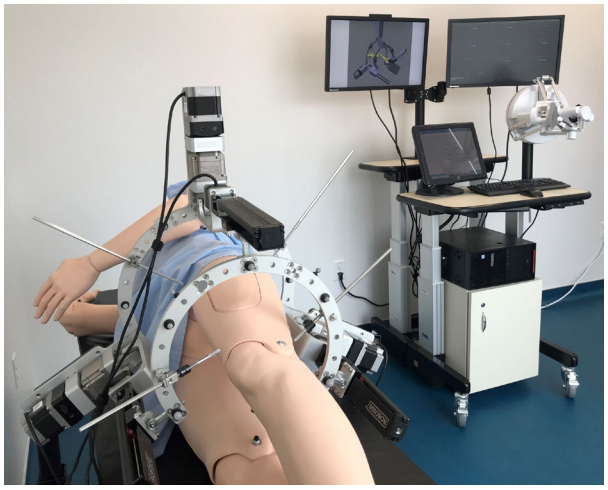
Rowan University

HENRY M. ROWAN COLLEGE OF ENGINEERING



2021 Clinic Showcase Book

TABLE OF CONTENTS

PREFACE

A hallmark of the Henry M. Rowan College of Engineering is the Engineering Clinic Program. Engineering clinics are an eight-semester sequence that thread through every students' course of study, emphasizing a "hands-on, minds-on" approach, empowering students with an entrepreneurial spirit toward developing engineering solutions.

The first-year and sophomore clinic experience emphasizes the art and science of design through an interdisciplinary approach, highlighting the integration of the fundamentals of engineering into problem solving, along with the evaluation and presentation of results. Through the junior and senior experiences, students work in small teams, under the guidance of faculty and external sponsors to integrate lessons learned from their coursework into solutions for open-ended engineering problems that exist in our world today.

This publication features the work of 139 clinic projects, involving over 600 students. While these results represent this year's specific clinic projects, when viewed more broadly, they represent the accomplishments of our students, faculty, mentors, and partners. Moreover, they illustrate the extraordinary resiliency, creativity, and dedication of our students, who overcame the extraordinary challenges associated with the COVID-19 pandemic. Our students worked to meet the needs of their communities, while pursuing rigorous academic study. These projects are a reflection of the quality 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 enjoy sharing them with you. For more information, or to become a part of the clinic program, please reach out to Associate Dean for External Affairs, Sean Fischer, fischers@rowan.edu or 856-256-5354.

Sincerely,

Dr. Stephanie Farrell
Interim Dean, Henry M. Rowan College of Engineering

INNOVATION AT ITS CORE

Our engineering programs train the students to apply engineering fundamentals to solve real-world problems. Junior and Senior Engineering Clinics allow our students to put those skills into practice. Students have a choice of directing their skills on a variety of projects. This way students can choose the path based on their interests and ambitions. Beyond the engineering fundamentals, the last two years of engineering clinics facilitate practice in professionalism, communication, project management, and team work. Therefore, these clinic projects represent the penultimate step for our students before their 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. This past year especially required them to innovate their approach. Students relied heavily on their computational and analytical skills to continue making progress over the Fall semester; eventually transitioning to on-the-ground efforts. Nevertheless, they made commendable progress, as captured in this booklet. 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.

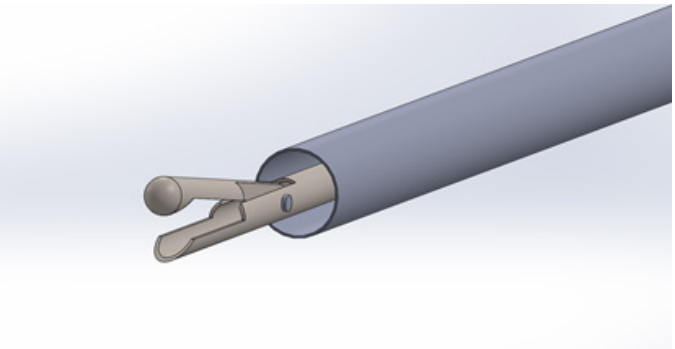
Sincerely,

Dr. Smitesh Bakrania
Junior and Senior Engineering Clinic Coordinator

BIOMEDICAL ENGINEERING

A Clinical Path to Cartilage Biopsy Procurement

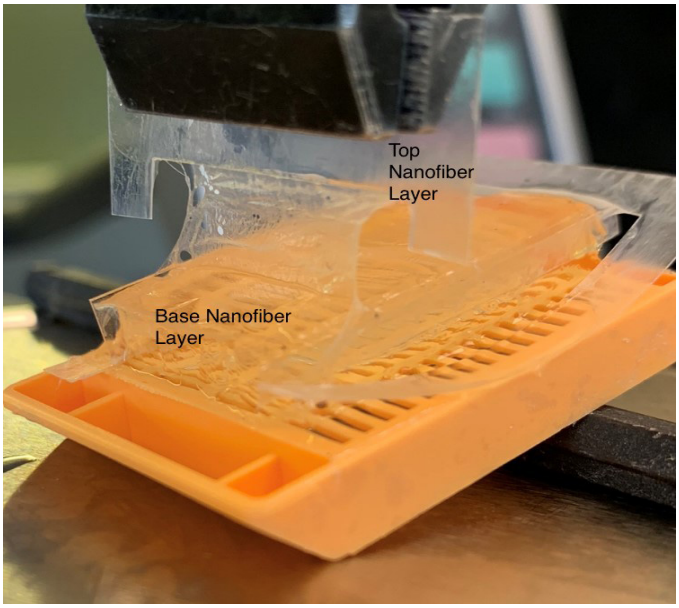
TEAM MEMBERS
Stephanie Fanok, Joseph Oteri, Hannah Bonelli, Austin Pharo, Autumn Alexis Lopez
PROJECT MANAGER
Dr. Mohammad Abedin-Nasab, Dr. Erik Brewer, Dr. Sean McMillan (Virtua Health), Angelo Patrinicola (Trice Medical), Al Intintoli (Trice Medical)
SPONSOR
Trice Medical



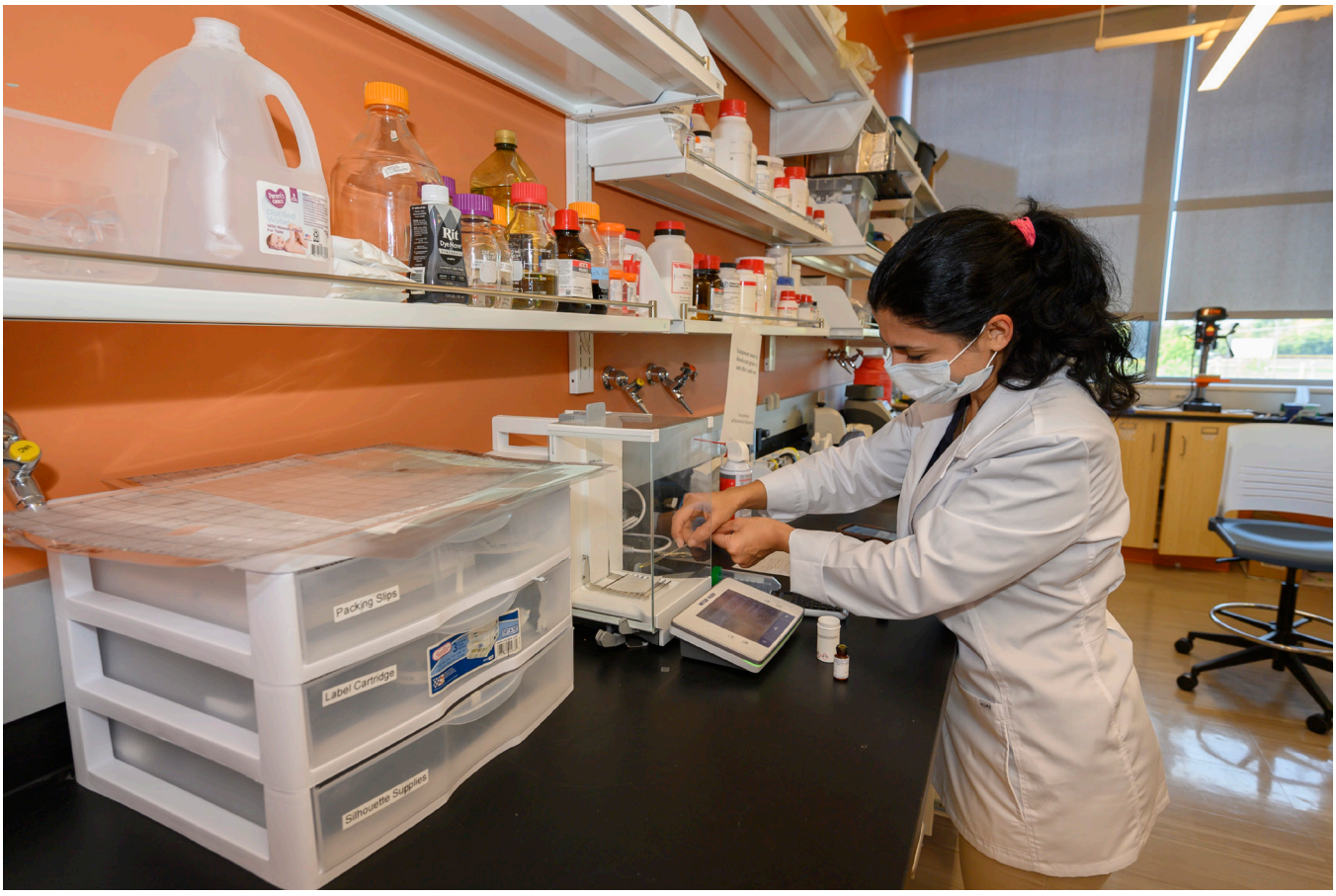
Damaged articular cartilage is a debilitating condition that causes pain and inflammation in the knee and limits the range of motion, affecting up to 66% of patients undergoing arthroscopy of the knee. This results in over 200,000 surgical procedures in nearly 900,000 Americans every year. As an alternative to total knee replacement, many younger patients are recommended to receive the Matrix-Induced Autologous Chondrocyte Implant (MACI) procedure. The MACI requires a 200-mg cartilage sample to be harvested, regrown, and implanted through two invasive surgeries. The nature of the biopsy procurement procedure poses risks and deters patients from returning for the second surgery to implant regenerated cartilage. A team of undergraduate students, industry partners at Trice Medical, and an orthopedic surgeon aim to eliminate the need for a surgical biopsy by creating a minimally invasive, clinical cartilage biopsy device capable of harvesting cartilage from the condylar surfaces of the knee, eliminating one of the invasive surgeries. The device includes a sharpened lower gouge and a herringbone upper jaw grasper enclosed by an outer sheath. These components allow for cutting and retrieving of a cartilage biopsy through a single portal in the knee, making the procurement an in-office procedure.

Adhesion Testing of Additive Hydrogel Nanofiber Scaffolds

TEAM MEMBERS
Keith Vantuono, Kassandra Dobson,
Dana Van Fossen
PROJECT MANAGER
Dr. Vince Beachley

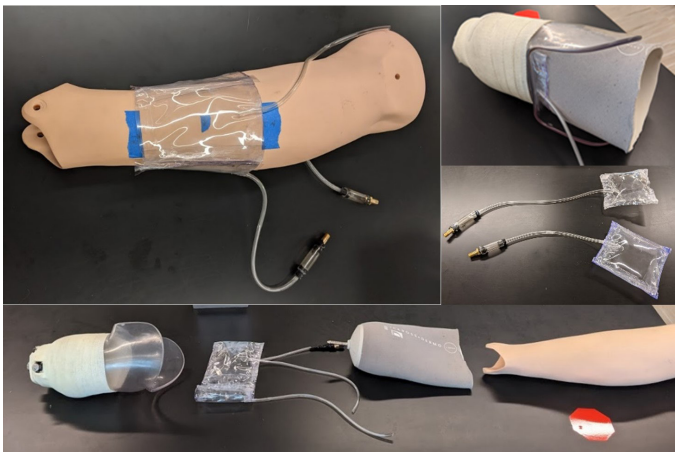


Hydrogel nanofiber engineering is one of many approaches used to assemble tissue scaffolds in tissue engineering. In this project, tissue scaffolds for nerve grafts are synthesized from electrospun nanofibers coated in a hydrogel. A scaffold is then constructed using an additive assembly technique of 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.



Air-Fit Prosthetic Sleeve addressing Residual Limb Volume Change

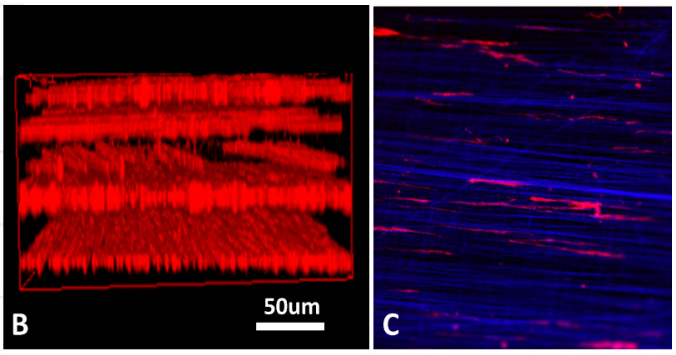
TEAM MEMBERS
John DesRochers, Nicholas Sancilio, Daniel Ball, Anthony Boyko, Carley Tool
PROJECT MANAGER
Dr. Erik Brewer, Dr. Mohammad Abedin-Nasab, Dr. Barbara Springer (Quality of Life Plus)
SPONSOR
Quality of Life Plus (QL+)



Prosthetic technology is constantly improving and evolving as modern engineering practices advance, however there is no shortage of obstacles to overcome when trying to improve the quality of life of an amputee. One such issue is residual limb volume change, the small change in volume from the swelling or shrinking of an amputee's residual limb. Everyday factors such as extreme heat, extreme cold, pressure changes, altitude, bloating, and more can all contribute to changes in the limb size of an amputee. This issue of residual limb volume change has prompted the QL+ Team to begin working on a prosthetic solution in the form of an adjustable inflatable sleeve to fit between the limb liner and prosthetic socket. The design focuses on using thin vinyl material to build air bladder compartments that can be controlled via small vinyl hoses coming out of the prosthetic capped with Schrader valves. While keeping in contact with our QL+ challenger, military veteran and amputee Chris Roseberry, and different vendors to potentially outsource the design to, the team is striving for an effective, novel, and inexpensive solution to improve Chris' lifestyle and potentially that of other amputees.

Aligned Polycaprolactone Nanofiber Hydrogel Composites through Layered Assembly

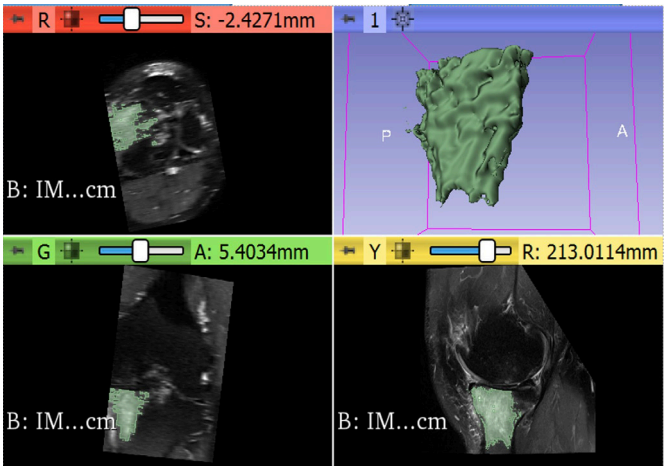
TEAM MEMBERS
Nikolas Belanger, Cameron Burns
PROJECT MANAGER
Dr. Sebastián Vega, Dr. Vince Beachley
SPONSOR
National Science Foundation (NSF)



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.

An Informed Delivery Strategy for Percutaneous Fixation of Bone Marrow Lesions

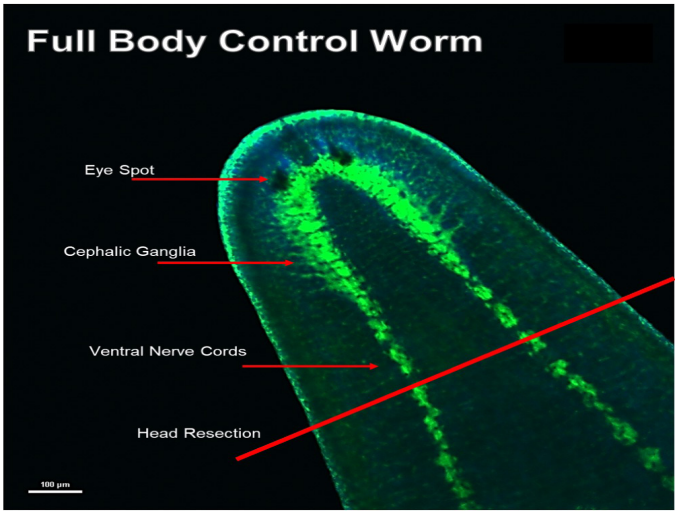
TEAM MEMBERS
Angelo-Jesus Pingol, Aamila Shaik,
Conor Magerr, Kevin Yanagisawa
PROJECT MANAGER
Dr. Erik Brewer,
Dr. Sean McMillan (Virtua Health)
SPONSOR
Virtua Health



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 slow or stop deterioration. However, the injection procedure is unguided and relies on the surgeon's perception for when it is complete. Furthermore, in about 30% of injections, there is under or overfilling of the site, which can result in incomplete restoration of bone and further progression of the disease or osteonecrosis, stress fractures, and pain. Therefore, this requires a need for a method of predicting the volume on an individual patient basis. In order to assist physicians with better efficacy of the filling procedure, our lab is continuing to develop MRI image analysis techniques, utilizing both semi-automated volumetric segmentation tools and non-linear regression code to provide surgeons with an accurate injection volume to decrease the risks associated with under/over filling.

Assessing the Translatability of Planarian Research to Humans

TEAM MEMBERS
Omnea Elgendy
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
NIH



Planarian flatworms have recently been identified as attractive model organisms for stem cell research and regenerative medicine. Although planarians lack overall complexity, their brains are molecularly similar to the mammalian brain. To further understand how experimental results from planaria can be applied to human medicine, we investigated the genetic similarities between genes expressed in planaria during regeneration and the human genome. To do this, a literature review was conducted with a focus on Schmidtea mediterranea expressed sequence tags (ESTs) and gene knockdown during regeneration. It was found that 66% of ESTs are similar to those in public databases (Zayas et al., 2005). A majority of these genes play key roles in metabolic processes and protein translation. A total of 124 ESTs are similar to proteins only present in humans, 63% of them having an unknown function (Sanchez Alvarado et al., 2002). Following the study of individual planarian gene homologs and overall EST similarity occurrences, we concluded that experimental results from planarian studies may be more applicable to humans than the differences in overall complexity would suggest.

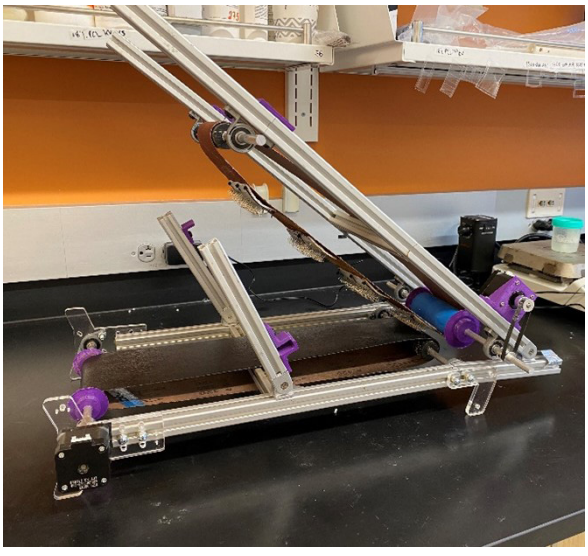
Assessment for Toxicological Impact of Cosmetic Ingredients During Regeneration

TEAM MEMBERS
Lauren Repmann
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
NIH

According to the U.S. Food and Drug Administration, cosmetic ingredients do not require approval before being used in mass production processes. This leaves numerous products unregulated and potentially harmful to consumers. Of these unregulated cosmetic ingredients, Di-(2-ethylhexyl) phthalate (DEHP) and benzophenone-3 (BP-3) have been identified as endocrine-disrupting chemicals with the ability to interfere with the normal processes of hormone signaling. Many studies have shown the negative effects of these chemicals on reproductive processes, but few have assessed the effects on neurological development. To explore this, we assess the toxic effects of DEHP and BP-3 on Schmidtea mediterranea (Smed) flatworms. Smed flatworms have the ability to regenerate completely upon head resection, which stems from an abundance of pluripotent stem cells. However, when neuroregeneration is disrupted, common behavioral abilities of these flatworms are compromised. We hypothesize that DEHP and BP-3 exposure during the regeneration period will impact flatworm neurodevelopment and behavioral patterns. These results would provide insight into potential toxicological responses to cosmetic ingredients.

Automated Dip Drawing Method for Creating Lignin Nanofibers

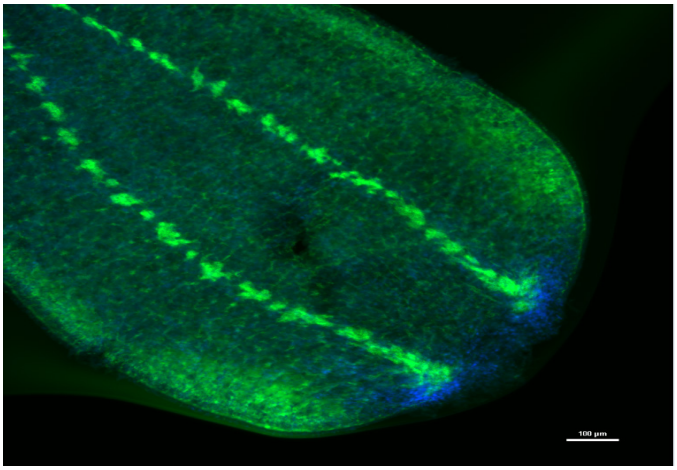
TEAM MEMBERS
Abigail Heinz
PROJECT MANAGER
Dr. Vince Beachley, Dr. Dave Jao
SPONSOR
US Army Research Lab, National Science Foundation



Dip drawing is an often-overlooked method of creating nanofibers. A novel method, called a trackspinner created by our laboratory, is being used to create nanofibers with a lignin-based solution. The trackspinner utilizes small needles that rotate on a belt. When the needles contact the lignin solution, they are able to pull out fibers. After the fibers have been fully stretched out, they are collected at the end of the belt using a rack. We have studied the relationship between glycerol content in the lignin solution and the characteristics of the fibers like mechanical strength and fiber diameter. We have been able to reach an ideal glycerol content (between 3-4%) that produces the desired mechanical strength. Minimum fiber diameter at this concentration is about 2m, so to decrease this into the nanoscale, the collection area design is being modified to increase draw ratio. In the future, we hope to achieve nanofibers as well as successfully carbonize them.

Behavioral and Anatomical Effects of Drugs of Abuse on Neurodevelopment

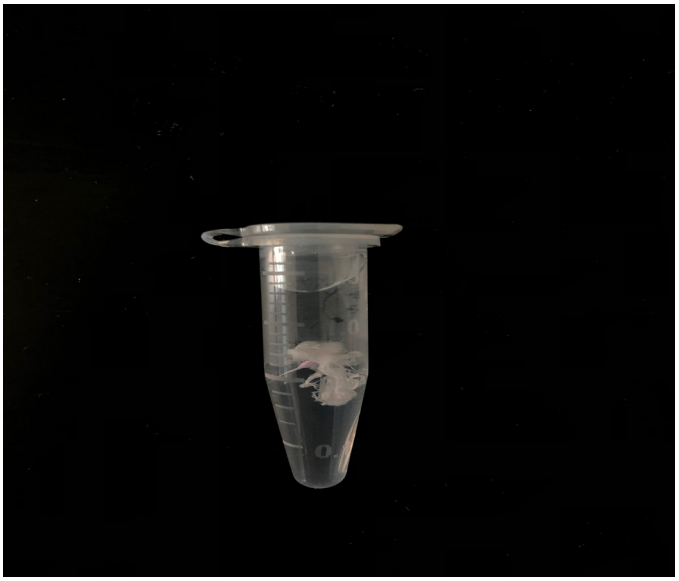
TEAM MEMBERS
Hannah Bonelli, Brennen Covely
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
NIH



Drugs of abuse are becoming an increasingly prevalent public health concern. Abusive drugs have been shown to yield detrimental repercussions in many pathways of the body, especially neurological function. The effect of these drugs on the neurodevelopmental status of infants born to addicted mothers is a phenomenon that remains poorly understood. Schmidtea mediterranea (Smed) planaria have an incredible capacity to fully regenerate their heads only 9 days after decapitation, thus providing a potential model system to assess the impact of drugs of abuse on nervous system development. In this project, we utilize Smed to assess behavioral and anatomical effects of drugs of abuse. Behavioral assays of Seizure-Like Movements (SLMs) evaluate the impact of this exposure, while anatomical assessment via immunostaining enables the visualization of gross anatomical changes in the central nervous systems of exposed animals. While others have assessed the behavioral status of fully intact worms and their response to abusive drugs, the regeneration of planaria with drug exposure has yet to be considered. Therefore, this work will provide invaluable insight into the effects of drug exposure in nervous system development within an in vivo system, and provide innovative approaches to discover molecular mechanisms underlying these effects.

Crystallization kinetics of electrospun nanofibers for controlled drug delivery

PROJECT MANAGER
Dr. Vince Beachley, Matthew Flamini

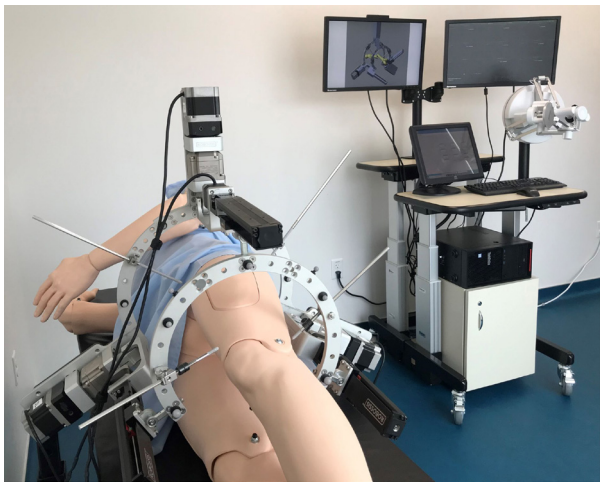


“Since polycaprolactone (PCL) nanofibers are biodegradable they are useful for biomaterial applications, such as drug delivery, however there is insufficient research surrounding nanofibers on the molecular level. Drugs may diffuse faster out of amorphous regions compared to crystalline regions of the nanofiber therefore controlling the crystallinity is essential for controlled release. The objective is to determine how the crystallization and alignment of the nanofibers impacts the drug release rate. Greater crystallinity resulting in higher molecular alignment in the polymer chain was hypothesized to result in a more controlled drug release. Both aligned and randomly aligned 18% PCL electrospun fibers were loaded with the model drug Rhodamine B through physical adsorption. The fibers were heat-treated and the resulting drug released was measured using an absorbance plate reader. The initial burst release was the greatest for the untreated randomly aligned fibers releasing 0.11 mg/mL of dye on day one. It was concluded that the untreated randomly aligned fibers had the least sustained release of dye. The heat-treated aligned fibers released slightly more drug compared to the untreated aligned fibers overtime. Therefore it can be concluded that the nanofiber’s crystallinity and resulting drug release rate can be modified through thermal treatment.”

