mechanics of the human annulus fibrosus. Thus far, a benchtop design has been developed using high-density silicone wrapped concentrically into a cylinder to replicate the organization of collagen fibrils within the annulus. The silicone material is ideal for creating defects like those seen in cases of DDD and for injecting HYDRAFIL without resistance. By manipulating the size of the model annulus and testing it under an axial load, we hope to determine the ideal parameters of an accurate replica that can be used successfully in mechanical testing. At this point in our experimental timeline, we continue to optimize this model by varying its diameter and height to achieve physiological mechanics during mechanical testing.

Multi-Dose Vial Cap with Self-Healing Polymer for improved Drug Stability

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ChromoLogic

Healthcare-associated infections (HAIs), or illnesses that patients acquire during their stay at a hospital, have increased by 36% which can cause hospitals an annual cost of up to $45 billion. HAIs can spread through improper handwashing, direct patient contact, and contaminated equipment. Scopolamine Hydrobromide Trihydrate (Scop-HBT) is an anticholinergic medical countermeasure used often for both military personnel and civilians that are exposed to organophosphorus nerve agent (OPNA) poisoning. However, there is not yet a multi-dose vial that can accommodate the repetition and speed at which Scop-HBT is administered and maintain a stable formulation. Multi-dose vials (MDVs) have demonstrated bacterial contamination rates up to 27%, encouraging a need for an improved disinfection method that leaves less room for error. In collaboration with ChromoLogic, we are seeking to modify a device (referred to as the Vial Cap) that reduces human error when preparing and using MDVs, reduces HAIs, and maintains a stable drug formulation by incorporating ChromoLogic's self-healing polymer. The current design of the Vial Cap is made from 3D printed polylactic acid (PLA) and houses a sponge saturated with 70% isopropanol alcohol (IPA) and the self-healing polymer.

Novel Biopsy Device to Support Matrix-Induced Autologous Chondrocyte Implants

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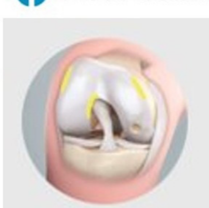

Total Knee Replacements, the current solution for osteoarthritis, present several drawbacks. The MACI procedure has improved outcomes for a less invasive procedure at a lower cost. Currently, the MACI procedure has a low patient compliance rate due to the invasive tissue biopsy process. Trice Medical has tasked Rowan engineering students to design a one-handed, sterile, disposable device capable of retrieving 200mg of healthy cartilage under local anesthetic in an office setting, with arthroscopic assistance. the team is pursuing three unique design pathways based on the previously identified device criteria. Utilizing 3D printing and industrial machining, we intend to assemble a functional prototype for each of the three-design pathways that range from simple to complex biopsy methods. We are utilizing industrial manufacturing capabilities with the support of Trice Medical. Our prototypes will undergo a gradient testing scheme starting with preliminary resilience testing and cadaver biopsy with arthroscopic aid. A critical objective data point to collect at all stages along the gradient is the number of passes needed to collect 200mg of equivalent cartilage mass. Moreover, valuable subjective data will be gathered from our orthopedic surgeon partner as we develop the ergonomics of our device.

Novel Hydrogel Contact Lenses For Delaying Myopia Onset in Pediatrics

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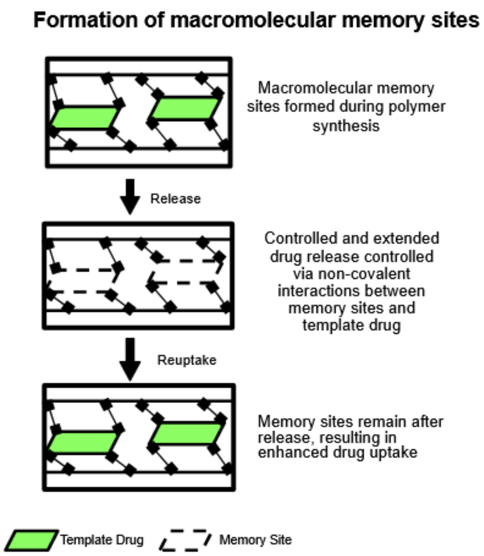

Myopia is caused by an abnormal shape of the eye improperly refracting light onto the retina leading to blurriness in vision and headaches in severe cases. The myopia institute approximates that 30% of the world's population suffers from myopia, and an estimated 50% of the population will be myopic in 2050. Myopia is treated via application of topical solutions, which are an inefficacious method of ocular drug delivery due to issues such as poor bioavailability (only 2-8% of applied drug to 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 molecular 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. These memory sites 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 customizable therapy that has the potential for a more efficient and bioavailable treatment of myopia.

Novel Nucleic Acid Nanostructures for Chemotherapeutic Drug Delivery

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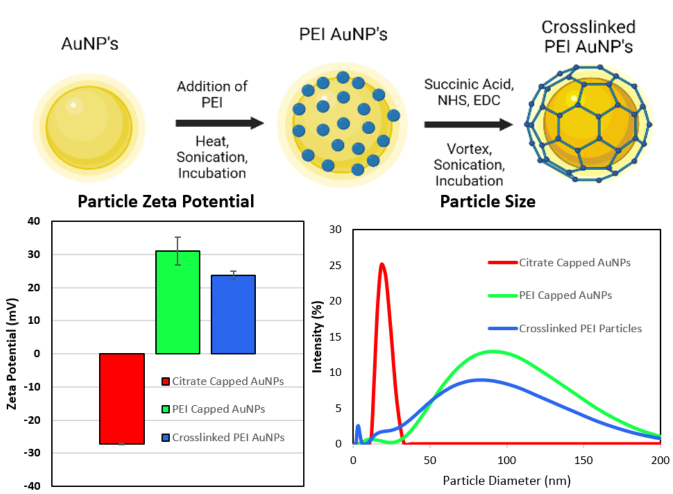

The next generation of anticancer agents will emerge from the rational design of nanostructured drug delivery vehicles. The overarching goal is to develop novel, targeted drug carriers capable of overcoming physiological boundaries, accumulating in diseased tissue, and releasing cytotoxic payloads in site-specific conditions. Important design parameters are particle shape, surface properties, mechanical properties, and the functionalities of the particle shell layer. Our group has led the field in the controlled release of drug payloads from the surface of DNA-conjugated gold nanoparticles (DNA-AuNPs). In this project, we are investigating novel methods of manipulating the physical properties of these nanocarriers to modify and improve their functionality. The polymer polyethyleneimine (PEI) is bound to the surface of citrate-capped, 15nm AuNPs via electrostatic adhesion and cross-linked via organic dehydration reactions to form polymer-shell nanoparticles (PEI-AuNPs). Polymersomes can be synthesized with controllable size by changing the diameter of the AuNP core, bind a high density of nucleic acids via cationic condensation on the highly curved surface, and load drug payloads within the DNA layer or in the polymersome core. Thus, determining methods of formulating PEI- polymersomes with controllable properties will significantly improve the design of biohybrid nanoparticles for the delivery of chemotherapeutic drugs.

Optimizing Molecular Cloning Techniques For Engineering Synthetic Receptors

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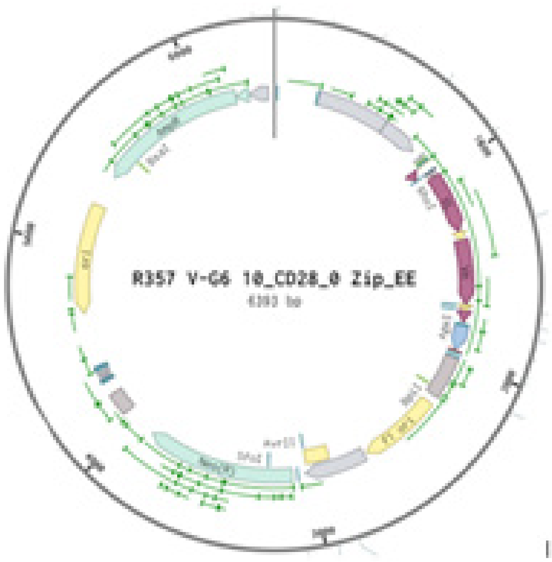

Molecular cloning plasmid to plasmid is a highly utilized laboratory technique. It is commonly used to create multiple variations of synthetic receptors in order to find the most optimal structure for the ligand of interest. However, the process is long, consisting of 8 steps and requiring multiple days of work. Therefore, our objective is to identify any points in the molecular cloning process that can be improved. To do this, the software Benchling was used to analyze the current plasmids in the lab, identifying a backbone and an insert which are sequenced together to produce the final plasmid. Multiple backbones and inserts were chosen to produce as many different plasmids as possible. After determining a target plasmid, the DNA was purified and then digested with the appropriate restriction enzymes. Purification is done in order to reduce any possible mutations. Once the digest is complete, the DNA undergoes Gel Electrophoresis for the isolation process. Next, the DNA is run through a ligation process, where the plasmid backbone and insert are fused together. Afterwards, the transformation, isolation, and sequencing process occurs for the finished plasmid. Currently, we have identified a checkpoint before digesting that ensures your DNA is pure to avoid inefficacy.

Plant tissues regulate stem cell mechanosensing and differentiation

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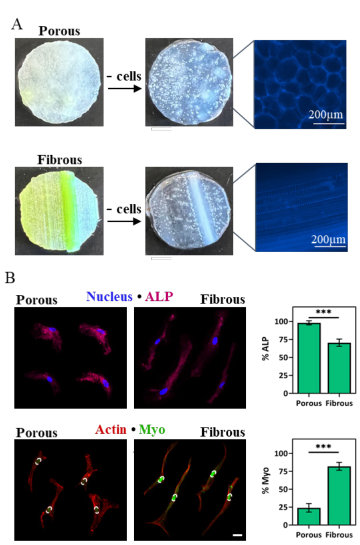

Nosocomial infections, or illnesses that patients acquire during their stay at a hospital, occur at a rate of 4.5 infections per 100 hospital admissions, resulting in annual costs upwards of $45 billion [1]. These infections spread through direct patient contact, improper handwashing, and contaminated medical equipment. Recently, multi-dose medication vials have shown to be sources of bacterial infection with evidence showing 34% of anesthesiologists never or rarely disinfect the septum of these vials prior to use [2]. In another study at a tertiary care hospital, it was found that 98.7% of multi-dose vials were not swabbed with alcohol in compliance with the current disinfection protocol [3]. The goal of the project is to design a device (referred to as the Vial Cap) that reduces human error concerning MDVs and reduces nosocomial infections. The current design is made from 3D printed polylactic acid (PLA) and houses a sponge saturated with 70% isopropanol alcohol (IPA).

Poly(ethylene glycol) hydrogels with tunable stiffness and peptide patterning

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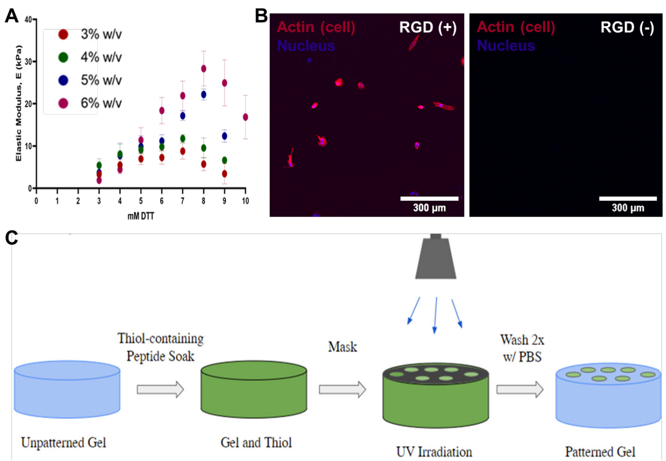

Poly(ethylene glycol) (PEG) is a bioinert and synthetic polymer that has immense potential in studying cell-material interactions and for tissue engineering applications due to the absence of biological components present in natural polymers. Norbornene-modified PEG (PEG-Nor) can covalently bind with di-thiolated crosslinkers to form hydrogels, and unreacted norbornenes in PEG-Nor hydrogels can undergo a secondary light reaction with thiolated peptides to bind adhesive and bioactive peptides. Despite the advantages of PEG-Nor over hydrogels formed with naturally derived macromers, design parameters to form PEG-Nor hydrogels with user-defined biophysical and biochemical properties are not fully understood. In this study, 8-arm PEG-Nor (8 norbornenes per PEG-Nor molecule) was used to form PEG-Nor hydrogels with tunable stiffness and peptide coupling. PEG-Nor hydrogels with a broad range in stiffness (2 to 28 kPa) could be synthesized by simply varying the total macromer content (wt%) or concentration of dithiothreitol (DTT) crosslinker (Figure 1A). Unreacted norbornenes in PEG-Nor hydrogels were used to couple with thiolated Arg-Gly-Asp (RGD) adhesive peptides, resulting in increased mesenchymal stem cells (MSCs) attachment on top of 2D PEG-Nor hydrogels (Figure 1B). Photopatterning can introduce heterogeneity present in tissue interfaces, and we are using photomasks to pattern peptides onto our PEG-Nor hydrogels (Figure 1C).

Polystyrene coating of carbonyl iron microparticles to mitigate cell toxicity

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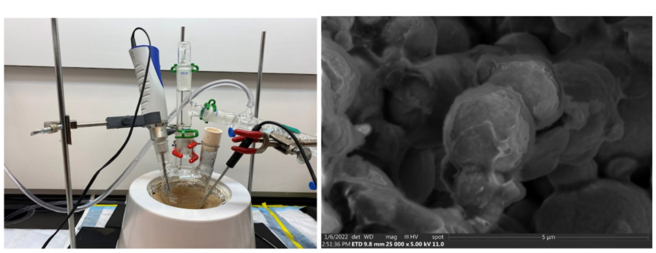

Figure 1: Coating setup and scanning electron microscopy that shows the coating of polystyrene on the carbonyl iron microparticles.

Previous studies from our laboratory have shown the ability to use magnetic fields to alter the mechanical properties of cell-seeded hydrogels to instantaneously and reversibly change storage and loss moduli. One issue with this approach is that the carbonyl iron microparticles used to implement this effect are toxic to many cell types of the span of several days. The goal of my clinic project is to develop a means to coat the carbonyl iron to reduce toxicity. Therefore, we developed ferromagnetic carbonyl iron nanoparticles coated in polystyrene polymer (CIPS) to increase stability and dispersion in suspensions and prevent cell death. These CIPS particles show similar magnetorheological properties compared to uncoated particles with little magnetic damping. The CIPS particles also decrease toxicity to cells in collagen gels with similar cell viabilities compared to controls without magnetic particles. Thus, when these carbonyl iron coated particles are dispersed throughout a collagen gel, it provides a biocompatible platform with a tunable stiffness that can match tissue properties. We aim to create a magnetic gel that can support that formation of vasculature in order to study neurodegenerative diseases. Such a platform also gives insight on cellular interactions under mechanical stiffening and subsequent morphological changes.

Predictive Delivery Strategy for Percutaneous Fixation of Bone Marrow Lesions

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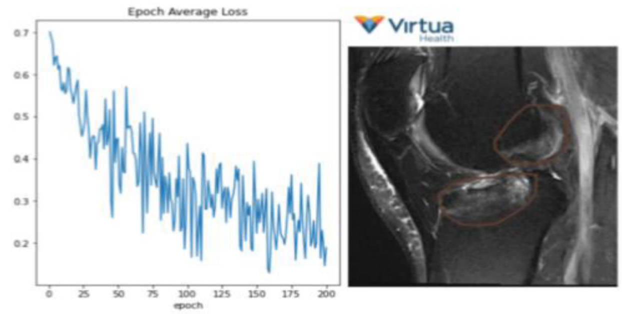
Virtua Orthopedics, Rothman Orthopedics



Damage to subchondral bone, and subsequent deterioration of the overlying articular cartilage is a major contributor to pain in Osteoarthritis, which affects approximately 25% of the U.S. population. Bone marrow lesions (BMLs), a symptom of the disease that results in pain, can be treated by a percutaneous injection of a calcium phosphate-based bone substitute material (BSM) at the damaged site to reduce deterioration. However, 30% of injections result in under or overfilling of the site, which causes incomplete restoration of bone and further progression of the disease or osteonecrosis, stress fractures, and pain. Therefore, our lab utilizes a DenseNet classification model with a Monai framework to provide the groundwork and setup for a better predicting BSM injection volumes using preoperative MRI scans retrieved in collaborations with both Virtua Orthopedics and Rothman Orthopedics. This algorithm determines which combination of MRI modality and viewing angle provides a precise model to classify images into their high and low dose injection bins. The epoch average loss indicates that T2 weighted coronal scan are a better predictive model. With a larger dataset and a refined algorithm, we can develop a deep learning network that will better predict BML injection volumes.

Probing the effect of oxygen gradient on angiogenesis in the blood-brain barrier

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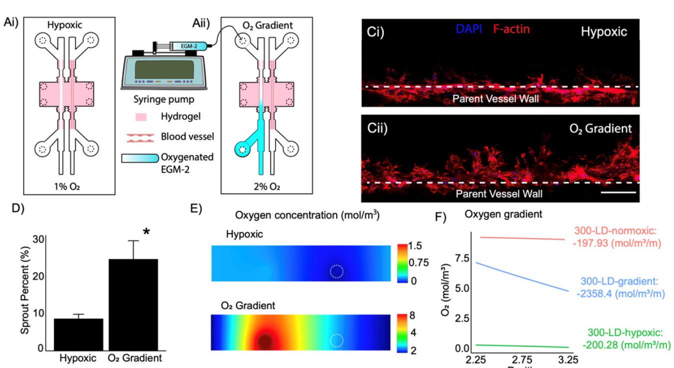

A variety of biophysical properties are known to regulate angiogenic sprouting, and in vitro systems can parse the individual effects of these factors in a controlled setting. In our clinic project, a three-dimensional model of the blood-brain barrier model is used to interrogate how variables including extracellular matrix composition, fluid shear stress, and radius of curvature impact angiogenic sprouting in cerebral endothelial cells. Tracking endothelial migration over several days reveals that application of fluid shear stress and enlarged vessel radius of curvature both attenuate sprouting. Computational modeling informed by oxygen consumption assays suggests that sprouting correlates to reduced oxygen concentration: both fluid shear stress and vessel geometry alter the local oxygen levels dictated by both ambient conditions and cellular respiration. Moreover, increasing cell density and consequently lowering the local oxygen levels yields significantly more sprouting. We conducted experiments in hypoxic chambers to determine whether oxygen level or oxygen gradient is the primary driving factor for angiogenesis. We found that the gradient of oxygen and not the absolute magnitude is responsible for instigating angiogenic sprouting. We will use these results to develop new therapeutics to mitigate angiogenesis in brain cancer.

Probing the effects of pericyte tunneling nanotubes in a 3D blood-brain barrier

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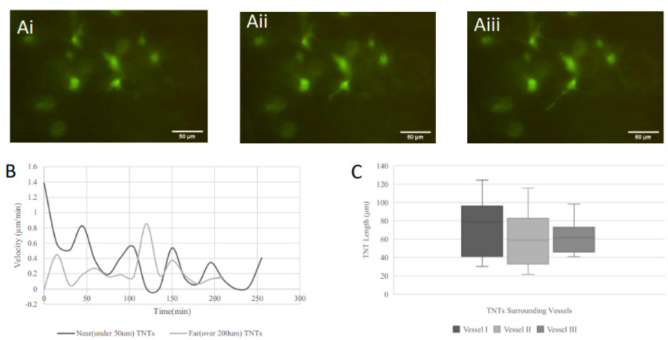

Figure 1. A. Epifluorescent microscope images visually demonstrating TNT extension over time. B. TNT extension velocity near and far from the parent vessel. C. Relative TNT length compared across vessels.

Human Brain Vascular Pericytes (HBVP) are found in cerebral vasculature, but their function remains mostly unknown. Clarifying pericyte function is crucial to improving our understanding of the blood brain barrier and subsequently implementing therapeutics to treat neuropathologies including stroke, aneurysm, and brain cancer. Previous studies have shown that pericytes form tunneling nanotubes (TNTs), long thin projections that have many roles in cancer metastasis and angiogenesis. The goal of my clinic project is to characterize the interactions of TNTs with endothelial cells, and interrogate the mechanisms by which TNTs form and communicate with their surrounding microenvironment. To accomplish this goal, I fabricate blood vessels within collagen hydrogels. I seed pericyte cells into the gel matrix and induce angiogenesis using a growth factor cocktail that includes sphingosine 1 phosphate and other pro-angiogenic factors. I measure the migration of angiogenic sprouts in conjunction with TNT formation using live cell microscopy to obtain a time lapse of the gel environment over time. Using these methods, I have investigated the formation of TNTs including projection speed and directionality of the TNTs with regards to the growth factor gradient and the parent vessel. These studies are currently being submitted as a manuscript to a peer-reviewed journal.

