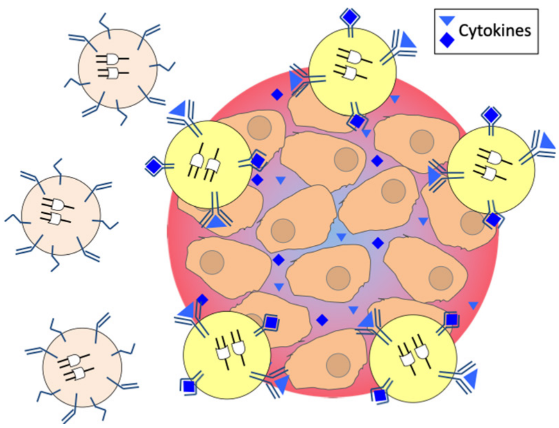
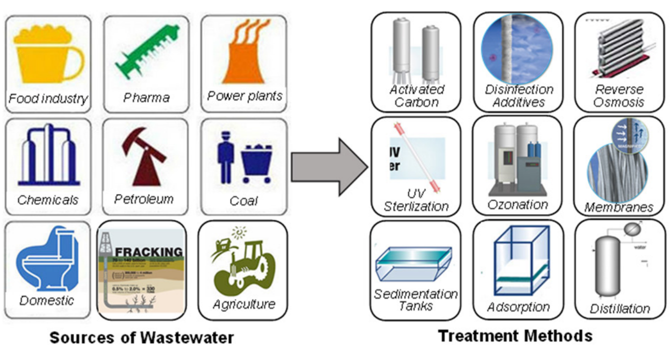
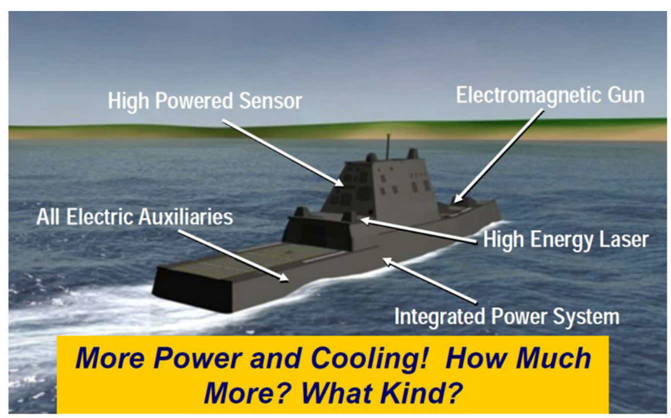
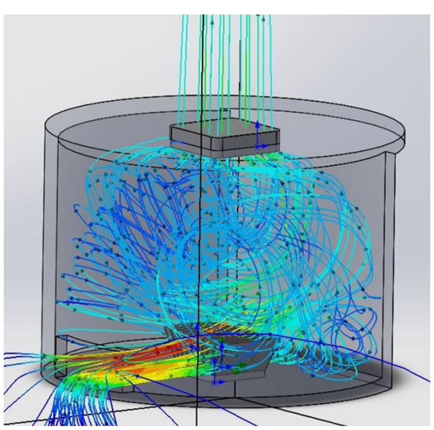
Rowan University

HENRY M. ROWAN
COLLEGE OF ENGINEERING









2020 Clinic Showcase Book

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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 freshman 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. In the junior and senior clinic experience, 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 113 clinic projects, involving over 525 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. The work is a reflection of the quality of our engineering education program, 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

ENGINEERS IN TRAINING

As students complete their first half of the undergraduate program, they are ready to move beyond the fundamentals. Students begin to apply the knowledge they have gained and practice their skills. Junior and Senior Engineering Clinics are a powerful platform that provides the training ground for our future engineers. The Clinics are designed to provide students with opportunities to solve real-world engineering problems under the supervision of faculty. Within these project-based learning experiences, students also develop crucial professional skills by working in teams and managing their tasks. This way project management and teamwork components can be integrated. Thus, the clinic projects represent the penultimate step for our students before they embark on their engineering careers.