Developing an Orthopedic Surgical Robot

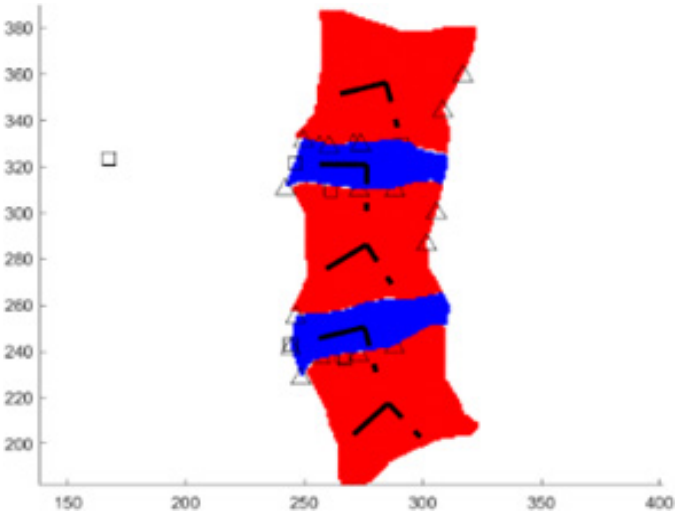
TEAM MEMBERS
Austin Carman, Lance Guzman, Akash Patel, Olivia Scro, Luke Reilly
PROJECT MANAGER
Dr. Mohammad Abedin-Nasab,
Dr. Sean McMillan (Rowan-SOM, Virtua)
SPONSOR
National Science Foundation (NSF),
New Jersey Health Foundation (NJHF)

Current femoral fracture surgeries are manual, and a major limitation with current protocols lies in the manual realignment step. Difficulties involved in the alignment procedure of femur fractures are attributed to the bone's elongated anatomy and the strength of the surrounding counteracting muscles. We are developing an orthopedic surgical robot for treating femur fractures, which benefits surgeons by improving alignments by 90%.



Disc Height Analysis Following Novel Spine Treatment for Lower Back Pain

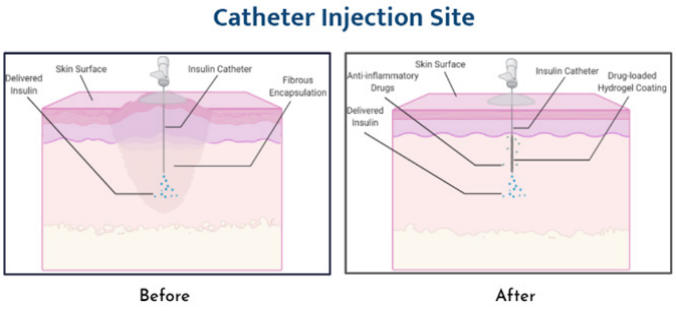
TEAM MEMBERS
Brandon Hickson, Jessica Rodgers, Conor Castro, Zack Brown
PROJECT MANAGER
Dr. Erik Brewer
SPONSOR
ReGelTec, Inc.



Degenerative Disc Disease is the leading cause of back pain, affecting 90% of adults in the US at some point in their lives. Current treatments involve highly invasive surgical methods, such as spinal fusion and disc replacement, that fail to fully restore the native mechanics of the disc and can lead to adjacent disc degeneration. ReGelTec has developed a hydrogel that, when heated, can be injected into the degenerated spinal nucleus in a minimally invasive procedure. After cooling, the gel would restore the mechanical properties of the spine. This team is investigating the correlation between pain relief and increase in injected disc height over time. Using several methods of statistical analysis, the percent change in disc height is calculated using techniques in MATLAB's photo analysis software. The results are automatically generated and populate a spreadsheet. Finally, the results are compiled together to provide an accurate depiction of a patient's spinal health throughout the entire time leading up to and following the procedure.

Dual-phase Drug Delivery Systems for Anti-Inflammatory Insulin Catheters

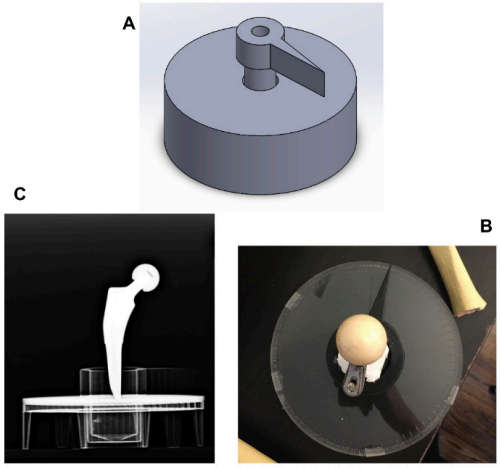
TEAM MEMBERS
Ryan Back, Lucinda Lau, Timothy Eck
PROJECT MANAGER
Dr. Erik Brewer and Dr. Jeffrey Joseph (Thomas Jefferson University)
SPONSOR
Capillary Biomedical, LLC



Modern subcutaneous insulin catheters require daily replacement in order to supply a consistent absorption of insulin. If the insulin catheter is not replaced periodically, the foreign body response (FBR) creates a fibrous encapsulation at the entry site, disrupting insulin absorption. Therefore, to decrease the FBR at the catheter's injection site and extend implantation duration, microparticles with anti-inflammatory drugs, lidocaine and dexamethasone, were combined within poly(lactic-co-glycolic acid) (PLGA) microparticles and suspended in hydrogel. Using High Performance Liquid Chromatography (HPLC), loading and release studies were performed analyzing the amount of drug present in the matrix and the percentage of drug released. The aim of this study was to create a dual-phase drug delivery system where both burst and sustained releases phases could be optimized independent of one another. This was achieved by combining both short-eluting free drug and drug-encapsulated microparticles in a hydrogel coating. Results showed that the greater the ratio of free active pharmaceutical ingredients (API) to drug encapsulated in the particle, the greater the initial burst release achieved along with a steady sustained release over time. Based on the data, we can successfully create a dual-phase drug release system to eventually combat the FBR at catheter injection sites.

Early Detection of Implant Loosening

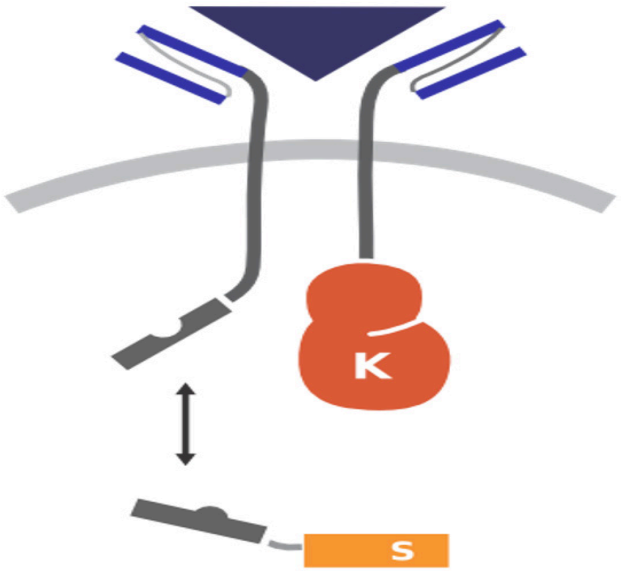
TEAM MEMBERS
Samantha Bollendorf, Mckayla Rebillon, Jerico Mellet, Alex Wiese
PROJECT MANAGER
Dr. Erik Brewer, Dr. Shreekanth Mandayam, Dr. Luke Austin (Rothman Orthopedics)
SPONSOR
Rothman Orthopedics



There is currently a patient population of around 2.5 million living with a hip prosthesis, with an additional 300,000 new hip replacements implanted annually. Along with being prevalent, the surgery is also costly for patients. A hip arthroplasty surgery can range in price between $40,000 and $50,000, depending on geographical location and hospital prestige. Historically, most implants would last for the duration of the patient's life, approximately 15 years. In 2016, the average age of revision hip arthroplasty patients was about 67 years. Advances in medicine have lengthened the human lifespan, allowing older adults with hip replacements to outlive their implants, leading to a rise in major revision surgeries. The most common cause of hip implant failure is aseptic loosening, accounting for 75% of cases of hip replacement failure. Micromotion at the implant edges produces debris that causes an inflammatory reaction called metallosis. This biological reaction is related to the implant lifespan, which is 20 years for 85% of implants. To combat this, a solution involving the detection of implant loosening prior to total implant failure via machine learning and biomedical design is explored by this group.

Engineering Synthetic Receptors for Cell-Based Therapeutics

TEAM MEMBERS
Alison Price, Sierra Wagensommer, Anu Fadare, Mostafa Gad, Brett Bush
PROJECT MANAGER
Dr. Nichole Daringer



The main purpose of this clinic is to develop synthetic cell receptors with engineered post-translational modifications. We are designing and characterizing synthetic receptors to detect cytokines that are important in the tumor microenvironment and in immunotherapy including vascular endothelial growth factor (VEGF), transforming growth factor-β (TGF-β), interleukin-2 (IL-2), interleukin-4 (IL-4), and interleukin-6 (IL-6). These receptors will eventually be used for studying the tumor microenvironment. The receptors respond very fast to changes in cytokines and produce dynamic fluorescent readouts so they can be used to measure how the tumor microenvironment changes over time. These receptors will be used to identify unique characteristics that differentiate tumor microenvironment from healthy tissue in order to better target cell-based therapies for the treatment of cancer.

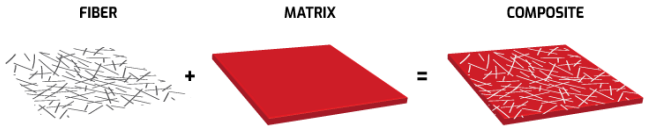
Fully Adjustable Powered Wheelchair for Children

TEAM MEMBERS
Jacqualyn Washington, Christina Sunbury, Amanda Yannarella, Charles Yahara
PROJECT MANAGER
Dr. Mohammad Abedin-Nasab, Dr. Erik Brewer, Dr. Christopher Keenan (CHOP)
SPONSOR
Children's Hospital of Philadelphia

"Nearly 75 million people worldwide require the support of wheelchairs. In the United States alone, there are over 124,000 wheelchair users under the age of 21. Powered wheelchairs aid children with mobility impairments as young as 18 months old. However, the treatment provided in hospitals is limited by a lack of power chair accessibility including availability, affordability, and sizes of the units. Facilities that treat children with disabilities, such as children's hospitals, schools, rehabilitation facilities, may have a few powered wheelchairs on site, but frequently rely on loans from wheelchair vendors due to a lack of funding and storage. Necessary chair size varies per child: from 10"x10" seats for 18-month-olds to adult size seats at 20"x28". It can be difficult to find a properly sized powered wheelchair because the availability of power wheelchairs is limited to the vendor's supply with a maximum of a two-week loan, limiting the training process. These challenges can be addressed with a chair that can easily and quickly adjust in size to meet the demands of diverse patients. In conjunction with Children's Hospital of Philadelphia (CHOP), this Rowan Biomedical Engineering project seeks to repurpose existing powerchairs to increase accessibility to rotating patients in applicable settings.

High Strength Resin/Nanofiber Composites

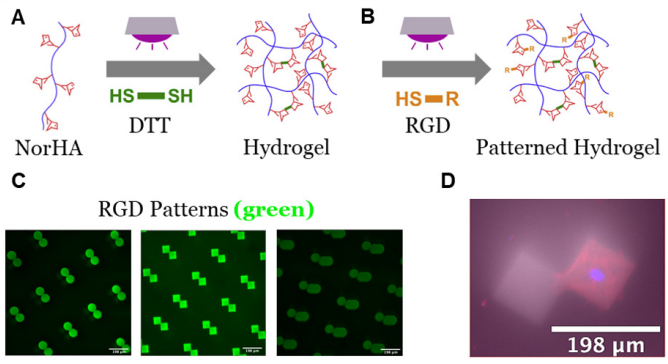
TEAM MEMBERS
Aakash Patel
PROJECT MANAGER
Dr. Vince Beachley



Nanofibers are fibers with a diameter of few nanometers that can be created using electrospinning. In electrospinning, a syringe is filled with the polymer solution and is placed in the pump that controls the flow rate of the solution. When the drop of the solution reaches the needle tip, a high voltage is applied which electrifies the droplet and the charge is spread evenly on the surface. This causes the droplet to deform into a “Taylor cone”. When the voltage reaches a threshold, electrostatic repulsion acts against the surface tension which causes the droplet to stretch and liquid erupts from the droplet to the metal collector. As the liquid travels to the metal collector, the solvent evaporates leaving the nanofibers on the collector. Changing various parameters can yield nanofibers with varying morphology. For our project, we are making films of electrospun nanofibers and UV cured composites using Polylactic acid (PLA) and covalently tied PLA and examining their properties through mechanical testing. This research is important because it can be useful to the 3d printing industry to help them manufacture mechanically stronger and durable parts. Our research attempts to advance the 3d printing industry by making high-strength composites using covalently tied PLA and photopolymer resin.

Hydrogel Micropatterning to Study 2D Mechanosensing

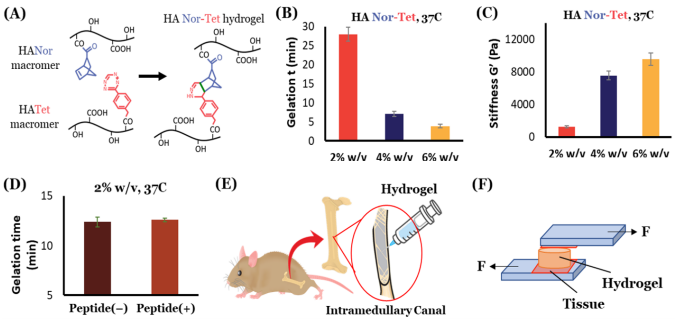
TEAM MEMBERS
Gatha Adhikari, Sarah Furman
PROJECT MANAGER
Dr. Sebastián L. Vega



Cellular mechanosensing is the conversion of extracellular inputs (cell-matrix & cell-cell interactions) into cellular action (mechanical activation). The goal of this project is to study the effects of cell-matrix and cell-cell interactions on mesenchymal stem cell (MSC) mechanosensing. MSCs were cultured on norbornene-modified hyaluronic acid (NorHA) hydrogels of low (6 kPa), medium (10 kPa), and high (20 kPa) stiffness. NorHA hydrogels were made through a thiol-norbornene reaction between norbornenes in NorHA and thiols in a di-thiol crosslinker (DTT) using UV light as the catalyst (Fig. 1A). MSCs are unable to attach to these hydrogels and photolithography was used to micropattern adhesive regions for single and two-cell attachment. Briefly, NorHA hydrogels were incubated in a thiolated adhesive peptide solution (RGD), placed on a photomask, and irradiated with UV light to transfer micropatterns (Fig. 1B-C). Shapes were chosen based on their potential to restrict (circles) or enhance (octagons) mechanical activation. Indeed, MSCs attach to micropatterns and adopt their shape (cell red; nucleus blue; micropattern white Fig. 1D). Current efforts are focusing on using this unique platform to study the combined effects of cell-matrix (underlying stiffness) and cell-cell (one vs. two-cell micropatterns) interactions on mechanical activation.

Injectable Hydrogels for Biomedical Applications

TEAM MEMBERS
Roshni Gandhi, Khushi Sarin, Kirstene Gultian
PROJECT MANAGER
Dr. Sebastián L. Vega, Dr. Amir Miri,
Dr. Tae Won B. Kim (Cooper)
SPONSOR
Camden Health Research Initiative, NIH



The purpose of this study is to develop an injectable material that is self-forming and can be delivered as a tissue substitute without the need for surgery. To create self-forming hydrogels, hyaluronic acid macromers were modified with norbornene (HANor) or tetrazine (HATet). Upon contact, these macromers undergo a Diels-Alder reaction which forms a covalent bond between HANor and HATet without a catalyst (Fig. 1A). The time to gelation (Fig. 1B) and mechanical properties (Fig. 1C) can be controlled by increasing the total macromer weight percent (w/v). By modifying HANor with methacrylate groups, injectable hydrogels can be functionalized with bioactive peptides without affecting mechanics (Fig. 1D). This platform is versatile, and we are exploring its use in two independently funded projects that aim to: strengthen osteoporotic bone and fill vocal fold tissue voids. To regenerate bone, injectable hydrogels will be modified with a bone-producing peptide mimic (bone morphogenetic factor-2, CGGGDWIVA). Bone growth will be evaluated in a rat femur intramedullary canal injection model (Fig. 1E). To replace missing vocal fold tissue, injectable hydrogels will be modified with an adhesive compound (hydroxyphenyl acrylate, HPA) to withstand vocal stresses which will be confirmed using a lap shear force test (Fig. 1F).

ISENET Organoid Tissue Microarray Automation

TEAM MEMBERS
Elizabeth Fox, Nicholas Smith
PROJECT MANAGER
Dr. Vince Beachley,
Dr. Mohammad Abedin-Nasab, Dr. Erik Brewer,
Andrea Deblasio (ISENET)
SPONSOR
Integrated Systems Engineering (ISENET)

In collaboration with Integrated Systems Engineering (ISENET), the goal of this project is to design and automate a tissue microarray processing device that is compatible with ISENET's tissue microarray device the Galileo. This task will include the ability to prepare and analyze organoid samples, increasing its efficiency and range of disease analysis. Tissue organoids are beneficial for in vitro study of disease, development, and regeneration. This will be done by incorporating a motorized pipette that will be able to transfer organoids from its initial vial to a microwell plate which can then be analyzed by ISENET's Galileo through paraffin embedding. This will increase researchers' and pathologists' ability to analyze organoids in a more productive and efficient way. The conclusion of this project will yield a fully autonomous system that will be the first of its kind to analyze both organoids and tissue cultures.

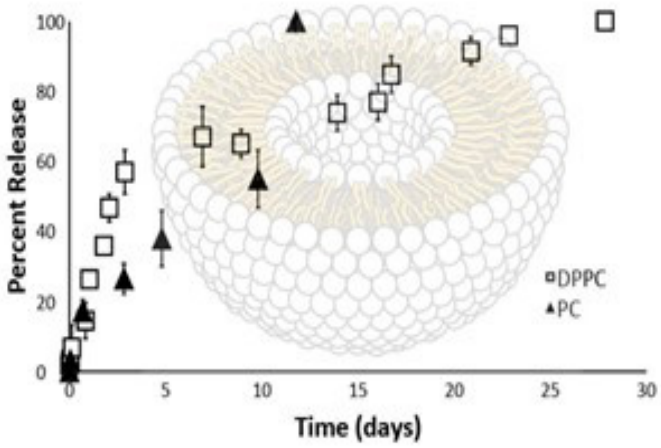
Lipid Nanoparticles for Drug Delivery During Pregnancy

TEAM MEMBERS
Jamie Medina, Qazi Faraz Ahmad
PROJECT MANAGER
Dr. Rachel Riley

Treating diseases and pre-existing conditions during pregnancy is challenging due to potential risks to the fetus, altered pharmacokinetics of therapeutics in pregnant women compared to non-pregnant women, and the constantly developing maternal-fetal interface as pregnancy advances. For these reasons, pregnant women often have to reduce or eliminate their use of medications during pregnancy. Thus, there is vast potential to develop drug delivery technologies, such as nanoparticles, that are specifically designed to be used during pregnancy to treat both pre-existing maternal conditions and diseases of pregnancy, such as preeclampsia. In this clinic project, we are developing lipid nanoparticles to encapsulate and deliver therapeutic nucleic acids to treat diseases during pregnancy. Lipid nanoparticles have recently gained worldwide attention for their use in coronavirus vaccines and have been proven highly safe and effective for vaccination. However, they have not been extensively studied for use during pregnancy. Ultimately, this project will provide new lipid nanoparticle technologies that are proven safe and effective to both the pregnant woman and fetus to treat a range of diseases.

Liposomal Drug Delivery System for the Treatment of Metastatic Spinal Tumors

TEAM MEMBERS
Antonio Abbondandolo, Dana Van Fossen
PROJECT MANAGER
Dr. Erik Brewer



The American Cancer Society projects 1.8 million new cases of cancer in the United States this year, and over 600,000 deaths due to the disease1. Close to half of all cancer patients will suffer from metastases to the spine.2 In current treatment methods, surgeons aim to remove total resection of diseased bones and tissue using spinal fusion cages. However, since the spinal column is near sensitive nerves, it is challenging to remove the whole tumor without immense risk3. In most cases, surgeons conservatively remove only part of the malignant tissue, causing prolonged patient discomfort and pain. As chemotherapy treatments also limit the healing process,4 systemic chemotherapy is often held in the perioperative period. The central hypothesis of this research is that a novel, biodegradable, dual release nano-liposomal composite hydrogel can control the release of chemotherapeutic and anti-inflammatory compounds in situ. Clinically, this localized treatment has the potential to reduce residual metastasized tumor growth, alleviate patient pain by reducing damage to the surrounding tissue, and reduce chemotherapeutic side effects. For controlled drug delivery, chitosan hydrogels serve as an ideal polymer due to their well-documented biocompatibility and ability to form thermosensitive hydrogels when combined with β-Glycerophosphate (β-GP).

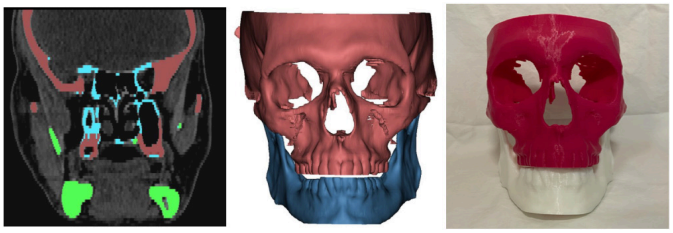
Mobile Application for Improved Management and Monitoring of Chronic Pain

TEAM MEMBERS
Dan Cafero, Makara Napoli, Manahil Nisar, Elena Nitting
PROJECT MANAGER
Dr. Erik Brewer, Dr. Kavita Gupta (Advocare)
SPONSOR
Advocare Pain Institute of South Jersey

Pain management is a significant public health challenge for patients with chronic pain. With the rise of smartphone use and increasing mobile applications, there have been a number of pain management applications that aim to monitor and help patients with pain relief. However, these applications have met little to no success, as they fail to both incorporate multiple metrics beyond pain scores that signify efficacy and facilitate communication of reported metrics between doctors and patients. Studies show that through the recording of a patient's general pain levels, depression, and anxiety over time, doctors can have considerably more information to diagnose patients and assess their treatment. Our project goal is to create a Pain Management mobile application that can be easily used by patients to monitor this biometric data, and medical practitioners to better understand how a patient is dealing with pain. Once ready for deployment, Rowan Engineers will begin beta testing the app at the Advocare Pain Institute of South Jersey.

Personalized 3D Models for Pre-Operative Planning

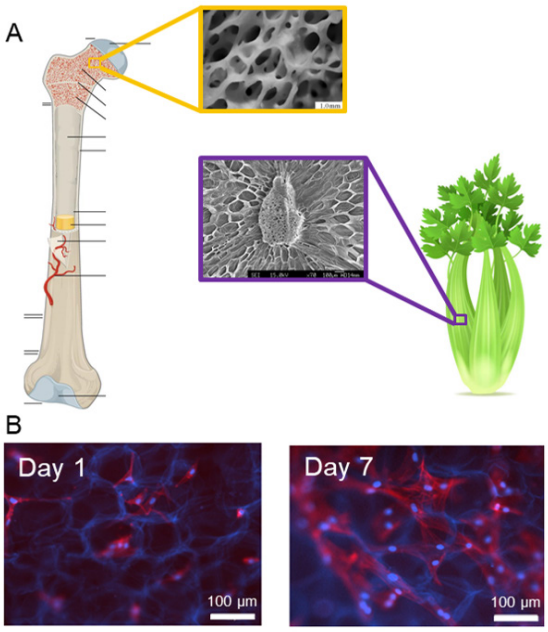
TEAM MEMBERS
Erin Van Dexter, MaKenna McMichael, Kyle Printon, Michael McNally
PROJECT MANAGER
Dr. Erik Brewer, Dr. Dorothy Bird (Cooper University Healthcare), Dr. Adarsh Yagnik (Cooper University Healthcare)
SPONSOR
Cooper University Healthcare



Reconstructive microsurgery is a subset of plastic surgery that utilizes precision instruments to reconstruct anatomical structures and/or transfer blood vessels autonomously when performing tissue or bone repairs in patients suffering from trauma, cancer and congenital anomalies. Due to current methods of pre-operative planning approximately 5-10% of tissue and 6-7% of facial reconstructions experience post-operative complications. To improve the study of two-dimensional CT scans for surgeons, Rowan Biomedical Engineers have developed a process that utilizes patient scans, segments them based on the necessary surgery and renders a three-dimensional model that can be printed for physical preparation. The rendered model can be used alone or in conjunction with the printed model. Early results of accuracy and precision validation testing show a 97% accuracy between rendering and print. Through improving pre-operative resources, a reduction in safety concerns, post-operative complications, and surgical cost are anticipated. Proof-of-concept work has utilized DIEP in the abdomen for breast reconstruction, zygomatic maxillary complex fractures in the temporal bone region, and jaw fractures that require oral realignment. Future plans involve expansion into the Oral/Maxillofacial and Orthopedic departments, as well as use in educational settings for medical students to improve confidence and understanding of anatomy structures.

Plant Tissues for Tissue Engineering Applications

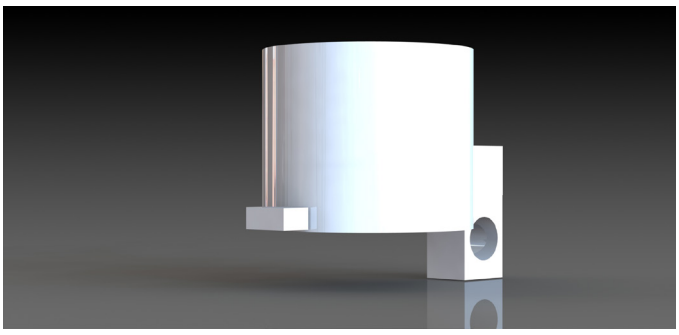
TEAM MEMBERS
Katie Driscoll, Maya Butani, Abigail Madden
PROJECT MANAGER
Dr. Sebastián L. Vega



Plant tissues are structurally analogous to many human tissues and provide a unique platform to study stem cell differentiation. For example, the highly porous structure of celery has structural similarities to cancellous bone (Figure 1A), making celery an abundant and biocompatible candidate material for bone tissue engineering. Plant tissues with small (carrot) and large (celery) micropores were evaluated for their ability to support human mesenchymal stem cell (MSC) viability and bone differentiation. To evaluate material properties, carrot and celery were first cut into disks (8 mm Ø, 2 mm height) and decellularized. Although the compressive moduli of carrot (8-9 kPa) and celery (3-4 kPa) is inferior to cancellous bone (350 MPa), the micropores (50 µm carrot; 160 µm celery) are within the range suggested for bone regeneration in biomaterials. To evaluate MSC viability and function, MSCs (10,000 cells/cm2) were cultured on carrot and celery disks for one week. MSC viability was >90% and rapid cell division was also observed (Fig. 1B red cells; blue nuclei). MSCs on celery tissue were also successfully differentiated into osteoblasts (data not shown). These results show that decellularized plant tissues possess microarchitectures similar to human tissues and are promising biomaterials for tissue engineering.