ROBOSSIS Imaging Software for Femur Fracture Alignment

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National Science Foundation,
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Femur fractures are a common occurrence in traumatic injury incidents where a rigorous process is required to fix the fracture. While manual techniques are now used for fraction reduction surgery, Robossis introduces a new innovative technique that uses imaging software to help accurately align. Using the software, surgeons can track the 3D position and rotation of the fractured femur during surgery. This software cap¬¬tures the 3D position of the distal and proximal parts of the fractured bone in real-time to create a 3D vision for the surgeon during the alignment procedure. For further confirmation, important femoral landmarks of both femurs are detected using x-ray imaging and positional probing. These landmarks are triangulated by identifying the same point from two different views to reconstruct a 3D projection to understand their relative position and rotation in the space. These landmark positions are used in conjunction with the position of the rigid bodies attached to the bone, which are obtained by the optical tracker, to determine the real-time relative orientation of the distal and proximal parts. Therefore, the software provides surgeons with a vision of the bone movement to reach accurate alignment.

Size Characterization of a Hydrogel For Degenerative Disc Disease

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Dr. Erik Brewer (ReGelTec, Inc.)
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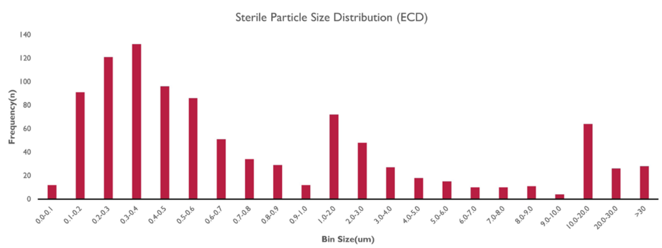
ReGelTec, Inc.



Back pain is the most common condition that patients will visit a doctor for, accounting for upwards of $100 billion each year in net medical costs. Nearly 30% of the United States population experienced back pain in 2019, with degenerative disk disease accounting for over 3 million cases. In mild instances, steroids or physical therapy is recommended, but in more serious diagnoses, surgery is required in the form of a discectomy or complete disk replacement. RegelTec has developed HYDRAFIL, a polymeric hydrogel that can help alleviate back pain in situ by providing mechanical stability and swelling mechanics that mimic the properties of a healthy annulus. When in the body, any polymeric hydrogel has the potential to degrade when subject to constant mechanical forces and negatively affect the neurological system. As a result, studies were conducted to manufacture particles aseptically using cryomilling techniques in liquid nitrogen, and representative SEM images and analysis were conducted according to ASTM F1877-16 for implantation into a rabbit model. The particles had an equivalent circle diameter of 3.88 ± 8.75μm, form factor of 0.824 ± 0.0790 μm, roundness of 0.691 ± 0.133 μm, and aspect ratio of 1.51 ± 0.331 μm.

Software Design for Increasing Timely and Effective Sepsis Treatment Compliance

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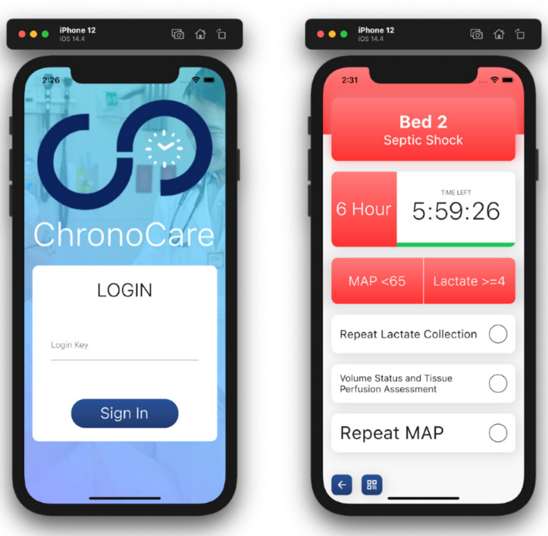

Sepsis is the body's response to an infection, and claims 270,000 lives annually in the United States alone. To combat the high mortality rate of sepsis, the Centers for Medicare and Medicaid Services enacted a set of compliance standards, SEP-1, specifically designed to guide sepsis treatment. The national SEP-1 compliance rate is 57.8%, driven by the protocol's complicated and time sensitive requirements in high pressure environments, including emergency departments and intensive care units. To combat this national crisis, we have designed and developed the ChronoCare software platform. The software package consists of a mobile application to assist nurses throughout treatment of septic patients, and a corresponding administrative analytics platform that enables operational insights and decision making for hospital administration. The mobile application has been designed in consultation with leading experts at Our Lady of Lourdes Hospital and Cooper University Hospital, and is currently being implemented at Our Lady of Lourdes Hospital under an IRB-approved protocol. When used together with the analytics dashboard, the application strives to improve SEP-1 compliance by allowing accurate reporting hospital wide and operational procedures to be evaluated.

Solvent-Assisted Nanochannel Encapsulation for Thermal Energy Storage

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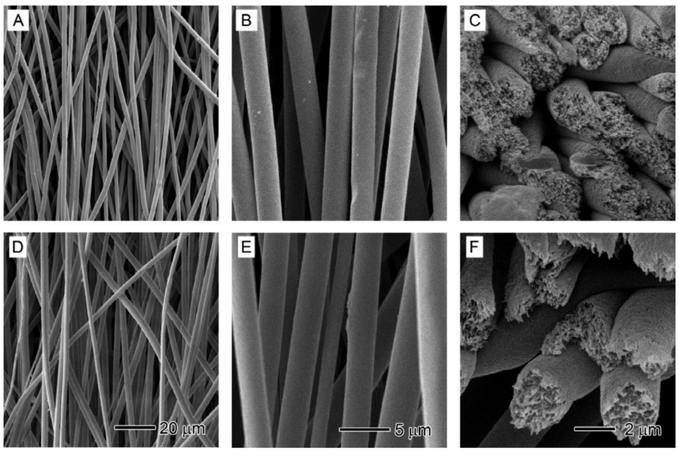
Rowan University



Our research demonstrates a green method for the encapsulation of a natural phase change material (PCM), lauric acid (LA), in polystyrene (PS) hollow fibers through a solvent-assisted diffusion process inside fiber nanochannels. The obtained LAPS composite fibers had a melting enthalpy of up to 147.8 J/g, which was 82.0% the heat storage capacity of pristine LA (180.2 J/g). The LA content in the composite fibers could be controlled by the solution concentration and the solvent. The optimal LA loading (82.2%) was achieved in 0.4 g/mL LA ethanol solution for 1 h, which was more than 4 times the weight of PS fibers. Simultaneous TGA−DSC, ATR, Raman, and SEM measurements confirmed the homogeneous distribution of LA inside the fibers across the whole membranes. Further, the LAPS composite fibers showed a long-lasting stability during cycling without storage capacity deterioration, as well as an exceptional structural stability without LA leaking and fiber rupture during 100 heating−cooling cycles. The energy-dense and form-stable LAPS composite fibers have a great potential for various thermal energy storage applications.

Surface Functionalization

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The goal of Surface Functionalization is to design fiber sheets that could be more beneficial than scaffolds while attaching them to tissues. These fiber sheets can possibly attach themselves with organisms that scaffolds are not able to and while they are attached, we can have the ability to control them as well, The goal is trying to use these fibers sheets to attach themselves to the peptides and test how long these sheets can last onto the tissues as well. The materials being used for these experiments are polycaprolactone (PCL) and PEG Norbornene (PEG-Nor), The quantity of these compounds and the size of the sheets can influence how efficient the attachments are to the peptides of the tissues. The method being used to combine these compounds is called a Melting and Blending method which requires the PCL and PEGNor is melted to liquid or viscous form and manually blended. Photopatterning is conducted to see how efficient the attachments were.

Synthetic Receptor Targeting of Human Fibroblast for Solid Cancer Therapy

TEAM MEMBERS
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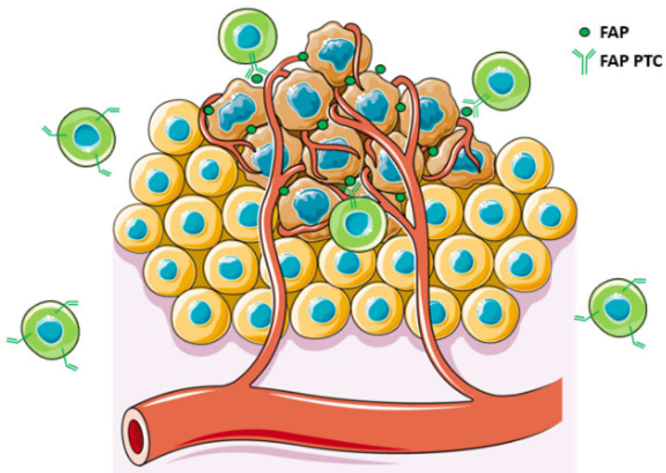

Adoptive cell therapy (ADT) genetically engineers a patient's T-cells with synthetic transmembrane receptors to target specific antigens prevalent in cancerous cells and regions. ADT has been shown to be an efficacious treatment for patients presenting with liquid tumors, such as lymphoma and leukemia, but lack the same level of effect in solid tumors. However, the structure of novel synthetic receptors, like post-translational circuits, has dramatically improved in the past years with new downstream binding effects having been studied. As a result, there remains a strong, compelling reason to further investigate the ability of ADT to limit solid tumor growth and progression. A common antigen released by solid tumors is fibroblast activation protein (FAP) which is significantly upregulated by cancerous cells. As such, FAP was chosen to be targeted by ADT. The ability of post-translational circuits to target FAP is being tested through flow cytometry for the most optimized structure that allows high affinity binding to human fibroblast activation protein.

Targeting IL-4 In The Tumor Microenvironment With Synthetic Receptors

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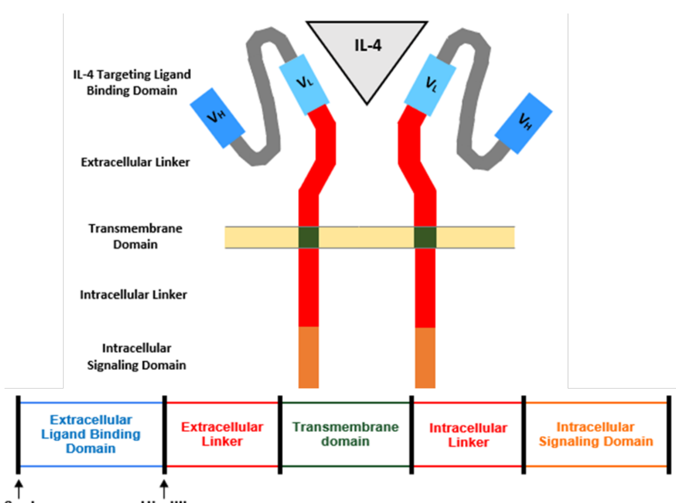

Cancer is the second leading cause of death in the United States. Synthetic post-translational circuits can be used as biological receptors that will respond to signals like those sent out by tumors, triggering the activation of the immune system by controlling and monitoring cellular activity. Many signaling pathways in eukaryotic cells involve the modification of proteins and often involve adding or removing a phosphoryl group post-translation. The synthetic receptors developed in this lab can respond to extracellular ligands and utilize phosphorylation mechanisms as seen in native signaling pathways to maintain the same fast, layered response. This specific project focuses on constructing receptors that will bind to the signaling protein, interleukin-4 (IL-4). IL-4 is an anti-inflammatory cytokine that can modulate the immune system. A post-translational circuit is composed of an extracellular ligand binding domain, a 10, 20, or 30 amino acid extracellular linker, a transmembrane domain, a 0, 10, or 20 amino acid intracellular linker and an intracellular signaling domain. To target IL-4, the restriction enzymes SpeI and HindIII were used to replace the current extracellular ligand binding domain and with the IL-4 scFv (short chain variable fragment). Future work includes optimization of receptor design through varying linker lengths.

Testing for Less Lethal Aerosol Devices Used by Public Safety Officers

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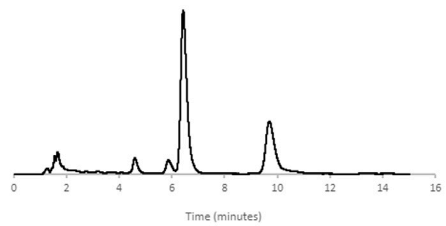

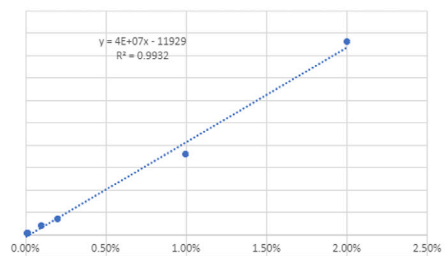

Less lethal aerosol devices have become popular among public safety officers due to their simplicity. These devices can spray either Orthochlorobenzalmalononitrile (CS) or Oleoresin Capsicum (OC) formulations. To verify the quality and consistency of these devices, standards have been put in place by the American Society for Testing and Materials (ASTM), and Guardian Protective Devices has tasked Rowan students with the testing certification of their devices. Following ASTM standard designation E3187/E3187M−19, standard operating procedures were written to verify the aerosol devices' resistance to crushing, dropping, extreme temperatures, and inflammability. Methodology for high-performance liquid chromatography testing was developed and used to quantify the amount of CS or OC in these devices. Chromatograms were produced using foam formulations of CS and OC which possessed high signal to noise ratios indicating that the lower limit of detection for these analyses were well below our targeted concentration of interest. Since this ratio is increased with a flat baseline, our method could detect peaks of samples with low concentrations. The chromatograms were integrated to obtain solvent peak areas. These areas were used to create standard curves for both formulations. Using these curves, area calculations through HPLC can yield OC and CS concentration predictions.

Testing of Novel Bromfenac Ophthalmic Extended-Release Hydrogel Contact Lenses

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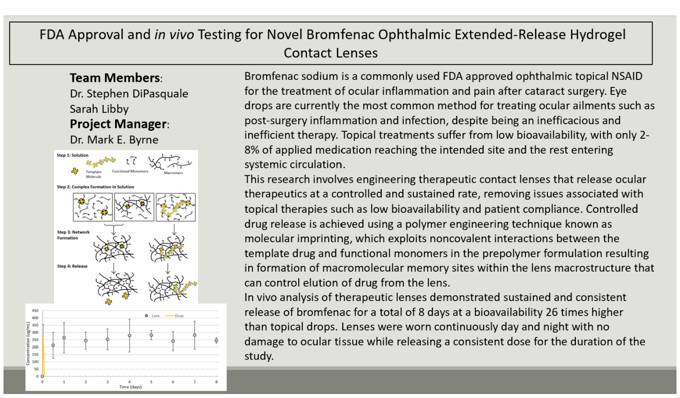

Bromfenac sodium is a commonly used FDA approved ophthalmic topical NSAID for the treatment of ocular inflammation and pain after cataract surgery. Eye drops are currently the most common method for treating ocular ailments such as post-surgery inflammation and infection, despite being an inefficacious and inefficient therapy. Topical treatments suffer from low bioavailability, with only 2-8% of applied medication reaching the intended site and the rest entering systemic circulation. This research involves engineering therapeutic contact lenses that release ocular therapeutics at a controlled and sustained rate, removing issues associated with topical therapies such as low bioavailability and patient compliance. Controlled drug release is achieved using a polymer engineering technique known as molecular imprinting, which exploits noncovalent interactions between the template drug and functional monomers in the prepolymer formulation resulting in formation of macromolecular memory sites within the lens macrostructure that can control elution of drug from the lens. In vivo analysis of therapeutic lenses demonstrated sustained and consistent release of bromfenac for a total of 8 days at a bioavailability 26 times higher than topical drops. Lenses were worn continuously day and night with no damage to ocular tissue while releasing a consistent dose for the duration of the study.

Testing the Self-Healing Properties of Hydrogels

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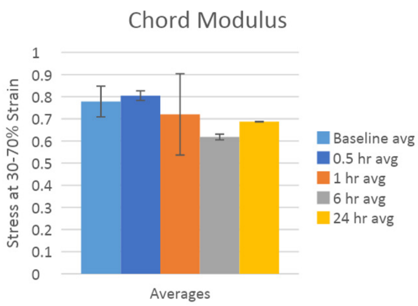
ReGelTec



ReGelTec, Inc., has developed a thermosetting, injectable hydrogel (HYDRAFIL) that can perform as a non-invasive implant for the treatment of degenerative disc disease. Depending on the specific patient anatomy, clinicians may choose to inject at multiple sites or in back-to-back sessions, relying on the hydrogel to coalesce in place from multiple sites. Thus, Rowan Engineering students are exploring the ability of the hydrogel to self-heal and to adhere to itself to form one uniform piece. To understand and test this property in HYDRAFIL, tensile strength, compression, rheology, and visual tests were performed. For tensile strength, two separate pieces of hydrogel were put into contact with each other, changing the time between the first and second injection and pulled until it breaks to see if self-healing would increase or decrease as the gel hardens. In the compression tests, two separate pieces were driven apart with a wedge and the breaking force was measured, as well as the stress strain properties of the combined piece. With rheology, two separate injections immediately after one another were tested and compared to a single injection using a step-strain procedure. Lastly, the visual test consists of a dyed hydrogel injected into a well plate, then a second, differently dyed hydrogel injection is done after a certain time period to see how quickly and how far the dyes diffuse in the sample.

Time Dependency and Toxicity in Planaria Using High-Throughput Testing

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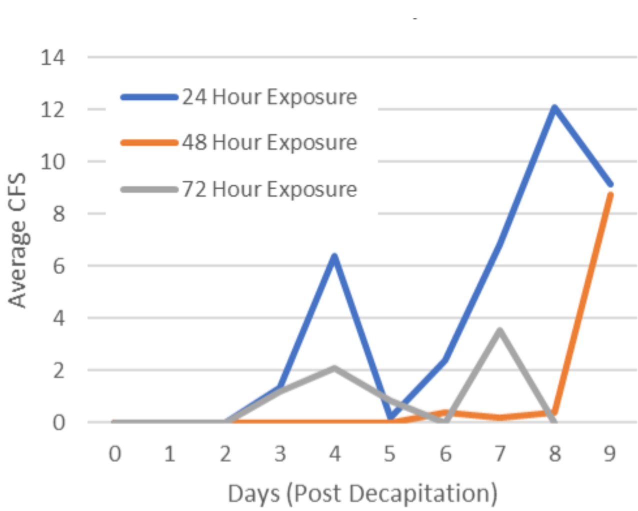
SPONSOR
National Institutes of Health



Planaria flatworms are durable and resilient with remarkable regenerative abilities. These worms naturally move away from light, and this aspect of the worms' behavior can be used as a variable to determine loss of function or damage to the organism. Furthermore, the worms uptake substances from their environment by a process involving epithelial diffusion, which allows for straightforward manner to induce exposure to chemicals. In this work, we expose head-regenerating worms to chemicals and test their reacquisition of light avoidance behavior. Using image processing and statistical computation software, the worms can be analyzed and scored based on their movement into or out of the light in their environment. In this work, we investigate whether this planarian model can be used to evaluate exposure timing. Chemical exposure is limited to specified time intervals. Preliminary data suggest that the exposure time after decapitation is negligible, however, longer exposure is more detrimental to cognitive function. Together, this suggests that the planarian regenerative processes compensate for any chemical-induced changes, which limits our ability to utilize the model for characterizing exposure timing.