Clinics are also designed to provide a breadth of experiences for our students. A typical student often works on three different projects over the last two years, giving our graduates numerous opportunities for growth. Working closely with experts in the field, students build lasting relationships with faculty and their peers. Depending on the funding source for the project, the students may have external partners. At the end of each project, students present their work as an oral presentation and a technical report. Some projects even entail conference presentations, field visits, or journal publications. This gives our graduates the much needed communications skills to succeed. The variety and the specific needs of each project present unique challenges to each team member that they must manage. Students are expected to assume leadership roles based on their comfort levels. This year presented an additional hurdle with the pandemic. Students and faculty quickly adopted and made measurable progress on their objectives. It is not surprising that potential employers use the clinic experience as a distinguishing attribute 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.

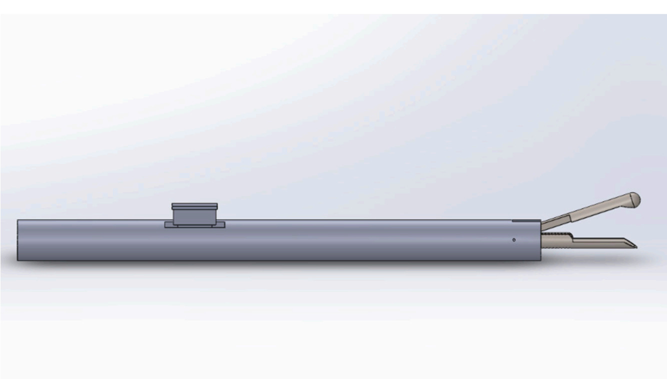
Sincerely,

Dr. Smitesh Bakrania
Junior and Senior Engineering Clinic Coordinator

BIOMEDICAL ENGINEERING

A Clinical Path to Cartilage Biopsy Procurement

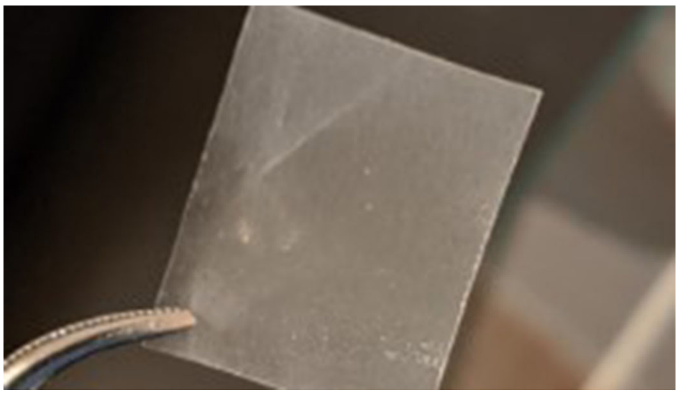
TEAM MEMBERS
Maura Francis, Samantha Struble, Stephanie Fanok, Joseph Oteri
PROJECT MANAGER
Dr. E. Brewer, Dr. S. McMillan (Rowan SOM), A. Intintoli, and A. Patrincola
SPONSOR
Lourdes Health System, Trice Medical



Damaged articular cartilage is a debilitating condition that causes inflammation to the knee, limiting the range of motion. It affects six million people each year in the United States. Wear and tear on the knee joint leads to a knee replacement in most cases. However, in young individuals, procedures like the MACI (Matrix-Induced Autologous Chondrocyte Implant) are recommended to avoid the limited lifespan of a knee replacement. The MACI requires a 200-mg of cartilage and two invasive surgeries, which causes risks and deters patients from completing the procedure. 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 non-load bearing condylar surfaces of the knee, avoiding the need for a second surgery. The device includes a gouge tip to procure the cartilage from the surfaces and a gripper to grasp the cartilage to complete the harvesting process while being minimally invasive. The device is articulated by a slider and linkage arm, making it an all-in-one tool. The team has filed a patent and plans to create a fully manufactured prototype.

Aligned Nanofiber Embedded Composite Thin Films and Layer-by-layer Structures

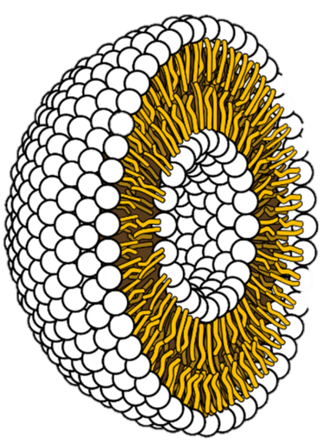
TEAM MEMBERS
Nikolas Belanger, Aakash Patel,
Cameron Burns
PROJECT MANAGER
Dr. Vince Beachley
SPONSOR
U.S. Department of Defense –
Army Research Laboratory