Prophylactic Cap Designed for Multi-dose Vials to Reduce Nosocomial Infections

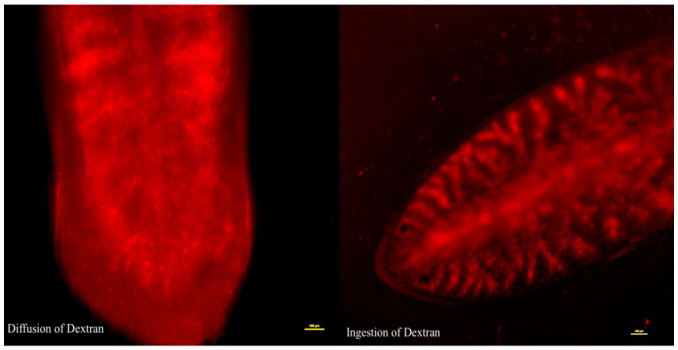
TEAM MEMBERS
Rebecca Charboneau, Sierra Nasoff
PROJECT MANAGER
Dr. Erik Brewer, Dr. Greg Captuo,
Dr. Mary Staehle and Dr. Patrice Tremoulet
SPONSOR
VCG, LLC, Phulassein, LLC,



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).

Routes of Administration in Dispersion Models in Schmidtea mediterranea

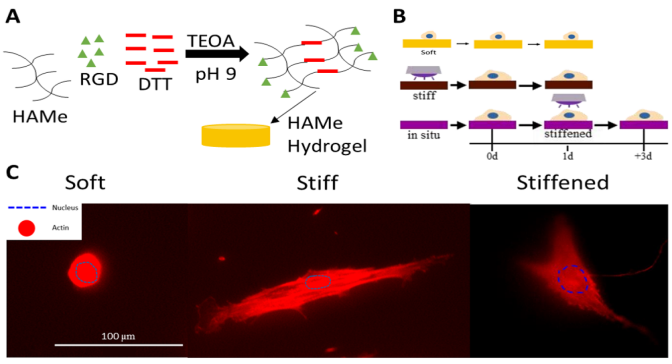
TEAM MEMBERS
Timothy Horchuck, Sarah Krajicek, Johnathan Morris
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
NSF, NIH



Schmidtea mediterranea (Smed) planaria are capable of regenerating completely from seemingly infinitesimal fractions in a matter of days. Planarian models have been shown to be promising candidates for in vivo models of toxicity screening. Typical assays of exogenous chemical exposure involve diffusing water-soluble toxins into the flatworms from their environment. However, toxins can also be introduced via consumption of food containing chemicals. Planaria eat through a bidirectional pharynx which is protruded when chemoreceptors detect nearby protein sources. To visualize differences in effects of administration routes, two exposure models were developed. One involved using dextran conjugated to the TRITC fluorophore. The other involved feeding planaria food dye infused food. Imaging results show that differences in route of administration result in different chemical dispersion. Dextran and food dye administered to planaria via the absorption model appears to have dispersed throughout the entirety of the flatworm, whereas dextran and food dye administered via the ingestion model appears to be confined to the digestive tract. These differences in routes of administration pose equally useful avenues to assess the broad effects of potential toxins on development and help to refine the Smed planarian model for use in toxicology studies.

Stiffening Hydrogels to Evaluate 2D Mechanosensing

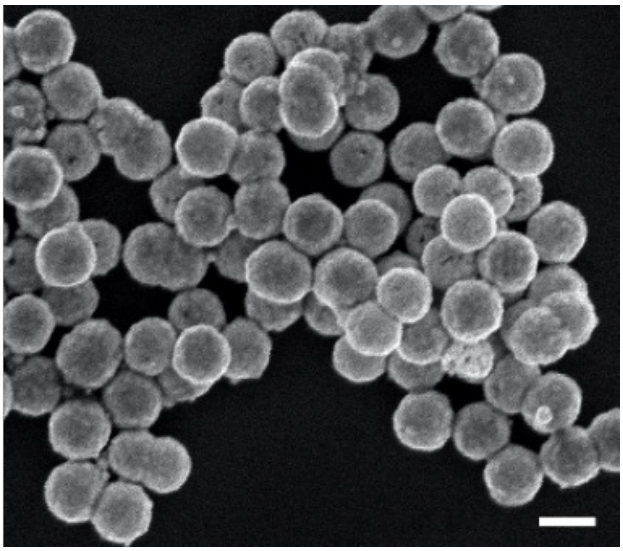
TEAM MEMBERS
Matt Lowe, Mehdi Benmassaoud
PROJECT MANAGER
Dr. Sebastián L. Vega
SPONSOR
National Science Foundation (NSF)



While most biomaterials are static, biological systems are dynamic, and there is a growing appreciation for biomaterials that expose cells to signals that vary with time. The goal of this study is to create soft materials that stiffen on-demand and are capable of peptide modification. Soft hydrogels were synthesized by reacting methacrylated hyaluronic acid (HAMe) with dithiothreitol (DTT) via a Michael-type addition polymerization reaction (Fig. 1A). To stiffen soft hydrogels, unreacted methacrylates underwent kinetic chain growth in the presence of a photoinitiator (I2959) and UV light (Fig. 1B). Stiffness measurements of soft (~5 kPa) and stiffened (~25 kPa) hydrogels confirm a rapid stiffness increase with UV activation (5mW/cm2, 5 min). To support cell adhesion, HAMe macromers were functionalized with RGD peptide via Michael-addition coupling. Mesenchymal stem cells (MSCs) attached onto soft hydrogels and exhibited an increase in cell and nuclear area after in situ stiffening (Fig. 1C). Using the same RGD coupling scheme, hydrogels were biofunctionalized with a cell-cell mimetic peptide (HAVDI) that reduces the ability for cells to “feel” hydrogel stiffness. We are currently investigating the combined effects of HAVDI signaling and soft hydrogel culture time on the ability for MSCs to mechanically adapt to new, stiffened environments.

Synthesis of Gold Nanoparticles for Cancer Treatment

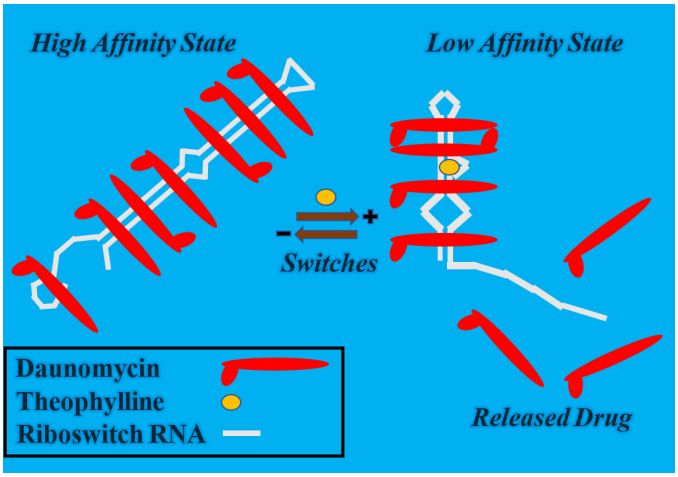
TEAM MEMBERS
Marie Green, Colleen Grehlinger
PROJECT MANAGER
Dr. Rachel Riley



Gold nanoparticles are often studied for cancer treatment due to their high stability, simple bioconjugation chemistry, and light absorption properties. Nanoshells, which are comprised of silica cores and thin gold shells, are one type of gold nanoparticle used clinically for photothermal therapy of solid tumors. In photothermal therapy, nanoshells are administered to patients, accumulate within tumors, and are then externally triggered with near infrared laser light. The nanoshells absorb the applied laser light and produce heat sufficient to irreversibly harm the surrounding cancer cells. In one aspect of this project, we are interested in using nanoshells for photothermal therapy of ovarian cancer, an aggressive disease with lower survival rates compared to other cancers. In addition to photothermal therapy, nanoshells can also be used for targeted drug delivery by attaching targeting ligands to their surfaces. In a second aspect of this project, we are conjugating therapeutic molecules, such as antibodies and chemotherapies, to nanoshells to improve the delivery of these ligands to tumor tissue compared to delivering them alone. Ultimately, this project will demonstrate how nanoshells can be used as tools for both photothermal therapy and targeted drug delivery to treat ovarian cancer.

Theophylline-Selective Riboswitch for the Controlled Release of Cancer Drug

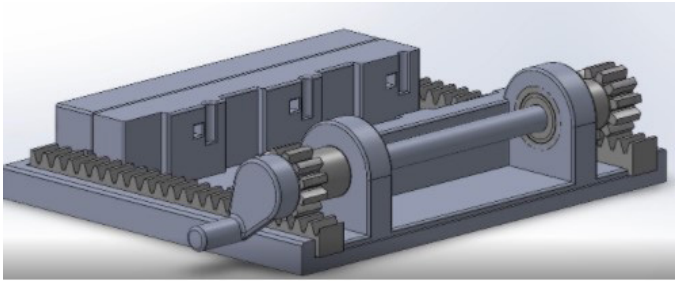
TEAM MEMBERS
Daniel Tepper, Andres Geffard,
Matthew Talarico
PROJECT MANAGER
Dr. Mark Byrne
SPONSOR
Dr. Jacek Wower, Professor, RNA Laboratories, Auburn University Department of Animal Sciences



In the pursuit of an intelligent drug delivery vehicle for cancer therapy, the biomimetic approach - especially using nucleic acid constructs – provides a cornucopia of potential carriers with a variety of functionality. Riboswitches are RNA sequences which contain two functional domains, one containing an aptamer for recognition and an effector domain which will alter its double-stranded conformation upon specific molecular interaction with the aptamer. The decreasing cost and increasing efficiency in synthesizing biomimetic RNA has opened an enormous toolbox for molecular recognition and controlled release. In the presence of theophylline, molecular interactions with its recognition domain triggers daunomycin to be released from the hairpin structure of the riboswitch through molecular rearrangement. This shift in conformation creates an orientation which has fewer base pairs and therefore fewer locations for daunomycin to intercalate, leading to a rapid release of chemotherapy drug. We expect that this technology can be incorporated into nucleic acid-based therapeutics as a bioresponsive element for selective delivery and release of cancer drugs.

Zip-Stitch Surgical Clip Assembly Fixture

TEAM MEMBERS
Ryan Ingrassia, Julia Bally, Connor Ranson, Chirag Patel
PROJECT MANAGER
Dr. Mohammad Abedin-Nasab, Dr. Erik Brewer, Dr. Dan Mazzucco (ZSX Medical)
SPONSOR
ZSX Medical

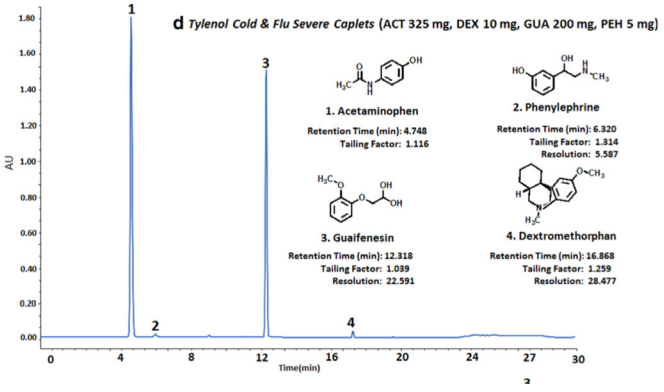


Zip-stitch is a surgical closure system that is designed to make difficult surgical closures fast and easy for physicians. One Zip-Stitch clip is comprised of three components: one right arm, one left arm, and one clip pin. Over the past few years, the Zip-stitch clips were being assembled by manufacturers using a first-generation assembly device. The device required workers to load rigid molds with the clip parts and manually compress them together. During its use, some weaknesses in the design have emerged. This device was not only slow by only producing three clips per minute, but also left room for user error. This resulted in increased production time, mis-assembled clips, and fracturing of the assembly device. Rowan University engineers, in collaboration with Dr. Mazzucco and Dr. Brewer, developed an improved clip assembly device that reduces assembly time, opportunity for user error, and is more reliable.

CHEMICAL ENGINEERING

Active Pharmaceutical Ingredient Chromatography

TEAM MEMBERS
Jennifer Lawson, Zachary Rosenzweig, Angel Cabrera
PROJECT MANAGER
Gary Thompson



Pharmaceuticals are a billion dollar industry in the United States with thousands of drugs currently in production. A key element of the drug production process is liquid chromatography for determining concentration of active pharmaceutical ingredients (APIs) and manufacturing those APIs. One major difficulty faced in the industry today is that certain APIs are difficult to separate via liquid chromatography. The goal of this proposed project would be to create an ideal liquid chromatography column. This column would decrease the retention time for APIs that are complicated to separate. Overall, the separation of the proposed API would become easier, and this column could be implemented into the industry to speed up production time of certain drugs.

Blend Time Measurements in Unbaffled Tanks

TEAM MEMBERS
Tim Laucius, David Ciocco, Chad Cochran
PROJECT MANAGER
Dr. Hesketh and Dr. Etchells
SPONSOR
North America Mixing Forum

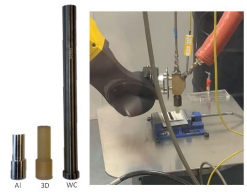
"Blend time is defined as the quantity of time required to completely mix two or more solutions in a given tank with a given impeller. Blend time measurements were taken in an 8 inch unbaffled tank using a 3 inch Rushton impeller. For these experiments the impeller speed ranging from 200-600 RPM and liquid levels from 6-13.5 inches. The blend time was determined using the salt tracer method which employs a conductivity probe placed at the top surface of the liquid in the tank. The results of blend time measured using the salt tracer method were found to be well represented by an equation developed by Grenville

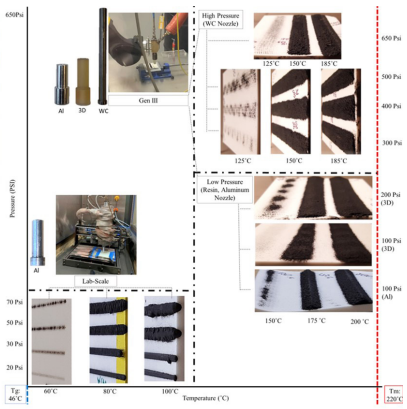
$$5.66 = Np^{(1/3)} * Re/Fo$$

Where Np is the power number, Re is the Reynolds number for a stirred tank and Fo is the Fourier number given by $Fo=\mu\theta/(\rho T^2)$ and θ is the blend time and T is the tank diameter. This data was reanalyzed using the color change method based on the reaction between sodium thiosulfate and iodine in the presence of starch."

Cold Spray Additive Manufacturing

TEAM MEMBERS
Dylan Manuguerra, Robert Marano,
Austin Ogren, Ryan Nicol
PROJECT MANAGER
Dr. Joe Stanzione, Dr. Mac Haas,
Dr. David Brennan, Tristan Bacha
Matthew Schwenger
SPONSOR
U.S. Department of Defense -
Army Research Laboratory

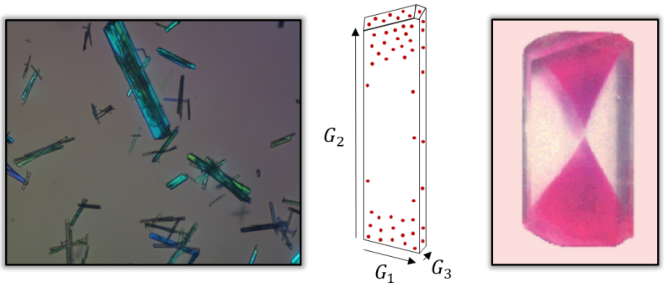




With the Advanced Materials and Manufacturing Institute's Cold Spray facility up and running, students have worked towards solving fundamental and applied polymer science and engineering problems related to cold spray additive manufacturing. Problems related to processing and handling polymer particles prior to spraying 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.

Crystallization as a Purification Process

TEAM MEMBERS
Diana Martinez
PROJECT MANAGER
Dr. Gerard Capellades

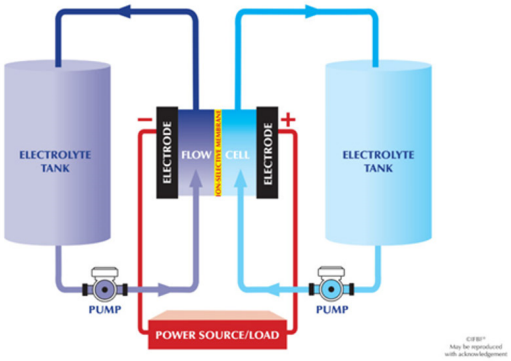


"One of the main challenges for the design of crystallization processes is the selection of appropriate conditions to control which foreign species incorporate to the crystalline phase, and to which extent. This selection is not only important for processes dealing with purification, but also for products that rely on additive-based crystal enrichment to meet the desired solid-state properties. Ironically, solution crystallization is one of the most popular separation processes in chemical industries, but to this day we don't have any generalizable models to predict how different impurities will incorporate in the crystalline phase. This is, in part, because each face of a growing crystal has its own surface chemistry, and because impurities can incorporate in a growing crystal following a wide variety of mechanisms.

This project started with a thorough review of the interplay between crystal growth kinetics and impurity incorporation in organic molecular systems. The different mechanisms of impurity incorporation were outlined to generate appropriate model libraries based on available first principles and mechanistic models. These model libraries will serve as a backbone for the development of novel expressions for the prediction of impurity incorporation rates in solution crystallization."

Deep Eutectic Solvent Flow Batteries

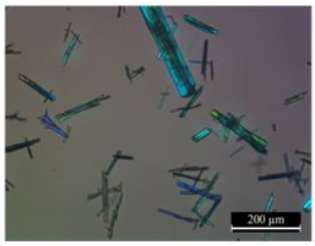
TEAM MEMBERS
Thomas Boyle, Jacob Molinaro
PROJECT MANAGER
Gary Thompson

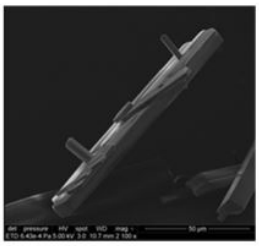


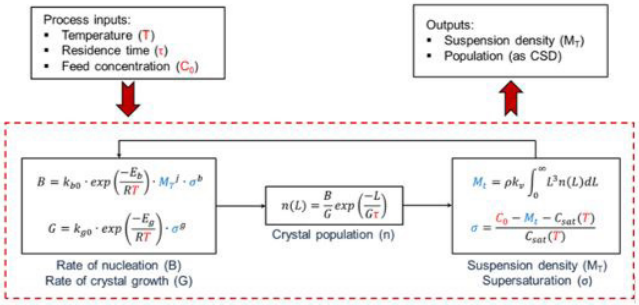
The Deep Eutectic Solvent Redox Flow Battery Clinic aims to characterize deep eutectic solvents (DESs), explore their applications in large-scale energy storage via redox flow batteries (RFBs), and publish a scientific review paper on this topic. Deep eutectic solvents are low-cost, environmentally-friendly mixtures with extremely depressed melting points. Redox flow batteries are scalable energy storage devices which operate via ion exchange and oxidation-reduction chemistry to convert chemical potential energy into electric energy. This review paper will explore the history of DESs and RFBs, delve into the specific operation and construction of an RFB, provide a method by which to characterize the important properties of any given DES, and then explain the process by which a group can describe the capabilities of their DES RFB. Finally, suggestions will be made for possible areas of future research and interesting applications of DES RFBs in extreme environments such as zero-gravity or extreme cold.

Design of Continuous Crystallization Processes

TEAM MEMBERS
Aidan Kayes
PROJECT MANAGER
Dr. Gerard Capellades, Dr. Kirti Yenkie
SPONSOR
PürGrow







This clinic is meant to be an introduction to the design and modeling of continuous crystallizers in the manufacturing of pharmaceuticals, bulk chemicals, and food products. During the first half of the clinic, students learn the basics of solubility, nucleation, and crystal growth, as well as the common equipment employed in industrial crystallization. They develop and implement mathematical models in MATLAB, to be used in the model-predictive optimization of continuous crystallizers. In the second half of the clinic, students utilize those models to conduct an uncertainty and sensitivity analysis of a given process. This analysis will be a first step for the assessment of optimal experimental design strategies for model calibration, and to evaluate the flaws of common heuristics in the design of industrial crystallizers.

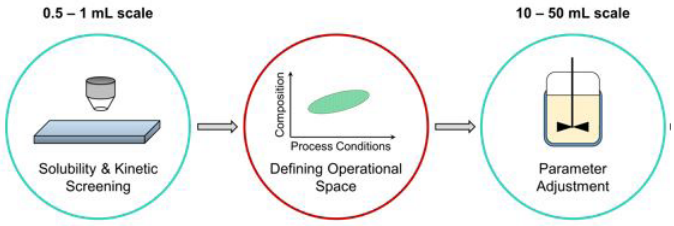
Electrochemical Power Source Design

TEAM MEMBERS
Montana Carlozo, Raymond Lewis, Alexa Lynch, Gurpreet Singh, Eric Zane, Thomas Klimek, Brendan Hansen, Bradley Smith, Jacob Engime, Douglas Fisher, Scott Woods, Robert McClernan
PROJECT MANAGER
Dr. Robert Hesketh

The purpose of this project was to design, fabricate, and test an electrochemical power source to be used in the Regional AIChE ChemE Car Competition. The competition goal is for the car to move a specified distance of anywhere between 30 and 100 ft in under 2 minutes. The constructed car was powered with aluminum air cell batteries linked in series. Each battery produces approximately 1.23 V and 0.134 A and the car's velocity can be varied by the total amount of batteries used. An iodine clock reaction coupled with a light sensitive photoresistor and the necessary controller logic was implemented to cut power to the motor when the reaction sufficiently darkened. Three reaction cells were used for this reaction to account for its variability. A correlation between the volume of each reactant and car stopping time was created as a predictive tool for the competition. Since the velocity of the car is known and the distance the car needs to travel was given, the iodine clock correlation can be used to find the reactant volumes necessary to stop the car at the specified distance. The car follows all safety rules and regulations for 2021 Regional AIChE ChemE Car Competition.

High-Throughput Screening of Crystal Growth Kinetics

TEAM MEMBERS
Margot Clarke, Adam Griefer
PROJECT MANAGER
Dr. Gerard Capellades

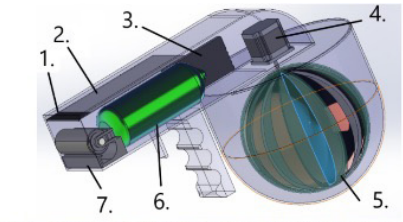


"Crystallization from solution is extensively used as a purification process and as means to obtain powders with the desired particle size, shape, and form. This process is especially important for pharmaceutical manufacturing, where these properties play a critical role defining the drug's stability and bioavailability. One of the main challenges for the development of crystallization processes is the typically large amounts of material and time required for process development, which are unfeasible for rapidly bringing a new drug to the market.

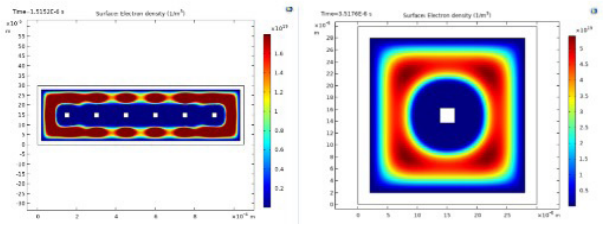
This project involves the design of automated flow cells for the high-throughput screening of crystal growth kinetics. These cells will provide an alternative for the highly accurate measurement of crystal growth rates under controlled conditions of supersaturation, solvent composition, and impurity concentrations, serving as a basis for several studies on crystal growth fundamentals, and as a tool for industrial development under time and material constraints."

Lunar Dust Removal by Tribocharging-Induced Plasma System (TIPS)

TEAM MEMBERS
Tanner Debus, Zachary Casper, Robert Patterson
PROJECT MANAGER
Gary Thompson



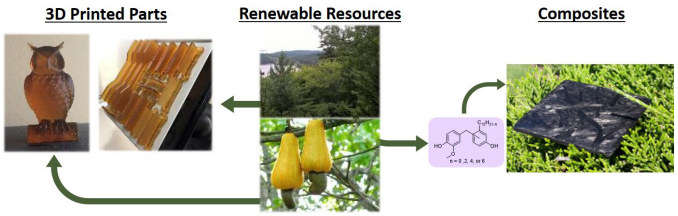
1. Tungsten Ground Electrode and Plasma Nozzle exit 2. DBD capillary 3. Battery 4. Motor 5. Triboelectric Generator 6. Noble Gas Chamber 7. Magnetic Capture Mechanism



Since the original lunar landing in 1969, every mission to the moon has had complications stemming from lunar dust. The Moon's outermost layer is regolith, a loose layer of rocks and dust. This regolith is easily dispersed and strongly adheres to spacecraft, astronauts, and equipment. Because the lunar dust is small, jagged, and electrically charged, it can be a complication for equipment. Our Clinic team was tasked to create a dust mitigation device to aid astronauts in cleaning habitations and their interior surfaces. Swabbing Lunar Environment Dust by Tribocharging-Induced Plasma System (SLED TIPS) uses cold microplasma to charge lunar particulates and remove them from essential surfaces using an electromagnetic field. This handheld device encompasses three major technologies: a triboelectric nanogenerator, a cold plasma outlet nozzle, and a rolling electromagnetic separator. The nanogenerator utilizes a fluoropolymer film rotating about spherical copper blades to sustain an electric field across electrodes in the discharge nozzle. The microplasma propelled from the nozzle (simulated using COMSOL Multiphysics) charges the regolith particles, allowing for subsequent capture with the electromagnetic separator. Our team is pursuing other applications of our novel plasma generator and related technologies, such as food preservation and sanitation.

Merging Bio-based Polymers with Additive Manufacturing (AM)

TEAM MEMBERS
Benjamin Afflitto, Danielly De Miranda Ribeiro, Courtney LeMasney, Hayley Lomas, Megan Master, Evan Vanzura
PROJECT MANAGER
Dr. Joe Stanzione, Alexandra Chong, Jasmin Vasquez
SPONSOR
U.S. Department of Defense - Army Research Laboratory & NSF



The synthesis of bio-based polymers and composites 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 to produce sustainable processes and products. Polymer science and engineering was at the core of this Clinic project. Resins have been formulated and cured, composites have been generated, and improvements in manufacturing such systems have occurred. All resin systems, pre- and post-cured, have been characterized using advanced techniques. Clinic students have worked closely with folks in the Sustainable Materials Research Lab (SMRL) in the Chemical Engineering Department at Rowan University as well as with Rowan's Advanced Materials and Manufacturing Institute (AMMI).

Mixing Technology Applications in Chemical Engineering

TEAM MEMBERS
Andrew T. Sikora, Justin Friel
PROJECT MANAGER
Dr. Zenaida Gephardt

"Mixing is part of many chemical engineering operations. Ineffective mixing can be costly and negatively impact product quality and safety. A general understanding of mixing operations can better prepare students to be strong contributors as they enter the profession. Combined with experimental design, it serves to increase the breadth and depth of students' engineering education and makes students more marketable. For this work, mixing experiments in tank-type systems have been developed to familiarize students with key aspects of the technology. Experimental programs were developed using Six-Sigma methodologies for experimental design and data analysis. Students learned important mixing regime designations, impeller selection, and efficient gas introduction in liquid and liquid/solid systems including measurements of relative power demand. Students also developed proficiency with experimental design and experimental design and data analysis software. The experiments developed for this work were tested in a unit operations course. They had a beneficial influence on student learning and yielded positive student responses. These experiments are highly flexible and can be used with a wide range of students. They can be easily adapted for courses such as fluid mechanics, mixing electives, modules to teach experimental design to first and second year students, and K-12 outreach efforts."