Validating the Submillimeter Precision of the Robossis Surgical Robot

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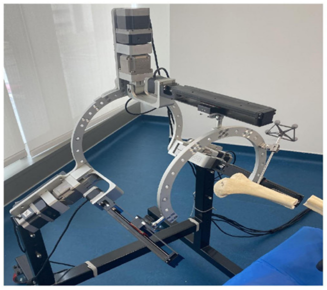

Figure 1a. Robossis Surgical Robot

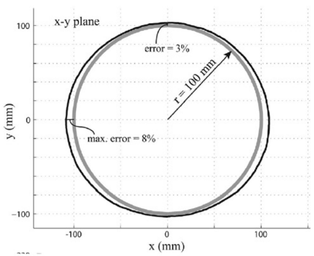

Figure 1a. Accuracy of Robossis without load

The Robossis Surgical Robot (Figure 1a.) aims to improve the surgical outcomes of femur fracture Open Reduction and Internal Fixation (ORIF). Nonunion complications are mainly caused by malalignment of the femur, Robossis offers surgeons improved precision to accurately align the femur fragments and improve surgical outcomes. Current literature has shown that the maximum resulting force observed during surgery is 411 N, and the maximum resulting torque is 74 N · m. Previously, the accuracy of Robossis was measured by comparing the theoretical and experimental path around a circle with no load. (Figure 1b.) We plan to expand upon this method to measure the accuracy of Robossis under load. We propose to test the accuracy of Robossis in all six degrees of freedom. Progressively larger forces will be applied in the three translational directions (x, y, z), and moments will be induced in the three rotational directions (α, β, γ), until accuracy decreases. Our goal is to validate the accuracy of Robossis under the maximum force observed during surgery. Should Robossis not have submillimeter accuracy under expected loads, we plan to increase accuracy by improving the passive joint clearance and increasing the strength of the motors.

Wounded Veteran Bicycle Project

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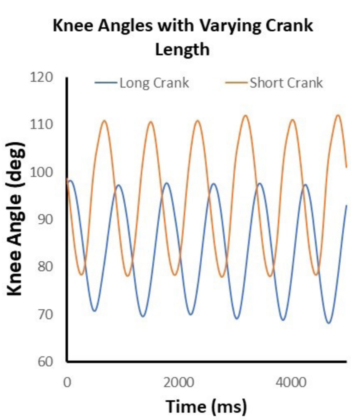
Quality of Life Plus



Many lower limb amputees who try cycling find it difficult and discomforting because of a lack of lower limb muscles and not being able to feel if their prosthetic foot is positioned correctly on the pedal. These difficulties result in many amputees not cycling up steep hills and having their prosthetic foot constantly slipping off the pedal while riding. In collaboration with the nonprofit QL+, engineering students have been tasked with solving these problems for a wounded veteran. After speaking with many lower limb amputees and researching both problems thoroughly, the student's proposed solutions are clipless pedals and crank arm shorteners. In conjunction with cycling shoes, the clipless pedals effectively lock the rider's foot and bicycle pedal together when cycling but allow for a quick release with the flick of a heel when coming to a stop. To mitigate the discomfort associated with climbing hills, the students have chosen to use machined aluminum crank arm shorteners which through their research and real-world testing have shown to decrease the prosthetic knee joints range of motion by up to 40%. The students have validated these modifications by analyzing videos of a team member pedaling the bicycle on a stationary stand.

Zero-order therapeutic release from engineered nucleic acid monolayers

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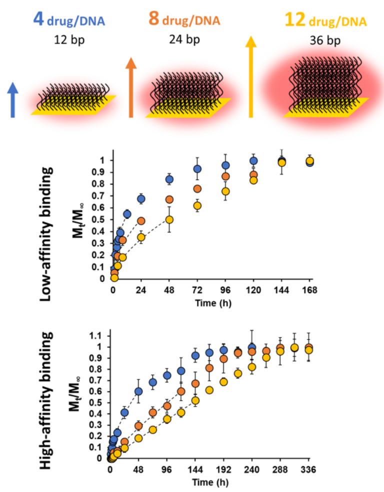
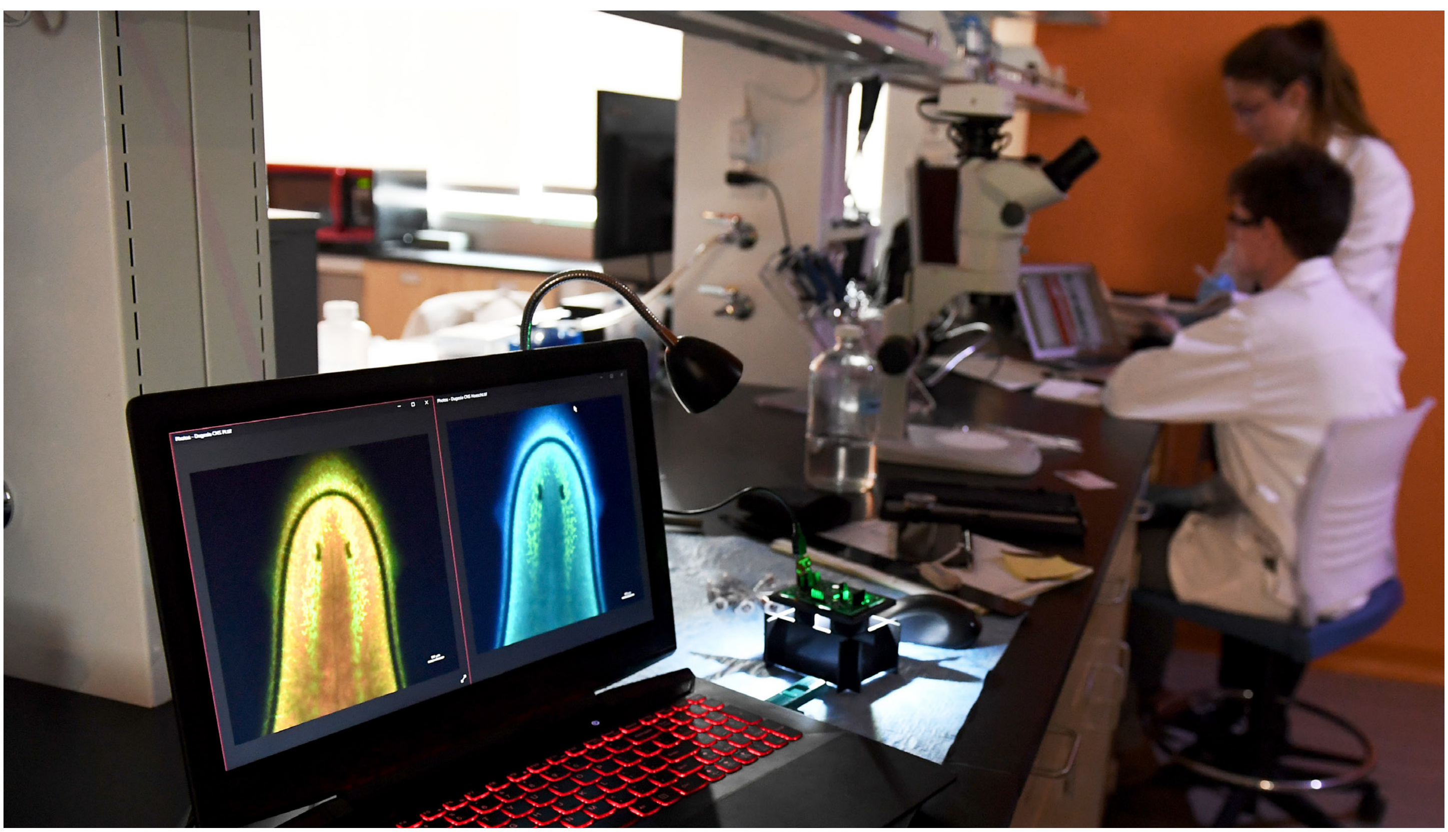
USDA (Hatch Program), National Science
Foundation



Biohybrid materials present a profoundly tunable platform for formulating next-generation therapeutic nanocarriers. However, controlling the transport of drugs at the nanoscale presents a significant challenge. In this work, we manipulated the nanoarchitectures of self-assembled nucleic acid monolayers to control the release of an intercalating drug. Two DNA sequences designed for low- and high-affinity drug binding were compared at oligonucleotide lengths corresponding to 4X, 8X, or 12X drug intercalation sites (12, 24, or 36 bp, respectively). Drug-loaded oligonucleotides modified with 5’ terminal thiol were assembled on gold films and submerged in PBS at 37oC. Cumulative drug release was determined by measuring release media samples via fluorescent spectroscopy. Increasing the length of oligonucleotides resulted in a correlated with a decreased release rate for both sequences. Comparing the sequences with 12X binding sites, the high-affinity sequence released drug for 288h with near zero-order release kinetics, while the low-affinity sequence released drug for 144h. On 15nm gold nanoparticles, faster drug release was observed due to the high curvature of nanoparticles. Our results show that precise control over DNA structures on surfaces, including DNA sequence and oligonucleotide length, can be exploited for drug transport. Supported by the Hatch program of the USDA



CHEMICAL ENGINEERING

Advancing Additive Manufacturing Resins

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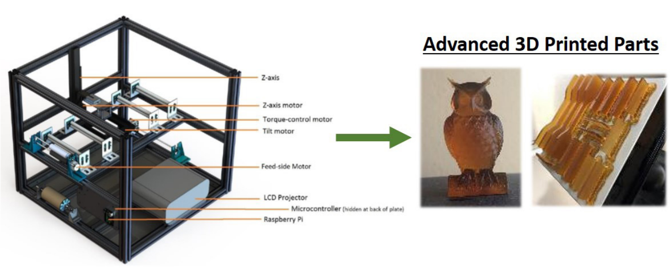
SPONSOR
U.S. Army Research Laboratory



The synthesis of novel liquid resins and the development of advanced additive manufacturing techniques are emerging frontiers in research and innovation. This Clinic has merged these emerging frontiers with the ultimate goal of producing stronger, more durable 3D printed parts. Polymer science and engineering was at the core of this Clinic project. Resins were designed, synthesized/formulated, characterized, and printed, with improvements in processing such systems have occurred. All resin systems, pre- and post-cured, were extensively characterized using advanced techniques. Clinic 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).

Awesome Stuff from Birch Bark

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PROJECT MANAGER
Dr. James Newell, Dr. Joseph Stanzione, Dr. Kirtie Yenkie, John Chea, Alexandra Chong

This Project examined the production of both thermoplastic and thermoset polymers from material extracted from birch trees growing on campus. Student teams collected the bark, extracted both ethanol and chloroform soluble fractions, purified the chemical compounds betulin and betulinic acid using a Soxhlet extraction technique, and were able to develop polymeric materials from the product of these extractions. The polymers were characterized in terms of both weight average and number average molecular weights and their rheological properties were measured. Ultimately, the goal of the project is 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.

Carbon-Carbon Composites from High-Performance Polymers

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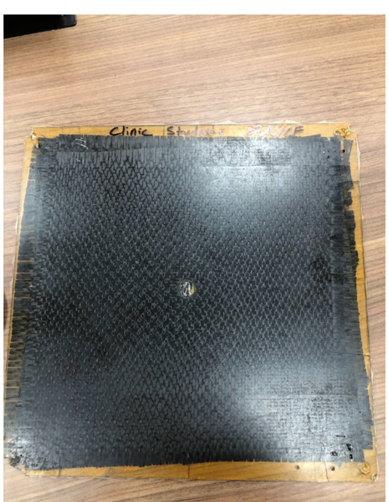
SPONSOR
U.S. Department of Defense



The blend of exceptional strength-to-weight ratio and high conductivity make carbon-carbon composites ideal for many military and aerospace applications, but the cost and complexity of making these composites limits their broader applicability. This project focused on developing new carbon-carbon composites from high-performance polymers including Kevlar and Zylon as an alternative to those made from the traditional PAN polymers. Unlike PAN, which requires a time-consuming and expensive stabilization step, Kevlar and PBO can be carbonized directly. Preliminary results from this study showed that both Kevlar and PBO make promising carbon fibers that bond well with potential matrix materials, but more work on the actual carbonization of the composites remains to be done.

Cold Plasma Sterilization

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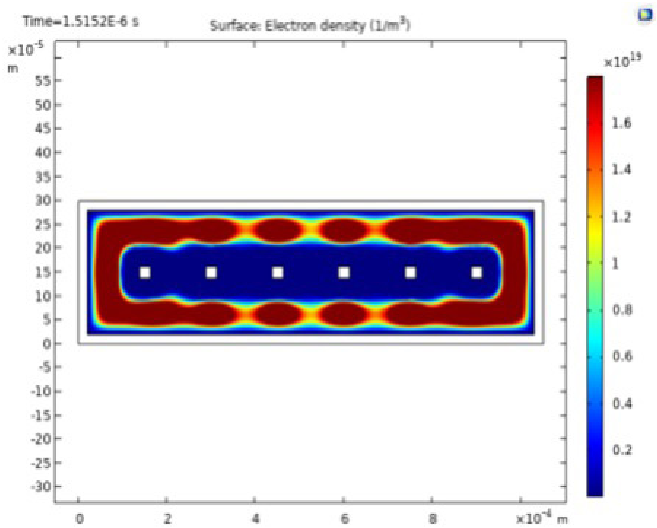
PROJECT MANAGER
Dr. Gary Thompson

Cold plasma is a low-temperature, low-energy state of matter that has been shown to kill microbes attached to a variety of surfaces. Plasma achieves decontamination by producing charged ions in the surrounding air and nearby liquids. These ions disrupt biomembranes and intracellular pathways of yeast and bacteria. Although the general mechanism of how cold plasma decontaminates surfaces is well-known, plasma-based decontamination technology is in its early stages. There is ample room for research, device development and optimization to meet industrial needs. This entrepreneurial Clinic starts to bring a cold plasma decontamination device from idea to prototype and ready a marketable technology.



Cold Spray Additive Manufacturing

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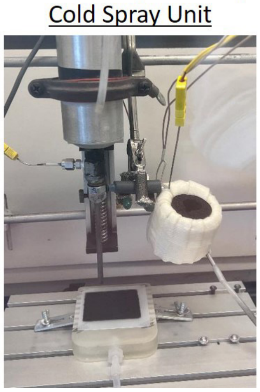
Dr. Joseph Stanzione, Dr. Francis Haas, Dr. Dave Brennan, Dr. Tristan Bacha
SPONSOR
U.S. Army Research Laboratory

With the Advanced Materials and Manufacturing Institute's Cold Spray facility up and running, students have worked towards solving fundamental and applied polymer science and engineering problems related to cold spray additive manufacturing. Problems related to processing and handling polymer particles prior to spraying, including particle rounding and conditioning and particle feeding, have been tackled and coupled with advanced characterization techniques. Different polymer particles have been cold sprayed following strategic sets of design of experiments and along with post-spray analyses. Clinic students have worked closely with graduate students, postdoctoral research fellows, and professors and have gained knowledge and experience in ultimately fabricating high-performance composites for advanced military and industrial applications.

Custom Built, Benchtop Cold Spray Unit



Cold Sprayed Polymer with High Deposition Efficiency

Elemeat

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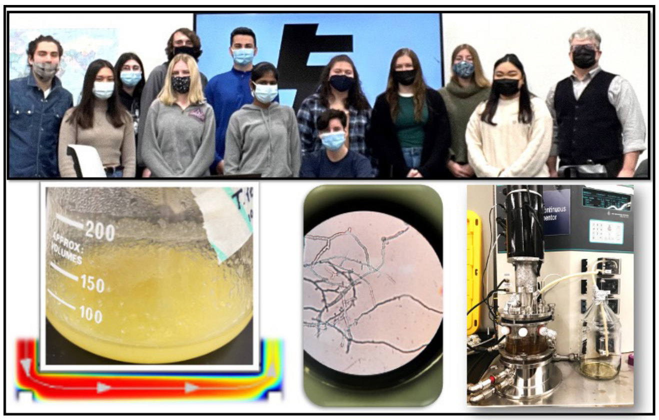

"Precision fermentation involves harvesting valuable byproducts from microorganism growth, and can be applied in multiple industries such as food, pharmaceuticals, and biofuels. Microorganism exposure to pulsed electric fields (PEF) during precision fermentation may improve protein and other byproduct yields and reduce fermentation time. The Elemeat clinic is developing a process to expose E. coli and T. reesei to PEF and quantify the effects this exposure has on protein extraction and cell proliferation. Samples are analyzed using several biochemical analytical techniques.
COMSOL simulations predict electric field distribution and flow patterns through an external treatment chamber. This aids in the design of a technology to bridge precision fermentation and PEF for widespread industrial use."

Engineering Board Game Design

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PROJECT MANAGER
Dr. Gerard Capellades, Dr. Thomas Meadowcroft

The design of a board game can be a highly rewarding experience, requiring a combination of creativity and statistical knowledge for developing a balanced and engaging game. From an end-user perspective, board games can be an effective method to learn how certain businesses operate, and to attract students with field-specific problem-solving skills to those disciplines. In this clinic, we designed an engineering-themed board game that can be used for education and outreach. The product highlights the historical evolution of engineering inventions, while teaching players about the engineering design process as well as common business models of engineering firms.

Greening Up Filament Wound Composites

TEAM MEMBERS
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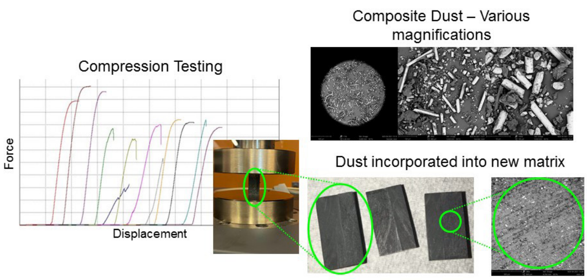
PROJECT MANAGER
Drs. Joseph Stanzione, Dr. Francis Haas
SPONSOR
US Army Research Lab,
GGB Bearing Technology



Microplastics are appearing with ubiquity in the environment, and have even been detected recently in human blood. This Clinic seeks to develop beneficial re-use of microplastics generated from an industrial grinding process used on filament-wound composite materials. This has the potential to directly reduce microplastic waste generation while also reducing upfront use of the chemicals used to make the thermoset polymer matrix for the composite parts - a win-win for the environment and manufacturers' bottom lines. Clinic efforts have focused on compression testing of thermoset matrix materials with and without addition of grinding dusts, as well as generation of filament-wound composite cylinders using matrices of varying concentration of grinding dust recycled from previous composite cylinders. Additional efforts have included continuous improvements to the computer-controlled filament winding hardware as well as improvements to the relevant composite curing process.

Impurity Incorporation in Crystal Growth

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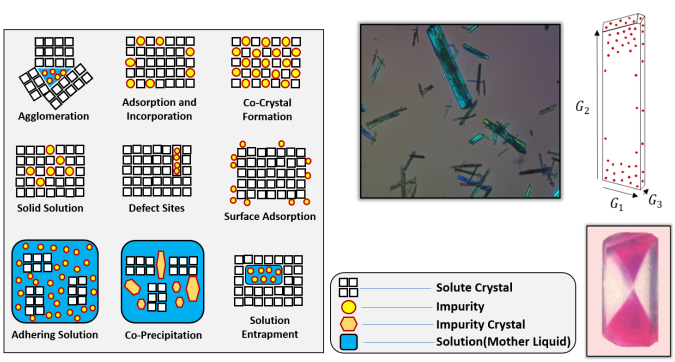
PROJECT MANAGER
Dr. Gerard Capellades



Crystallization as a purification process is widely used in the bulk chemical, pharmaceutical, and fine chemical industries. However, the mechanisms for impurity incorporation are poorly understood and hard to quantify. To this day, we still lack reliable models that predict which impurities will incorporate in a growing crystal, and to what extent. This clinic involved the growth of large crystals in the presence of impurities, and the experimental determination of impurity incorporation rates and mechanisms. Custom devices as well as diagnostic methods were explored and optimized, to facilitate their use by industrial practitioners and to set the grounds for advancing our fundamental understanding of impurity incorporation in crystal growth.

Optimization of Pipeline Flushing Operations for ExxonMobil LOBP

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PROJECT MANAGER
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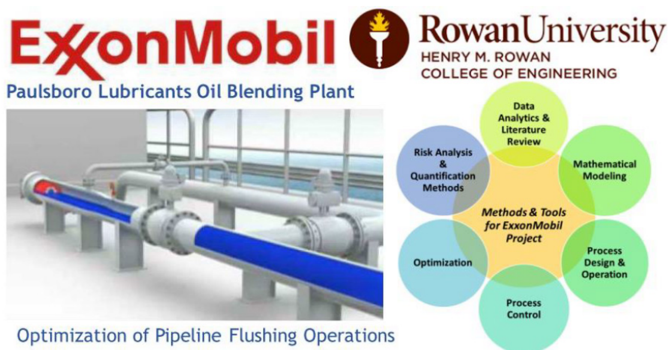
SPONSOR
ExxonMobil, NJ,
US Environmental Protection Agency



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. The plant uses an existing manifold system to perform multiple blending and filling operations as there is a growing demand for unique blend compositions/formulations for lube oils for different automotive, and machinery applications. Since products are greater than connections, lines must be reused for multiple formulations. This requires certain lines purged (flushed) of the leftover product from the previous operation before the next task. This is cost-intensive and utilizes a significant amount of pure product to perform flushing operations. Thus, the goal of this project is to reduce the amount of flush oil produced during the flushing of pipelines. This will be accomplished by understanding issues in line flushing at Paulsboro LOBP, identifying alternatives through the integration of chemistry, process design, and optimization.