Aligned nanofiber composites are useful in a wide variety of applications including tissue engineering grafts, high strength composites and electronic devices. The small size of nanofibers allows them to be embedded into very thin composite films with thickness smaller than the diameter of conventionally manufactured fibers. Such thin nanofiber composite films can be assembled with a layer-by-layer additive manufacturing approach to form higher order materials with precisely organized nanofiber composition and orientation with fine resolution throughout the height of the material. Optimal embedded nanofiber architectures can result in materials with excellent mechanical properties. Soft-cell permeable aligned nanofiber composites are fabricated using enzyme degradable photo-cross linkable hydrogel materials. Aligned nanofibers promoted cell alignment and elongation in the desired direction making these materials useful for regenerating aligned tissues such as nerve and muscle.

Chemotherapeutic and Analgesic Drug Delivery Systems

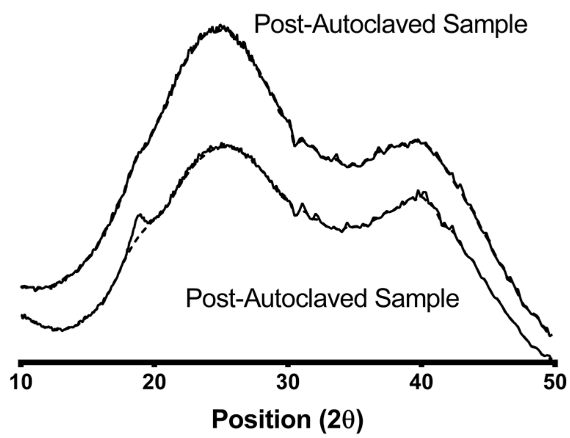
TEAM MEMBERS
Kassandra Dobson, Dana Van Fossen
PROJECT MANAGER
Dr. E. Brewer, Dr. J. Schuster, and
Dr. P. Zadnik



Approximately 10% of all individuals who develop cancer will additionally develop metastatic cancer in the spinal column. Current treatment of spinal tumors involves surgically removing an affected vertebrae and implanting a titanium cage in its place, followed by irradiation or chemotherapy, which balances the need to both kill remaining cancers cells while allowing for the treated area to heal. This clinic project aims to develop a localized delivery system of ellutes chemotherapeutic drugs to the spinal column of a patient following a tumor removal procedure. It is hypothesized that the sustained, localized treatment of chemotherapeutics will reduce the side effects of systemic treatment while allow for more rapid healing of the surgical site. Previously, two successful release studies validated the release mechanism of Dipalmitoylphosphatidylcholine (DPPC) liposomes at the average human body temperature of 37°C. This past academic year, research was focused to find the optimal formulation of a biodegradable, injectable, chitosan-based formulation compatible with the desired liposome release mechanism. Testing was conducted to characterize the gelation time and rheological properties. Future work should include further investigation of the release mechanism of the final promising concentration as well as further investigation of the hydrogel characteristics, including degradation studies.

Crystallinity, Reversibility, and Injectability of PVA/PEG Hydrogels

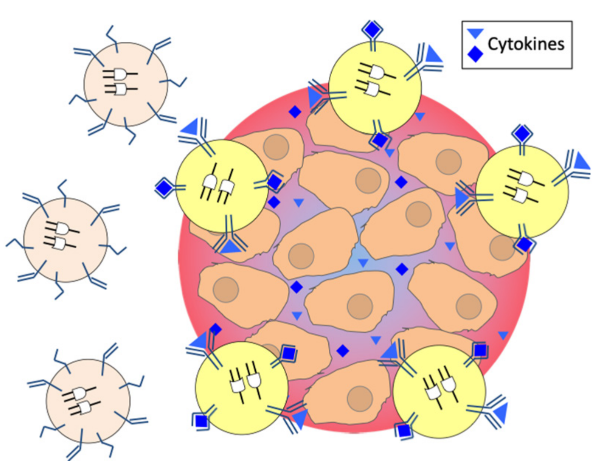
TEAM MEMBERS
Alexa Diano, Liam Kinnarney
PROJECT MANAGER
Dr. Erik Brewer and Dr. Anthony Lowman
SPONSOR
ReGelTec, Inc



Degenerative Disc Disease is the leading cause of back pain and will affect 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 thermosetting hydrogel that, when heated, can be injected into the degenerated spinal nucleus in a minimally-invasive procedure, cool, and restore the mechanical properties of the spine. This team is investigating the tendency of the amorphous gels to form crystalline structures over time that can hinder their ability to transition from a solid to a liquid when heated during a surgical setting. Using x-ray diffraction (XRD), the crystallinity of aged is quantified using percent crystallinity for samples aged up to eight weeks. The reversibility of crystallinity in aged samples is also quantified using percent crystallinity after subjecting samples to high temperatures. Finally, the injectability is evaluated based on hydrogel viscosity.