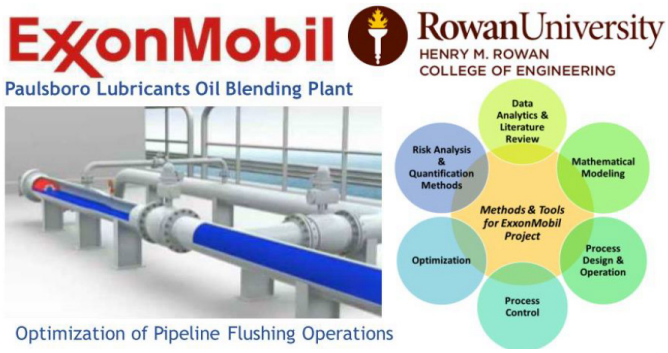
Numerical Methods MATLAB&Python Templates

TEAM MEMBERS
Nicholas Chase, Jordan Holman,
Christopher Dellisanti, Douglas Fisher
PROJECT MANAGER
Dr. Robert Hesketh
SPONSOR
Polymath Software

"PolyMathLite is a PolyMath Software app for Android Phones, Tablets and Computers. In this project we will be working on upgrading and improving this software to work with the current Android operating system.
This app will allow users to easily solve a wide variety of numerical mathematical problems with very efficient numerical analysis algorithms. This enables the efficient solution of very elementary to very challenging problems with efficient and accurate algorithms that have been developed since our first commercialization of PolyMath for the PC in 1984. All capabilities of PolyMathLite are available within the Android device as no internet connection is required for running the app. The following types of problems can be solved on the Android device:
1. Systems of Linear Equations
2. Systems of Nonlinear Equations
3. Systems of Differential Equations
4. Regressions including Linear, Multiple Linear, Polynomial and Nonlinear"

Optimization of Pipeline Flushing Operations for ExxonMobil LOBP

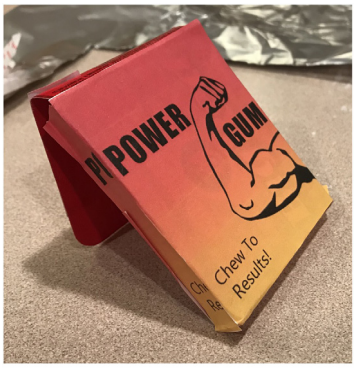
TEAM MEMBERS
Joseph D'Intino, Anthony Wylie,
Jacob Martin, Erik Dunn, Diana Martinez,
Emily Rooney, Swapana Jerpoth
PROJECT MANAGER
Dr. Kirti Yenkie, Dr. Robert Hesketh,
Dr. Stew Slater, and Dr. Mariano Savelski
SPONSOR
ExxonMobil, NJ and US Environmental Protection Agency

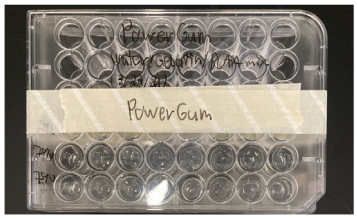


ExxonMobil Lubricants Oil Blending Plant (LOBP) in Paulsboro NJ is Company's 2nd largest facility in the world performing oil blending and filling operations at multiple scales. The plant uses an existing manifold system to perform multiple blending and filling operations as there is a growing demand 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
Chancellor Donahue, Mark Moser, Matthew Addona, Michael Lampasona, Frank Cianciotta, Mackenzie Vukicevich, Adam Griefer, Jacob Willetts
PROJECT MANAGER
Gary Thompson

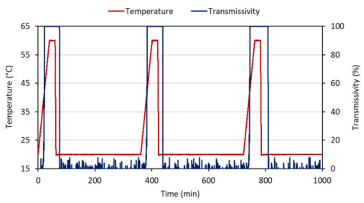


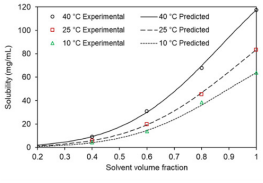


The primary goal of this project is to design either a polymer/biopolymer or gelatin based substance that allows for easier transportation and consumption of essential supplements (branched chain amino acids, beta-alanine, creatine and caffeine) for any fitness goers. Extensive research has been done around degradable polymers, non-degradable polymers, and gelatins in order to determine the best substance(s) for widespread usage. Extensive mechanical testing will be conducted, such as tensile and compression tests, to ensure that the chosen substance's material properties are similar to that of products that are normally consumed by consumers. Cytotoxicity testing, such as gauging ATP content and protease biomarking, will also be conducted in order to determine the safety of the novel supplement mixture. Over the course of the semesters, research dealing with compositions of polymers, gelatins and amino acids, understanding different chemical and mechanical tests, and conducting our own designed experiments has occurred. Further testing needs to be completed however, this project can lead us to developing a successful product that could be sold on the market to consumers around the world.

Solubility and Crystal Nucleation Kinetics

TEAM MEMBERS
Natalie Ogden, Paul Cally
PROJECT MANAGER
Dr. Gerard Capellades and Dr. Robert Hesketh



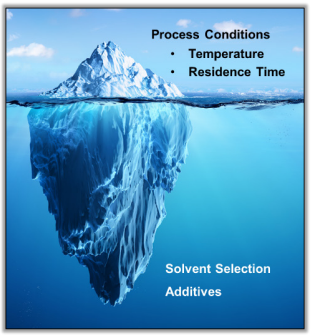


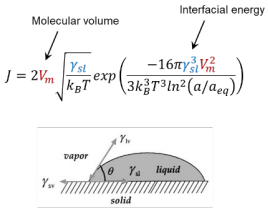
Solubility screening plays a critical role in the development of pharmaceutical processes, both as a first step in the design of crystallizers, and as means to select reactant concentrations that prevent precipitation in process streams. In this clinic, students learn how to apply the polythermal method for the high-throughput screening of solubility curves, as well as how to estimate common solubility parameters from experimental data. In parallel, they utilize the collected experimental data to investigate the probability of crystal nucleation in metastable process streams. The collected experimental data will give an insight on the solvent-dependent nucleation kinetics for different solutes.

Solvent Effects in Pharmaceutical Crystallization

TEAM MEMBERS
Paul Cally, Natalie Ogden
PROJECT MANAGER
Dr. Gerard Capellades

Current Industrial Design Space





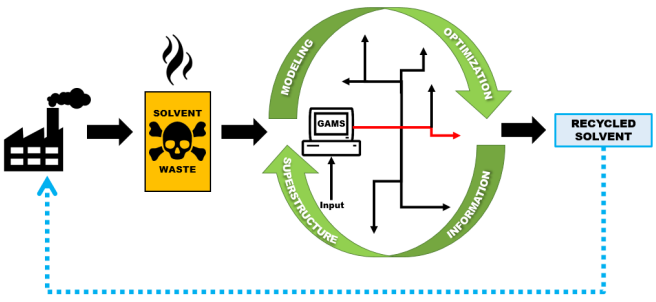
- 26 FDA Class 3 solvents
- ≈ 300 binary solvent combinations
- Infinite combinations for solvent:antisolvent ratios

"Antisolvent addition is one of the most popular methods to induce crystallization in pharmaceutical processes. By changing the solvent composition in a crystallizing solution, we can control both thermodynamics and kinetics of the crystallization process, allowing to generate crystals with a specific size, shape and form, or to reject critical impurities from our final product. Unfortunately, most of the studies on solvent-dependent crystallization are focused on a single parameter (solubility, nucleation, or crystal growth), and the mechanistic expressions that define those parameters have a large number of solvent-dependent variables that are difficult to quantify.

In this project, students drew from literature data on solubility, nucleation, and crystal growth for model organic molecular materials, with preference for products of interest for the pharmaceutical industry. The collected data was be evaluated using available thermodynamic and kinetic models, isolating a set of solvent-dependent parameters from each equation. A comprehensive experimental design for independently measuring those parameters from solubility, crystallization kinetics, or independent measurements, will be prepared. These results will set the basis for a generalized, mechanistic development workflow for antisolvent crystallization of pharmaceuticals."

Solvent Recovery Roadmap for Industries

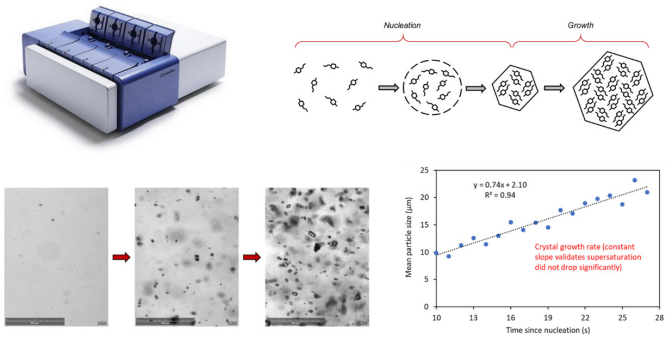
TEAM MEMBERS
Austin Lehr, Kayla Heider, James Geier, Michael Mackley, Jake Stengel, John Chea, Emmanuel Aboagye
PROJECT MANAGER
Dr. Kirti Yenkie, Dr. Stew Slater, and Dr. Mariano Savelski
SPONSOR
U.S. Environmental Protection Agency



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 consult with industries and develop a roadmap for solvent recovery that reduces cost, minimizes environmental impacts, limits waste produced, while also maintaining safe operation. This work is funded by the US EPA.

Solvent-Dependent Crystal Growth Kinetics

TEAM MEMBERS
Margot Clarke
PROJECT MANAGER
Dr. Gerard Capellades, Dr. Robert Hesketh



The rapid development of reliable processes is of utmost importance in the patent-driven pharmaceutical industry. In this context, crystallization often becomes the bottleneck for development due to its thermodynamic and kinetic sensitivity to small variations in the amount and nature of solvents and impurities. In this clinic, students utilize a state-of-the-art equipment for the high-throughput screening of nucleation and growth kinetics. The investigation is centered around batch crystallization of acetaminophen in different solvent systems, using eight parallel crystallizers with access to real time turbidity measurements and process video. Image analysis data is combined with population balance models for the determination of crystal growth kinetics in different solvent mixtures. The data provides an insight into solvent-dependent growth kinetics, and assists in evaluating the applicability of these methods for the design of a robust process from a limited availability of time and raw materials.

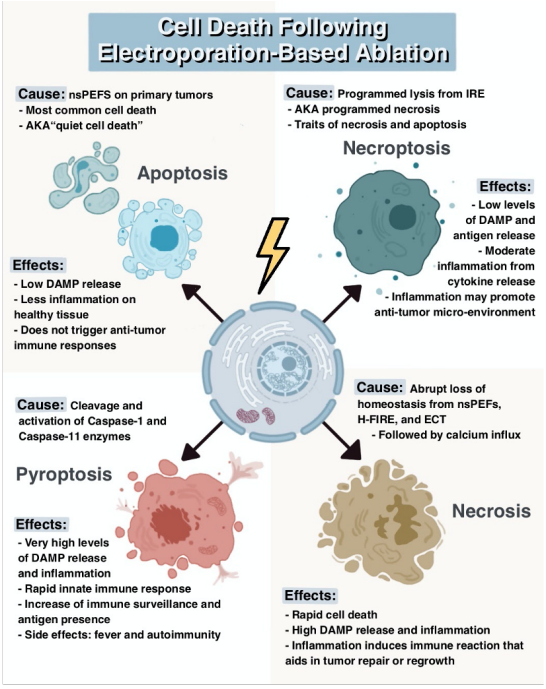
Sustainable Membrane Separations for Coffee Extract Processing

TEAM MEMBERS
David Aguirre, Liam Callahan, Adam Niznik
PROJECT MANAGER
Dr. Stew Slater, Mr. Michael Vincent O. Laurio
SPONSOR
Nestlé USA and U.S. Environmental Protection Agency

Sustainable food manufacturing research has been underway for the last several years with the support of Nestlé Beverage USA (Freehold, NJ) and U.S. Environmental Protection Agency. Currently, we are investigating the use of energy-efficient membrane processes to pre-concentrate coffee extract before spray/freeze drying. This has the potential to save energy by replacing more energy-intensive thermal separations, such as evaporation, thus improving the carbon footprint. Parametric studies were performed to determine optimal operating conditions. Modeling of mass transfer considerations enable an efficiently designed system. This has involved the use of models to further derive the transport mechanisms involved. Some of these concepts include mass transfer coefficients, shear-enhanced flow, fouling resistances, gel layer formation, etc. These correlations can be used to simulate vibratory filtration systems for coffee concentration. Estimated costs and environmental impacts of a proposed scaled-up membrane process have been determined. Our proposed process reuses the water recovered, in plant utility operations; and uses the concentrate as feed to the next drying step in the overall production process. By utilizing both streams (even partially), leads to economic and environmental benefits. This research is supported in part, by a grant from the U.S. Environmental Protection Agency, NP-96271316.

Switching Off Cancer

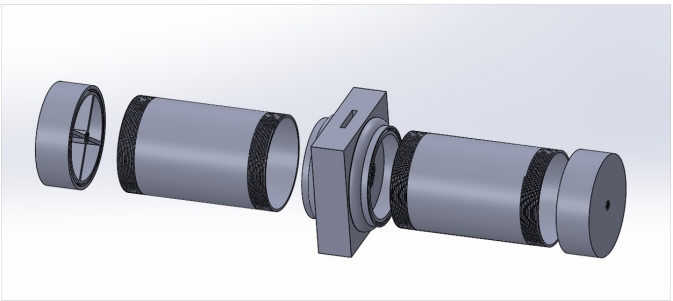
TEAM MEMBERS
Maria Bednar, Sherilynn Garcia
PROJECT MANAGER
Gary Thompson



Advances in less invasive cancer treatment continue to improve year after year. Electroporation ablation therapy has been a prominent contender in the mission to discover alternatives to chemotherapy, radiation therapy, surgery, and transplants. Electroporation therapy consists of delivering pulsed electric fields (PEFs) of various duration and voltages in order to trigger specific immune responses to treat tumors. PEFs work to increase the permeability of the tumor cell membrane making it easier to introduce cancer drugs, induce immune system responses, or cause cell death. PEF exposure can trigger one of four different types of cell death - necrosis, apoptosis, pyroptosis, and necroptosis. Investigating immune responses following cell death play an important part in determining and improving the type of immunotherapy given to a cancer patient. There are five typical immunotherapies including: immune checkpoint inhibitors, monoclonal antibodies, oncolytic virus therapy, T-cell therapy, and cancer vaccines. Our Clinic has reviewed the literature and begun developing approaches to combine PEF technologies with immunotherapies that can give rise to a reliable method of treating cancer with reduced fatigue, pain, and side effects.

Tissue Engineering Electrokinetics

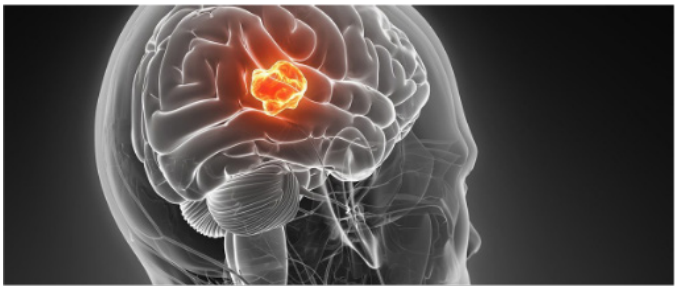
TEAM MEMBERS
Zachary Nicolella, Nicholas Brady
PROJECT MANAGER
Gary Thompson



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. Present decellularized tissue manufacturing methods involve the use of either a chemical treatment such as highly basic material, or a physical process like freezing or high-pressure treatment. Both of these methods lead to less-than-ideal decellularized scaffolds. Physical methods tend to not completely decellularize the tissue although the original structure of the matrix is retained. Chemical methods have the opposite problem, wherein cellular material is cleared but tissue structure is lost. Using a pulsed electric field can remedy the problems of prior methods by using electrophoretic movement of charged cellular materials and electroosmotic movement of uncharged materials. Our Clinic team has designed, manufactured and begun testing a custom chamber for measuring electroosmotic extraction of uncharged materials from decellularized cartilage samples.

Tumor Treating Fields

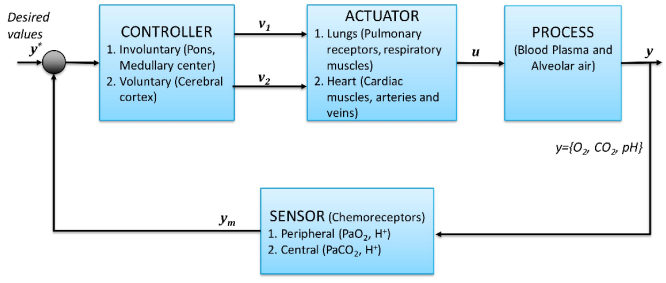
TEAM MEMBERS
Jacob Beyer, Maya Webb
PROJECT MANAGER
Gary Thompson



With nearly 700,00 people in the United States living with a brain tumor and an average survival rate for patients being 34.4%, it is becoming increasingly important to develop a way to treat the spread of tumor cells. However, treatments like surgery, chemotherapy, and radiation cannot always effectively treat cancer and will either not fully cure it or can only delay it, leading to eventual death regardless. Because of these drawbacks, many new pathways for the effective treatment of cancer are being explored to make treatment safer and more reliable. Specifically, ultrasounds or low-frequency pulsed electromagnetic fields (PEMF) in conjunction with chemotherapy drugs can target these tumor cells directly without adverse effects to the surrounding regions. Although both of these methods are effective on their own, they allow for an amplification of the potential of chemotherapy due to their ability to more effectively move the chemotherapy drugs into the system and to treat the tumor region in the process. They can increase the availability of the chemotherapy drugs through induced electroporation, immune cell activation, and ultrasound targeted microbubble destruction, as well as a variety of other mechanisms.

Understanding Respiratory health in COVID19 Patients

TEAM MEMBERS
Brianna Acosta, Kiana Ramirez, Justin York
PROJECT MANAGER
Dr. Kirti M. Yenkie



Control engineering representation in breathing regulation

The respiratory system failure from Acute Respiratory Distress Syndrome (ARDS) is the leading cause of mortality in COVID-19 patients. Some key diagnostic parameters and comorbidities such as hypertension, diabetes mellitus, oxygen saturation are highly correlated with collapsing health and mortality. The manifestation of collapsing cardio-respiratory health is highly complex and dynamic in nature, depending on recent diagnostics and medical history profile. This can be missed out and misinterpreted due to limited time and inefficient testing. This project incorporates deep physiological models and intelligent machine learning algorithms, and physiological control of the respiratory system to learn and use these complex relationships between diagnostics, comorbidities, medical history of individuals to give accurate assessment with minimized testing and suggestions for potential treatment This is in collaboration with IIT Bombay, MetFlux, and Govt. Medical College Nagpur.

Wastewater Treatment & Asset Management

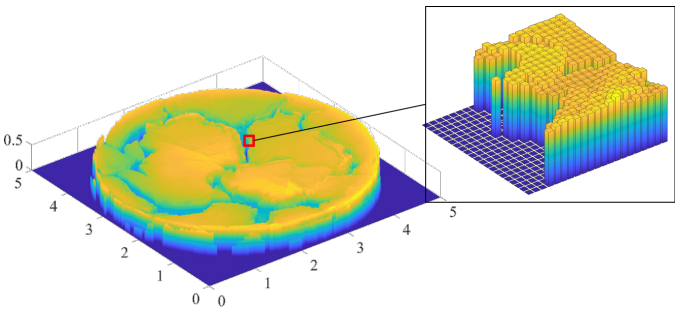
TEAM MEMBERS
Maya Desai, Carley Tran, Phuong Le, Nicolas Altieri, Jake Stengel, Emmanuel Aboagye
PROJECT MANAGER
Dr. Kirti M. Yenkie
SPONSOR
Atlantic County Utilities Authority (ACUA)

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.

CIVIL & ENVIRONMENTAL ENGINEERING

3D Characterization of Soil Using a Structured Light Scanner

TEAM MEMBERS
David Spell, Mitchell Myers, Lauren Blaze, Amanda Groschadl, Joseph Goodberlet, Jiwon Yang
PROJECT MANAGER
Dr. Cheng Zhu
SPONSOR
NSF Long Distance Seed Fund



To capture the 3D morphological features of drying soils, we explore the potential of using a structured light scanner. Bentonite clay is used for desiccation tests. Both 2D images and 3D scans are obtained at certain time intervals throughout the test. We develop a post-processing methodology to quantify the 2D and 3D features of soil cracking, including surface crack ratio, total volume, surface area, and fractal dimension. Experimental results validate that the structured light scanner enables 3D high-resolution and accurate scanning of the soil desiccation cracking patterns.

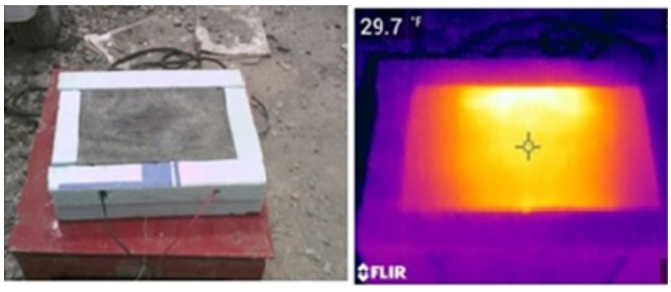
3D Printing of Cementitious Pastes

TEAM MEMBERS
Matthew Funk, Brian Bockius, Mitchell Myers, Joseph Goodberlet
PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Timothy Bertiz

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 as the project progressed to optimize extrudability and buildability. Printer settings were adjusted to maximize extrusion capacity. During the flow table test, flow values were found to range from 70-90% for the most optimized mixtures. 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.

Cold Weather Conductive Concrete

TEAM MEMBERS
Eric Sanchez, Noah Linden, Theodard Tassimbedo, Dino Spinelli
PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Shariar Abubakri
SPONSOR
Cold Regions Research and Engineering Laboratory (CRREL) / U.S. Army Engineer Research and Development Center (ERDC).



An emerging technology for deicing and anti-icing of pavements is using a thin layer of electrically conductive concrete. When given a power source, this concrete can generate adequate heat to prohibit ice formation on a pavement. De-icing is important during winter for pavement, bridge decks, airfields, and runways to ensure safety and low maintenance costs to keep snow and ice from forming. Self-de-icing pavements would allow runways to be opened remotely without heavy equipment. Cold weather conductive concrete (CWCC) has been developed by including conductive admixtures such as carbon fiber, nanofiber, and steel fiber. The mixing, casting, and curing process is done at a temperature of -5 °C (23 F) without frost damage. Assessment of mechanical properties such as compressive strength, flexural strength, shrinkage, conductivity, freeze-thaw durability, and bond between the concrete substrate and CWCC was performed.

Cold Weather Reinforced Concrete

TEAM MEMBERS
Christian Elimanco, Morgan Carr, Jeffrey Clouser
PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Douglas Cleary, Dr. William Riddell, Dr. Shariar Abubakri
SPONSOR
Cold Regions Research and Engineering Laboratory (CRREL) / U.S. Army Engineer Research and Development Center (ERDC).

The goal of the research is to apply the cold weather concrete mixture technology developed at CRREL (U.S. Army Engineer Research and Development Laboratory/Cold Regions Research and Engineering Laboratory) to reinforced concrete applications. A systematic step-by-step process of studying the characteristics of cold weather concrete (CWC) was undertaken to achieve this goal. The mechanical properties of the portland cement concrete under “normal” (20 to 25 °C) and cold weather conditions (10 to -60 °C) determined. The mechanical properties measured were compressive strength, elastic moduus, flexural strength, and shear strength. Durability tests were also conducted on the hardened concrete mixtures. The durability tests were cyclic freezing-thawing, carbonation, drying shrinkage, and chloride ion permeability. It was found that the mechanical strength and modulus tend to increase with decreasing temperatures and that CWCs are as durable as concrete made at normal conditions.

Controlling and Preventing Shrinkage Cracking in Concrete

TEAM MEMBERS
Seth Wagner, William Krenza, Michael O’Rourke, Michael Dorrer, Matthew Pensabene, Chris Pear
PROJECT MANAGER
Dr. Douglas Cleary, Dr. Gilson Lomboy, Dr. Cheng Zhu
SPONSOR
NJDOT

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 (w/cm), and various admixtures in the concrete. The overall goal of the study is to improve the longevity and performance of New Jersey transportation infrastructure through reducing the concrete shrinkage and cracking potential, which will prevent the ingress of water and other deleterious substances into the concrete. More specifically, it is to identify the major shrinkage components (chemical, autogenous, and drying shrinkages) currently present in New Jersey concretes and the application of recent innovations (shrinkage reductions, compensation, and internal curing, coatings, and fibers) in shrinkage cracking mitigation. In addition, this project will help quantify the magnitude of the shrinkage processes operating in New Jersey concrete and it will help evaluate how cracking prevention measures impact these shrinkages. It is expected that the research results will provide New Jersey engineers with the insight needed to improve both concrete mix proportioning and construction practices so as to reduce shrinkage cracking of infrastructure concrete.

Deck Truss Bridge

TEAM MEMBERS
Taimoor Akhtar, Marc Gernhardt, Daniel Frain, Sean Quick, Quang Nguyen
PROJECT MANAGER
Dr. Ralph Dusseau
SPONSOR
Delaware River and Bay Authority

Accurate modelling systems can greatly reduce the difficulty of analyzing existing structures, or assessing future structures. In order to create an accurate modelling system, it is crucial to ensure accuracy by comparing the results of the model against the known conditions of a real life example. The real life example observed for this project is the Betsy Ross Bridge. Span E2-E3 of the bridge is modeled in RISA 3D. The span is a steel truss made of steel I-beams and box beams. Currently, the bridge has been modeled in 2D and analyzed under dead loads and live loads. The bridge has also been modeled in 3D and all subjected loading is being calculated and applied. The resulting deflections under solely dead loads have been found to accurately match the expected deflection in the given bridge design plan's camber diagram with less than a five percent error for 2D models and less than three percent error for 3D models. Wind loads have been taken into account and calculated and implemented into the RISA 3D model to produce member stresses due to wind loads and dead loads. A similar analysis has been done in 3D with live loads and dead loads.

Developing Innovative Video Learning Modules for the Civil Engineering Classroom

TEAM MEMBERS
Cole Panek, Noah Pratt, Brittany LeMasney, Lisa Bianco, Richard Cabrera-Felix, Jack Schaefer, Filianna Zarifis
PROJECT MANAGER
Dr. Sarah Bauer, Dr. Mohammad Jalayer, Dr. Gilson Lomboy, Dr. Cheng Zhu
SPONSOR
Rowan University's Faculty Center

The use of innovative, educational videos not only enhances student learning, but reinforces difficult subject matter and increases the use of visual learning. The goal of this project is to incorporate the educational use of innovative technologies by developing learning modules for three disciplines of Civil Engineering (CE). Transportation Engineering: Wrong-way driving accidents are the most lethal form of accidents on the road and can be difficult to visualize without detailed drawings. Video animations developed to exemplify the ways that Transportation Engineering can mitigate the chances of such accidents. Environmental Engineering: A large component of Environmental Engineering is performing water quality assessment/monitoring in the field. To ensure students' understanding of the procedures of in-class laboratory experiments, visual modules were developed to demonstrate field-testing of water quality parameters. Geotechnical Engineering: Real world applications of geotechnical engineering can be at times difficult to understand. Videos were developed to display the application of geotechnical engineering in foundation designs. The implementation of technology-based learning modules offers new opportunities to teach students through visual aids. The implementation of these learning modules will demonstrate the application of various contemporary engineering technologies in the visualization of traditional CE concepts.