PowerGum

TEAM MEMBERS
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PROJECT MANAGER
Dr. Gary Thompson

Most pre-workout chewable gums just contain caffeine or vitamins, but the amino acids are the most important component for building lean muscle during recovery. To develop a product to fill this need and feel a better burn, materials are being researched to make PowerGum. The chemistry has been developed. Experiments to characterize physical properties and biocompatibility have been performed. And a manufacturing process that strictly adheres to food safety guidelines is being planned to make PowerGum.

Rapid Development of Pharmaceutical Crystallization Processes

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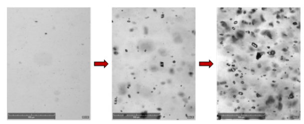
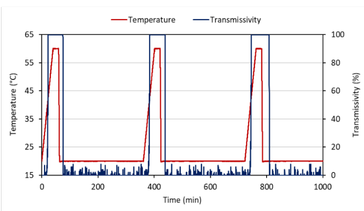
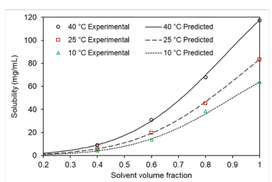
PROJECT MANAGER
Dr. Gerard Capellades



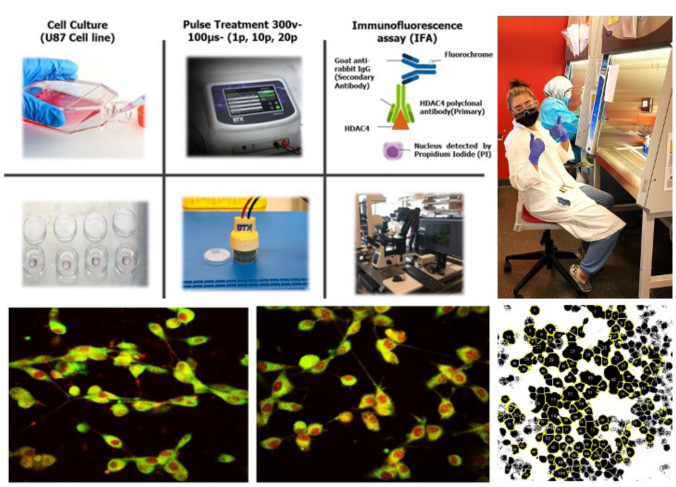




Solution crystallization processes are a key step in the purification of pharmaceuticals and for the isolation of powders with the right medical function. Crystallization development follows a lengthy process that can bottleneck the design of reliable processes for new pharmaceuticals. In this clinic, we developed and implemented a generalizable, automated methodology to rapidly obtain relevant metrics for crystallization development, including solubility, nucleation rates, and crystal growth rates. A data analysis plan has been designed to rapidly obtain these metrics from large data sets. Then, mathematical models were used for the virtual optimization of batch and continuous crystallizers.

Switching Off Cancer

TEAM MEMBERS
Nathan Garrison, Diana Martinez-Castro, Kayli Knipfer
PROJECT MANAGER
Dr. Gary Thompson



Pulsed electric fields (PEF) have been used to ablate soft tissues and tumors in humans. The goals of this Clinic are to determine molecular pathways by which PEF exposure can 'switch-off' cancer cells, especially via epigenetic alterations. Histone deacetylase (HDAC) inhibitor-based drugs have recently started undergoing clinical trials to treat tumors. However, solid tumors are difficult for pharmacological drugs to penetrate. By applying PEF to cancer cells, their plasma membranes are permeabilized, increasing calcium concentrations in the cells. Calcium influx leads to HDAC accumulation within the nucleus, ultimately killing or slowing the growth of cancer. Microscopy image results show intracellular HDAC enzyme localization in cell nuclei.

Systematic Synthesis of Solvent Recovery Processes

TEAM MEMBERS
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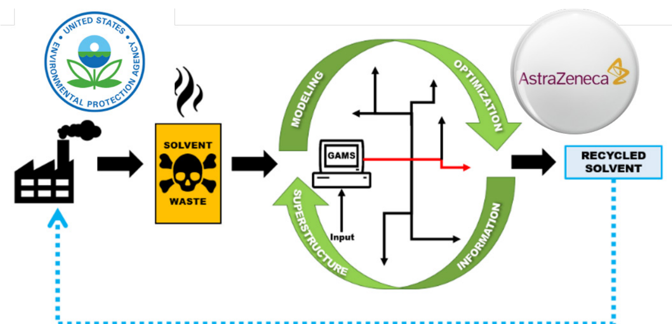
PROJECT MANAGER
Dr. Kirti Yenkie
SPONSOR
AstraZeneca,
US Environmental Protection Agency



Solvents are commonly used in both fine chemicals and pharmaceutical industries to aid reaction and purification steps to maintain product quality. Solvents can account for ~ 90% of the mass but are often disposed of after a single use. Incineration is most widely used for solvent disposal, though it is not a green method. Because of the detrimental effects on the environment, recovery methods are being considered to improve the sustainability of industries. Potential solvent recovery technologies have been researched for developing mathematical models. The models consist of material and energy balances as well as utility requirements, equipment design, and costs to assist in determining the most feasible method for solvent recovery. The ultimate goal is to develop a roadmap and software tool for solvent recovery that reduces cost, minimizes environmental impacts, limits waste produced, while also maintaining safe operation. This work is funded by AstraZeneca and the US EPA.

Wastewater Treatment & ACUA Asset Management

TEAM MEMBERS
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PROJECT MANAGER
Dr. Kirti Yenkie
SPONSOR
Atlantic County Utilities Authority (ACUA)

Wastewater treatment (WWT) for reuse and safe disposal has become crucial for sustainable existence. WWT methods must vary based on properties of the inlet waste stream, such as the number of contaminants, their amounts, toxicity, shape, size, etc. To this end, we will develop a methodology to generate a maximal structure comprising of all possible treatment methods and flow patterns using a systems approach, followed by elimination of inapplicable methods based on certain constraints, that will make the designing of WWT networks more efficient. In addition to this, WWT utilities, equipment, and assets such as pipelines, manholes, etc., will be analyzed for risks and failure probability. The holistic approach will enable cost-effective, energy-efficient, and sustainable WWT as well as facility management. This project is funded by Atlantic County Utilities Authority (ACUA) and in collaboration with Széchenyi István University and the University of Miskolc, Hungary.

Xenograft Tissue Engineering

TEAM MEMBERS
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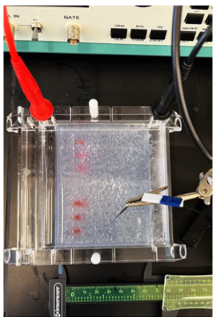
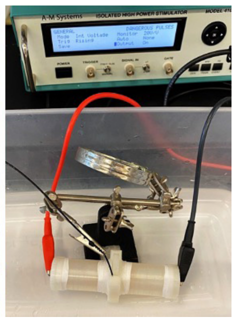
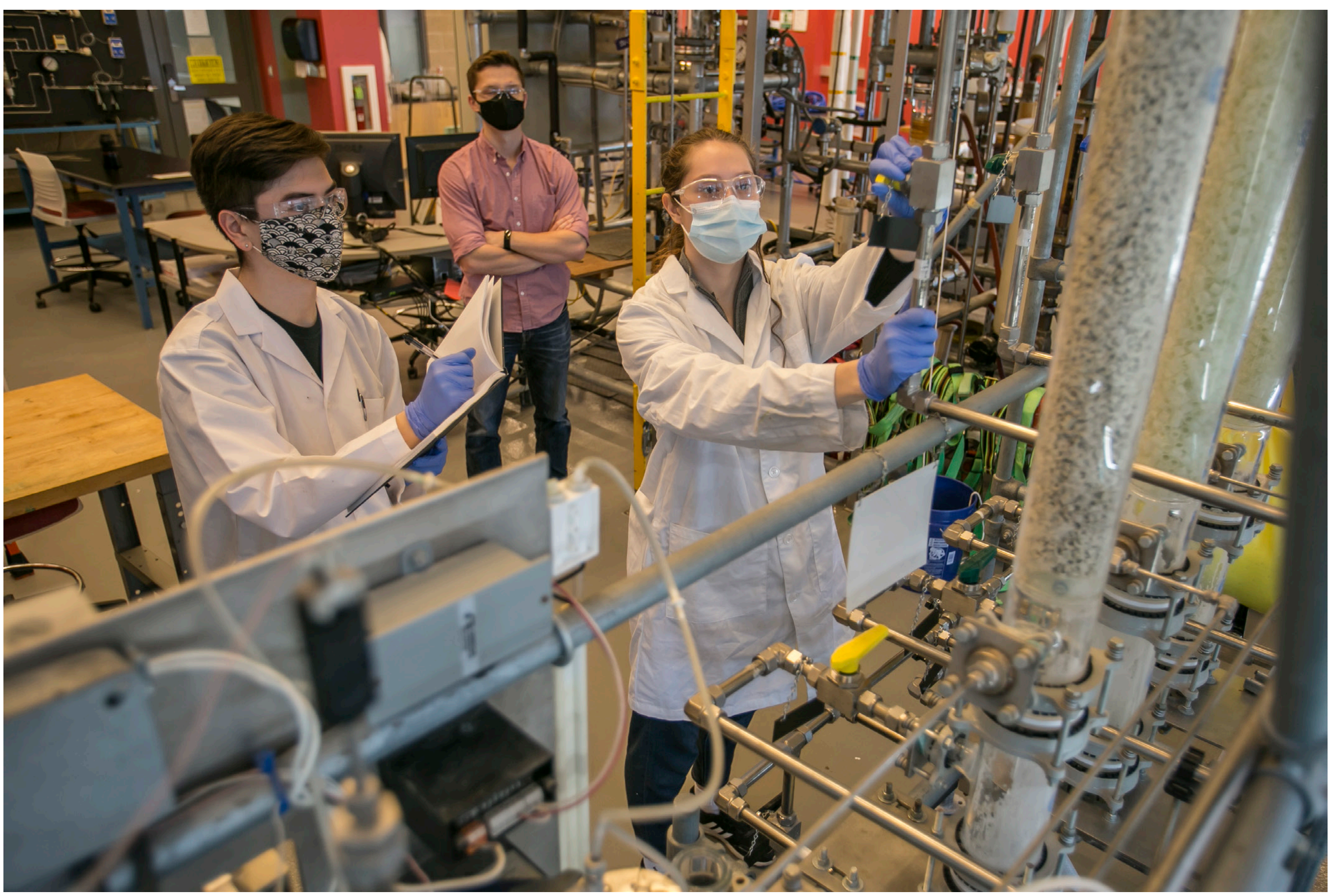
PROJECT MANAGER
Dr. Gary Thompson





Creating decellularized tissue scaffolds for therapeutic use, such as replacement cartilage in the intervertebral discs, is a burgeoning field for its revolutionary pharmaceutical uses and rehabilitation potential. Using a pulsed electric field to create movement of charged and uncharged cellular materials from the tissue to the running buffer using electrokinetic phenomena is a potential method for creating decellularized tissues. Using a pulsed electric field can remedy the problems of prior methods attempted by using electrophoretic movement of charged cellular materials and electroosmotic movement of uncharged materials. Our Clinic team has previously designed and manufactured a custom chamber for measuring electroosmotic extraction of uncharged materials from decellularized cartilage samples. The focus is now on using biocompatibility tests to ensure the effectiveness of these tactics. After electroosmosis has been performed, the tissues must be biocompatible with the human body to ensure that these replacements can be used effectively. Our Clinic team is now testing DNA, RNA, and glycosaminoglycan quantifications, along with potential testing of xenograft cells, to ensure that tissue samples can be implanted as replacement cartilage.

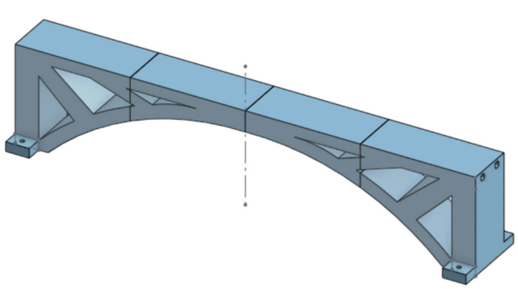


CIVIL & ENVIRONMENTAL ENGINEERING

3D Printed Bridge

TEAM MEMBERS
Zach Denuzzi, Stefano Sferra, Chris Pear, Matt Pensabene, Rich Cabrera-Felix, Connor Quinn, Michael Dustal
PROJECT MANAGER
Dr. Douglas Cleary

NJIT is developing a student competition involving the 3D printing of bridges. This team of students performed a mock participation in the competition in order to provide NJIT with feedback on the competition rules and processes. The students developed truss and arch bridge concepts, modeled them to evaluate performance, developed construction processes to locate model joints, and tested the final products. Through the process suggested rule modifications were developed and shared with NJIT.



3D Printing of Mortar

TEAM MEMBERS
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PROJECT MANAGER
Dr. Gilson Lomboy

3D printing technology has seen significant advancements in recent years, broadening its potential applications. One such application is construction through 3D printing. However, 3D printing cementitious materials require a balance between printability and strength. In this study, the procedures and parameters required to produce consistent cement prints are investigated. The relationship between printability and fresh cement paste properties is also explored. Various water-to-cement ratios were utilized in each mixture, which was refined to optimize extrudability and buildability. Printer settings were adjusted to maximize extrusion capacity. Using a retarding admixture, the paste's initial setting time was increased to 2 hours, maximizing workability. With a water-to-binder ratio of 0.285, the most optimal mixture achieved a specimen height of 48.2mm, with minor compression in the bottom layers resulting in a slight decrease from the intended height of 50mm. The procedures and parameters presented in this study allow for consistently extrudable and buildable prints. Future studies may examine the mechanical properties of prints, a measurement of extrusion force, and further increased buildability.

Bio-cemented Soil

TEAM MEMBERS
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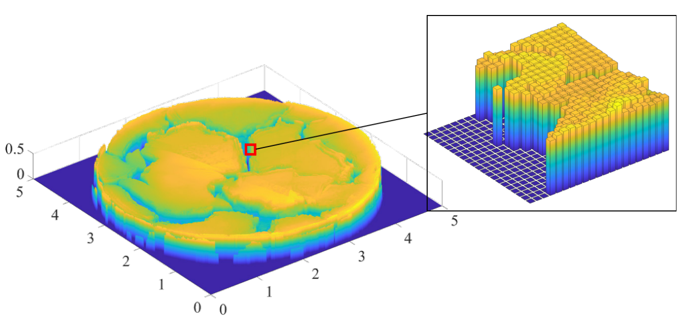
PROJECT MANAGER
Dr. Cheng Zhu, Melissa Montalbo-Lomboy, Kaniz Roksana, Shaini Aluthgun Hewage

This project aims to continue to explore the possibility of using bio-mediated technique to reinforce granular soil particles. 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.



Bridge Deck Condition Assessment

TEAM MEMBERS
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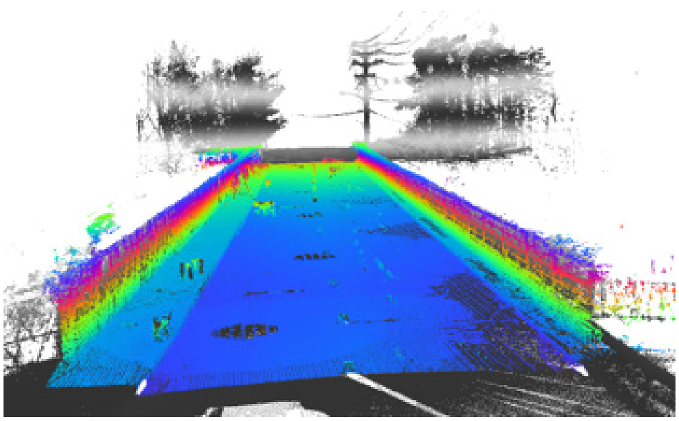
PROJECT MANAGER
Dr. Adriana Trias-Blanco
SPONSOR
University Transportation Center (UTC)



Bridge owners have begun to explore augmenting conventional deck condition assessment approaches with nondestructive evaluation (NDE), yet the primary barriers of current contact structural evaluations are the associated costs and the disruption of traveling traffic. Therefore, there is an important need for the implementation of wireless, non-contact, or remote sensors that can provide rapid and cost-effective data. To address these needs, the remote geometry characterization provided by LiDAR sensors has been evaluated as a potential tool used for rapid screening of bridge deck condition. The objective of this clinic project is to summarize the most relevant benefits and shortcomings of current NDE technologies as Impact Echo (IE), Half-Cell Potential (HCP), Ground Penetrating Radar (GPR), and Electrical Resistivity (ER), to provide information on potential contributions of LiDAR that could accelerate initial stages of data collection for bridge deck evaluation.

Building Information Modelling for NJARNG

TEAM MEMBERS
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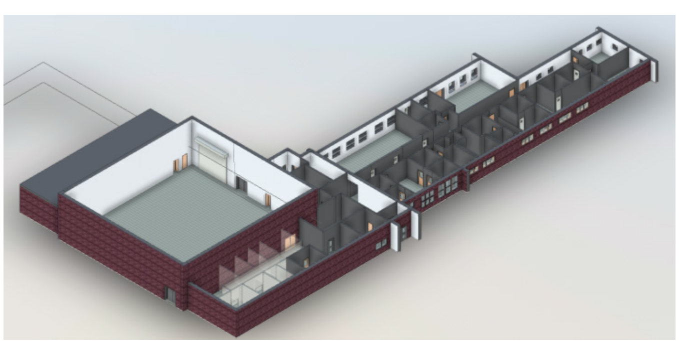
PROJECT MANAGER
Dr. Jess W. Everett, Dr. William Riddell
SPONSOR
NJ Army National Guard

Create 3D computer models of New Jersey Army National Guard buildings. Import data into AutoDesk ReCap and create the 3D Building Information Models (BIM) in AutoDesk Revit. Help Rowan provide NJARNG with comprehensive facility models. Learning the Scan-to-BIM technique and BIM software provides useful skills for a future career in the architecture/engineering/construction industry.



Co-Hydrothermal Liquefaction of Brewery and Sewage Wastes for Biofuel Production

TEAM MEMBERS
Jason Russack, Luke Molnar, Matthew Pacewicz, Jenna Sperduto, Matthew Price, Shane Flanzbaum, Robert Snyder
PROJECT MANAGER
Oluwayinka Adedeji, Dr. Sarah Bauer

Currently, the primary sources of energy worldwide are nonrenewable fossil fuels. The demand for renewable energy continues to increase as the earth's population increases and nonrenewable resource reserves diminish. "Waste to energy" conversion processes have become a point of interest that centers around processing waste for reuse as fuel. One such process is Hydrothermal Liquefaction (HTL). It is a technology that converts wet wastes into biofuel. Co-Hydrothermal Liquefaction (co-HTL), the combination of two or more feedstocks for HTL processing, is utilized to optimize oil quantity yield and energy output, especially from the deficient feedstock portion. Specifically, this study evaluated the co-Hydrothermal Liquefaction of sewage sludge and brewery waste to document possible synergistic effects between these feedstocks as regards product distribution, product yield, energy content, and chemical composition. Brewery trub and return activated sludge were co-liquefied at ratios 100/0, 75/25, 50/50, 25/75, and 0/100. The raw feedstocks were characterized before the liquefaction experiment while the co-HTL products were characterized after. At the end of the experiment, the optimal ratio of co-liquefaction for energy output was determined to be the 50/50 ratio. The results of this study represent a favorable method for the simultaneous conversion of both sewage sludge and beverage waste into bioenergy products.