Developing Biosensors for Studying the Tumor Microenvironment

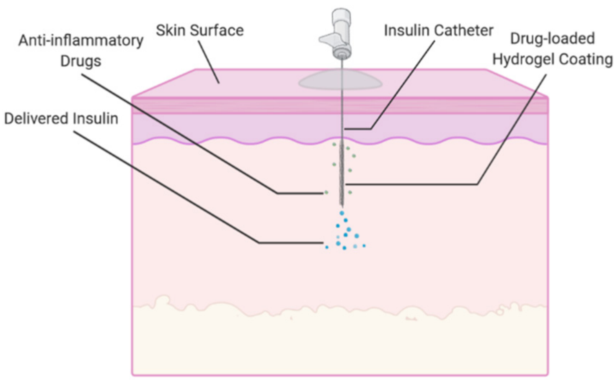
TEAM MEMBERS
Evan Hutt, Sierra Wagensommer, Alison Price, Anuoluwapo Fadare
PROJECT MANAGER
Dr. Nichole Daringer



The main purpose of this clinic is to develop synthetic cell receptors with engineered post-translational modifications. We are developing these post translational circuits able to study the tumor microenvironment. The post translational circuits will be able to measure the number of cytokines and other ligands in the tumor microenvironment, which is essential for studying the response of the tumor over time. The cytokine that I am looking at specifically is the cytokine transforming growth factor–β. Studying TGF- β is important to this clinic because TGF- β has been found to restrain the body's antitumor response by blocking the ability for T-Cells to infiltrate the tumor. By having a direct way to measure TGF-β, as well as other cytokines, we will have a better understanding of the dynamics within the tumor cells and its microenvironment.

Dexamethasone and Lidocaine hydrogel to lessen inflammation at insulin pump site

TEAM MEMBERS
Ryan Bach, Timothy Eck, Lucinda Lau
PROJECT MANAGER
Dr. Erik Brewer and
Dr. Jeffrey Joseph (Rowan SOM)
SPONSOR
Capillary Biomedical Inc., University of Pennsylvania Innovation Seed Grant, Singh Center for Nanotechnology



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 catheterâ€™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. These particles were then mixed into a Polyvinyl Alcohol (PVA) matrix and coated onto the transdermal portion of the insulin catheter. Using High Performance Liquid Chromatography (HPLC), loading and release studies were performed analysing the amount of lidocaine present in the matrix and the percentage of drug released. Results showed that half the lidocaine drug release occurred within a day, logarithmically increasing until it plateaued at almost full drug release on day 4. This suggests steady release, which effectively combats FBR over extended periods. To test coating integrity, delamination studies were performed by inserting and extracting the catheters from pig epidermis samples and imaged using Scanning Electron Microscopy (SEM). Based on the data, we can successfully reduce local FBR through loaded catheters that actively release anti-inflammatory drugs over a 7-day period.

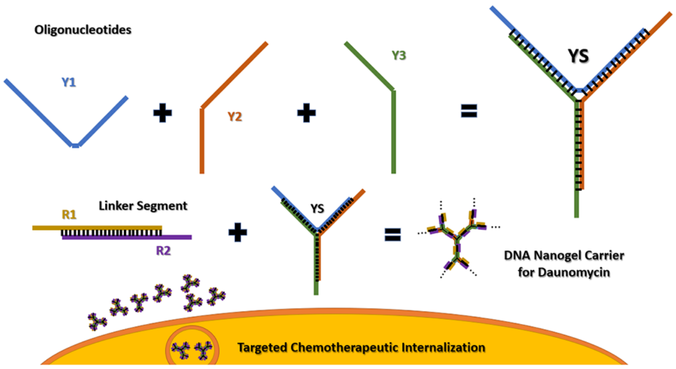
Dimension Adjustable Power Chair

TEAM MEMBERS
Jacqualyn Washington, Natalie Bonamassa, Peter Gawason
PROJECT MANAGER
Dr. Erik Brewer and Dr. Christopher Keenan (Children’s Hospital of Philadelphia)
SPONSOR
Children’s Hospital of Philadelphia