Development of 100% Recycled Asphalt Mixture for Military Use

TEAM MEMBERS
Christopher McCormick,
Woodrow Crosby-Piszczek
PROJECT MANAGER
Dr. Yusuf Mehta, Dr. Daniel Offenbaker
SPONSOR
US Department of Defense

The “Development of 100% Recycled Asphalt Mixture for Military Use” project aimed to design an asphalt mixture that can be used to recycle and repurpose existing military roadways. The project involved the modification of asphalt binder with rejuvenators and rheological testing of the modified asphalt binders. Specifically, the research team identified four different rejuvenators from literature that would be appropriate for this project. Following the literature search, the research team conducted several laboratory activities including: mixing rejuvenators and binders, aging the modified asphalt binder to be representative of field construction, and performance grading of the modified asphalt binder. The research team found that the rejuvenators were capable of reducing the stiffness of asphalt binders. With this information, the research team found that the modified asphalt binders were capable of being used in harsh arctic climates. Based on the laboratory results, the research team was able to identify and recommend specific rejuvenators that would be suitable for the development of a full-recycled asphalt mixture.

Development of hands-on activities for geotechnical outreach in K-12 classes

TEAM MEMBERS
Michael Mroz, Samuel Mossop, Tyler Mericle,
Adam King, Dino Spinelli,
Piero Benites-Navarrete
PROJECT MANAGER
Dr. Cheng Zhu, Dr. Sarah Bauer
SPONSOR
Lindback Foundation

Geotechnical engineering subjects are perceived as difficult, emanated from the fact that soil and rocks are complex, heterogeneous materials, and geotechnical design involves significant uncertainties. Research indicates that it is important to demonstrate the social relevance of the topic and its interesting applications. This study aims to develop diverse hands-on activities to attract K-12 students into the field of geotechnical engineering. We develop a class module to introduce to local school students the fundamental concept and various applications in the field of geotechnical engineering. To further demonstrate the geotechnical concepts, four in-class hands-on activities are designed, covering topics such as coastal erosion, soil reinforcement, earth retaining wall, and soil liquefaction. These activities use simple materials and are easy to implement in a regular classroom setting. Survey questions are designed to collect the feedbacks of students and teachers, and help further improve these hands-on activities. Through the development and implementation of such geotechnical engineering activities, expected outcomes include: (1) increased student interest in learning geotechnical engineering topics, (2) increased student aptitude in geotechnical engineering concepts, and (3) increased student connections between geotechnical engineering practice and community goals and values.

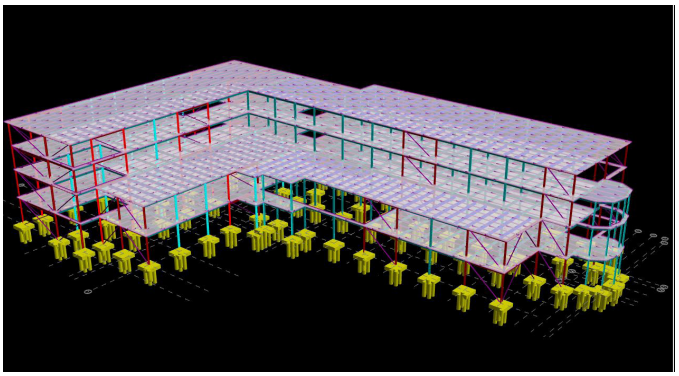
Durability of Concrete with RCA

TEAM MEMBERS
Ross Capri, Matt Yoslov, Michael Graziano, Sarah Herchenroder, Meghan Sparks, William Holloway
PROJECT MANAGER
Dr. Gilson Lomboy, Dr. Douglas Cleary, Tasnia Khan, Ariel Aragoncillo
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. The research covers determining the durability properties of concrete with 100% crushed concrete coarse aggregates and relating the durability of concrete to the physical, mechanical, and durability properties of RCA and the RCA parent concrete. RCA being studied have two nominal maximum sizes and mixed in concrete with two water-to-cement ratios. The concrete durability properties obtained are resistance to degradation, resistance to alkali-silica reactivity, resistivity test, density, absorption, and voids in hardened concrete. The research results contribute to increasing the use of RCA in concrete through the development guidelines on its incorporation in concrete. This is also expected to contribute to the reduction in cost as well as increasing environmental benefits.

Engineering Design Software

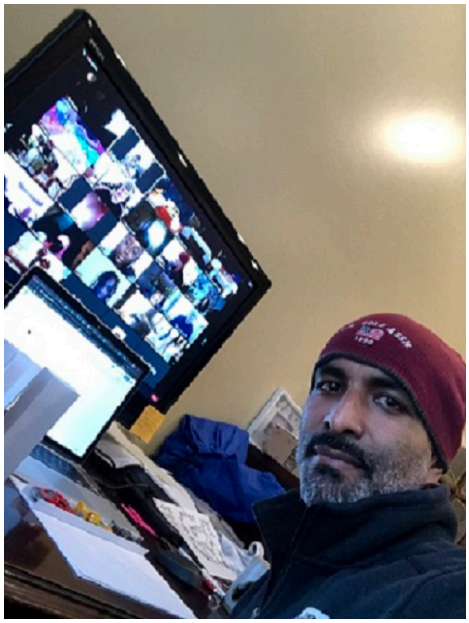
TEAM MEMBERS
Andrew Pierson, Caleb Nicholson, Timothy Osgood, Christopher Kaminskas, Isabella Tarantino, Michael Murray, Evan Kelly, Nicholas Matarazzo, Zarrella Matthew
PROJECT MANAGER
Dr. Douglas Cleary



“Universities have access to civil engineering design software for use in an educational setting at low or no cost. In this project the team of students is learning how to use selected design software for which Rowan University is licensed. This includes Autodesk Civil3D, Microstation, STAAD, REVIT, RAM Structural System, Plaxis, ArcGIS and Synchro. The team is improving their skills with this software, developing tutorials for use by future students that implement their own experiences navigating the software learning curve, and exploring ways the software could be used to supplement current instruction in courses throughout the civil engineering curriculum. The team is also developing sample projects that can be used to teach and demonstrate how to use these varied software packages.“

Engineering Outreach Virtual STEM projects inspire over 200 K-8 students

TEAM MEMBERS
John Mazzagatti, Kareem Pitts, Julia Konstantinos, Karl Hauck, Erick Leon-Garcia, Sean Wilson
PROJECT MANAGER
Melanie Basantis



"Due to this year's transition to virtual, the engineering clinic team had to quickly and creatively develop engineering projects for the K-8 audience to be presented in the remote environment and determine a process for delivering these hands-on engineering activities to virtual classrooms throughout the region. Working with Pennsauken School District, the engineering students developed projects and determined online delivery options. However, after almost a semester of development, the pilot project was unsuccessful due to several variables. Applying the engineering design theory of "design, test, re-design", the clinic team the clinic team quickly re-designed the projects to accommodate at-home learners. Four successful projects were presented remotely last semester and engineering students learned valuable lessons.

The Clinic team was determined to continue presenting remote projects to showcase the exciting and dynamic field of engineering to their K-8 audience so Spring semester, with the ground rules established and additional team members, the 2021 clinic team developed new projects using the online software TinkerCAD and OnShape while improving on the simpler hands-on projects such as bridge building. The clinic team will be remotely presenting multiple times to Pennsauken, Winslow, Estelle Manor and Girls Inc this semester, introducing over 200 K-8 students to engineering through project-based virtual learning."

Evaluating the Roadway Warning Signs for Autism Spectrum Disorder

TEAM MEMBERS
Buket Sadak, Alexander Vapooris, Pawl Woods, Owen Yovoski, Patrick Skurat, Haley Jones
PROJECT MANAGER
Dr. Mohammad Jalayer

In 2014, the New Jersey Academy of Science reported 1 in 34 eight-year-old children were diagnosed with Autism Spectrum Disorder (ASD). New Jersey has the highest rate of ASD diagnoses in the country, which raises concern about interactions between children with autism and traffic safety. Over the past years, different agencies across the nation used disability warning signs to warn traffic of existing hazardous conditions on roads. However, the effectiveness of these signs in changing driver behaviors needs to be explored. This study evaluated the effectiveness of these signs in the state of New Jersey using two locations that had ample traffic volumes. To do so, traffic studies were performed in areas with "Autistic Child Area" signage to monitor driver behavior with respect to the posted signs using a speed radar and video camera. With this equipment two proxy measures were taken for vehicles: brake lights and recorded speed. The results of this study show that over 92% of drivers do not change their speed when they encounter these signs. In addition, study also looks to better understand the effectiveness of Autism Spectrum Disorder roadway warning signs by collecting data based on interviews.

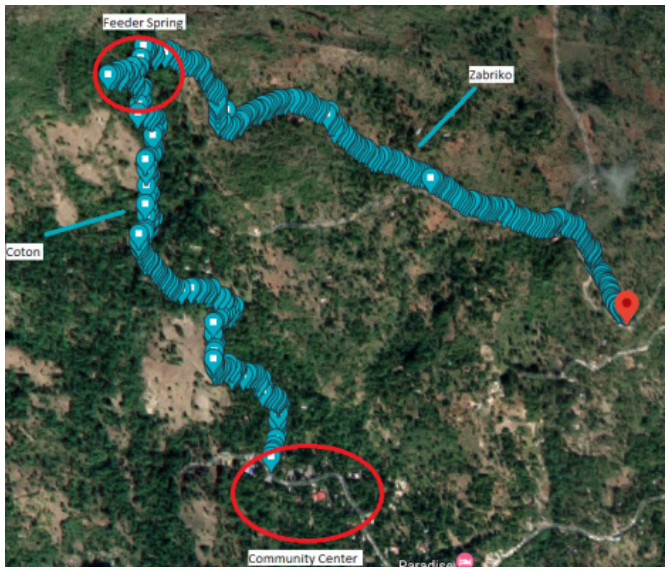
Full-Scale Evaluation of Geosynthetic Interlayers in Asphalt Pavements

TEAM MEMBERS
Britton Williams, Jonathan Muller, Herys Rivera, Amanda Leber
PROJECT MANAGER
Dr. Yusuf Mehta, Dr. Daniel Offenbacker
SPONSOR
U.S. Department of Defense

"Full-Scale Evaluation of Geosynthetic Interlayers in Asphalt Pavements" project evaluated the use of geosynthetic interlays in asphalt pavements to prevent pavement cracking. The project involved laboratory testing and full-scale evaluation using the Heavy Vehicle Simulator (HVS). The project included one geogrid and one geotextile as different interlayers in delaying pavement cracking. The research team fabricated laboratory specimens for bending beam fatigue testing. The research team also developed and prepared the full-scale HVS sections for testing. This included sensor installation and evaluation, HVS preparation, and preliminary heavy weight deflectometer testing. The research team found that the heavy weight deflectometer testing was capable of detecting underlying pavement cracks beneath the surface. Further, the heavy weight deflectometer was able to identify the reinforcing impact of geogrid interlayers. HVS testing is currently being conducted and the research team is monitoring each section for cracking through visual inspection and profilometer measurements.

Haiti Community Water Project

TEAM MEMBERS
Rylie McBreen, Cole Panek, Stefano Sferra, Eric Schuhrer, Jeremy Brown, Alexander Salazar, Kyle Akah
PROJECT MANAGER
Tiago Forin, Dr. Scott Streiner



This project is concerned with securing water in a rural community in southern Haiti. There are subsistence farmers who live outside of Jacmel, Haiti who rely on collecting water from a nearby spring as well as rainwater harvesting. There are three communities that utilize footpaths that travel to the spring. Clinic students focused on mapping out the footpaths to see where a gravity-fed system and sites for rainwater harvesting can be established. Mapping out a gravity-fed transportation system is essential for engineers to understand how to implement the project in a effective manner by providing information for system design and contributing cost estimations for implementation. While partnered with community partners, students also looked at the possibility of having rainwater harvesting sites along the footpaths that will allow farmers better access to more water. Students also took this experience and helped develop a case study for assisting future students who are interested in having an experience involving humanitarian engineering.

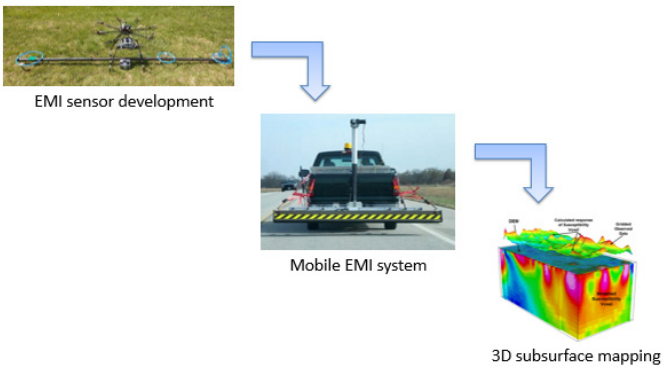
Identify the Distracted Drivers in New Jersey

TEAM MEMBERS
Omar Al-Sheikh, El-Hadj, Zach Bakley, Connor Mccafferty
PROJECT MANAGER
Dr. Mohammad Jalayer
SPONSOR
NJDHTS

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

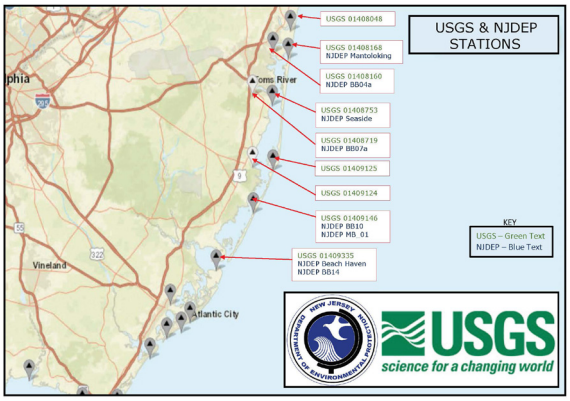
TEAM MEMBERS
Ryan Eno, Flynt Tuller, Jackie Charlton, Jacob Bohn, Marybeth Sanford
PROJECT MANAGER
Dr. Cheng Zhu
SPONSOR
U.S. Department of Defense



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.

Investigation of Hydrodynamics and Water Quality in Barnegat Bay, NJ

TEAM MEMBERS
Piero Paolo Benites-Navarrete, Matthew A Dreisbach, John Xavier Henley, Brett J Hughes, Adam Michael Kaczorowski, Paul J Reiff, Connor Patrick Quinn, Kyla Noelle Rollo, Katherine Villacis
PROJECT MANAGER
Dr. Jeong Eun Ahn
SPONSOR
Armand Corporation



The impacts of sea level rise have exposed social, economic, environmental, and structural vulnerabilities for communities established along coast lines. Barnegat Bay is one of the most vulnerable and susceptible areas to coastal storms and hurricanes in the state of New Jersey, as shown when it experienced SuperStorm Sandy. To increase resilience of coastal communities to storms and hurricanes, investigation and prediction of hydrodynamics is crucial. Therefore, this research uses ADCIRC (ADvanced CIRCulation Model) to develop a 2-D hydrodynamic model in Barnegat Bay; the 2-D hydrodynamic model calculates currents, water levels, salinity, and temperature. To fully develop and validate the model, water elevation, velocities, salinity, and temperature data should be collected. This clinic team obtained data sets from various NJDEP and USGS stations located in the Barnegat Bay and analyzed the data to be used as the input data for the model and validation efforts. The fully tested model will be used to investigate the water flow and tidal movements. Most importantly, the model simulations will allow the predictions of impacts of climate change, sea level rise, as well as future extreme weather events.

Investigation of Saltwater Intrusion in Cape May County, NJ

TEAM MEMBERS
Nicolas Delano Amariles, Stephania Bocanegra, Jennifer Nissa Crown, Emily D Twining, Edward J Kane, Adam Sander King, Joseph A Rotondo, Grace Watson
PROJECT MANAGER
Dr. Jeong Eun Ahn
SPONSOR
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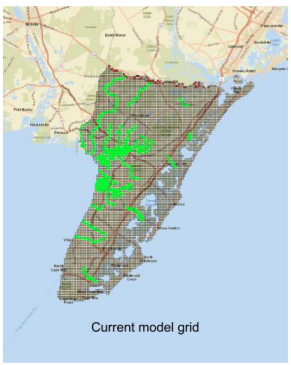
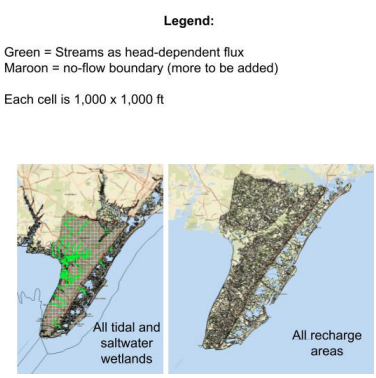




Saltwater intrusion has become a major problem for Cape May County, New Jersey. Aquifers and wells have been severely affected by saltwater intruding the fresh groundwater supply. As saltwater enters a freshwater aquifer or well, it effectively renders that water supply useless for water consumption or usage. As a result, many wells in the Cape May area were shut down or relocated due to high salinity and chloride concentrations within the water being withdrawn. This clinic team collected and analyzed data such as water withdrawal and recharge rates of Cape May County aquifers, sea level, depth of water in specified wells, hydraulic conductivity, leakance, porosity, and confining boundary units. The data collected is being implemented to create a model using the program GMS MODFLOW (Modular Three-Dimensional Finite-Difference Groundwater Flow Model) and SEAWAT. The SEAWAT program was developed to simulate three-dimensional, variable- density, transient ground-water flow in porous media. The model is developed by using a 3D grid to define layers, elevations, and material properties. The model results will help determine the future impact of saltwater intrusion and allow us to further investigate how much of an impact saltwater intrusion is having on potable water within Cape May County.

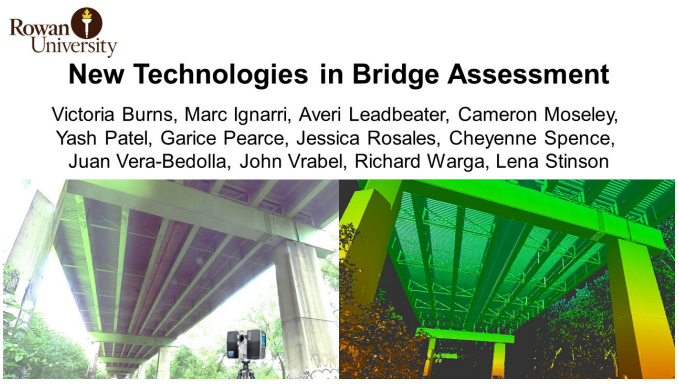
Measuring Driving Behavior Using VR

TEAM MEMBERS
Rich Cabrera-Felix, Liron Derguti and El-Hadj Drame
PROJECT MANAGER
Dr. Mohammad Jalayer

Virtual Reality (VR) has been a growing field over the past decade. It allows the user to create, experience, modify, and explore a completely immersive 3D world from their seat. VR can be implemented in designing models, training programs, and many other areas. Over the past years, different research centers across the world used VR in their transportation sectors to focus more on pedestrian and driver behaviors. In addition, researchers have made great strides in fully immersing their subjects in order to get the best possible results. The objective of this project is to summarize the applications of Virtual Reality that can explore the effects of roadway and highway features on road users' safety. Additionally, the project also has the goal to examine human behaviors in certain traffic scenarios using different case studies to discover any possible opportunities, challenges, and issues associated with the implementation of VR technologies. The results of this study will provide valuable information for researchers, engineers, and policymakers to employ.

New Technologies in Bridge Assessment

TEAM MEMBERS
Victoria Burns, Marc Ignarri, Averi Leadbeater, Cameron Moseley, Yash Patel, Garice Pearce, Jessica Rosales, Cheyenne Spence, Juan Vera-Bedolla, John Vrabel, Richard Warga, Lena Stinson
PROJECT MANAGER
Dr. Adriana Trias-Blanco



The New Technologies for Bridge Assessment clinic focuses on processing data acquired through a terrestrial laser scanner (TLS) utilized for bridge geometry characterization and further structural analysis purposes. The data collected through the TLS or Light Detection And Ranging (LiDAR) is registered and assembled to create a point cloud containing X Y and Z coordinates of every point that made contact with the structure in question, within the range of the equipment. On this clinic students were able to process the point cloud data through (1) Manual data selection, and (2) MATLAB-based code, which allowed them to identify a detailed comparison of benefits and shortcomings of the two processing methods. The data processing consisted on measuring the cross section of the as-built geometry of the bridge girders. The final product of this clinic was the estimation of the structural capacity of the bridge members, based on the cross-section geometry measured following the aforementioned processing methods. This clinic provide students with the understanding of bigdata visualization and processing methods and software, as well as state-of-the-practice structural analysis mechanisms.

NJDMAVA Resiliency Planning

TEAM MEMBERS
Parth Patel, Patrick Marshall, Maximilian Husar, Brandon Reyes, Earnest Daniel
PROJECT MANAGER
Dr. Jess Everett, Dr. William Riddell, Dr. Rachel Margolis
SPONSOR
NJ Department of Military and Veteran Affairs

Students learn about sustainable engineering while helping the New Jersey Army National Guard improve mission capability. Rowan University helps NJARNG reduce energy & water consumption, increase efficiency & renewable energy percentage, reduce building & fleet greenhouse gas emissions, write federally mandated energy conservation and power resilience documents, research innovative technologies, conduct life cycle cost assessments, assist with energy project development, and develop education/awareness materials.

Figure 4. Rooftop solar panel arrays. In FY20, this system generated 464,000 kWh of energy, enough to power 44 typical homes.

NJDMAVA Building Audits

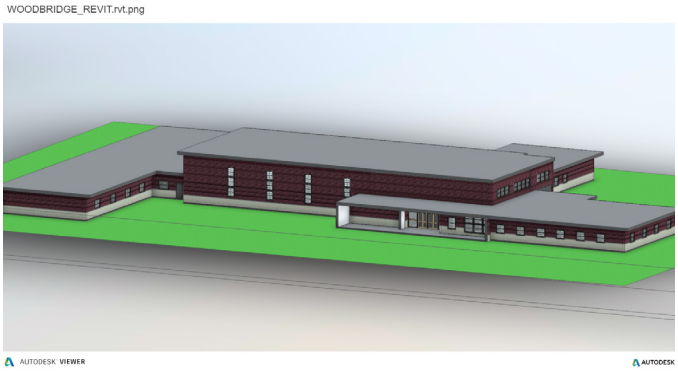
TEAM MEMBERS
Jacob Christy, Brandon Cunningham, John McAvey, Jason Halvorsen, Justin Hillman, Oluwagbogo Ajimoko, Ali Elhamawi, Thomas Nappi, Jeff Stewart, LN Blackburn, Jason Muermann
PROJECT MANAGER
Dr. Jess Everett, Dr. Robert Krchnavek, Mac Haas
SPONSOR
NJ Department of Military and Veteran Affairs

Students carry out building audits (energy & water) for the NJ Department of Military & Veterans Affairs. They use field equipment: light meters, clamp ammeters, killawatt meters, ballast checkers and/or blower doors. They use software to model energy consumption, including eQuest & Excel. They make recommendations for saving energy & water. This is three Clinics, one each in Civil, Mechanical and Electrical Engineering.

NJDMAVA Building Information Models

TEAM MEMBERS
Amanda Zabielski, Zachary Hyson, Thomas Julian, Juan Solano-Linares, John Quinn, John Foster
PROJECT MANAGER
Dr. Jess Everett, Dr. William Riddell
SPONSOR
NJ Department of Military and Veteran Affairs

Students create 3D computer models of New Jersey Army National Guard buildings. They stitch 3D point clouds in AutoDesk ReCap and create the 3D Building Information Models (BIM) in AutoDesk Revit. Rowan provides 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.



NJDMAVA Sustainable Facilities

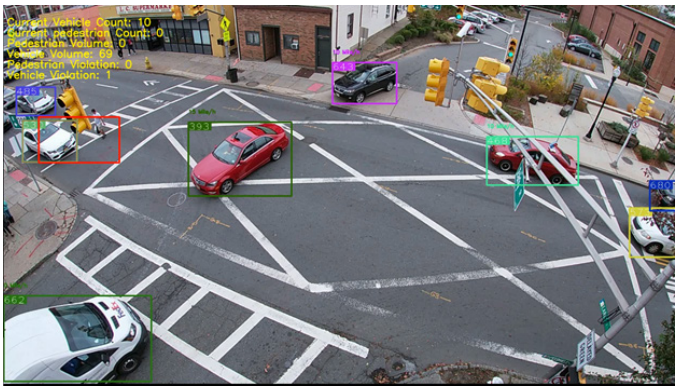
TEAM MEMBERS
Wyatt McCart, Christopher Malone, David Palacios, Samuel Ramos,
PROJECT MANAGER
Dr. William Riddell, Dr. Jess Everett, Dr. Kathy Mullins
SPONSOR
NJ Department of Military and Veteran Affairs

“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; create unique design solutions that include repair vs. replace cost estimation and life cycle analyses; and solve problems that are structural, HVAC, plumbing, and/or electrical in nature. “

Real-Time Intersection Safety Monitoring

TEAM MEMBERS
Quang Nguyen, Connor McCafferty, and Patrick Marshall
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.

Rebar at Cold Temperatures

TEAM MEMBERS
Marc Ignari, Christopher McCormick, Tyler Mericle, Christopher Pear, Steven Selfridge, Sean Smithson, Leslie Soto Miranda
PROJECT MANAGER
Dr. William Riddell, Dr. Douglas Cleary, Dr. Gilson Lomboy
SPONSOR
Cold Regions Research and Engineering Laboratory (CRREL), U.S. Army Engineer Research and Development Center (ERDC)

The potential for extreme cold is of concern for the construction and service life of reinforced concrete structures in the Arctic. As part of a comprehensive program, mechanical properties of reinforcing materials (A615 GR60, A706 GR60, A955 GR75 and A1035 GR100) at temperatures ranging from +20 °C down to -60 °C were evaluated. The effects of temperature change on impact energy, yield stress, ultimate stress, elongation at failure and the ability to withstand deformation in bend tests were quantified. Sample reinforced concrete structural components were then analyzed accounting for changes in behavior for reinforcing and concrete materials. The purpose of these analyses was to identify compatibility issues where structural behavior might become brittle as a result of changes in material properties. Results of these studies inform recommendations for the application of Unified Facilities Criteria to construction in the Arctic.

RED Project

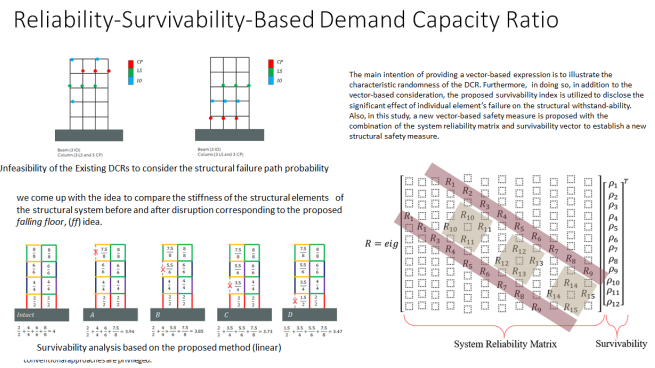
TEAM MEMBERS
Mitch Burnham, Jen Carson, Andrew Fuzesi, Brandon Hayes, Jeff Kincaid, Sydney Iatarola, Matt Pace
PROJECT MANAGER
Dr. Ralph Dusseau

ROWAN
ENGINEERING

This clinic project involved creating curriculum guides for Civil Engineering students that plan on transferring to Rowan University from a Community College in the surrounding local area. This study covered over 20 community colleges from the surrounding areas including Pennsylvania, Delaware, and New Jersey. As a team, we ensured all of the curriculums would fulfill both the community college requirements for an Associate's Degree in Engineering Science and a Bachelor's of Science in Civil Engineering at Rowan University. Most of the curriculum guides conformed to the standard 8 semesters of schooling, although some required an additional semester of classes during the Winter or Summer. The completed curriculum guides for each college are detailed enough for the transfer student to understand which courses to take in order to stay on track to graduate in 4 years.