Cold Temperature Eeffects On Reinforced Concrete Structural Behavior

TEAM MEMBERS
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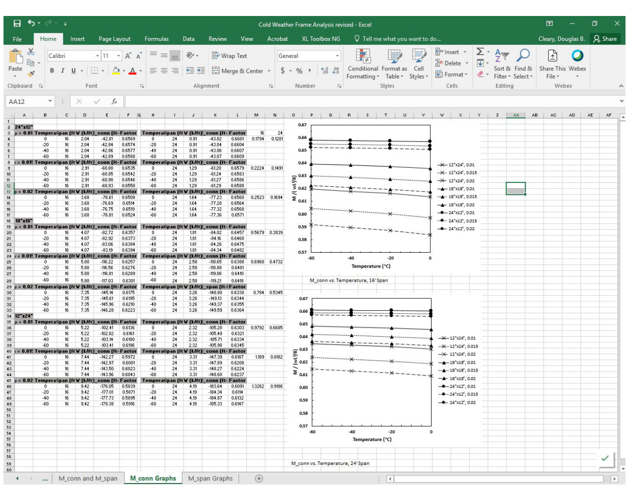
PROJECT MANAGER
Dr. Doug Cleary, Dr. William Riddell
SPONSOR
Cold Regions Research and Engineering Laboratory



The design and construction of reinforced concrete structures in the arctic is of increased interest. Concrete and steel properties change as temperatures drop below freezing. Change in concrete properties such as compressive and tensile strengths and elastic modulus can be large. The changes in steel properties are smaller over this temperature range, but could still be important. These changes in properties due to arctic temperatures will impact the structural behavior of reinforced concrete elements as well as frames. In this study, representative elements of reinforced concrete frames are analyzed to determine how changes in element stiffness over a range of temperatures influences moment demand in frame elements based on variations in material properties with temperature that are reported in the literature. The temperature-affected strengths and stiffness of these elements were incorporated into a simple, analytical frame model to assess the impact of reduced temperature on frame behavior. In particular, the changes in demand on elements and connections for service load conditions as the temperature decreases is evaluated.

Concrete Shrinkage Cracking

TEAM MEMBERS
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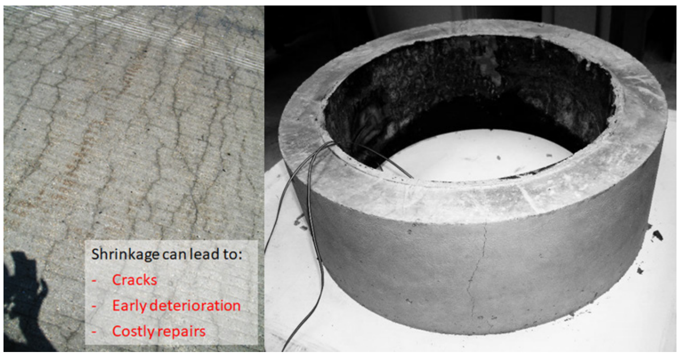
PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Doug Cleary, Dr. Cheng Zhu, Seth Wagner
SPONSOR
New Jersey Department of Transportation



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 New Jersey transportation infrastructure by reducing the concrete shrinkage and cracking potential, which will prevent the ingress of water and other deleterious substances into the concrete. Fifteen high-performance concrete mixtures' autogenous shrinkage, drying shrinkage, and restrained shrinkage cracking were measured. Concrete mixtures with high shrinkage and cracking potential are being 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. Recommendations will be provided for the control of shrinkage cracking to the sponsor.

Developing Hands-On Activities for WaterMOBILE

TEAM MEMBERS
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PROJECT MANAGER
Dr. Jeong Eun Ahn, Dr. Sarah Bauer
SPONSOR
US Environmental Protection Agency

"With a constantly growing population, and limited resources, engineers around the world are required to come up with new and innovative solutions in response. Employment in water resources is expected to skyrocket as society continues to grow out of its pre-existing infrastructure, and will soon be in dire need of a new wave of young engineers. Water resources engineering is a broad field with many focuses within public and private sectors including, drinking and wastewater treatment, and building and sustainability design. Through exposing young students to this field of engineering opportunities, the likelihood of growing into aspiring engineers increases significantly.

WaterMobile is a portable learning experience focused on outreach to K-12 students. This has three focus areas of water: Forces of Water, Water Pollution, and Water Treatment. In providing hands-on labs and curriculum following the New Jersey Student Learning Standards (NJSLS), educators across New Jersey can download learning materials from the WaterMobile website, and integrate these lessons into their daily instruction. The experiments provided are entirely comprehensive, as no prior knowledge or experience is needed to perform. Similarly, WaterMobile aims to be affordable to all school districts, and families who wish to conduct these experiments for at-home instruction."

Geotechnical Game

TEAM MEMBERS
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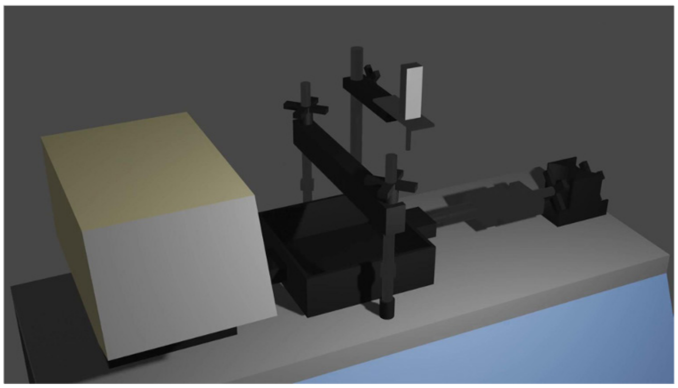
PROJECT MANAGER
Dr. Cheng Zhu, Ying Tang, Chenchen Huang

This project aims to develop mixed reality games for geotechnical engineering education. Clinic students work in groups to develop VR and AR games to provide real-world geotechnical design experience to junior and senior CEE students.



Identify the Distracted Drivers in New Jersey

TEAM MEMBERS
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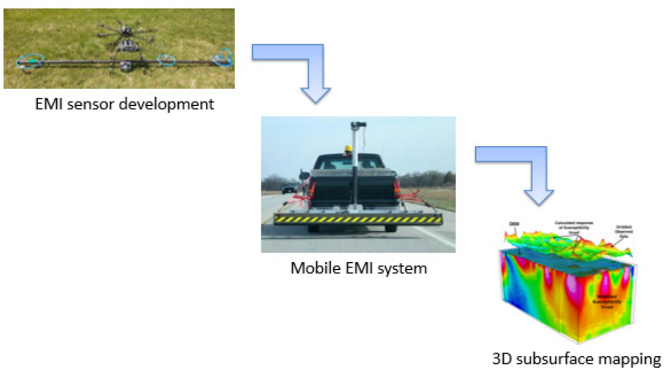
PROJECT MANAGER
Dr. Mohammad Jalayer
SPONSOR
NJ Department of Highway Traffic Safety

Cell phone distraction is an emerging traffic safety concern in the United States, which is often held responsible for severe traffic crashes. Texting and receiving phone calls during driving is restricted in various states. Even after having awareness campaigns to minimize cell phone crashes, the behavioral pattern of people did not change much. Hence, various techniques to monitor driver behavior was introduced in transportation safety. In this study, we used two novel methods to identify distracted drivers in the state of New Jersey, including the dash camera method and floating car method, an innovative, flexible, and dynamic technique to collect the data for distracted drivers. In this method, a test driver drove through the highways with an equipped vehicle supplemented with cameras mounted around it. The videos were preprocessed and fed to various pre-trained deep learning algorithms (Convolutional Neural Networks) for the detection of the driver's distraction. The model accuracy and loss rate would optimize the convolution layers and components of the model. The results obtained from this study will further help state and local agencies promote awareness about cell phone distractions in New Jersey.

iFrost Mapper

TEAM MEMBERS
Flynt Tuller, Ryan Eno, Michael Barrasso, Jacob King, Lauren Mulvihill, Thai Ho, Matt Fernandes
PROJECT MANAGER
Dr. Cheng Zhu, Dr. John Schmalzel, Rui Liu



"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 electro-magnetic 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."

Improving Pedestrian and Bike Safety in NJ

TEAM MEMBERS
Anthony Mackin, Nicolas Zugaib, Alexander Salazar, William Bright
PROJECT MANAGER
Dr. Mohammad Jalayer
SPONSOR
NJ Department of Transportation

According to the Federal Highway Administration (FHWA), in 2020, more than 50% of fatal and injury crashes occurred at or near the intersection. In addition, millions of minor crashes and conflicts are not reported every year due to their lower level of intensity. This increase in the crash fatality rate and unidentified traffic conflicts have raised concerns for the safety of road users at the intersection. The main objective of this study is to develop an innovative artificial intelligence (AI)-based video analytic tool to assess intersection safety using surrogate safety measures (SSM). Non-compliance behaviors, such as red-light running and pedestrian jaywalking, were also captured to better understand the risky behaviors at intersections. Thereafter, the SSMs, including Post-Encroachment Time (PET) and Time to Collision (TTC), were calculated using the trajectory data. Afterward, an extreme value (EV) model was developed to integrate SSMs as the traffic conflicts for crash frequency estimation.

Increasing resilience of New Jersey by utilizing trending technologies

TEAM MEMBERS
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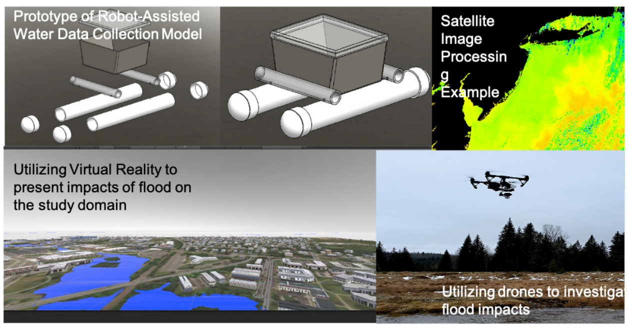
PROJECT MANAGER
Dr. Jeong Eun Ahn



Parts of New Jersey are susceptible to floods due to the effects of climate change, land-use changes, etc. This clinic team has worked toward increasing the resilience of New Jersey using trending technologies. Virtual reality is used to provide the showcase of flood impacts for a better understanding of flood threats. This study has focused on Triad Apartments on Rowan Campus since this area is susceptible to flooding. Using virtual reality, simulated flood impacts can be viewed via Oculus. Using satellite imaging, the impacts of storms like hurricane Ida can be investigated. Data for satellite images were collected from USGS and imported into SeaDAS to be analyzed. Similarly, drones are utilized to investigate the impacts of flooding on the local scale. This clinic team has worked to process the collected drone data of NJ regions for the creation of flood maps. Besides, the robot team works with robotics to address water sustainability. This research has developed a small remotely operated watercraft capable of traversing small bodies of water and collecting data on water quality using attached sensors. This can be used to address or prevent harmful events such as algal blooms.

Instructional Lab Videos for Civil Engineering Majors

TEAM MEMBERS
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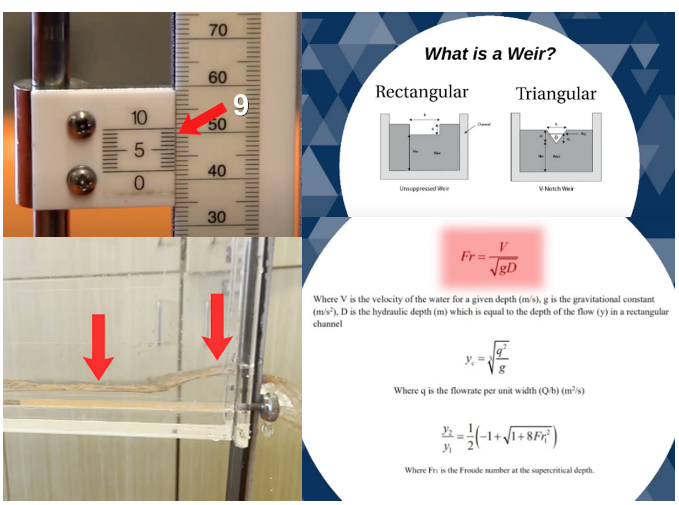
PROJECT MANAGER
Dr. Jagadish Torlapati, Dr. Jeong Eun Ahn



The goal of this clinic was to create and improve upon instructional lab videos to help students understand how to perform the lab experiments done in class, while also providing a conceptual understanding of topics critical to the labs. In the fall semester, instructional videos were made for the Fluid Mechanics course, while videos for Water Resources Engineering were made in the spring semester. The conceptual portion of each video was created in Prezi and narrated over for in-depth explanations. The instructional lab demonstrations were recorded with the use of iPhones and the footage was edited together using Vegas Pro software. Typical edits added to the instructional footage include zooms, subtitles, and visual aids such as arrows and diagrams. The combination of these conceptual overviews with highly-edited instructional demos allow students to come to labs prepared with the knowledge required to successfully complete the experiments.

Investigating Water Movements and Quality of Barnegat Bay

TEAM MEMBERS
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Kyla Rollo, Katherine Villacis, Boramy Virya,
Sydney Wright
PROJECT MANAGER
Dr. Jeong Eun Ahn
SPONSOR
Armand Corps.

Floods are a concerning natural hazard that have continuously caused harm to human lives and property. Climate change has caused frequent, stronger floods and hurricanes. The Jersey Shore is susceptible to floods and the effects of climate change, as experienced by Superstorm Sandy and Hurricane Ida. To increase climate resilience for these coastal communities, this study developed a two-dimensional hydrodynamic model for one of the most vulnerable areas in New Jersey - Barnegat Bay. The model has been developed by utilizing ADvanced CIRCulation (ADCIRC), which calculates water elevations and velocities. To improve simulation accuracy, a data bank was developed, which incorporates water elevations, velocities, and other parameters collected by USGS, NOAA, and NJDEP stations at Barnegat Bay. The simulation results of this model for August, 2012 were compared to the collected and predicted governmental data to validate and calibrate the model. The model will be employed to investigate water flows and predict future coastal flooding events with the impacts of sea-level rise and extreme weather events. To investigate water quality of Barnegat Bay, Watershed Modeling System (WMS) and CE-QUAL-W2 are used to simulate water flows and display what will occur if chemicals are dispersed at points along the stream.

Laboratory Evaluation of Fiber Reinforced Asphalt Mix

TEAM MEMBERS
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Dr. Yusuf Mehta, Dr. Harsh Pandya,
Ali Raza Khan
SPONSOR
U.S. Department of Defense -
Army Corp of Engineers

This study was commenced to evaluate the impact of fiber types and binder types on the volumetric properties and laboratory performance of fiber-reinforced asphalt mixtures (FRAMs). One asphalt mixture (Control) and four fiber types (Fiberglass, Basalt, Carbon, and Polyolefin/Aramid [PFA]) were used to evaluate the impact of fiber types, with two different types of binders (PG 58-28, and PG 76-22). Volumetric properties were determined for different types of fibers using two types of binders. Several asphalt mixtures were subjected to different laboratory performance tests such as Dynamic Complex Modulus (DCM), Cantabro Durability, Asphalt Pavement Analyzer (APA), Flow Number (FN), and Indirect Tensile Asphalt Cracking Test (IDEAL-CT) to evaluate the impact of fiber types with two types of binders. The performance of fiber-reinforced asphalt mixtures was compared with control mixtures. Results showed that fibers affected the volumetric properties, mix durability, and rutting resistance of FRAMs. It was also found that the dispersion of fibers into the mix affected the consistency of FRAMs samples. Overall, the results of this study showed that all fiber types enhanced the mix characteristics and durability of asphalt mixtures. The use of PFA fiber improved the rutting performance of asphalt mixtures.

NJDMAVA Energy and Water Use Audits

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Jonathan Gerges, Margot Hansen,
Josh Mauchly, Sarah Morgan, Aaron Nunn, Liam O'Brien, Jack Peterson, Brandon Reyes, Charles Rudderow, Jordan Schuller,
Alexander Suarez, Theodard Tassembedo, Bryson Townsend, Brianna Wietecha,
Jason Muermann
PROJECT MANAGER
L.N. Blackburn, William Johnson,
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Dr. Robert Krchnavek, Dr. William Riddell,
Dr. Jess Everett
SPONSOR
NJ Department of Military and Veteran Affairs

Student teams have performed 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 studied 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, candidate measures to reduce energy and water use, as well as opportunities to generate clean energy on site through solar power were identified. The models for energy and water use were then used to evaluate each candidate measure for potential savings, C02 emission reduction, and return on investment. These recommendations help NJ DMAVA to operate their facilities in an efficient manner.

NJDMAVA Sustainable Facilities Management

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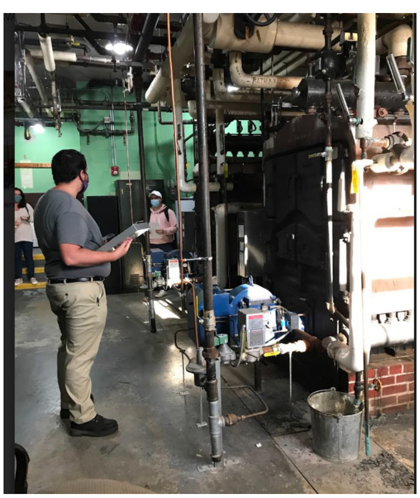
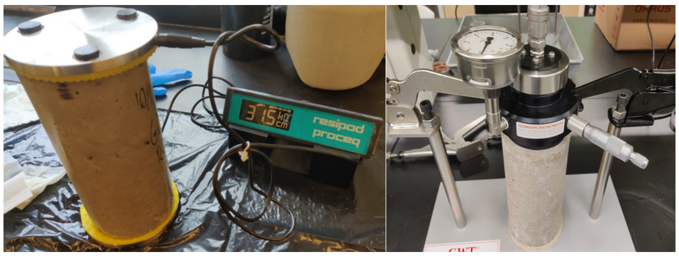
Anthony Freglette, Kyle Peterson, William Holloway, Keith Evans, Teresa Sroczynski, Meghan Sparks
PROJECT MANAGER
Dr. Jess Everett, Dr. William Riddell
SPONSOR
NJ Department of Military and Veteran Affairs



Students help 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 Facility Dude CMMS and USACE's BUILDER SMS software to optimize maintenance and repair. They use their education and experience to help NJARNG and NJDMAVA maintain mission readiness by creating planned maintenance recommendations for building systems and equipment that can extend the service life of NJDMAVA assets and assist with repair vs. replace decisions. Planned maintenance recommendations involve building structural, HVAC, plumbing, fire protection and/or electrical systems as well as various building equipment.

Permeability of Concrete

TEAM MEMBERS
Anthony Altomonte, Anthony Freglette, Joseph Kayal, Garrett Kerr
PROJECT MANAGER
Dr. Gilson Lomboy, Ariel Aragoncillo



Several studies found a strong correlation between the electrical resistivity of concrete and the other concrete permeation properties, such as water permeability and rapid chloride penetrability. However, most of these comparisons used conventional concrete in which dense natural aggregates were used. This research measures the permeation properties of concrete with porous course aggregates, particularly lightweight aggregate and recycled concrete aggregate. The concrete properties obtained are the electrical resistivity (AASHTO TP 95 and AASHTO TP 119) and the other permeability tests: rapid chloride ion permeability (ASTM C1202) , sorptivity/rate of absorption of water (ASTM C1585), and the Germann Water Permeability test (GWT). In the end, the evaluation of different permeation properties of porous aggregate concrete based on the electrical resistivity measurements will be developed, along with understanding how the concrete void structure influence the measurement. Establishing the correlations between the electrical resistivity and other permeation properties of porous aggregate concretes may result in faster and easier durability testing.

Real-Time Intersection Safety Monitoring

TEAM MEMBERS
Averi Leadbeater, John McAvey, Jennifer Carson, Thomas Vadeika, John McCleery, Adam Cuevas
PROJECT MANAGER
Dr. Mohammad Jalayer
SPONSOR
US Department of Transportation

Identification of conflict and behavior of road users have been considered as key aspects for the evaluation of roadway safety. This project works on an innovative artificial intelligence-based video analytic tool to evaluate the surrogate safety measures and non-compliance behaviors of road users at intersections. Surrogate safety measure is an extensively used method for recognizing future threats that may arise due to the conflict of all road users. Non-compliance behaviors such as red-light running and pedestrian jaywalking are calculated to better understand the violation rate at an intersection. For safety analysis, surrogate safety measures such as Post-encroachment Time (PET) was employed to assess the vehicle to vehicle and vehicle to pedestrian conflicts. The results demonstrated that the developed tool would provide valuable information for policymakers to employ effective countermeasures to enhance intersection safety.