Reliability-Based Demand Capacity Ratio Concerning the Survivability Index

TEAM MEMBERS
Bridget Guinan, Kyle Rink,
Lesly Soto-Miranda,Lucas Stroud
PROJECT MANAGER
Dr. Seyed Hooman Ghasemi



Demand-capacity ratio (DCR) is a measure of structural demand on a member against its capacity. While it has been widely used in representing structural safety and economic aspect of a member, conventional DCRs have three major weaknesses including the deterministic expression of DCR with ignorance of its probabilistic nature, the inconsequential link between element's DCRs and system's DCRs, and obliviousness of the influence of the structural survivability on the failure pattern. Hence, the main contribution of this research is to provide a background for a new generation of the demand-to-capacity ratio to prevail the abovementioned weakness. In fact, a vector-based expression is proposed to demonstrate the inherent randomness of DCR. Accordingly, a new structural metric called survivability index is introduced. The survivability indicator is introduced to reflect the rank of the structural elements regarding the structural stability concern. The survivability indicator is corresponding to the structural load-carrying capacity before and after the disruption. Accordingly, using the system reliability concept and graph theory two types of the new DCRs were proposed including scalar and vector-based DCR.

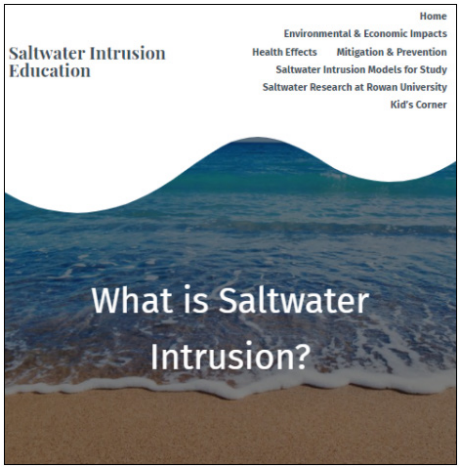
Repair with UHPC

TEAM MEMBERS
Randall Sivak, Cole Quimson, Eric Gilbert, Nicholas Giagunto, Steven Selfridge, Dominic Lepone
PROJECT MANAGER
Dr. Gilson Lomboy, Harshdutta Panda

Ultra-high performance concrete (UHPC) is a portland cement-based composite with very low water-to-cement ratios, optimized gradation, and short discontinuous fibers. UHPC has high flowability and has compressive strengths that are greater than 22 ksi. The UHPC developed by the clinic team comprises of Type I portland cement, undensified silica fume, high range water reducer, fine silica aggregates, and 12 mm steel fibers. The current research activities were repairing corroded beams with UHPC and determining their response to cyclic loading. Additionally, the behavior of corroded rebar reinforced HPC beams with UHPC used as a repair material were analyzed using the finite element method. Six foot long beams were cast, subjected to corrosion, repaired with UHPC, and tested by cyclic loading. Beams repaired with UHPC were able to withstand the original design strength of the beams.

Saltwater Intrusion Educational Outreach

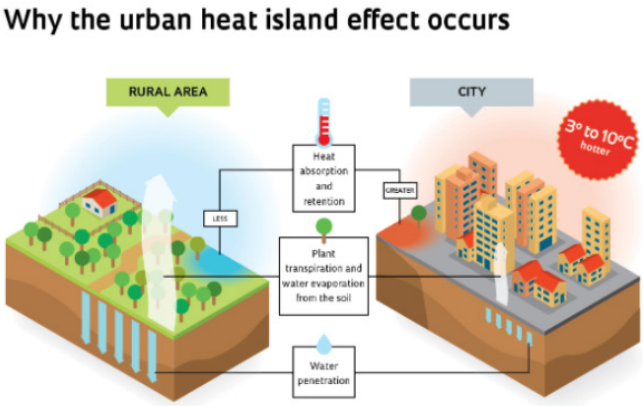
TEAM MEMBERS
Brayden Carr, Brandon Carmosino, Anthony Havens, John Restrepo, Brandon Vecere
PROJECT MANAGER
Dr. Sarah Bauer, Dr. Jeong Eun Ahn
SPONSOR
New Jersey Water Resources Research Institute



The goal of the saltwater intrusion educational outreach clinic is to spread awareness throughout New Jersey of the threat of saltwater intrusion in and around our communities. The vehicle for their message was a custom-made website (www.saltwaterintrusioneducation.wordpress.com) that will educate New Jersey residents on the threats saltwater intrusion poses to private property, personal health, environmental well-being, and local funding. The website also includes a section dedicated to a much younger audience to fulfill the K-12 level of educational outreach. This section, titled the “Kid’s Corner” contains more simplified information than the other sections of the website as well as powerpoint lessons and interactive experiments and activities. Kid’s Corner activities are presented not only as instructional videos, but also as printable handouts for teachers and parents to use in the classroom and the home. The website will also display the results of Dr. Ahn’s research team which is studying saltwater intrusion in Cape May, New Jersey.

Social Viewpoints of Urban Heat Islands and Green Infrastructure

TEAM MEMBERS
Gillian Castaldo, Benjamin Chan, Kira Rose, Joseph Rynkiewicz, Jordan Schuller
PROJECT MANAGER
Dr. Sarah Bauer, Mahbubur Meenar



https://land8.com/how-landscape-architecture-mitigates-the-urban-heat-island-effect/

The Urban Heat Island (UHI) effect has been shown by prior research to have significant negative effects on cities' levels of air pollution, energy consumption and human health due to its nature of causing increased temperatures in dense urban environments. This localized increase in temperature is due to the impacts of human activity and modern urban infrastructure. This research aims to provide insight on the public's perception of the UHI effect in Camden City, which is a densely populated area and an example of a location that is known to be susceptible to the impacts of this phenomenon. This study's intent is to understand social perspectives of UHI by analyzing Twitter social media data that mentions the UHI effect and similar topics. Additionally, a survey was conducted to gather the personal impacts and viewpoints of those who live, work, and/or frequently visit Camden City. This social insight allows for deeper understanding of the population's understanding of and opinions on UHI. This research will inform future recommendations regarding effective UHI education and mitigation strategies.

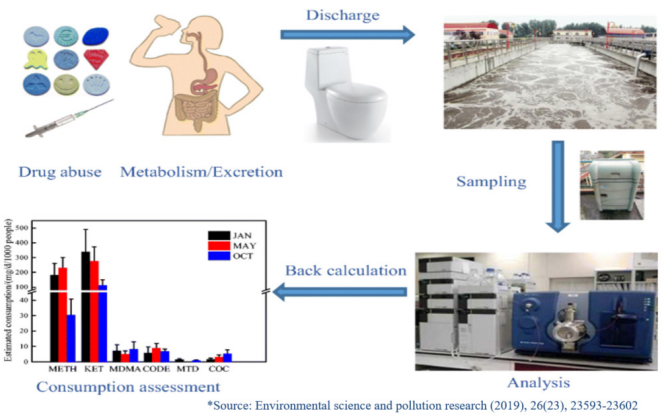
Strength of Concrete with RCA

TEAM MEMBERS
Daniel Rubin, Vincent Letizia, Christian Jones, John Trabucco
PROJECT MANAGER
Daniel Rubin, Vincent Letizia, Christian Jones, John Trabucco
SPONSOR
Cold Regions Research and Engineering Laboratory (CRREL) / U.S. Army Engineer Research and Development Center (ERDC)

Recycled concrete aggregates (RCA) are produced by crushing the old concrete. 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 mixed type RCA will also be 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.

Tracking of Opioids through Wastewater Based Epidemiology

TEAM MEMBERS
Liam Cutri-French, Liron Derguti, Taylor Repko, Ryan Stroka, Joseph Walsh, Karim Chowdhury
PROJECT MANAGER
Dr. Sarah Bauer
SPONSOR
Rowan University's Camden Health Research Initiative



*Source: Environmental science and pollution research (2019), 26(23), 23593-23602

Typical ways to determine drug usage in an area are through self reported surveys, consequence data such as overdoses, toxicology lab results, treatment admission, and drug related crimes. These methods leave gaps in the data and are not able to account for the possible illegal drug usage that exists. Wastewater-based epidemiology (WBE) has recently become one of the most rapidly evolving disciplines engaged in the measurement of population-level illicit drug use. This process involves collecting wastewater and analyzing it to find drug metabolites that have been excreted by users. Techniques such as liquid chromatography and mass spectrometry can be performed to get an accurate gage of how much drugs are in a given sample of wastewater. Back-calculations can be used to relate these sample findings to the total drug use of a given area. Through this study, the usage of illicit drugs and overdose fatalities in the City of Camden, located in South New Jersey, will be studied through the use of WEB. The results of this study will then be used to determine the most affected area of the city in hopes a rehabilitation plan will be implemented in the city.

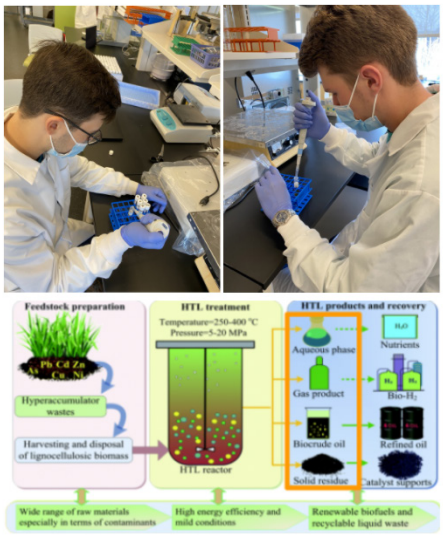
Virtual Engineers on Wheels

TEAM MEMBERS
Kara Natoli, Kara Banks, Elizabeth McWeeney
PROJECT MANAGER
Dr. Kauser Jahan
SPONSOR
Edison Venture

Virtual Engineers on Wheels (ViEW) is a student run program through Rowan University's Junior and Senior engineering clinic classes. In the midst of COVID-19, providing a safe transfer of information has become essential. The focus is on how to uphold a level of quality instruction without diminishing the safety of those involved by promoting proper health practices and giving hope to students as well as their families. Furthermore, ViEW has created resources on effective strategies that minimize risk factors of COVID-19 and inform families that there is still a promising future ahead. ViEW has created a comprehensive website that students can leverage to explore the different fields of study. The approach is online video lectures followed by experiments within different engineering disciplines. A sample experiment entails teaching about drone usage, and how it might play a factor in the future of unmanned deliveries. Some of the other experiments focus on the differences in mask materials and their effectiveness, as well as their environmental outlook. Having students perform from home enables them a safe environment to learn at their own pace, while still providing the quality instruction that would normally be achieved in the classroom.

Waste to Energy Conversion Using Hydrothermal Liquefaction

TEAM MEMBERS
Jason Russack, Luke Molnar, Matthew Price, Caroline Thistle, Filianna Zarifis, Kayla Fericy, Yinka Adedeji
PROJECT MANAGER
Dr. Sarah Bauer
SPONSOR
Rowan University Seed Funding Grant



The demand for renewable energy continues to increase while earth's population increases and non-renewable resource reserves diminish. The Water-Energy nexus explains how the supply of food and water are constrained as the demand for energy increases. This poses the challenge of being able to provide additional energy to the world while not consuming more resources to do so. "Waste to energy" technology has become an increasingly developed field that centers around processed waste being reused to create fuel. In Southern NJ, there is an abundance of industries that are heavily reliant on water and produce high levels of waste, which makes them ideal candidates for bio-oil creation partnerships. Hydrothermal liquefaction (HTL), a process in which wet, organic biomass is converted into a liquid biocrude, biochar, and wastewater, proves initial viability for converting waste into an alternative energy source. The objective of this research is to convert wastes feedstocks such as primary and return activated sludges from wastewater treatment plants, trub from brewery and rose lees from winery into biocrude through HTL processing.

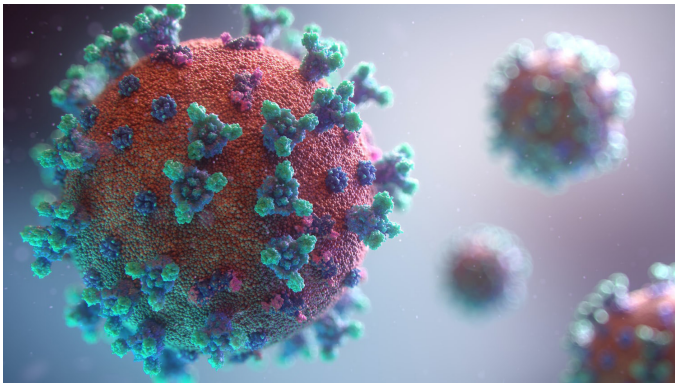
Wastewater Grit Characterization Study

TEAM MEMBERS
Samantha Andeer, Connor Mack, Christa Ouellette, and Leo Thottumari
PROJECT MANAGER
Tetiana Kolosovska and Dr. Sarah Bauer
SPONSOR
Atlantic County Utilities Authority

The objective of this research is to analyze the solid fraction of the wastewater samples collected from six stages of the Atlantic County Utilities Authority (ACUA) Wastewater Treatment Plant, as well as three different locations in the facility's collection network. This work is done in order to evaluate its constituents, especially in terms of grit, which is known to have adverse effects on treatment plant infrastructure. The ultimate goal of the project is to determine a feasible grit removal technology for ACUA. Tests performed include: total suspended solids (TSS), total organic carbon (TOC), size gradation, and settling velocity experiments. Preliminary results indicate that grit particles in a wide range of sizes (e.g. sand, seeds) are present in the samples collected from the plant. The duration of the project is one calendar year with samples being collected on a monthly basis. This will allow for evaluation of seasonal and weather effects on the composition of the wastewater influent. Comparison of the historical TSS data provided by the internal ACUA laboratory to the records of the significant weather events will provide an insight of a possible correlation between stormwater runoff and grit influx. This research will provide impactful foresight into the quality and quantity of grit in wastewater treatment systems, preventing future damages to wastewater treatment infrastructure.

WBE for COVID 19 Testing and Tracking

TEAM MEMBERS
Victoria Santanello, Peter Argerakis, Nicole Caramanna,
PROJECT MANAGER
Dr. Kauser Jahan
SPONSOR
Rowan University



Wastewater-based epidemiology (WBE) is a powerful tool used to monitor community health. WBE has been used to estimate drug consumption and drug use habits in a community, monitor food consumption patterns, and the success of poliovirus vaccination campaigns. The ongoing pandemic of coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), presents an urgent need to determine and identify those who are affected in order to protect the health of communities. SARS-CoV-2 and viral RNA are shed in bodily excretions, such as saliva, sputum, and feces. The primary routes of transmission currently include inhalation via person-to-person aerosols and droplets. Currently, sewage surveillance and WBE are being pursued by researchers around the world with hopes to identify and prevent outbreaks of COVID-19. This study focuses on the global use of WBE to track COVID -19 and prevent community outbreaks.

ELECTRICAL & COMPUTER ENGINEERING

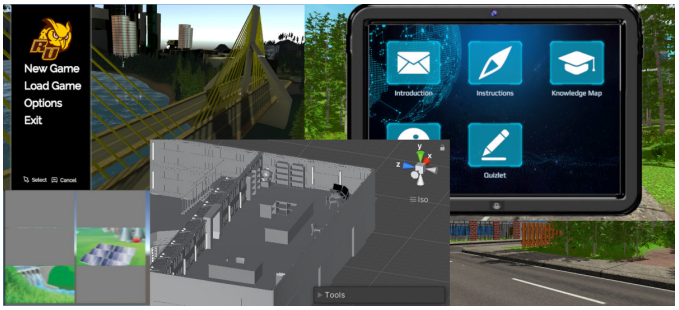
Augmented Reality Heads Up Display for Helicopters

TEAM MEMBERS
Grant Morfitt, Michael Johns, Matthew Amato, Nicholas Schooley
PROJECT MANAGER
Dr. Shreekanth Mandayam,
Dr. George Lecakes, Ardit Pranvoku
SPONSOR
Federal Aviation Administration

"The focus of this project is to assist helicopter pilots by improving flight safety using Augmented Reality (AR). This project aims to develop a heads-up display (HUD) for the Microsoft HoloLens 2 by displaying data from a helicopter flight simulator, X-Plane 11, in real time. Development of the HUD takes place in Unity, and is then deployed through the HoloLens 2. The HUD will provide critical information to the pilot during flight while eliminating the need for the pilot to take their focus off the horizon.
Students work primarily in the Unity and Photoshop software environment. Flight indicators are programmed to be accurate and conforming to incoming data from X-Plane. Currently, licensed FAA helicopter pilots are testing and providing feedback on the HUD. Using this feedback, students regularly modify and update the AR environment until it will be fully compliant with FAA standards."

Automated Educational Game for Sustainable Energy Education

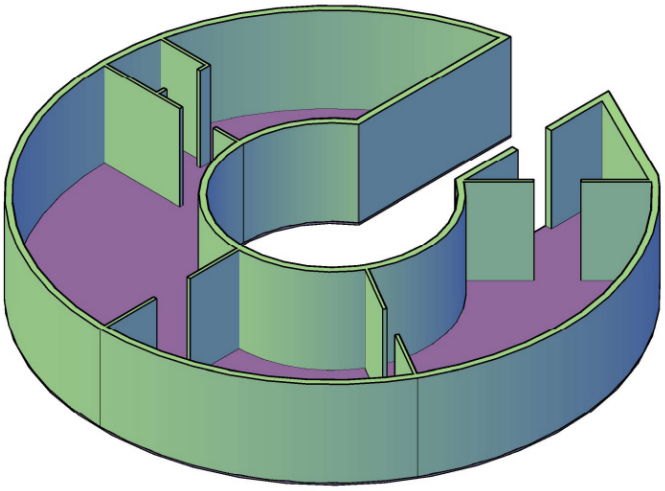
TEAM MEMBERS
Cedric Jankowski, Eboseremhen Eigbe, Allison West, Tyler Rossnagel
PROJECT MANAGER
Dr. Ying (Gina) Tang, Andrew Sun, Ryan Hare



This project builds on prior semesters' work that created a series of virtual, educational games. This semester, students will assist in the synthesis of a new version of Powerville, a pre-existing game that covers knowledge about sustainable energy. Several design components will be created and implemented throughout the semester in order to build Powerville into a fully-automated educational game experience for students to play, complete with AI-assisted personalized student assistance. Students will develop using the C# coding language, the Unity 3D development environment, and even 3D modelling tools to create an interesting educational game experience. Further, Powerville will work as a development and testing environment for several modular components that will be used to make the development of future educational games even easier.

Durable Low Mass Lunar Habitat

TEAM MEMBERS
Alec Woolley, Andrew Aweeky, Anicia Colon, Brian Hunt, Christian Garcia, Jacob Cusumano, Julia Curry, Mark Diorio, Matthew Traina, Michael Barrasso, Michael Guardiani, Rob Mullin, Rob Foerst
PROJECT MANAGER
Dr. John L. Schmalzel



"The purpose of this project is to design a low-mass lunar habitat that can support a crew of two for 30 days with the ability to be reused in the future. The base is intended to be used by astronauts to complete research projects on the Moon, and it should be durable enough for re-use during future missions. Our design uses a basalt-based, regolith concrete material that will be gathered from the lunar surface. The habitat will be constructed using a concrete 3D printer powered by a large array of solar panels that the astronauts will assemble upon first arriving on the Moon. Once the foundation is completed, the plumbing and power will be integrated into the habitat structure. Oxygen will be produced inside the habitat using an electrolysis station that takes in water and outputs oxygen. The temperature inside the habitat will be controlled by a Multi-Layer Insulation and an Active Control Thermal System, similar to the processes used on the ISS. The habitat consists of 6 rooms including the airlock, kitchen, living room, bedroom, bathroom, and equipment/research room to provide our astronauts with the necessary comfort for their time on the Moon."

Electric Propulsion

TEAM MEMBERS
Elisabeth Davis, Jacob Dimond, Timothy Smith, Nicholas Riggins, Sean Prendergast, Woo Lee
PROJECT MANAGER
Dr. John Schmalzel

The goal of the Electric Propulsion project is to characterize key components used in electric propulsion. Testing is in progress and consists of multiple full-scale tests utilizing different combinations of components. Results can then be scaled to predict performance on an actual plane. Central to the project is a battery powered model plane, known as the “Believer.” Baseline testing of components including batteries, motors, and solar panels is being conducted to verify proper output levels of each component. Lithium Polymer (Li-Po) and Lithium Ion (Li-Ion) batteries are being evaluated to verify expected output levels and to compare them with one another in flight scenarios. Solar panels are being evaluated to determine if their performance efficiency on an aircraft would make them candidates for use; posing the question, is enough power produced to justify their mass/aerodynamics? Recent laboratory measurements were conducted, consisting of recording charge and discharge times for battery systems and evaluation of total energy storage. Battery testing results provide the basis for recommendations of the optimum type of battery for electric propulsion. This information is important to evaluate the load profiles presented to the batteries during phases of flight: take off, cruise, and landing.

Global Holocaust Education through Virtual Reality

TEAM MEMBERS
Donté Carter, Karolina Kolodziej, Brittney Nickel, Nathan Pyles
PROJECT MANAGER
Dr. Shreekanth Mandayam, Dr. George Lecakes, Dr. Jennifer Rich, Cayla Ritz
SPONSOR
Paul Grand and Sunitha Menon-Rudolph

Holocaust studies are vital for students, who can apply this understanding of trauma and hardship to many sensitive real-world issues that are happening today. It is imperative that students learn from the atrocities of the past to prevent suffering like that of the Holocaust from happening again in the future. Holocaust education, however, has not fully adapted to the ways present generations learn most effectively, and crucial knowledge of the Holocaust and the greater impact on modern Jewish communities has been slipping from public perception. In order to combat this, a multidisciplinary team has been tasked with the creation of a new form of history education in virtual reality (VR). This team seeks to create an interactive virtual environment depicting the Warsaw Ghetto in a historically accurate fashion, enhancing users’ understanding of the Holocaust. Users will be able to interact with different models, images, and avatars in these digital spaces while investigating at their own pace. The team has focused on digitally reconstructing the Warsaw Ghetto to teach students about what life was like for those under Nazi occupation. The ultimate goal of the project is to properly educate students on the Holocaust, as misinformation and outdated teaching methods have left a widening knowledge gap between present and past generations.

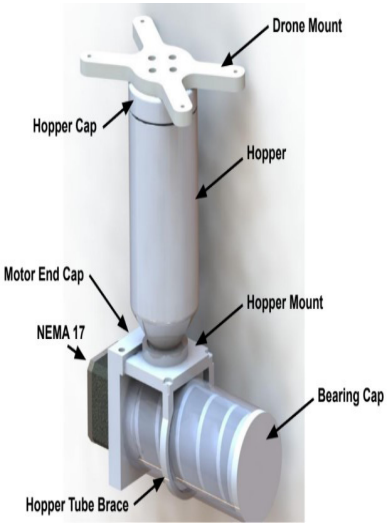
Intelligent VR Game Development

TEAM MEMBERS
Moises Hernandez, William Bielicki
PROJECT MANAGER
Dr. Ying (Gina) Tang, Ryan Hare, Andrew Sun

This project follows the prior semester's work on an educational game called Gridlock. This virtual game covers the basics of digital logic design for students in higher education settings. Following prior work, continued tasks from the previous semester focus on UI improvements, overall polish and testing, and the implementation of a reinforcement learning agent to provide automated, personalized assistance to students. This project offers students experience in programming and game development, as well as data collection and sensor informatics, machine learning, cognitive psychology, and education research. By furthering the development of this game, students will gain understanding of the role technology can play in personalized student assistance and student education. Students will learn programming experience, Unity 3D development, data analysis skills, and student information gathering such as emotion recognition methods.

Mighty Mite - Precision Agriculture

TEAM MEMBERS
Eric Seyfried, Olga Koturlash, Justin Reuter, Melissa Green, Ethan Cantor, Amanda Leber, Derek Bogdewicz
PROJECT MANAGER
Dr. John Schmalzel
SPONSOR
Rutgers University, Verge Aero



Organic farmers often require unconventional methods of pest control to avoid the use of pesticides. For the organic tomato farmers of southern New Jersey, one pest that requires attention is the 2-spotted spider mite. An effective method to control these damaging mites is the introduction of a natural predator, named Phytoseiulus Persimilis. This predator mite specializes in hunting and eliminating spider mites, without harming the plant or native wildlife. Currently, mite applications are performed manually: The farmer walks up and down each row with a salt shaker like container, spreading out predator mites mixed with a packaging substance. A novel method for dispersion of the beneficial mites is needed to minimize the workload of the farmer while avoiding potential damage to plants during application. This will be achieved by combining a drone (provided by Verge Aero) with a dispensing apparatus, utilizing an auger and hopper system. The drone flight path is pre-programmed and the auger is controlled by an Arduino to dispense the mites in the appropriate concentration.

NASA Big Idea Challenge - Dust Removing Environment for Artemis Missions (DREAM)

TEAM MEMBERS
Omar Alsheikyoussef, Matthew Amato, Matthew Bumbera, Brendan Callahan, Thomas DiPietro, Jacob Engime, Allison Gracie, Michael Harper, Christopher Juan, Kaitlyn Langschultz, Thomas Mroczkowski, Nicholas Spinelli, Natalie Young
PROJECT MANAGER
Dr. John Schmalzel
SPONSOR
Dr. Haim Baruh

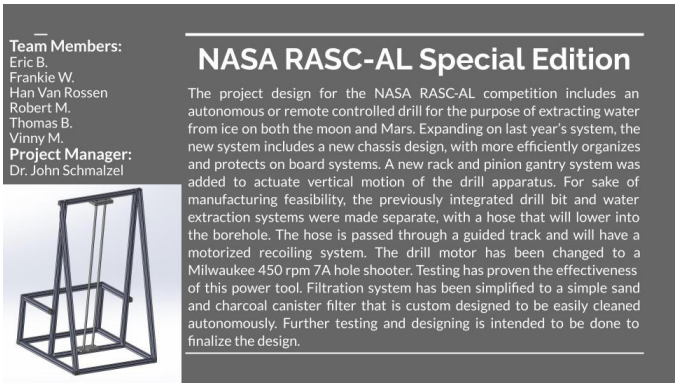
"The NASA Big Idea Challenge is a way for NASA to gain insight from students on various technical challenges. This year, the competition was searching for innovative ways to remove abrasive lunar dust from surfaces, specifically spacesuits after exploration during the upcoming Artemis missions. The dust is razor sharp, gets lodged deep in spacesuit fibers, is dangerous to inhale, and is cited as one of the biggest challenges to overcome for lunar exploration. Our team drafted a proposal leveraging mechanical, electrical, and magnetic methods to remove as much of the dust as possible within a safe environment.

We continued to work on the proposal with more feedback from the NASA team. After making adjustments to the written work, we've begun physical testing. Our team has created a lunar dust simulant composed of the most common minerals on the Moon. We are beginning to conduct small scale tests to investigate its behavior with our various removal methods. Depending on the test results, our design will incorporate UV lights, electromagnetic fields, electrostatic charges, and/or mechanical vibrations.

Our design uses suitports which interface with the back of the spacesuit. This allows the astronauts to enter the habitat without tracking in any lunar dust. Once the suit is docked in DREAM and the astronaut exits, the suit will be cleaned using the methods found through experimentation. "

NASA RASC-AL Special Edition

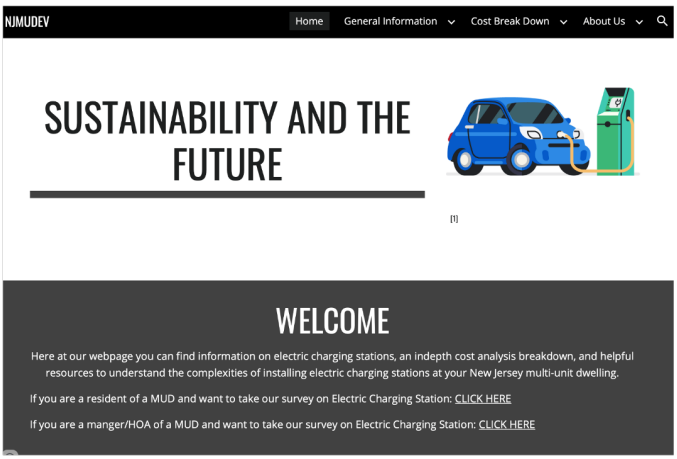
TEAM MEMBERS
Eric Benyon, Francis Warburton, Johannes van Rossen, Robert Michaelchuck, Vincent Musanti, Thomas Basile
PROJECT MANAGER
Dr. John Schmalzel



The project design for the NASA RASC-AL competition includes an autonomous or remote controlled drill for the purpose of extracting water from ice on both the moon and Mars. Expanding on last year's system, the new system includes a new chassis design, with more efficiently organizes and protects on board systems. A new rack and pinion gantry system was added to actuate vertical motion of the drill apparatus. For sake of manufacturing feasibility, the previously integrated drill bit and water extraction systems were made separate, with a hose that will lower into the borehole. The hose is passed through a guided track and will have a motorized recoiling system. The drill motor has been changed to a Milwaukee 450 rpm 7A hole shooter. Testing has proven the effectiveness of this power tool. Filtration system has been simplified to a simple sand and charcoal canister filter that is custom designed to be easily cleaned autonomously. Further testing and designing is intended to be done to finalize the design.

New Jersey Multi-Unit Dwelling Electric Vehicle Adoption Study

TEAM MEMBERS
Alex Cerami, Jonathan Gerges, Sean Prendergast, Donte Carter, Woo Lee, Michael Sherrier, Mitchel Yee, Tyler Humbert, Bruce Wildermuth, Amanda Dias-Liebold, Sean O'Hare, Jonathan Was, Matthew Klinger
PROJECT MANAGER
Dr. Jie Li
SPONSOR
NJ Board of Public Utilities



Transportation electrification, fueled by carbon-free electricity when possible, is regarded as one of the major contributors in reducing petroleum use, meeting air quality standards, improving public health, and achieving greenhouse gas emissions reduction goals. In January of 2020, Governor Phil Murphy signed legislation establishing statewide goals and incentives for the increased use of Electric Vehicles (EV) and EV charging infrastructure. Multi-unit dwellings (MUDs), including apartment buildings and condominiums, represent a key underserved EV market. In this project, a baseline analysis of different EV charging technologies that meet the requirements for urban or regional travel vehicle use of MUDs is conducted, and a planning tool is developed to support the MUDs with interests in EV charging investment. In the next, we will work with several MUDs in Washington Twp., Newark and New Brunswick, to build action plans for their EV charging planning. Challenges, barriers, and potential solutions will be compiled to make recommendations to NJBPU for EV promotion in New Jersey's MUDs.

Precision Ag: Rural WiFi

TEAM MEMBERS
Spencer Williams, Ben Zalewski
PROJECT MANAGER
Dr. John Schmalzel
SPONSOR
John O'Neal and The Old Homestead

Precision Ag is the concept of reducing the needed resources in farming while maximizing the total crop yield through the use of new technological advancements. Precision Ag technologies have pushed the agricultural industry to become more efficient and enables more tasks to be automated with the use of new mapping, IoT, and automation technologies. This project seeks to further Precision Ag efforts with the development of a user friendly mapping application, the Field Automated Routing Module (FARM) app, which will maximize the efficiency and reduce costs for field fertilization. The development of the FARM app seeks to utilize real-time kinematic GPS corrections to provide precise location tracking while in the field to avoid under and over application of fertilizer. This project also seeks to address the problem of implementing these Precision Ag technologies in rural settings, especially when those technologies are internet dependent. This clinic seeks to find solutions for the internet disparities that exist in these rural communities so that the advantages of Precision Ag can be utilized to their fullest extent.

Prosthetic Arm

TEAM MEMBERS
Barhoumi Yassine, Richard Stelts, Nicholas Gambino, Hayley Shuster, Ryan Meehan, Aidan Sorensen, Leonardo Florero, Yael Garcia, Eric Wolan, Richard Chao, Melody Probert, Christina Holshue, Nicholas Gambino, Keith Brockunier, Nicholas Lepold

PROJECT MANAGER
Dr. Ghulam Rasool, Dr. Nidhal Bouaynaya

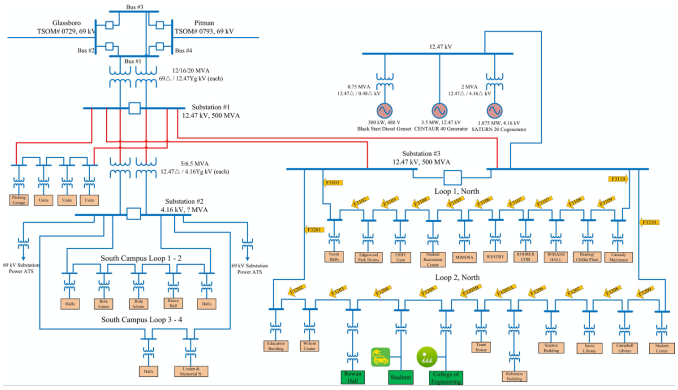
SPONSOR
New Jersey Health foundation

Loss of functionality of a limb can have devastating impacts on one's quality of life. Completing everyday tasks can be a challenge, which further adds to the emotional, social, and mental distress. The 'prosthetic arm clinic' is developing a dexterous prosthetic arm with 3D printed parts and intuitive control using machine learning algorithms. Given the nature of the complex work in the clinic, three different teams work in an integrated fashion, including the mechanical team, the electrical team, and the machine learning team. The mechanical team designed and tested several 3D printed parts and conducted strain tests to measure the prosthetic arm's mechanical characteristics. The electrical team developed the wiring and serial connection diagrams for all the electrical components. The machine learning team developed a model that processes the electrical signals from human muscles and determines the intended action. The computational requirements for machine learning are met with NVIDIA Jetson Nano, an internet-of-thing (IoT) edge device.

Rowan Campus Microgrid Feasibility Study

TEAM MEMBERS
Nicholas Kabala, Christopher Contos, Colin Eckenhoff, Carmen DiGironimo, Ryan Lawless, John Henley, Mark Butler, Christopher Lentini, Michael Cherosnick, Ethan Cantor

PROJECT MANAGER
Dr. Jie Li



The vision of this research is to explore an optimal solution to convert the Rowan University's electricity grid into a Campus Microgrid to improve its energy economics, sustainability, reliability and resilience. A feasibility study is conducted, including engineering design and benefit cost analysis. Our initial study shows, by optimally operate the Rowan's onsite combined heat and power cogeneration units, as well as the power purchase from Atlantic City Electric, the overall campus utility bill and emissions could be considerably reduced, while maintaining a higher energy reliability and resiliency. In addition, a 40-acre, 12MW solar photovoltaic (PV) farm long-term planning as well as its potential integration schemes into the Rowan Campus Microgrid is investigated. Under current assumptions, a $33 to $36.65 million USD of net profit over the next 15 years could be generated from the PV farm. In the next, we will be collaborating with Siemens to investigate the integration of smart buildings into the Campus Microgrid to further promote the campus energy efficiency.

Sounding Rocket (Spaceport America Cup)

TEAM MEMBERS
Erik Hercek, Daniel McMullen,
Sean Van Dongen, Joseph Gummere,
Noah Ng, Benjamin Magee, Noah Rodums, Nicholas Kreuz, Ethan Fox, Nicholas Gushue, Ali Mujahid, Jaxson Quigley, Jesse Cave,
Brian Csillag, Joshua Sparks, Jeremy Brown, Special Thanks: Nicholas Kabala,
Michael Sherrier
PROJECT MANAGER
Dr. John Schmalzel
SPONSOR
Rowan AIAA

The Rowan University Rocket team formed six years ago to participate in the 2016 International Rocket Engineering Competition. At that time the team consisted of only five members. The team has expanded to include 15 students from Rowan's ECE and ME departments. At our last flight in 2018, Rowan's entry, "The Fifth Day", flew to 9,672 feet. Over the course of the past three academic years the team has developed its most complex and ambitious challenger yet, "Mach Damon". This new rocket has been constructed to reach a target height of 30,000 feet. In doing this it will become the first Rowan University rocket to break the sound barrier. Developing this has involved extensive study of rocket aerodynamics and structures to ensure this year's challenger is capable of tackling the rigorous demands of supersonic flight. It has also involved the use of cutting-edge manufacturing materials, complex manufacturing methods, and the development of innovative and targeted electronics solutions to allow the rocket to function, and compete in the payload challenge. This year's payload has been created with the purpose of collecting air quality data ensuring "Mach Damon" stands as both a strong engineering achievement and a force for good.

Virtual Reality for Orthopedic Surgery

TEAM MEMBERS
Felicia Veneri (ME), Garrett Williams (ECE),
Stephen Kowalski (ECE),
Jason Boucher (ECE)
PROJECT MANAGER
Dr. Shreekanth Mandayam,
Dr. George Lecakes, Amanda Almon,
Alex Wiese (Graduate Student)
SPONSOR
Camden Health Research Initiative

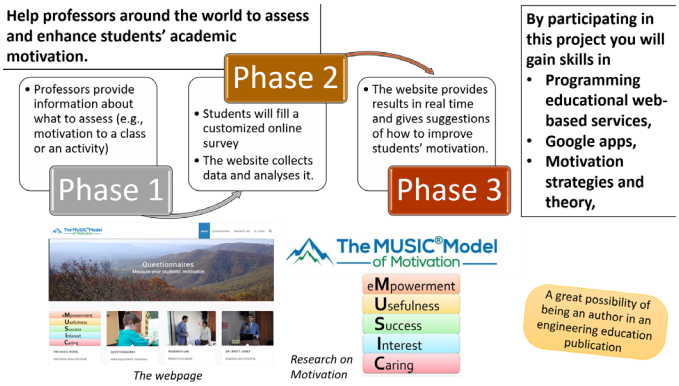
"Medical students can gain hands-on surgery experience from only a few sources: live surgeries performed by attending surgeons with limited time, or via cadavers which are limited in supply. Virtual Reality (VR) is a method of teaching medical students that is functional, accessible, and repeatable. Students on this project focused on developing an existing in-house virtual reality simulation of an orthopedic hip surgery. Particular emphasis is placed on creating a demonstration suitable for larger scale testing by testing the student's anatomical awareness throughout the surgery. This not only includes properly performing the surgery by correctly placing and using surgical tools, but also provides the user feedback in case of major surgical mistakes, such as making contact with the patient's sciatic nerve. Engineering Clinic students modeled surgical tools and placeholder body parts, and then coded the surgical simulation with focus towards anatomical accuracy allowing the attending surgeon to provide meaningful feedback."

EXPERIENTIAL ENGINEERING EDUCATION

Assessing students' academic motivation

TEAM MEMBERS
Mario Conde, Olivia Mawson, Jacob Hunt, Jason Grasso, Madison Jeski
PROJECT MANAGER
Dr. Juan M. Cruz

The purpose of this project is to create a way for professors to easily assess an entire classroom for how motivated their students are. The results of this research-based assessment will also help professors to understand what could be improved in the classroom to make sure that students are more motivated to learn. Previous cohorts of this project have developed the working prototype of this system. Spring 2021 was devoted to test the system, incorporate the feedback, and ultimately launch it for professors around the world to use it.



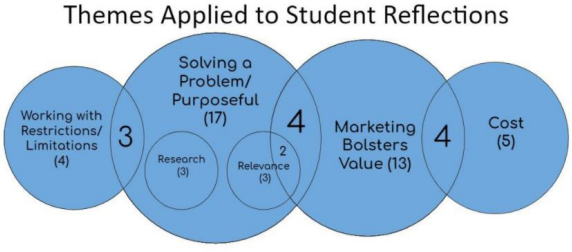
Engineering Students' Entrepreneurial Mindset Development

TEAM MEMBERS
Rebecca Hansson, Alexandra Jackson, Samantha Resnick
PROJECT MANAGER
Dr. Cheryl Bodnar
SPONSOR
Kern Family Foundation (KEEN grant)

Development of an Entrepreneurial Mindset (EM) has become an integral component in the training of engineers. EM concepts are typically integrated into either courses or extracurricular activities. However, only few studies have touched on student's feedback about EM development regarding their curricular, co-curricular, research, and outside of university experiences. This research study seeks to answer the following research questions: (1) Which types of experiences contribute to engineering students' EM development?; and (2) What types of attributes of EM do engineering students perceive are developed through these experiences? Nineteen undergraduate engineering students participated in virtual interviews, where they were asked about their perception of EM and their experiences that lead to their EM development. They were also asked to name specific attributes they believed were developed during their experiences. These interviews were then transcribed and analyzed. Upon review of the transcripts, most students mentioned developing their EM through their curricular experiences with courses and projects, and some discussed their experiences with jobs outside of the university and their high school experiences. As a result of these experiences, students had commonly mentioned having developed business skills, communication skills, and character traits such as motivation, persistence, and confidence.

Evidence of Students' Entrepreneurial Mindset from Post-RCIE Event Reflections

TEAM MEMBERS
Ginger Harnack, Christian Dvorak, Christopher Morehead
PROJECT MANAGER
Dr. Kaitlin Mallouk, Darby Riley



Fostering an entrepreneurial mindset in engineering students has become a focus in many engineering programs in recent years. Having an entrepreneurial mindset is about possessing a specific set of skills, beliefs, and knowledge that allow people to overcome challenges, make the most of opportunities, and succeed in a variety of settings. An engineer who demonstrates an entrepreneurial mindset possesses the ability to look beyond the technical issue at its mathematical core and hone in on creating value for themselves, their company, and stakeholders by taking advantage of opportunities within relevant markets. Rather than accept a given set of results, someone using an entrepreneurial mindset will question those results and figure out ways to improve upon them moving forward. This clinic focuses on how students link extracurricular entrepreneur and innovation activities and the 3Cs of an entrepreneurial mindset by analyzing numerous student reflections. Common themes are identified across the reflections that students associate with having an entrepreneurial mindset.

Gamifying Engineering Education: Advanced Roleplaying Simulator (GEEARS)

TEAM MEMBERS
Jessica Haya, James Glynn, Marcin Safin, Matthew Klinger
PROJECT MANAGER
Dr. Scott Streiner, Josh Reed (Graduate Student - Rowan University), Landon Bassett (PhD Student - University of Connecticut)

Through both success and failure, many engineering projects have a profound impact on individuals and society. Thus, ensuring future engineers consider these impacts and reflect on the ethical implications of their future work is an extremely important topic. Gamifying Engineering Education: Advanced Roleplaying Simulator (GEEARS) improves on traditional engineering ethics instruction by situating ethical dilemmas in everyday decisions as they do their work. This interactive, 'choose-your-own-adventure' game called Mars: An Ethical Expedition, unfolds over a series of chapters in a narrative arc in which students are part of an engineering team that recently arrived on Mars as part of a colonization expedition. The narrative evolves and presents different choices to students based on their responses to ethical dilemmas. The dilemmas can range from potential life or death adventures to more mundane scenarios. Should they let an infected individual onto the colony? Do they choose to spend time comforting a co worker instead of finding the saboteur? GEEARS was created and ported to an online, story-telling portal (https://twinery.org/) and includes visual and audio components for a more playful, interactive experience. Data is being collected on student pathways through the story which are informed by various normative ethical frameworks.

Impact of Grader Feedback on Student Success

TEAM MEMBERS
Connor O'Malley, Britney Williams
PROJECT MANAGER
Dr. Cheryl Bodnar, Cara Mawson

The quality and layout of feedback provided during formative assessment has an influence on a student's perception of their self-performance. A total of 82 students from a second semester first-year engineering design course completed assignments using a gamified homework platform. In cases where an assignment was completed incorrectly, personalized feedback was provided to instruct students on necessary corrections. The feedback was categorized for quality and layout and the results were compared with the number of attempts to gain insight into the following research question: How does grader feedback quality and layout impact the number of attempts a student needs to be successful in a quest? Feedback quality appeared to have a minimal effect on the number of attempts a student required. The impact of feedback layout was also shown to have little effect on the number of student attempts. Although the sample size was limited, evidence suggests that feedback that was entirely corrective in nature may have been less effective for students. The results of this research can help improve the outcomes associated with the application of gamified homework by providing a better understanding for how feedback received correlates with student success.

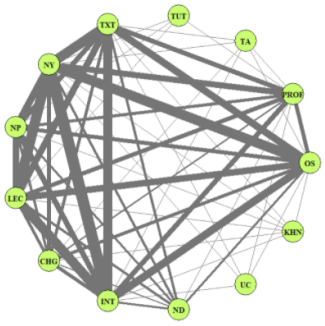
Process Safety Immersive Training

TEAM MEMBERS
Caleb Hill, Robert Mcerlean, Jacob Willetts
PROJECT MANAGER
Dr. Cheryl Bodnar, Jeffrey Stransky
SPONSOR
NSF improving undergraduate STEM education (IUSE DUE#1711376, 1711644, 1711672, and, 1711866)

New safety features and regulations are actively employed within the process industry to reduce operational risks. Despite advancements, chemical plants remain hazardous places, and engineers will always be involved in decision based risk mitigation. Previous studies promote improving engineers' decision making and balance of competing criteria. This research sought to address the following two research questions: (1) How do senior chemical engineering students prioritize safety in comparison to criteria such as budget, personal relationships, plant productivity, and time in a process safety context, and (2) How does their prioritization of decision making criteria change after exposure to Contents Under Pressure (an immersive training tool)? 187 senior chemical engineering students completed pre-/post-reflection surveys around their engagement with Contents Under Pressure, which asked them to rank their prioritizations of previously stated criteria. Pre-reflection results showed safety was prioritized statistically significantly more than other criteria with a very large effect size. Whereas, personal relationships had statistically significantly increased in prioritization with a large effect size upon post-reflection; although, safety was still found to be most important. These results suggest that students may undervalue the role of personal relationships before gaining process safety decision making experience.

Resource Usage and Academic Outcomes in Undergraduate Engineering Students

TEAM MEMBERS
Amanda DaSilva, Tyler Garrett, Keval Patel, Sydnee Reyes
PROJECT MANAGER
Dr. Kaitlin Mallouk

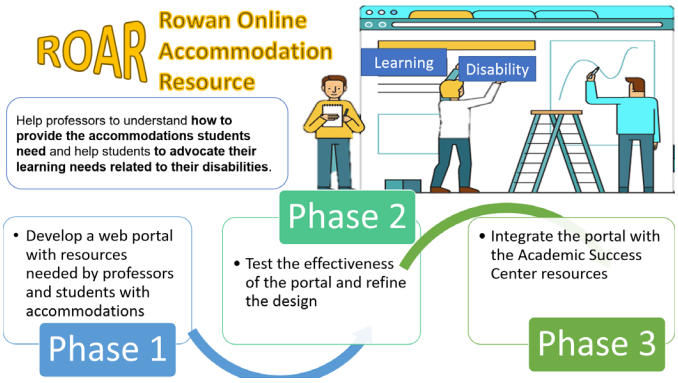


- LEC: Recorded Lectures
- NP: Notes from the professor
- NY: Your notes
- TXT: Textbook
- TUT: Tutors
- TA: Teaching Assistants
- PROF: Professors
- OS: Other Students
- KHN: Khan Academy
- UC: Upperclassmen
- ND: Notes from a different class
- INT: Internet
- CHG: Chegg

The research completed in this clinic focuses on the resource usage of college engineering students and attempts to link these resources to self-reported feelings of overall student performance. The research team created a survey to gauge engineering students' overall performance (both perceived and self-reported GPA) and the resources they use in their classes. The survey consisted of 19 different questions relating to which resources work best for engineering students. The main purpose of this survey was to get a better understanding of what resources students use, which ones they use the most, and which ones work best for them. The survey was distributed to engineering students across all disciplines and all classes. The survey was sent to several professors who then distributed it to their students, generating 70 responses. Once all the survey results were analyzed by the team, they generated a resource network (shown) to visualize the interconnectedness of these resources, and how students use resources in different combinations.

ROAR: Rowan Online Accomodation Resource

TEAM MEMBERS
Michael Weinberg, Daniel Nachtigall
PROJECT MANAGER
Dr. Juan M. Cruz



"The purpose of the project is to develop a web portal that aids professors and students with providing and receiving accommodations. It aims to streamline the process required to file for accommodations, receive accommodations and communicate learning needs with professors. It ultimately will assist students in advocating for their learning needs. Currently, the project is in the identification of needs and use case design (phase 1)"

VR Behavioral Vaccination Site Training

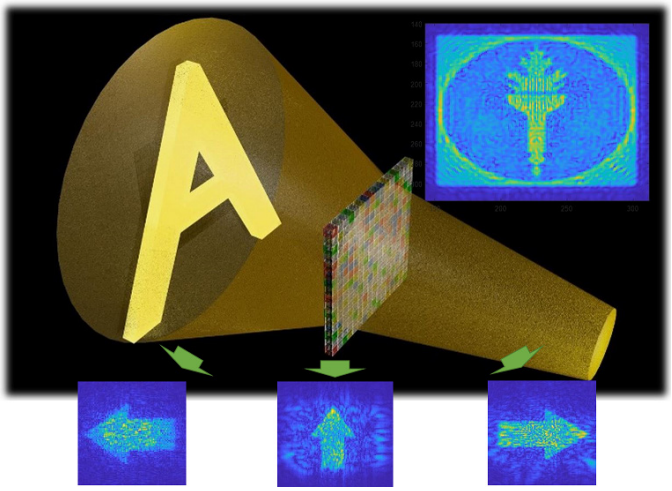
TEAM MEMBERS
Connor O'Malley, Britney Williams
PROJECT MANAGER
Dr. Cheryl Bodnar, Dr. Shreekanth Mandayam, Cayla Ritz
SPONSOR
Rowan University Foundation

The role of the nurse at a COVID-19 vaccination site is critical. They are instrumental in providing the vaccine but also interacting with patients to determine if any issues exist that might pose complications for the proposed vaccine and require modifications to procedures in real time. This clinic focused on developing a virtual reality training program with the primary goal of preparing nurses for interactions with patients on COVID-19 vaccination sites. Nurses are not frequently trained in behavioral situations and vaccination sites can create high intensity situations that require in the moment decision making to best address the needs of patients and ensure safety of all parties involved. The proposed training incorporates a variety of patient models in a "choose your own adventure" style story path that allows for the nurses to be prepared for several real world situations that may occur at these vaccination sites. The modules were iteratively developed with feedback obtained from nurses working at these sites and then passed along to the VR team for further development. Upon completion of the training module, it will be implemented, tested, and revised as necessary to ensure it meets the training needs of nurses working on COVID-19 vaccination sites.

MECHANICAL ENGINEERING

Acoustic Hologram Techniques

TEAM MEMBERS
Edward De Asis, Ian Meighan
PROJECT MANAGER
Dr. Chen Shen



Acoustic holograms are useful in a wide variety of applications such as soundscape design, acoustic wave control and underwater particle manipulation. Existing acoustic hologram algorithms are often limited by their capacity such as bandwidth and image quality. In this project, we aim to develop acoustic hologram algorithms that can work with multiple frequencies and can project multiple holographic images at different depths. We also explore ways to fabricate the designed hologram through 3D printing and project complex acoustic fields in air and underwater environment. A customized scan stage is built to measure the hologram.

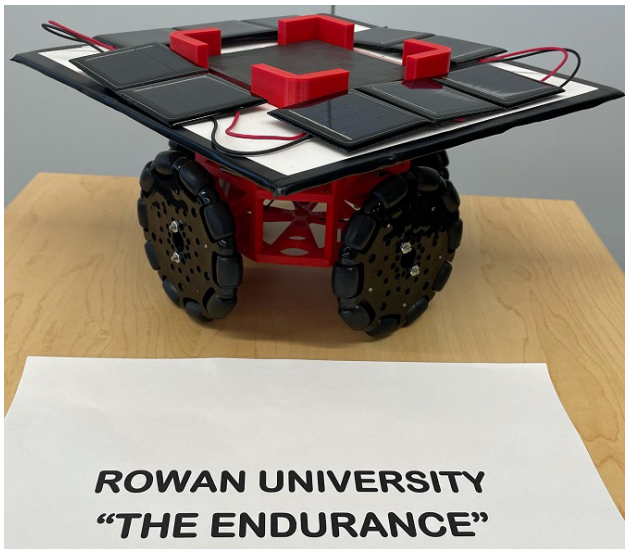
Additive Manufacturing with the Cold Spray Action Team

TEAM MEMBERS
Peter Yochim, Matt Fucci, David Adelsohn, Alex Hess
PROJECT MANAGER
Dr. Mac Haas, Dr. Joe Stanzione
SPONSOR
GGB Bearing Technologies,
US Army Research Lab

This clinic has made substantial contribution to additive manufacturing (AM) efforts in the Haas and Stanzione labs. Several sub-projects central to AM have been conducted in the past year, including development of applicators and CNC x-y table configuration for cold spray AM, as well as adoption and commissioning of an X-winder filament winding machine provided by GGB Bearing Technologies. This latter project includes development of improved processing conditions, X-winder hardware, and parametric testing of different fibers, fiber lay-down variables, and resin systems. Pictured here - left: winding experiments using different combinations of mandrels, resins, fibers, and sectioning techniques; right top: X-winder after hardware reconfiguration to better fit Rowan lab space; right bottom: additive manufacturing for additive manufacturing - SLA 3D-printed X-winder fiber applicator prototypes compared with original aluminum fixture.

ASME Design Contest

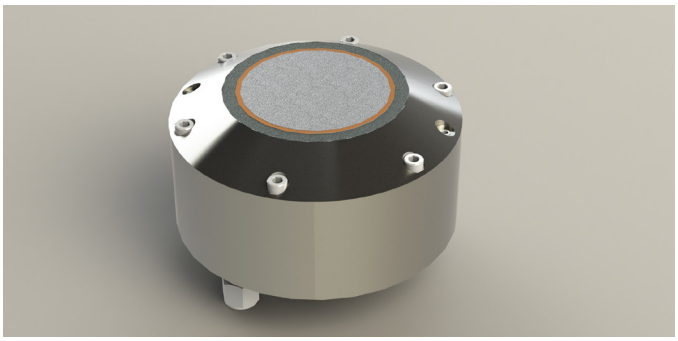
TEAM MEMBERS
Brian Clemens, Joshua Knospler, Anthony Luciano, Will McCusker, Christopher Parisi, Patrick Sellers, Dylan Sica, Ryan Staerker
PROJECT MANAGER
Dr. Hong Zhang



Every year, a team from Rowan University will participate the ASME design competition. This year, the topic is to develop a remotely controlled cart that is powered by one single AA battery yet to travel a 5mx5m course while carrying steel loads in it. The cart also needs to pass designate points marked within the course during the 5 minutes competition time. Within this time, the cart can also be recharged by solar panels or a wind turbine. The team of 8 ME students successfully designed and built the cart, and participated the virtual competition at April 3, 2021.