Recycled Concrete Aggregates

TEAM MEMBERS
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PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Doug Cleary, Dr. Shahriar Abubakri
SPONSOR
Cold Regions Research and Engineering Laboratory (CRREL), U.S. Army Engineer Research and Development Center (ERDC)

The supplies of concrete aggregates from natural sources are rapidly depleting. An alternative to natural aggregate is Recycled Concrete Aggregates (RCA) that can be produced by crushing the concrete obtained from demolished concrete structures. There is great interest in using crushed concrete to supplement and replace virgin aggregates because aggregates from natural sources are rapidly depleting. This project aims to provide guidance for classifying and producing recycled concrete aggregates based on the crushed concrete or parent concrete properties. It also studies mitigation measures from unfavorable effects of using RCA, if present. Six concrete mixtures were selected based on virgin aggregate and water-to-cement ratio to be crushed and graded into aggregates, which made twelve RCA types. Six types of RCAs were also acquired from commercial recyclers for the study. Concrete strength and flexural properties of concrete with 100% RCA are being tested, along with the aggregate properties. The concrete durability properties obtained are resistance to alkali-silica reactivity, resistivity test, density, absorption, and voids in hardened concrete.

SWEET (Society of Women Engineers: Engineers in Training) Workshop Development

TEAM MEMBERS
Deborah Baran, John Pineda, Jordan Schuller, Dylan Torrance, Matthew Walter
PROJECT MANAGER
Dr. Sarah Bauer, Dr. Cheng Zhu
SPONSOR
Engineering Information Foundation (EiF), PSEG Nuclear, LLC

The purpose of this clinic is to develop exciting and intuitive experiments for middle school students to perform and to educate them on engineering. The purpose of these projects is to introduce students to engineering concepts and the design process. Within this clinic, four experiments were selected and were fully developed throughout the semester, namely Water Filtration, Maglev Trains, Catapults, and Parachutes. Materials were selected and instructions were created for each project. Kits were made for each student, and contained the materials for the two projects for each workshop, one in March and one in May. Kits were mailed to the students for the virtual March workshop, and the students are coming to Rowan for the in-person May workshop. Clinic students work with members of Rowan’s SWE chapter on how to conduct the experiments with the participating students and help teach them the necessary definitions, concepts, and methods used in engineering design. The goal of these projects is to educate the students on engineering and to spark a passion within them to pursue an engineering degree in their future.

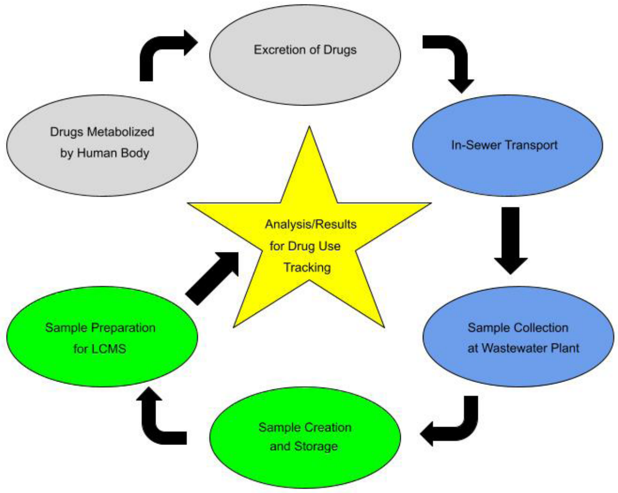
The Scholar Bridge

TEAM MEMBERS
Jake Bohn, Jackie Charlton, Stephen Ciarletta, Bill Gantz, Bridget Guinan, William Karaces, Jessica Rosales, David Spell, Juan Vera-Bedolla
PROJECT MANAGER
Dr. Adriana Trias-Blanco

The objective of this clinic project is to build physical models of bridge structures that will be used for research data validation and as hands-on learning tools for civil engineering undergraduate courses. This project will focus on the design of multifunctional bridge physical models, that will provide tangible integration of research projects and academic experiences. The models will be design for three main structural engineering courses: (a) Structural Analysis, (b) Steel Design, and (c) Structural Dynamics. For this, the models will be equipped with strain gauges, potentiometers, and accelerometers depending on the learning objective.

Tracking Opioid Consumption Using Wastewater Based Epidemiology

TEAM MEMBERS
Liron Derguti, Nasir Brown, John Hayes, Brandon Jones, Thomas Julian, Lucas Stroud
PROJECT MANAGER
Dr. Sarah Bauer
SPONSOR
Camden Health Research Initiatives



The addiction of opioids has become a nationwide public health crisis as of recent years, with overall usage and overdose rates increasing every year. A main issue of the opioid crisis is the lack of real time data pertaining to consumption and overdose rates of opioids in a community. A prevalent area of opioid use in New Jersey is Camden City, which qualifies the location as a target area of study for this project. This project aims to produce real time results on opioid consumption in Camden City using the method of Wastewater Based Epidemiology (WBE) to target remaining drug analytes found in wastewater after consumption. Wastewater samples were collected from the influent of the wastewater treatment plant everyday for one week each month. Samples were prepared using vacuum filtration and solid phase extraction (SPE) process. In SPE, samples were eluted using methanol to concentrate the analyte of interests. Liquid Chromatography Mass Spectrometry (LCMS) is a technique that was used to detect the residual chemical compounds of drug analytes in the collected samples and determine the drug consumption rate. The results will be used to develop state and federal prevention programs to eradicate the opioid crisis.

Warm Mix Additives for Cold Climate

TEAM MEMBERS
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Evelyn Rodriguez, Sadia Rawsan,
Brandon Carmosino, Deborah Onibuore,
Meghan Sparks, Boramy Virya, Anthony Carr
PROJECT MANAGER
Dr. Yusuf Mehta, Dr. Sk Faisal Kabir,
Abdelrahman Ali
SPONSOR
US Department of Defense

This project was conducted to show how different warm mix asphalt additives (WMA) affect the performance of the asphalt at lowered production temperatures in colder regions. Original binder PG 58-28 and PG 76-28 were used along with the additives to modify and conduct this study. The undergrad research plan was split into two parts; the first was to analyze the rheological properties of the binder both pre-and-post additive, and the second was to examine the effects that the additives have on the volumetrics as well as the performance of the asphalt mix. A gyratory compactor was used to compact and measure the volumetrics of the prepared samples. In Fall 2021 the study focused on air voids percentage present in the samples at different compaction temperatures. Adding the WMA additives showed a compactibility for the PG58-28 binders at temperatures as low as 180F passing the New Hampshire standard of 3-5.5% air voids. In the Spring 2022 Semester, the study is focused on performance testing of these prepared samples as well as on precise measuring of low temperature cracking using an Asphalt Binder Cracking Device (ABCD). So far, this research reinforced the idea that WMAs help to compact more easily at lowered compaction temperatures while keeping the air voids within the range.

Waste Plastics to Improve Binder properties for Cold Weather

TEAM MEMBERS
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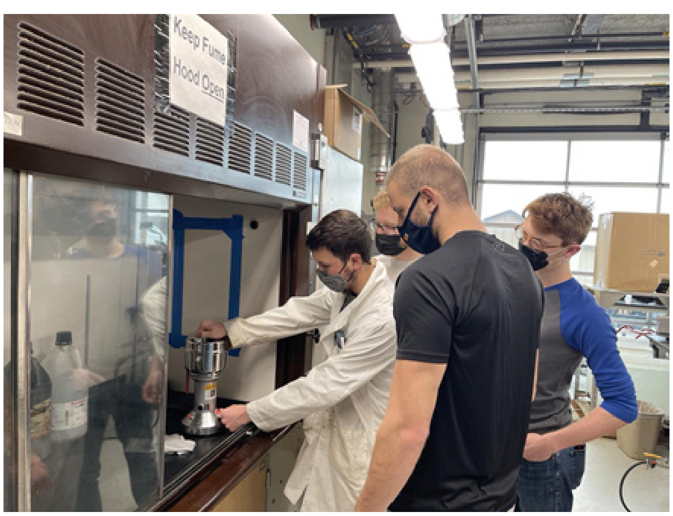
John Meale, Garrett Kerr, Christian Jones
PROJECT MANAGER
Dr. Yusuf Mehta, Dr. Sk Faisal Kabir,
Venkatsushanth Revelli
SPONSOR
US Department of Defense



This study was conducted with the goal of evaluating asphalt binder with plastic modifiers to establish plastic compatibility with asphalt binder and improve cracking resistance. Polypropylene (PP), high-density polyethylene (HDPE), low-density polyethylene (LDPE), polystyrene (PS), and polyethylene terephthalate (PET) are all the plastics that were considered with a base binder of PG 58-28. Preliminary tests such as Fourier-Transform Infrared Spectroscopy (FTIR) and Differential Scanning Calorimetry (DSC) were employed to verify the plastic and determine the melting points of each plastic sample. As the first step of compatibilizing, these waste plastics were separated depending upon their melting point, and PE and PET were selected for the wet mixing method as modified binder preparation. All modified binders were prepared at different dosages for testing purposes. A treatment cycle on the plastics along with the usage of a few compatibilizers was also have been identified to improve the workability of the plastic during mixing. Moving on with the experimental plan the study is split into two phases, compatibility tests, and binder tests. To test the compatibility of the modified binder the Cigar Tube test was employed, so far using Cigar Tube testing phase separation of LDPE, HDPE and PET have been performed with plans to continue with Cigar Tube testing for the remaining modifiers.

WaterWorks: Structural/Geotechnical Engineering

TEAM MEMBERS
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Tyler Mericle, Lisa Bianco, Jacob Christy
PROJECT MANAGER
Dr. Adriana Trias-Blanco, Dr. Cheng Zhu
SPONSOR
US Environmental Protection Agency (USEPA)

Liquefaction simulation of the potential behavior of buildings during an earthquake.

Concrete tank in water treatment plant / Water storage concrete tank.

The overall objective of WaterWorks is to provide capacity to students to explore various career opportunities within the water workforce. Particularly, the Structural/Geotechnical Engineering project focuses on the development of hands-on activities for high-school students to learn how geotechnical and structural engineering play an important role in water infrastructure. The activities developed during this clinic project will be part of the WaterMOBILE section of WaterWorks, which will be implemented in the City of Camden, New Jersey. The activities, concerning geotechnical engineering, developed on this clinic provide knowledge for understanding liquefaction under different scenarios and soil conditions. While the activities that involve structural engineering, are oriented towards understanding the importance of the structural behavior of concrete water tanks and different aspects that affect their structural integrity.

ELECTRICAL & COMPUTER ENGINEERING

Campus Renewable Energy Potential

TEAM MEMBERS
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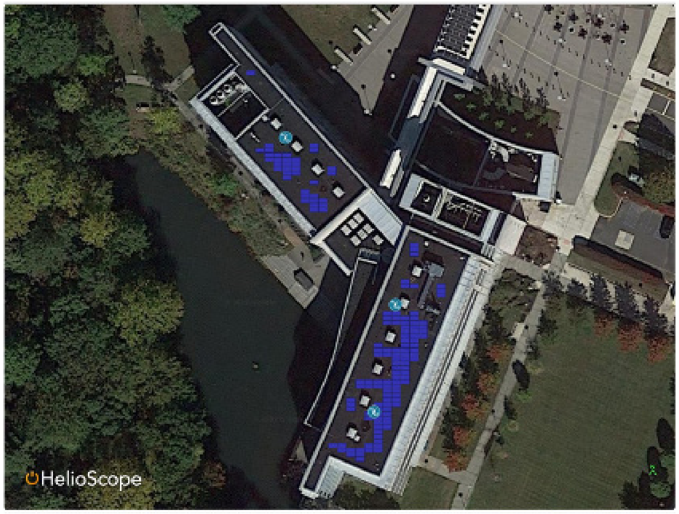
PROJECT MANAGER
Dr. Jie Li



This project aims to explore the renewable energy potential in Rowan Campus, specifically the energy potential from solar Photovoltaic (PV) systems. The project team will investigate and develop metrics to encapsulate the economic and environmental potential of rooftop solar PV systems for each campus building. Professional PV system planning software Helioscope is utilized to conduct detailed PV system deployment analysis based on each Campus building's rooftop conditions including area, tilt angle, shading, etc., to provide monthly and annual energy production estimations. A visualization tool is developed to provide a flexible system design options for different input configurations and illustrate the system layout and outputs. Furthermore, HOMER Pro software is utilized to analyze the impact of increasing renewable penetration into the Campus power grid based upon current campus load and generation capacities. Students involved in this project will get familiar with basics of PV system technical, economics, environmental benefits, as well as gain a better understanding of the impact of renewables on existing power grid.

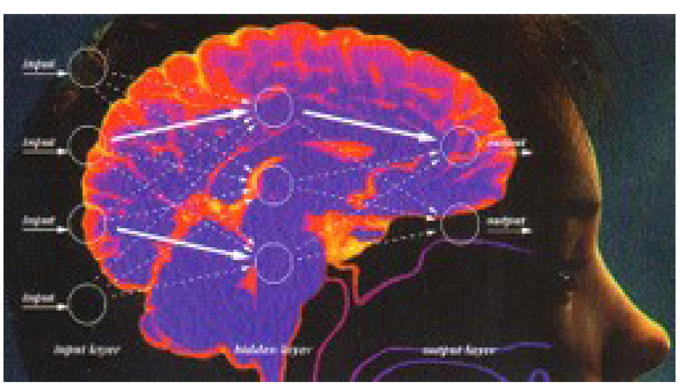
Documenting Injustice: Forensic VR: The Warsaw Ghetto & Holocaust 1939 - 1941

TEAM MEMBERS
Jack Bonham, Donte' Carter, Isabel Dory, Eimeria Duller, Yael Garcia, Delano Hendrix, Diana Lahr, Harley Modestowicz, Sydney Pender, Nathan Pyles, Abagael Riley, Nicholas Rochino, Hayley Schuster, Alexandra Tatem, Allison West, Britney Williams, Garrett Williams, Qi Xi
PROJECT MANAGER
Amanda Almon, Dr. Jody Manning, Dr. George Lecakes

The team has focused on digitally reconstructing various Virtual Reality interactive scenes and spaces of the Warsaw Ghetto with the goal of teaching recognition of injustice through learning about propaganda and the historical reality behind it. Work for this project is highly interdisciplinary, allowing the clinic team to develop a wide range of skills. The team demonstrated development of 3D assets that combined research in history, sociology, visualization-art (graphics production and design), coding and education. As Holocaust education has not fully adapted to the ways present generations learn most effectively about history and injustice, a multidisciplinary team has been tasked to combat this with the creation of a vital new form of historical education in virtual reality (VR). This clinic will have a Study Abroad component during the upcoming winter session in 2023 that will be an intensive exploration of sites, archives, and spaces related to the Holocaust with special attention given not only to Warsaw but to possible future sites, projects, and cooperation with international educational institutions. Holocaust studies and digital humanities remain vital for students, who can apply this understanding of trauma and hardship to many sensitive real-world issues that are happening today.

Early Diagnosis of Alzheimer's Disease Using the Clock Drawing Test

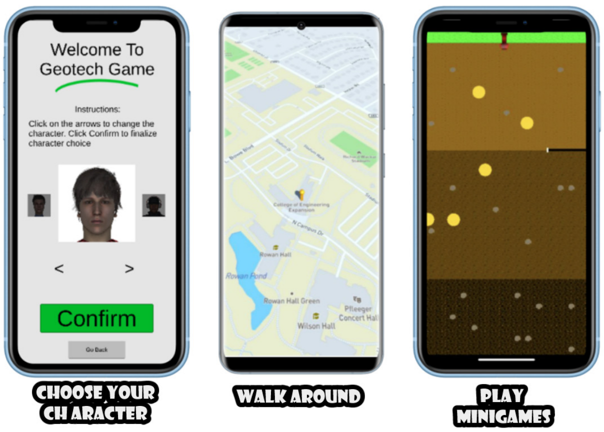
TEAM MEMBERS
Matthew Owen, Vincent Del Tufo, Parker Hopkins
PROJECT MANAGER
Dr. Robi Polikar



Several neurological disorders, such as Alzheimer's disease (AD) are common among the elderly, with no definitive mechanism for differential diagnosis and no cure. The most common approach for diagnosis uses a series of neuropsychological tests evaluated by neurologists. Misdiagnosis is not uncommon, and the decision is often subjective. Machine learning may help with an automated and objective diagnosis of various diseases. In this project, we analyze vast amounts of data collected through such neuropsychological tests, primarily the unique clock-drawing test that has been shown to generate relevant predictors of cognitive decline. This test alone generates hundreds of such features, however, and it is not clear which ones are most informative or relevant. Our primary goal is to determine features that are most relevant to diagnosis, and develop appropriate machine learning algorithms to obtain a diagnostic accuracy that is as good or better than current state of the art. This project is in collaboration with Rowan Univ. School of Osteopathic Medicine - New Jersey Institute for Successful Aging.

GeoTech - Mixed Reality Game Development

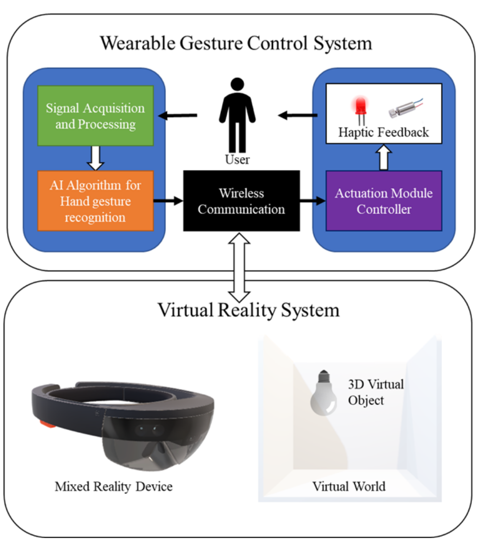
TEAM MEMBERS
Tyler Ziesse, Conor Peterson,
Sha'Lynn Clarke, Long Chau, Jordan Lees,
Ezekielle Duller
PROJECT MANAGER
Dr. Tang
SPONSOR
National Science Foundation



Our fully-integrated mixed reality game focuses on improving student education in the context of geotechnical engineering through a "Pokemon Go" like mobile application. This project allows users to play as a character that walks around the map using their phone's location to collect tools and play mini games. These mini games will educate the user on geotechnical topics that will lead to the main laboratory simulation. For example, we adapt a Digdug-like mini game which will introduce properties of soil at different layers. With the necessary tools and basic understanding, the game will lead the player to the first laboratory - a Thermal Conductivity Test. This work allows students to participate in online learning in a more inclusive way while playing a game. By providing students visualization, collaboration, and simulation, we hope to promote problem-solving and improved learning.

Gesture Control in Mixed Reality

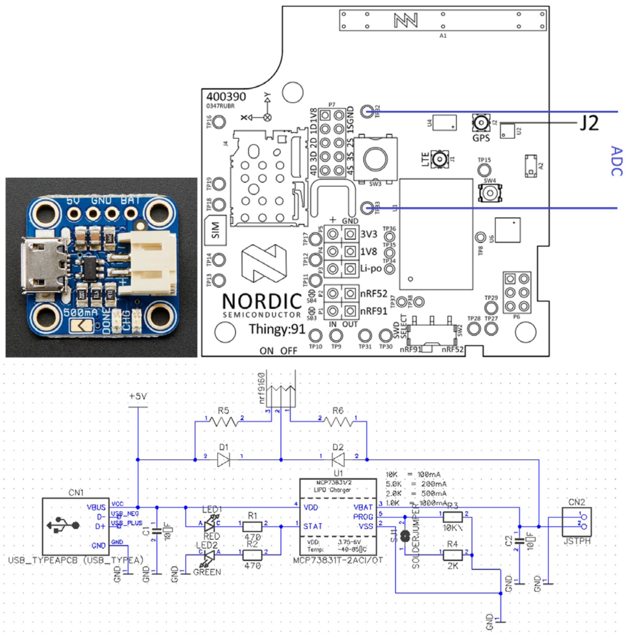
TEAM MEMBERS
Aakash Tripathi, Tyler Baer, Hunter Ford,
Nicholas Lardieri, Eric Bucikowski,
Ali Elhamawi
PROJECT MANAGER
Dr. Ghulam Rasool
SPONSOR
NJ Health Foundation



We are developing technologies to allow users to interact with virtual reality systems seamlessly. We can understand electrical impulses sent by our brains and translate them into actions in the virtual world by using AI. Simultaneously, we can give users haptic feedback, which will provide the users with a sense of touch, making the experience more realistic. This technology has many potential applications, including virtual reality education, gaming, and training. Especially in fields such as medicine, it could be used to provide realistic simulations of surgeries or medical procedures that can be practiced repeatedly without any real-world consequences.