Combustion Burner Development

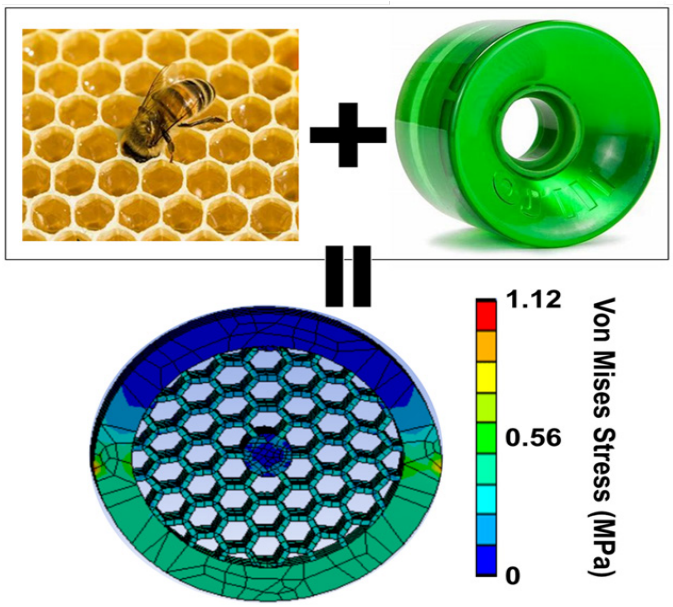
TEAM MEMBERS
Jake Jackson, Josh Mauchly
PROJECT MANAGER
Dr. Mac Haas



This clinic is contributing to the development of two different laboratory burners to study different aspects of combustion: (1) an ASTM-standard Smoke Point lamp used to determine the sooting propensity of jet fuels and related hydrocarbons, and (2) a McKenna burner used to study the complex chemistry that occurs as fuel and oxidizer convert into water and carbon dioxide. Both burner facilities will support ongoing research, as well as advanced coursework in the thermal-fluid sciences. Pictured here is the McKenna burner, which when fully assembled, will allow for individually controlled flows of fuel, oxidizer, and nitrogen to establish a nearly flat flame above the top of the water-cooled burner. This permits adjustment of flame equivalence ratio (fuel:air), which dictates both flame temperature as well as important pollutant chemistry (e.g., incomplete burn-out of carbon monoxide to carbon dioxide). Nitrogen passes through the outer annular ring to separate the flame from the oxygen present in ambient air, helping to isolate the flame chemistry.

Design and Development of Non-Pneumatic Wheels

TEAM MEMBERS
Caroline Dudeck, Patrick Frangie,
Csaba Otvos, Harveer Bains
PROJECT MANAGER
Dr. Behrad Koohbor



Flexible honeycomb structures have found use in various applications. One of the most interesting of these applications is non-pneumatic (a.k.a airless) wheels. Non-pneumatic wheels are those that are not supported by air pressure. Instead, the load-bearing capacity of the wheel is supported by a network of interconnected cellular structure. This clinic project aims at implementing the idea of 'density-graded' honeycombs in the design and development of lightweight and durable wheels with tunable mechanical properties. The project includes extensive use of FE-based modeling as well as design and fabrication of prototypes by additive manufacturing. The primary goal of this clinic is to develop an understanding of the role of cellular structures in applications that require efficient impact energy mitigation characteristics.

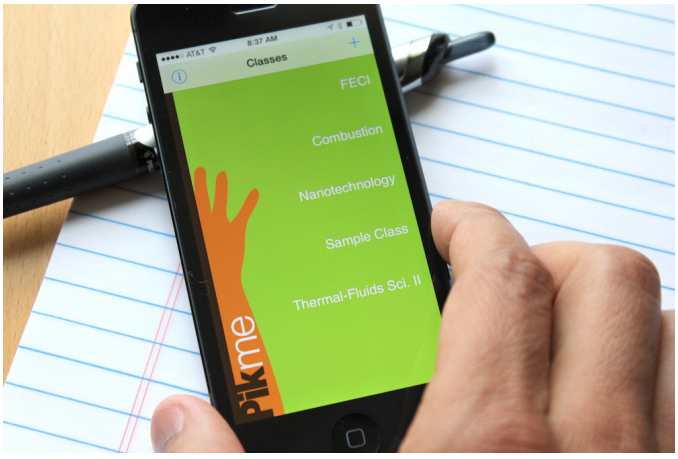
Design, Build, Test of Baja SAE Vehicle

TEAM MEMBERS
Matthew Reingold, Peter Wilenta, Andre Benson, Devlin Cox, Justin Elko, Andrew Galloway, Nazar Kovch, Eric Matos, Brendan McGrath, Joshua Nastarowicz, Noah Pentlicki, Matthew Pilla, Robert Pinder, Mustafa Sahbaz, Mason Szeplaki, Kenneth Thomas
PROJECT MANAGER
Dr. Anu Osta

"The Society of Automotive Engineers (SAE) hosts yearly competitions in which "Mini Baja" vehicles are designed and fabricated by participating university engineering teams. The objective of the competition is to produce a reliable, safe, off-road vehicle for recreational use. Design of the Rowan Motorsports 2022 Baja Car began in the summer of 2020 with the goal of producing a lightweight car without sacrificing strength or reliability. The 2022 car will compete in Epreuve du Nord, and the regional SAE Baja competitions in 2021 and 2022. They will test, identify design flaws and redesign the systems. The Baja team is broken down into the following 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."

Educational App Development

TEAM MEMBERS
Meredith Baubles
PROJECT MANAGER
Dr. Smitesh Bakrania



This project focuses on developing mobile applications for educational purposes. The applications are primarily designed for instructors to use to enhance learning using iPad and iPhone devices. There are already a couple of successful apps on the app stores and we continue to develop new ones. Students begin by learning the mobile app development programming language. This year the primary focus was on upgrading the popular Pikme app. This app has been downloaded over 30,000 times and users had requested a number of features to improve the user experience and introduce new capabilities. In addition to improving the features, we decided to completely overhaul the platform using the new Swift programming language. This would allow better versatility for future changes and bring the app up to speed with the recent changes to the mobile apps. Significant effort was placed on developing the backend of the app and learning new technologies to future-proof the development.

Exoskeleton for slip-and-fall prevention & development of trip triggering device

TEAM MEMBERS
Duncan Stevenson, David Grosmick, Devin Conner, Damien Filoramo, Melody Probert, Marcus Perotti, Cole Kirstein
PROJECT MANAGER
Dr. Mitja Trkov

Existing exoskeleton devices are often specifically designed to aid with a targeted task, such as level-surface walking or stair climbing. The ability of an exoskeleton device to assist during walking with gait perturbations still presents a challenge. The goal of this project is to improve the design of an existing exoskeleton device that augments human bipedal gait capabilities and enhances safety during gait perturbations. This focus of the project was to build upon previously developed device to improve the functionality of the device. In addition, the project included the design of the gait perturbation device to trigger trips during walking. An ergonomic component was considered in the design process to achieve optimal shape and fit of the device on to a human leg, while considering weight and cost requirements.

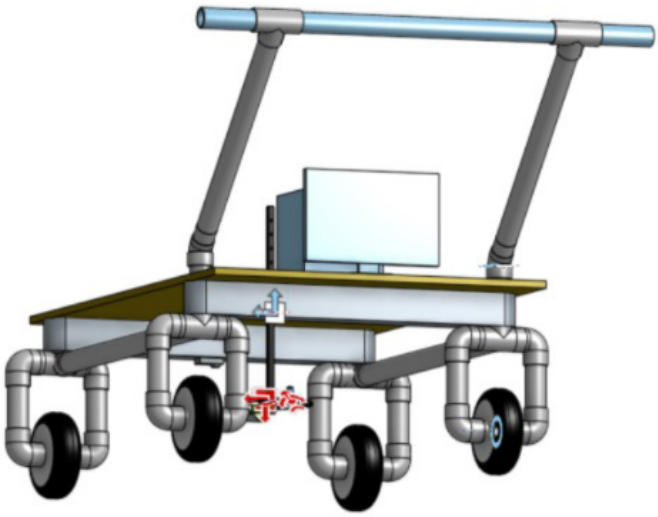
FAA Challenge -- Smart Airport Student Competition

TEAM MEMBERS
Brandon Carmosino, Matthew Guardiani, Cole Kirstein
PROJECT MANAGER
Dr. Hong Zhang
SPONSOR
Arke Aeronautics LLC

FAA Smart Airport Student Competition is a national collegiate competition to recognize students with the ability to demonstrate innovative thinking focused on improving the efficiency, effectiveness, and utilization of smart technology in and around the airport environment while enhancing the overall traveling experience. Arke Aeronautics LLC is a startup company founded and run by former Rowan students. A three member Rowan student team participated the competition with an innovative smart phone-based emergency management platform – Arke. Using a proprietary data-fusion algorithm and Artificial Intelligence the platform ingests, organizes, and serves the most critical information to each responder in a customized incident dashboard via their cell phone or tablet. Arke is designed to work with the existing network of hardware and software infrastructure to maximize existing investments while enhancing operational effectiveness through quality insights. This modern solution simultaneously considers the current technology ecosystem and unique operational challenges that First Responders and emergency management personnel face. The Rowan team was selected as one of the three finalists. The team will be invited to demonstrate their concepts at the FAA Challenge Forum and compete the first place.

Farming Robot

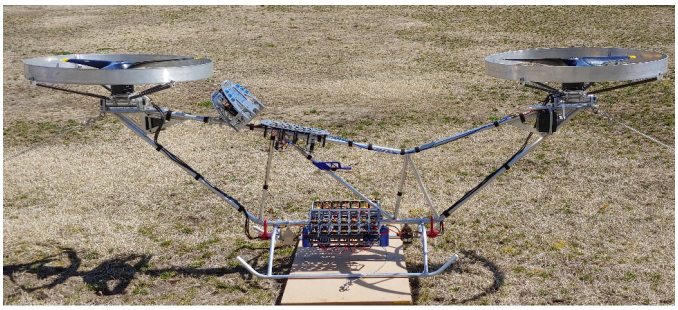
TEAM MEMBERS
Xian Apdian, Luis Caba, Sergiy Dovgopol, Edward O'Melia, Jack Schaefer
PROJECT MANAGER
Dr. Hong Zhang, Paolo Sanchez



Labor is the costliest aspect of farming, especially during harvest. Technological advances are making it possible to harvest with autonomous robots. This is the most powerful aspect of robotic farming since it would dramatically reduce the cost of production. There has been an explosion in the farming robot industry, especially over the last decade. In this paper, we first surveyed scholarly articles, conference papers, and commercial literature to assess the current state of the art in farming robotics. The team surveyed the current literature and developed a schematic for a standardized robotic implement. Areas in which standardization would be beneficial are computing architecture, and the basic form on which new, more sophisticated, functions could be added. After literature research, the team started to develop a reconfigurable, modular, farming robot. The modular farming robot can be operated manually in a solo mode, or be combined together in a team mode and working with a tractor or an unmanned vehicle. It will automatically recognize the crops and weeds, spray the fertilizer or herbicide. The farming robot will greatly reduce the intensity of labor and improve the productivities of both large and small farms.

Hoverbike

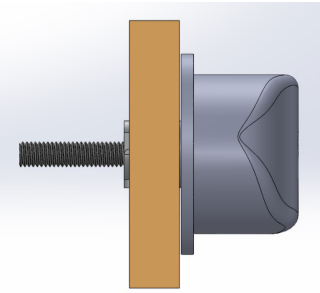
TEAM MEMBERS
Jacob Okun, Nicholas Behr, Rebecca Michnowski, Casey Robinson, Alexander Suarez, Lillian Cahill, Stephen Curreri, Edward J Nowak, Mike Matje, Thomas Fritz
PROJECT MANAGER
Dr. Hong Zhang

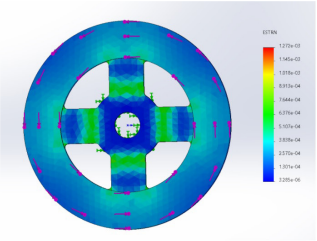


The Hoverbike clinic is an interdisciplinary engineering design team with the central goal of fabricating, and proving a prototype of bi-copter. This challenge builds heavily on supplementary skills such as Intellectual property, manufacturing industry connections, marketing/PR, and team management. To stand out from similar crafts, which could be quadcopters or gas-powered rotorcraft, the craft being developed by this clinic utilizes a bi-copter configuration. This requires active thrust vectoring, and an extremely lightweight design. The craft in its final state will have full-scale tethered flight testing and untethered flight testing.

Instrumented rock climbing holds

TEAM MEMBERS
Alexander Stieglitz, Kyle Peterson,
Eric Schmalzried, Nicholas Mennie,
Jacob Jackson, Caroline Thistle, Tyler Humbert
PROJECT MANAGER
Dr. Mitja Trkov

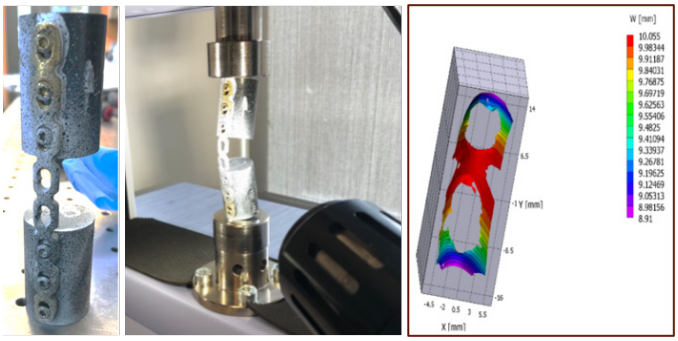




Indoor rock climbing is a fast growing sport attracting many climbing enthusiast to train and compete in gyms on indoor climbing walls. Due to covid pandemic and restrictions of organized competitions, there is a need for a reliable, low-cost system that could monitor progress of climbers on a set route on a wall and allow 'virtual' execution of competitions. The goal of this project is to design a low-cost instrumented climbing system to monitor progress of climbers on a set route on an indoor climbing wall. The requirement for the system is that it has to be easy to use and the system should be integrated with monitoring system that can monitor the progress of a climber. The ultimate goal is to design an interface and a complete monitoring system that can transmit and upload this information to a software and a digital display.

Mechanical Characterization of Additively Manufactured Parts by DIC

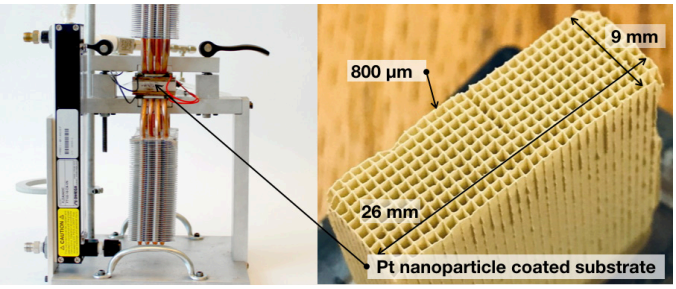
TEAM MEMBERS
Megan Duman
PROJECT MANAGER
Dr. Behrad Koohbor
SPONSOR
Dupuy Synthes



The objective of this project is to use the newly acquired digital image correlation (DIC) equipment to characterize the local and global deformation response of 3D printed parts supplied by Depuy Synthes. 2D and stereo DIC will be used to measure the full-field deformation response of the test piece. The output of the DIC analyses will be used to validate FE models developed in Depuy Synthes. The specific goals of this project are to (1) develop an understanding of DIC, (2) conduct sample preparation and mechanical testing, (3) generate full-field strain maps, and (4) identify deformation hotspots by extracting local deformation information from DIC analyses.

Microcombustion-Powered Thermoelectric Generator

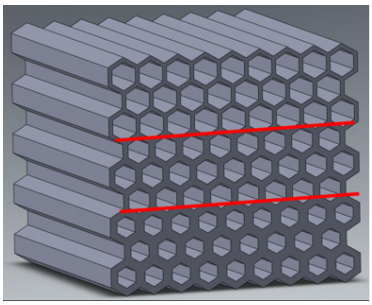
TEAM MEMBERS
Jack Camins
PROJECT MANAGER
Dr. Smitesh Bakrania

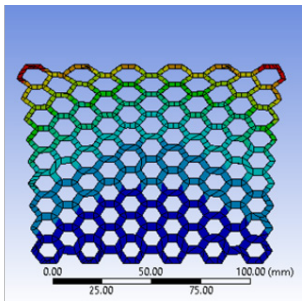


Catalytic combustion-powered thermoelectric generators can be viable alternatives to batteries in portable electronic devices. Such devices take advantage of energy-dense hydrocarbon liquid fuels, are robust without any moving parts, and have low operating temperatures preventing degradation of the thermoelectric modules. Existing micro-reactor designs have shown high efficiencies, but have yet to demonstrate truly portable and functional for power production. Our previous work has demonstrated self-ignition of methanol-air mixtures using platinum nanoparticles deposited on rectangular cordierite substrates. The cordierite substrates with 800 µm-wide square channels act as a catalyst bed. The heat generated by the reactor is converted to electrical power using two thermoelectric modules. The recent work focusses on managing the temperature distribution within the substrate and across the device for improved device performance. The combination of heat recirculation, preheating, and catalyst distribution strategies were explored and resulted in a journal publication. The combined efforts have yielded marked improvements in device performance that will be guide future efforts.

Modeling and Design of Flexible Honeycomb Structures

TEAM MEMBERS
Brandon Criss, Michael D'Orazio,
Korey Greene, Derek Miebach
PROJECT MANAGER
Dr. Behrad Koohbor

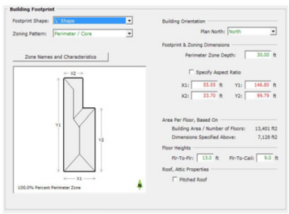


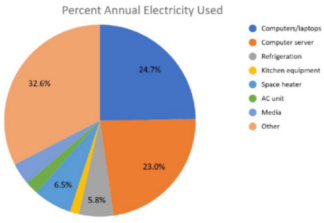


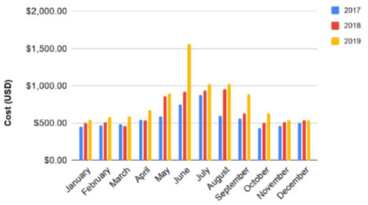
Honeycomb structures are utilized in several applications due to a combination of favorable mechanical properties such as high specific strength and excellent impact energy absorption capacity. In recent years, there has been an increasing interest in the use of honeycomb structures in automotive and aerospace applications. The objective of this clinic is to design and develop lightweight and flexible honeycomb structures with improved strength, cushioning capacities, and resistance to failure. The specific goals of this project are to (1) develop an understanding of the role of cellular structures in applications that require efficient impact energy mitigation characteristics, and (2) design and optimize flexible honeycombs based on a modeling approach, achievable by multiscale finite element analysis.

NJDMAVA Building Audits – Washington Readiness Center

TEAM MEMBERS
Thomas Nappi, Justin Hillman, John McAvey
PROJECT MANAGER
Jason Muermann, LN Blackburn, Dr. Mac Haas
SPONSOR
NJ Department of Military & Veterans Affairs



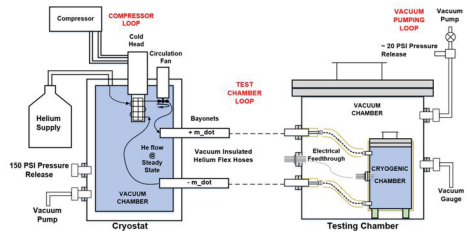


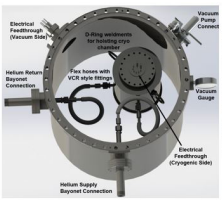


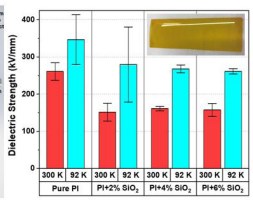
The Rowan University Sustainable Facilities Center (RU-SFC) Energy Audit Team conducted a site visit of the Washington Readiness Center located in Port Murray, NJ, as part of a comprehensive energy and water use assessment. The objectives of this audit were to find the significant sources of energy consumption and to offer suggestions to NJ Department of Military and Veterans Affairs (DMAVA) to reduce the total energy consumption through economically viable measures. Onsite observations have been compiled into a Load and Plug Model (LPM), which is complemented by analysis of historical facility utility bills as well as facility energy modeling using US Department of Energy's eQuest program. Possible measures identified by this audit will be grouped into (a) Energy Conservation Measures (ECMs) (b) Water Conservation Measures (WCMs) and (c) Renewable Energy Measures (REMs).

Polymer Composites for Navy Applications

TEAM MEMBERS
Tanner Coles, Madison Buck, Matthew Gartland, Forest Hinds, Jack Latham, Aaron Haines, Dawson Tocarchick, William Emmerling, Jean Han, Daniel Smith, Nicholas Nowak
PROJECT MANAGER
Wei Xue, Robert Krchnavek
SPONSOR
Naval Surface Warfare Center Philadelphia Division (NSWCPD), Naval Engineering Education Consortium (NEEC)



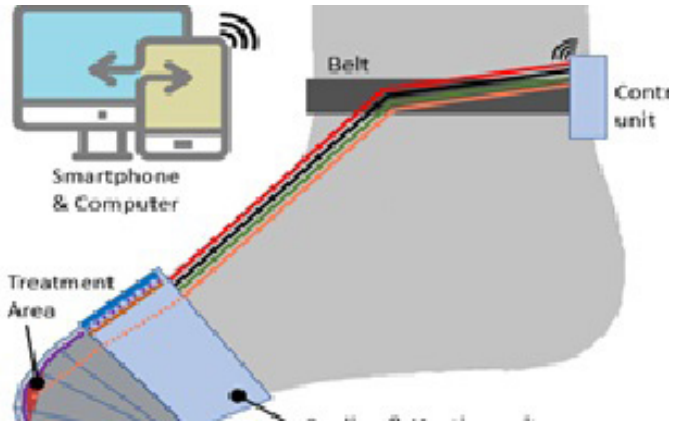




The primary objective of this clinic is to study the potential of nanocomposite materials as dielectrics in high-temperature superconducting (HTS) cables for the United States Navy. The material team aims to investigate polymer-silica nanocomposites as cryogenic dielectrics. The design team aims to design 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.

Smart Bio-Cooling (CASTMS)

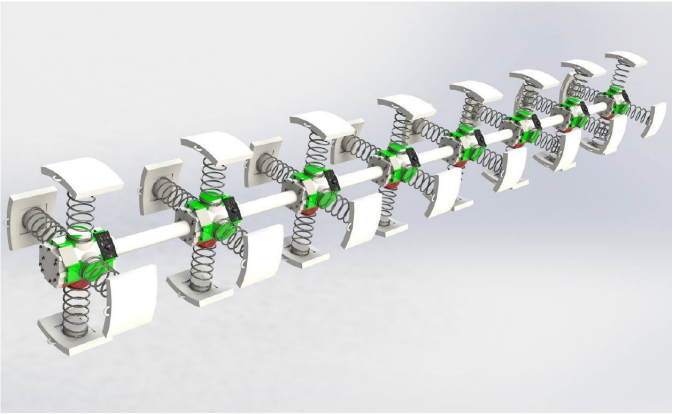
TEAM MEMBERS
Jack Camins
PROJECT MANAGER
Dr. Hong Zhang
SPONSOR
New Jersey Health Foundation



In treatment of regional inflammation such as rheumatoid arthritis and muscle sprains, or during the post-surgery recovering period, people always need to cool down the affected area. Common practice is to wrap the area with an ice patch. However, the ice patch may not be available or convenient to apply when the inflammation attacks. This project is to research and develop an actively controlled cooling device using thermoelectric effect called Controlled Active Skin Temperature Maintenance System (CASTMS). The system will 1) detect the temperature of the targeted skin area; 2) cool down the area with solid-state cooling technology; 3) record the time and intensity for future analysis and research. With the data, a doctor can predict the attacks and proactively start the cold therapy while a researcher may learn more insight of the disease and look for a better treatment strategy.

Soft Robot - Snakey Bakey

TEAM MEMBERS
Thomas Syx, Pat Twomey, Kyle Phillips, Hunter Ford, Samuel Caulley, Mark Udowiczyk, Victoria Falkenstein, Luke LaBianco, Brian Chesko
PROJECT MANAGER
Dr. Mitja Trkov



Soft robot manipulation has multiple applications, including robotic surgery, agriculture, and search and rescue. The shapes of soft manipulators are often inspired by animals, such as octopus tentacles. However, the functionality of the existing manipulators still lags behind compared to the capabilities of the animal counterparts. To advance such soft robots' capabilities, this project aims to investigate novel designs, mechanisms, materials and actuators to develop soft robots capable to withstand large multi degree-of-freedom deformations and overcome interaction forces, while preserve its motion and/or shape. In this project, we designed a fully modular soft robotic snake, named Snakey Bakey, that can bend in multiple directions and contract in diameter by over 50%. The design excels in the four categories of resilience, adaptability, system integration, and energy independence. Resilience is provided by the robust inner structure and the durable outside skin. The modular design shows adaptability to achieve versatile motions.

Sonic Shield

TEAM MEMBERS
Jonathan Castagna, Ryan Kennedy, Michael Ravaschiere
PROJECT MANAGER
Dr. Hong Zhang, Dr. Charles McGlynn

"According to the National Transportation Safety Bureau, Nearly every 2 hours, a person or vehicle is hit by a train in the U.S." This issue is mainly caused by people who tried to cross railroad crossings ahead of trains. In unguarded crossings the issue with this is pretty self evident, but even when crossings have lights on them motorist will often decide to take their chances and try to beat the train. This reckless behavior has led to many accidents. These accidents also take a serious psychological toll on train engineers especially if the crash is fatal. In Sonic Shield project, we try to develop a portable device designed to detect sound waves and vibrations from moving locomotives and alert drivers of a potential collision with enough time to take the proper avoidance measures. a) Passive sensor technology that does not require installation at rail crossings to function; b) Ability to be widely distributed at minimal investment while offering cross platform functionality; c) Additional margin of safety provided to users, especially at night or in otherwise low visibility situations; d) High potential to create new knowledge of vehicular mounted sensors for the development of driverless cars."

Testing and Tuning of SAE Baja Vehicle

TEAM MEMBERS
Nathan Bell, Jamie Cadle, Anthony DiAntonio, Christopher Ferry, Jason Ippolito, Zackary Johnson, Adam Korb, Matthew Olsack, Matthew Rizzi, Matthew Snyder
PROJECT MANAGER
Karl Dyer

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. The first year Baja team completes the designing and manufacturing portion of the competition. The second year Baja clinic was formed to provide more testing and tuning opportunities to the Baja team after they manufactured the Baja vehicle to better prepare the team and vehicle for competition. During this clinic year, a new data acquisition system was developed, a Baja Guidebook was written, and physical testing on the Baja vehicle was performed. The new DAQ system includes the DL1 system with linear potentiometers, an engine tachometer, and an accelerometer. The Baja Guidebook is a technical document that explains the full Baja design cycle - going from concept to product. And finally, physical testing on the car included acceleration testing, skid pad testing, avoidance tests, mock endurance tests and more.

External Sponsor Index

External Sponsor Index cont.

Rowan University
Henry M. Rowan College of Engineering
201 Mullica Hill Road
Glassboro, NJ 08028
Phone: 856-256-5300
Email: engineering@rowan.edu
Website: engineering.rowan.edu
Social Media: @RowanRCE