Hurricane Ida: Grid Resiliency Solutions

TEAM MEMBERS
James Burns, Julia Curry, Margot Hansen
PROJECT MANAGER
Dr. Jie Li, Dr. John Schmazel



"Hurricanes, tropical storms and tornados are becoming more frequent and stronger due to global warming. Solutions are in urgent need to be developed to decrease the effects these and other natural disasters have on electric power supply. This project aims to design and implement a lightweight device in support of the emergency management of critical power supply for medical equipments relying on continuous electricity service. Currently in the US there are over 2.7 million individuals who rely on electrically powered medical equipment, with 2,137 people in Gloucester county around the campus. Currently when the power goes out, the only options are to wait or make them to a hospital, which introduce high cost and long waiting time. The proposed device will plug into an outlet to detect whether the outlet has power or not, and when wall power goes out, the device will instantaneously switch to internal battery mode, and maintain the communication with Emergency Management offices and utilities to optimally coordinate the critical power supply and medical support."

Personalized Instruction in a Virtual Educational Game

TEAM MEMBERS
Long Chau, Sha'Lynn Clarke, Ryan Hare, Jordan Lees, Conor Peterson
PROJECT MANAGER
Dr. Ying Tang
SPONSOR
National Science Foundation

As education continues to expand, both in outreach and in content, so too does the need for automated systems that can augment a student's educational process. This work focuses on developing an adaptive tutoring system inside of a virtual game. Our virtual game, called Gridlock, allows students to explore a virtual environment and design a traffic light logic controller to help them learn digital system design. The in-game tutoring system evaluates a student's performance based on their in-game actions and uses machine learning to provide appropriate support. The game system also captures a student's emotional state through webcam images and machine learning. This semester's work focuses on improving the existing in-game systems and making the game more usable and more fun for students, while further developing the AI methods.

Turret Gunner Threats Simulation in VR

TEAM MEMBERS
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PROJECT MANAGER
Dr. Shreekanth Mandayam, Dr. George Lecakes, Amanda Almon
SPONSOR
US Army - Picatinny Arsenal

Our project team was tasked with implementing a Joint Light Tactical Vehicle (JLTV) inside a VR simulation to assess the JLTV’s turret effectiveness against current and future combat scenarios. Particular focus is placed on drone warfare, as their usage includes but is not limited to: scouting enemy positions, swarms presenting a combat threat, and carrying supply payloads. Machine learning analysis tools are in development to better assess the safety and effectiveness of the vehicle in combat situations, as well as present potential drone threats to the simulation’s trainees. The Unity Engine is used alongside the HTC Vive for the VR simulation, with the ultimate goal being a demonstration within the Rowan VR Center’s 10-sided CAVE system. Alongside the HTC Vive, an application of hardware sensors in the real world will integrate with the simulation to allow for training scenarios to exist beyond an open space, laboratory setting that currently exists in most VR training environments. This simulation will allow for the training of soldiers for usage of emerging technologies against new threats.

VR Head Up Display for Helicopter

TEAM MEMBERS
Christian Garcia, Mark Diorio, Brian Hunt, Andrew Aweeky, Robert Foerst, Jacob King, Thomas Basile, Ardit Pranvoku, Grant Morfitt
PROJECT MANAGER
Dr. Shreekanth Mandayam
SPONSOR
Federal Aviation Administration

The VR Head-Up Display for Helicopters is a collaborative project between Rowan University and the FAA Aviation Research Division. The project utilizes augmented reality to increase spatial awareness, safety, and efficiency for rotorcraft pilots through the use of a head-up display (HUD). The HUD is deployed through the Microsoft HoloLens 2 to simulate aircraft avionics with virtual gauges to aid the user. The HUD was developed in the Unity engine and tested using the X-Plane Flight Simulator. Models of important helipads and surrounding architecture were created and added to the X-Plane flight simulator to enhance realism in the virtual environment. The HUD is highly customizable and can have information added, removed, or altered at the request of the user. Multiple declutter modes are available to adjust how much information is on the screen at once. The goal of the HUD is to place valuable information in the field of view. This enables the pilot to maintain situational awareness without having to look away from their windshield and at their dashboard.

WaterPAL: Android App Development

TEAM MEMBERS
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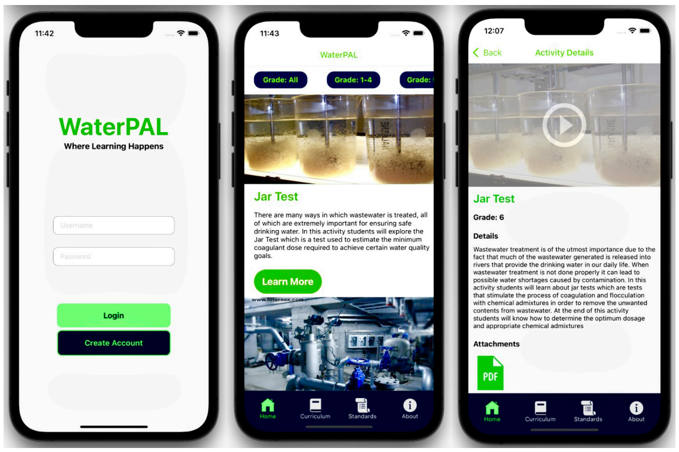
PROJECT MANAGER
Dr. Ying (Gina) Tang, Ryan Hare
SPONSOR
U.S. Environmental Protection Agency



This project aims to develop a mobile application called WaterPAL that will energize students and teachers to learn about the water and wastewater workforce. WaterPAL will facilitate the implementation of interactive hands-on activities that are mapped to local curriculum standards. Educators will be able to navigate to modules that correspond to core curriculum content that includes videos, lab exercises, and instructional material. Students will be able to use WaterPAL to engage in exciting games that will allow them to select an avatar for a water worker (i.e. pipefitters, construction laborers, pipelayers, managers, hazardous waste removal workers, meter readers, machinery mechanics, engineers, lawyers, etc). Upon selection, they will spend a day in the life of this water worker to learn about the roles and responsibilities related to the position. In these games, students will also learn about topics such as pumps and pipes, water treatment, and water pollution. Ultimately, this app will allow students to learn that these utilities require a broad range of skill sets and levels of education. Furthermore, through WaterPAL our team hopes to expose and prepare young students for potential careers in something as important as water and wastewater utilities.

What’s in Your Genome?

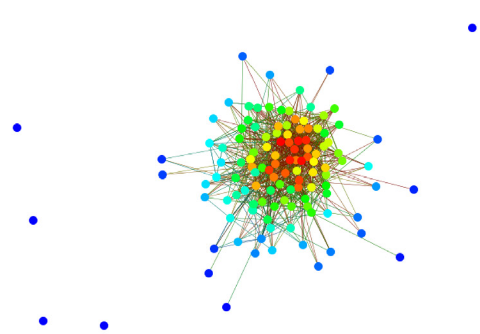
TEAM MEMBERS
Adriana Fasino, Zechary Heras, Emrecan Özdoğan
PROJECT MANAGER
Dr. Robi Polikar
SPONSOR
National Science Foundation

Some estimates put microbial cells to outnumber human cells, meaning you are really less than half-human. The community of these microbial cells determines much of your health, and we know so little about it. Metagenomics is involved in the analysis of environmental samples that contains many organisms, whose identity and function are often unknown. Hence, metagenomics is interested in the analysis and classification of metagenomic data to determine what microbial organisms are in a given environment (such as your gut), and what they are doing there. The problem, however, is that this is a huge, unlabeled, unsupervised, incremental clustering problem of epic proportions. We explore computationally efficient, incremental and continual machine learning algorithms for the analysis of metagenomic data. Conventional classifiers are usually trained on a large reference database, which needs to be updated every time new data become available. That retraining is often done from scratch, using the entire, newly expanded database, even though only a few new genomes may have been added since the last update. Such an indiscriminate update process - as opposed to an incremental and selective one - is computationally unsustainable with the exponential growth of databases. Hence, we are working on developing an incremental, semi-supervised approach that can also characterize previously unknown new genomic sequences.

EXPERIENTIAL ENGINEERING EDUCATION

Senior Mechanical Engineering Students' Social Connectedness

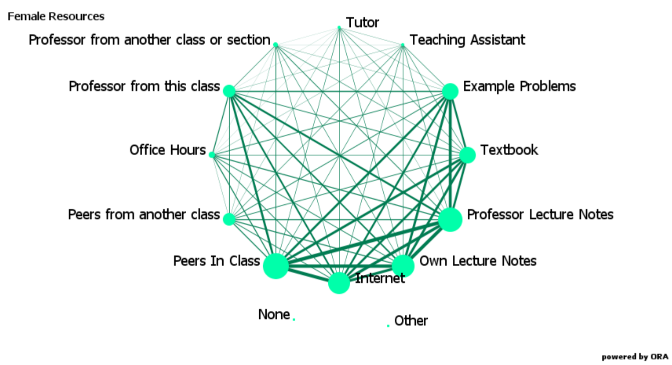
TEAM MEMBERS
Jacqueline Giordano, Jared Markunas, Olivia Mason, Bryce Pruitt, Michael Vena
PROJECT MANAGER
Dr. Kaitlin Mallouk, Darby Riley



The formation of strong social networks in college is closely related to student performance in coursework. This research study aims to answer the questions 1) how does a mechanical engineering student's first-year living situation affect their social connectedness within their major/year? and 2) do engineering students tend to work with other students of the same gender or the opposite? Participants completed a survey in which they were asked to identify who they know from a pre-populated list of senior mechanical engineering students, as well as provide demographic and other details, such as whether they were in the Engineering Learning Community (ELC). The results showed that students who lived in the ELC during their first year were in each other's social networks through senior year, suggesting that the ELC is beneficial for helping students connect and stay connected to their peers. The gender-based results suggested that male students' social networks are predominantly made up of males, while female students' networks have a higher fraction of females. This lack of diversity in the average mechanical engineering male student's social network could have negative consequences for their engineering design performance. As such, male students should be encouraged to meaningfully connect with students of other genders during their college career.

Student Resource Networks: Use of Faculty and Office Hours

TEAM MEMBERS
Hannah Corbin, Grace Culley, Christian Jones, Nolan Pickett, Jacob Willetts
PROJECT MANAGER
Dr. Kaitlin Mallouk, Darby Riley



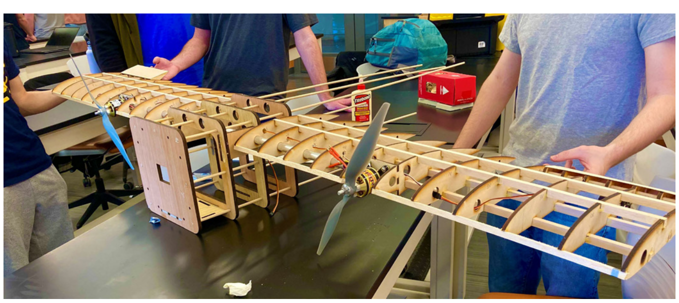
“When attending college, students have access to a variety of resources that are available to set them up for academic success. Despite these available resources, it is ultimately the decision of the student to utilize what they are given. In this research study, we dive deeper to understand how students use their faculty as a resource and the impact of student-faculty relationship on students’ use of faculty office hours. More specifically, we seek to address the following research questions: (1) How does a student’s perception of their relationship with their faculty influence how they use faculty as a resource? and (2) What resources do students use when they need academic help?

As a part of this study, 58 students from Rowan University’s College of Engineering completed a survey about their engagement with their professor and the resources they typically use while completing assignments for that class. We used network analysis software to help visualize the connection between what resources are being used most frequently. By understanding how students prioritize and utilize their academic resources and how students’ relationship with their faculty affect this resource usage, we can begin to make recommendations for students and faculty regarding relationship building, impactful resources, and structuring in-person help to ensure students are achieving the learning outcomes of their coursework.”

MECHANICAL ENGINEERING

AIAA Design/Build/Fly

TEAM MEMBERS
Ethan Adair, Robert Blecha Jr., Brian Clemens, Gerardo Cortes, Asia Cunningham, Thomas DiMario, Zachary Hearon, Anthony Luciano, Rebecca Michnowski, John Mollo, Thomas Mroczkowski, Jaxon Quigley, Dylan Sica, Mikhlid Alzubi, David Motley, Ryan Oliver, Maxwell Rebstock, Nick Steel, Joshua Sparks, Gianna Figueroa, Biran Csillag, Ethan Segal, Vincent Astarita
PROJECT MANAGER
Dr. Ratan Jha
SPONSOR
Rowan AIAA Club



"The goal of this project was to design, construct, and test an aircraft worthy of flight. This year, the team had to design around three different missions that would test the abilities of the plane. The first mission was to fly three laps around a set course within five minutes, the second mission was to carry as much cargo as possible while flying three laps, and the last mission required the plane to fly a lap, land, deploy shock-sensitive cargo, and repeat. Due to the nature of the missions, the design of this year's plane took inspiration from cargo aircraft such as the C-130 and C-5. Throughout the semester the team had to design for and optimize many parameters such as aerodynamics, weight, cost, structures, and power. Rowan's 2021-2022 AIAA Design, Build, Fly team consisted of 23 mechanical and electrical engineers divided into five teams: Fuselage, Wing, Empennage, Propulsion/Electronics, and Special Mission. In addition, there were also specialty roles including overall project manager, material acquisition manager, and the pilot. Once constructed, the plane had to undergo many different tests including ground tests, cargo tests, and flight tests. Overall, this project allowed the team to apply knowledge learned in their classes in a large team-based environment."

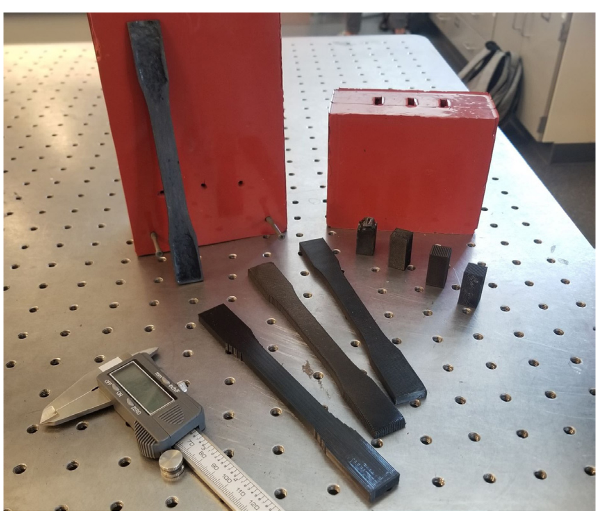
Beach Stabilization

TEAM MEMBERS
Nicholas Burd, Victoria Collinsworth, Anthony Garavento, Michael Mertz, Ali Mujahid, Nicholas Rossi, Gillian Volpe
PROJECT MANAGER
Smitesh Bakrania
SPONSOR
Dr. Michael Coates

Beach erosion is a problem that continues to impact our coastline communities. Current mitigation strategies can be financially and energetically costly. Alternatives that can use existing materials with limited impact to the environment can be very attractive. The project's ultimate goal was to stabilize beach sands from erosion and protect existing dune structures; using cohesive blocks of sand to resist the erosion and form a base for natural dune flora. The project began with a literature review of existing methods and potential alternatives. The team identified a promising method to bind local beach sand together, to form inert blocks, using common, cheap, metasilicates solutions which are transformed into polymeric silicon dioxides during the binding process. The team also conducted financial analysis of this alternative approach and compared it to existing mitigation strategies. The team carried out experiments to determine the combination of chemical processing methods to bind sand samples. Systematic tests were conducted to determine the maximum load the samples can withstand before crumbling. Furthermore, chemical treatments were studied to determine the moisture resistance of the samples prepared. This work has the potential to generate a novel beach stabilization approach that is not only inexpensive but also adheres to the environmental standards.

Characterization of 3D printed parts

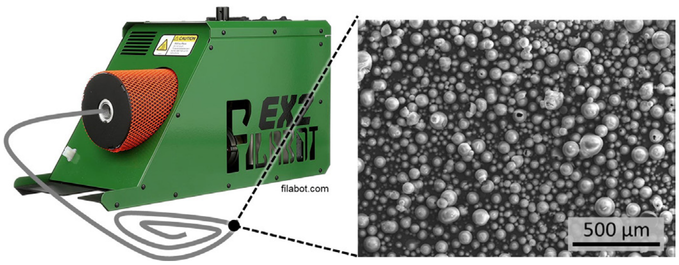
TEAM MEMBERS
Samuel Caulley, Garrett Kleinknecht, Ian Meighan, Ryan Nicol, Ralph Vanaman, Sean Wilson,
PROJECT MANAGER
Dr. Behrad Koohbor, Dr. Chen Shen
SPONSOR
Parts Life, Inc.



The goal of this externally sponsored clinic project was to explore the possibility of using metal 3D printed as an alternative for cast and forged parts for certain parts relevant to applications sought by the US Air Force. The clinic started by developing an understanding of the effect of rastering angle on the mechanical behavior of 3D printed plastic prototypes. Efforts were made to develop simple mathematical expressions that correlate build/rastering angle with tensile and compressive responses of 3D printed parts. Later, the team attempted to develop plastic prototypes of the parts supplied by the external sponsor and perform mechanical testing to identify the deformation and failure 'hotspots'. The knowledge acquired in the first phase of the project is utilized to propose an optimized rastering process for the fabrication of 3D printed parts.

Custom 3D Printing Filaments and Composites Micromechanics

TEAM MEMBERS
Daniel Corrigan, Joseph Kenney,
Daniel Nerbetski
PROJECT MANAGER
Dr. Behrad Koohbor, Nicholas Pagliocca



The fundamental idea in this clinic project was to develop functionalized 3D printing filaments by re-extruding commercially available PLA filaments. To this end, the clinic started by setting up a commercial filament extrusion instrument. Neat PLA filament spools were purchased, chopped into smaller pieces, and fed into the extruder along with various fillers. The fillers included but were not limited to ceramic microballoons, added to reduce weight and control the porosity of the PLA filaments. The re-extruded custom filaments were used in a regular 3D printer to fabricate lightweight polymer structures with added functionalities, such as improved impact energy absorption capacity. These structures were then characterized using various micromechanics approaches, including a table-top test frame developed by previous Mechanical Engineering clinic students. Micromechanics tests were supplemented by multiscale image-based deformation analyses facilitated by digital image correlation (DIC).

Density Graded Foams and Cellular solids

TEAM MEMBERS
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Christopher Morehead, Kyle Phillips,
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PROJECT MANAGER
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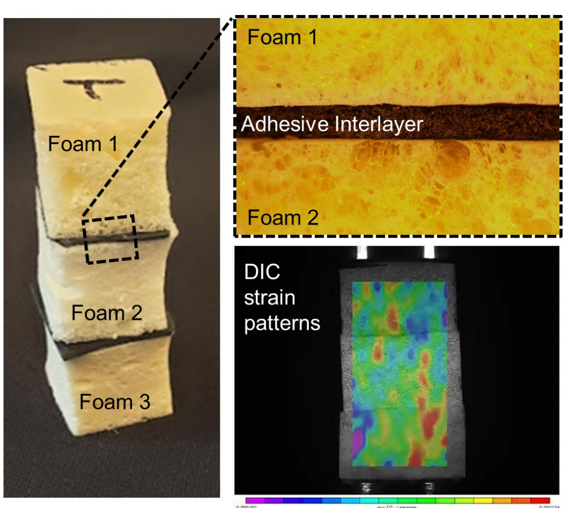
SPONSOR
National Science Foundation



Graded cellular solids are structures created from several individual lightweight, architected layers, with each layer serving a specific purpose. In density-graded structures, the main goal is to stack layers with different densities to improve both load-bearing and impact energy absorption characteristics of the structure while keeping the overall weight at a minimum. The main objectives of this clinic were to design, fabricate, and optimize the properties of novel graded cellular solids, including foams and 3D printed cellular structures, for various applications. The primary applications sought in this clinic were flexible honeycombs and graded foams for protective body pads. The clinic teams were able to successfully fabricate and test graded foam structures by using various adhesive interlayers and characterizing the strength and impact energy absorption characteristics of the density-graded structures by modeling and experimental validations. Digital image correlation (DIC) was extensively used to understand the local deformation patterns generated in cellular structures under load.

Design, Build, Test of Baja SAE Vehicle

TEAM MEMBERS
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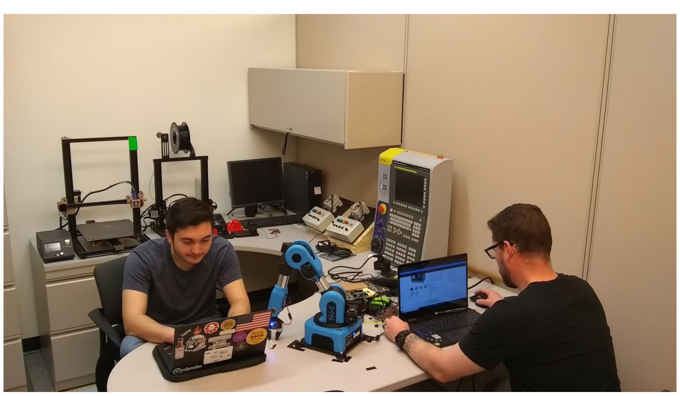
PROJECT MANAGER
Dr. Anu Osta

"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 2023 Baja Car began in the summer of 2021 with the goal of producing a lightweight car without sacrificing strength or reliability. The 2023 car will compete in the regional SAE Baja competitions in 2022 and 2023. 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."

Developing Educational Hands-on Modules

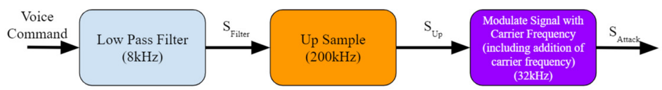
TEAM MEMBERS
Jonathan Gallinaro, Jacob Taylor
PROJECT MANAGER
Dr. Anu Osta
SPONSOR
Procter & Gamble

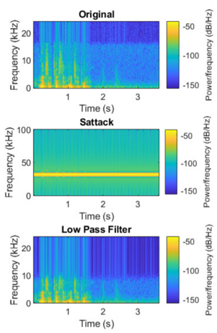


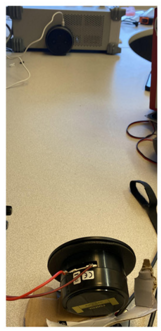
Students in this clinic developed in-class demonstration and laboratory modules. The modules were based on 3D printing, CNC, PLC controllers and Robotic equipment. They employed a combination of manufacturing processes for making the kit components, integrating them with off-the shelf electronics, along with using programming languages and computer CAD modelling. The lab modules served specifically the Advanced Manufacturing course. The objective was to enable the students taking the course to acquire hands-on skills in operating CNC machines, robotic manipulators, programming logic controllers, additive manufacturing equipment like SLA and FDM 3D printers.

Hacking an Amazon Echo

TEAM MEMBERS
Mark Butler, Evan Gould, Christopher Lentini, Joshua Lloyd, Casey Robinson
PROJECT MANAGER
Dr. Chen Shen



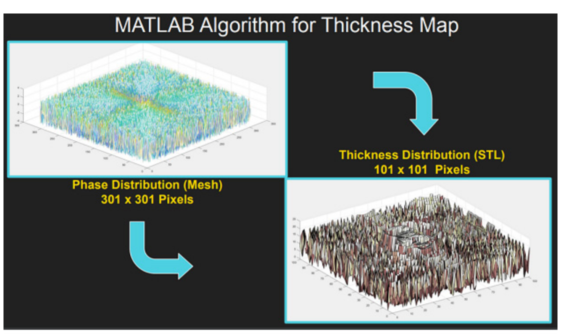


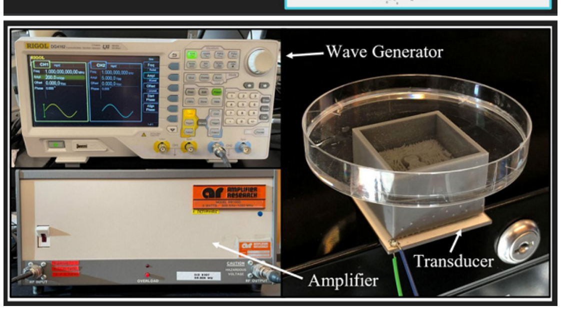


Smart speakers (Amazon Echo, Google Home, etc.) have become important in the contemporary society. In this project, a strategy to hack an Amazon Echo using inaudible signals is developed. The approach encodes normal voice command in an ultrasonic signal that is totally inaudible to human ears and can send commands to smart speakers in a silent manner. A setup with ultrasound speakers and other electrical components is designed and the inaudible attack is verified with a customized Matlab code. To defend such attacks, 3D printed filers are designed that can reject ultrasound waves while having no impact on normal audible waves. The concept is validated with a carefully designed 3D printed structure that is installed on the smart speakers. It effectively defends the inaudible attacks and does not interrupt normal commands. It shows that defending at the physical layer is possible and this approach does not need to alter the fundamental components of the microphones or the speakers. The filters are in the mm size and therefore are easy to be installed in the smart speakers.

Holographic particle patterning

TEAM MEMBERS
Edward De Asis, William McCusker, Valerie Molinari, Zachary Thistle
PROJECT MANAGER
Dr. Chen Shen





The goal of this project is to use a numerical algorithm that was developed over the past semesters to design an acoustic holographic lens that can generate a complex pressure distribution. The lens is 3D printed to have a certain thickness profile to interact with the actuator. An optimization process is adopted to improve the boundary conditions and other factors. The concept is experimentally verified with a platform built this semester, evidenced by a stable liquid surface profile. Particles and other small objects can be trapped at desired positions with desired shapes in water. The design as well as the setup could be used in a wide range of applications, including medical ultrasound that can generate focal points at certain distances and microparticle manipulation in biomedical applications for contact-free control of cell and bioparticles.

Jet Fuel Pollution Performance Rating

TEAM MEMBERS
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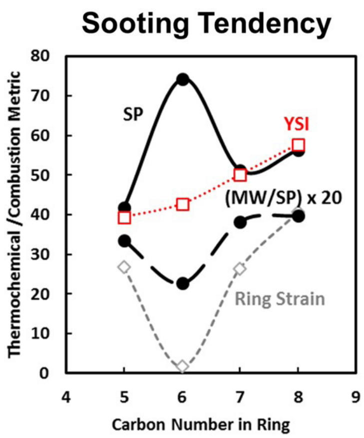
PROJECT MANAGER
Dr. Francis Haas



This Jet Fuel Pollution Performance Rating Clinic has been supporting research into the sooting tendencies of conventional and alternative aviation fuels. As the aviation industry moves towards decarbonization, there is potential to replace highly-sooting fractions of conventional jet fuel with bio-derived molecules that not only form less soot, but are also “green” in origin. This Clinic has measured the sooting tendency of some of these alternative jet fuels using the ASTM D1322 smoke point standard, which is essentially the worldwide standard for jet fuel sooting tendency. This method is based on a simple candle flame height measurement in a standardized wick-based burner, per the calibrated eye of a trained operator. Present efforts have been to aid the operator’s determination of the smoke point through inexpensive Raspberry Pi-based image capture. A database of images of flames above, below, and at the smoke point has been created for training of machine learning algorithms to assist the operator in determining when the flame has reached the smoke point.

Learning Analytics

TEAM MEMBERS
Meredith Baubles
PROJECT MANAGER
Dr. Smitesh Bakrania

Online teaching can lack the subtle cues from the students that instructors can gather when teaching in-person. However, there are aspects that an online instructor can gather that are rarely available when teaching in-person. During the pandemic, majority of the courses were taught remotely. With this transition to remote learning, a new resource of learning data was made available. This project utilized remote student data to analyze the learning outcomes for an Introduction to Thermal-Fluid Sciences (iTFS) course. Trends such as video length, video content, video completion, student engagement, assignment performance, student communication, etc. were analyzed to recognize strengths and weaknesses of the instruction. Strategies to mitigate the weakness were identified. The analysis was also used to predict student performance. Additionally, a survey was designed to understand how faculty use this information to improve their teaching effectiveness. Overall, when combined with in-person instruction, remote learning has the potential to enhance student engagement.

Light-weighting Industrial Storage Units

TEAM MEMBERS
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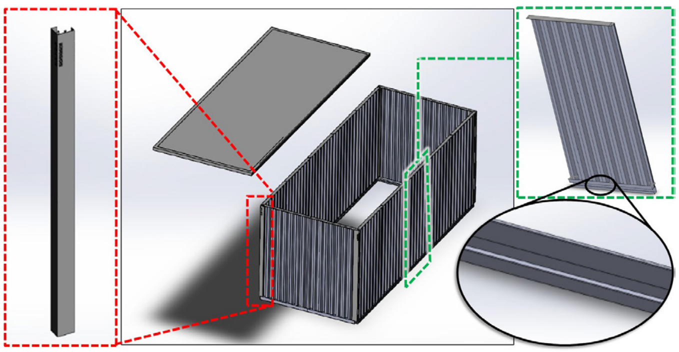
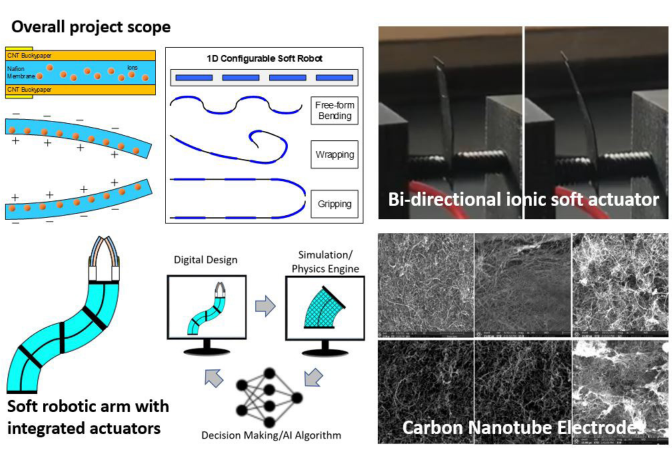
PROJECT MANAGER
Dr. Joseph Stanzione, Dr. Francis Haas, Dr. Behrad Koohbor
SPONSOR
Atlantic Trailer Leasing



The goal of this project was to develop an inexpensive, portable, easily deployable alternative to commercial storage containers. The clinic started with collecting information about Atlantic Trailer Leasing (customer) needs and identifying the overall goal/scope of the project. Among the customer's requirements for the new storage design were weight reduction, safety and security, fire and weather resistance, load-bearing capabilities, low cost, ventilation, lighting, ease of transportation, and assembly. The first clinic team was able to propose a base model that meets most of the aforementioned requirements and constraints. In the second semester, the new team was able to modify the existing designs and make them compatible with polymer-based storage units, create scaled-down prototypes by 3D printing, and explore various design options, e.g., side vs. end doors, locks, ventilation, etc.

Nature-Inspired Soft Robotics

TEAM MEMBERS
Ryan Kennedy, Nicholas Gushue, Luke Reilly, Maxwell Rutka, Dana Yarem, Jake Breyer, Thomas DeGroat
PROJECT MANAGER
Dr. Wei Xue, Dr. Mitja Trkov



Soft robotics, made of inherently soft materials and empowered with intelligent control logic, will be crucial in future engineering applications. Inspired by biological systems in nature, especially animals such as fish or worms, soft robots have highly flexible and deformable bodies. With actuators similar to human muscles, these robots can quickly adapt to the surrounding environment, change their shapes, apply compliant motions, and manipulate complex objects. In this project, the clinic team will investigate soft, flexible, and self-configurable robots. The team will (1) explore material options that are suited for actuation, (2) design, fabricate, and test soft actuators, (3) explore and implement control logics, and (4) develop a one-dimensional (1D) self-configurable soft robot that can achieve complex functions.

Polymer Composites for Navy Applications

TEAM MEMBERS
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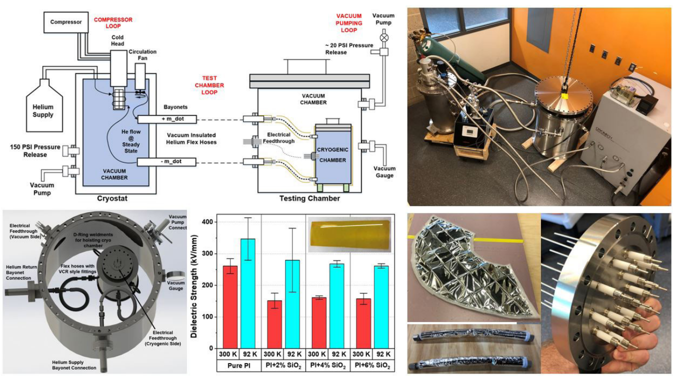
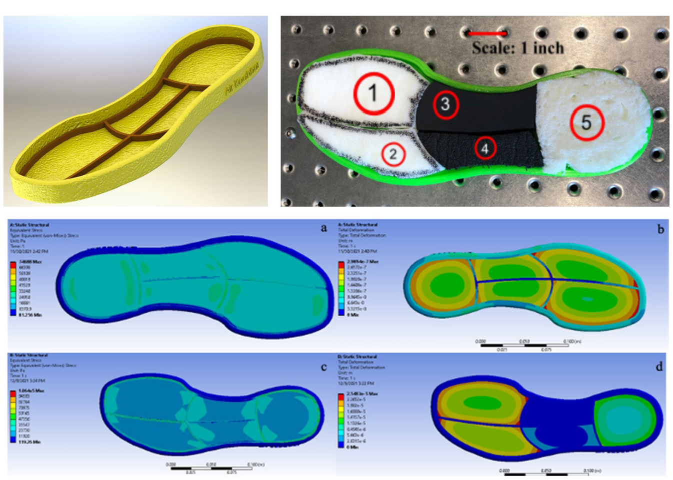
PROJECT MANAGER
Dr. Wei Xue, Dr. Robert Krchnavek, Dr. Joseph Stanzione
SPONSOR
Naval Surface Warfare Center Philadelphia Division, Naval Engineering Education Consortium



The primary objective of this clinic is to study the potential of nanocomposite materials as dielectrics in high-temperature superconducting (HTS) cables for the United States Navy. The material team aims to investigate polymer-silica nanocomposites as cryogenic dielectrics. The design team aims to design and build a cryogenic testing chamber that would allow material testing down to 40 K. The two teams are working together to provide detailed measurements of new nanocomposites. Using dielectric polymers as the host material, the behaviors of polymer/silica nanocomposites have been explored. The dielectric performance of the composites measured at room and cryogenic temperatures shows that the new materials are promising candidates for future cryogenic applications.

Property-Adjusted Shoe Soles

TEAM MEMBERS
Jacqueline Johnson, Nicholas Mennie, Jeffrey Stewart
PROJECT MANAGER
Dr. Behrad Koohbor, Nicholas Pagliocca
SPONSOR
New Jersey Health Foundation



The goal of this clinic project was to create a shoe midsole with tunable mechanical properties. A shoe outsole and respective model were designed using data from a foot pressure map and then 3D printed from thermoplastic polyurethane. The clinic team designed and created several sections to house materials inside the midsole, separated by a thin non-intrusive frame. Foams were considered in this work. The placement of different foam sections was determined based on their mechanical properties which were characterized in quasi-static compression. The midsoles designed and developed in this work aid people with foot pain that need better cushioning or support in certain areas. In addition, the design proposed and implemented in this clinic can be an alternative to expensive custom orthotics for athletic purposes. The future direction of this project will include the addition of force-sensitive resistors in each section of the prototype shoe frame. It is interesting to characterize how well the foams in each section react to the pressure of a foot, rather than a load in a compression test. Another plan to pursue is to scale the prototype up and then study the variation of stress distribution at the top and bottom of the midsole.

Rocket Propellant - Make & Test

TEAM MEMBERS
Emma Beyer, Ryan Johnson
PROJECT MANAGER
Dr. Francis Haas
SPONSOR
Army Research Lab

Propellant "putty" ignition at ~6000 fps

This clinic is developing tools and know-how for proposed research into energetic materials. Present efforts have focused on development of an inexpensive Arduino-based thrust stand for measuring rocket propellant performance with sub-millisecond resolution. This has been used to monitor thrust evolution in off-the-shelf and custom-built rocket motors. As shown here, high speed imaging has assisted in evaluation of motor ignition strategies for a base "rocket candy" motor blend. Static thrust measurements have been complemented with altitude measurements from model rocket test firings; together these measurements have enabled evaluation of different rocket candy chemical compositions and internal motor geometries.

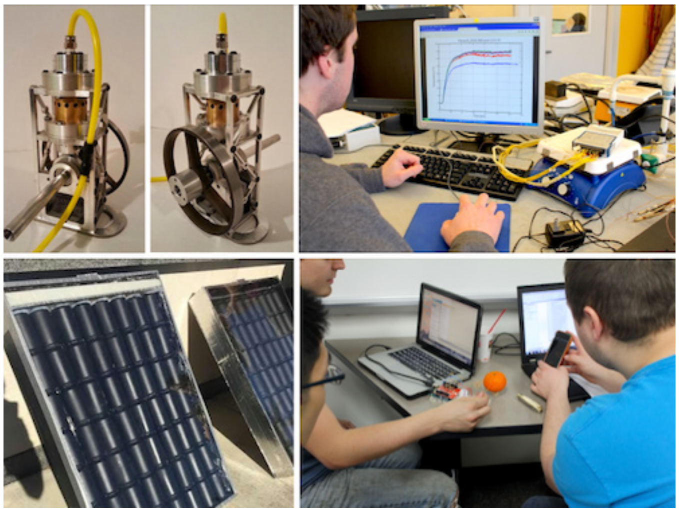
Testing and Tuning of SAE Baja Vehicle

TEAM MEMBERS
Andre Benson, Justin Elko, Nazar Kovch, Noah Pentlicki, Matthew Pilla, Robert Pinder, Mason Szeplaki, Kenneth Thomas
PROJECT MANAGER
Dr. Anu Osta

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 was designed and manufactured in compliance with the rules set out by the Society of Automotive Engineers as per the SAE BAJA collegiate design series. The Fall semester of 2021 was focused on the completing manufacturing and assembly of Rowan's first 4WD SAE BAJA vehicle, as per new requirements. A vehicle was successfully designed with an ideal top speed of 38 mph, torque of 350 lb-ft, weighing approximately 520 lbs. and featuring components with validated strength and ergonomics. The Spring semester exclusively focused on manufacturing and assembly. This will be the first year that Rowan has attempted a 4WD/AWD vehicle, and many deviations from the Rowan 'standard' procedure were taken in order to produce a successful vehicle.

TFS Projects

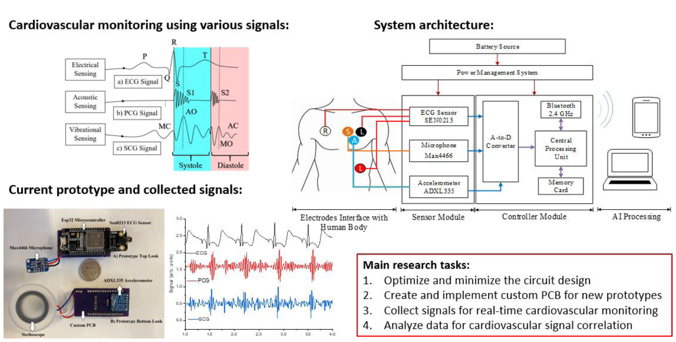
TEAM MEMBERS
Austin Metcalf, Alex Herrman, Jack Latham
PROJECT MANAGER
Dr. Smitesh Bakrania



Hands-on projects allow students to practice and apply their knowledge gained on building, testing, and analyzing a thermal-fluid system. The previous project required both time and resources to be administered that were no longer readily available. With a recent curricular change in the thermal-fluid science course series, there was a need for a hands-on design project that can be accommodated within the new reduced credit courses. The aim for this project was to identify potential projects that fit the new criteria by researching existing engineering educational resources. After a broad survey, a handful of projects were identified and researched for their fit to the courses. Next, three projects were developed for proof-of-concept and testing. Lab activities related to these projects were developed and instructional components documented. Additionally, a temperature monitoring tool was tested and prepared for lab activities in the future. The report documented several projects that can be incorporated in future thermal-fluid science courses.

Wearable Heart Health Monitors

TEAM MEMBERS
Brian Berry, Alexander Herrman
PROJECT MANAGER
Dr. Wei Xue, Dr. Francis Haas, Robert Hirsh, Dr. Ben Wu
SPONSOR
Camden Health Research Initiative



Cardiovascular diseases are the leading cause of death in the US. The current medical practice is not suitable for long-term, out-of-hospital use. This project aims to investigate a wearable heart monitor, which will provide sensing and learning abilities for detecting abnormal cardiac rhythms in real time. As part of collaboration between ME/ECE at Rowan University and Cooper University Hospital, the clinic team will (1) optimize and minimize the circuit design, (2) create and implement custom PCB for new prototypes, (3) collect signals for real-time cardiovascular monitoring, and (4) analyze data for cardiovascular signal correlation.

External Sponsor Index

External Sponsor Index, cont.

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