Nearly 65 million people worldwide require the support of powered wheelchairs. These devices provide mobility for those who have motion complications such as musculoskeletal disorders and can be required as early as 18 months old and last for life. Currently, the treatment provided in hospitals is limited by a lack of power chair accessibility which includes the availability and sizes of the units. These challenges can both be addressed with a chair that can easily and quickly adjust in size. A secondary obstacle patients face is navigational control. After creating a size adjustable power chair the team will move to update the training methods for patients, with an emphasis on virtual reality. Utilizing a Quantum Tru Balance power chair we were able to begin modeling our designs. In conjunction with Children’s Hospital of Philadelphia, Rowan Biomedical Engineering students seek to reimagine the power chair. This project is aimed towards expanding accessibility for those who need it.

DNA Nanogels for Targeted Delivery of Chemotherapeutics

TEAM MEMBERS
Daniel Tepper, Matthew Talarico
PROJECT MANAGER
Dr. Mark Byrne and
Dr. Jacek Wower (Auburn University)
SPONSOR
Auburn University,
RNA Biochemistry Laboratories



Pure DNA drug-carrying nanoparticles were synthesized using a predictable Watson-Crick base pairing design which allows for the engineering of complex, 3D, nanoscale hydrogel structures. Due to the enhanced permeability and retention effect (EPR) of tumors and utilizing single-stranded DNA motifs such as aptamers, these structures target cancer cells in vivo with high specificity. Chemotherapeutic drugs such as Daunomycin can be carried to tumor sites via intercalation inside the DNA helix, leading to a lower systemic dose requirement while achieving the same life-saving dose at the cancer site. The specificity and reduction in systemic dose reduces unwanted side effects and damage to nearby healthy cells. Our group has designed a DNA nanoparticle consisting of multivalent subunits upon which we can attach targeting, tracing, or drug-loading specialized sequences. Since the effectiveness of the EPR effect depends on particle size, we compared dynamic light scattering measurements to study how ion and DNA concentration, oligonucleotide sequences, buffer pH, and annealing processes affect the particle size and homogeneity. We believe that these strategies can be implemented to create a platform of cancer cell targeting, biocompatible DNA drug delivery nanostructures which can decrease the side effects of conventional cancer chemotherapy.

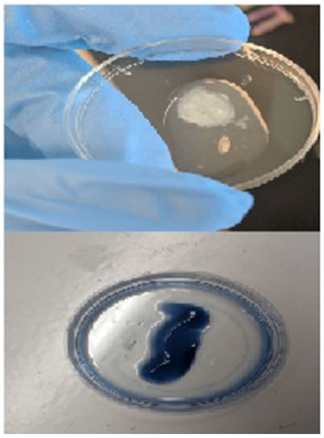
Early Detection of Implant Loosening to Prevent Total Implant Failure

TEAM MEMBERS
Ann DiGuglielmo, Jerico Mellet,
Mckayla Rebillon
PROJECT MANAGER
Dr. Erik Brewer and Dr. Luke Austin
SPONSOR
Rothman Institute

In 2016, 150,000 hip replacement surgeries were performed in the US. Historically, the 10-year failure rate of implants is approximately 10%, of which 75% are caused by aseptic loosening. Implant failure requires a total revision procedure, which is invasive, costly, and painful. Currently, there are no existing solutions for tracking implant loosening before failure. The development of an implant loosening detection system would pave a way for development of early prevention measures. Our design incorporates a secondary reference implant that can enable doctors to track the migration of the primary joint implant. It utilizes pre-existing surgical tools and the use of a neural network detection system. Radiographic imaging was selected as the primary visualization method since radiographs are easily accessible. X-ray testing was conducted to validate our design. A metal implant was translated and rotated at 1 mm and 2.5° increments. These images were then tested against the original image. Translational tests successfully found the translation within 0.1 mm of the true value. Rotation was tested with a neural network which detected the degrees rotated within 0.5° of the true value. A patent was filed in February 2019 to protect the findings of this project.

Effects of Genipin Crosslinking on the Mechanical Properties of Hydrogels Derived from Decellularized Bovine Tendon

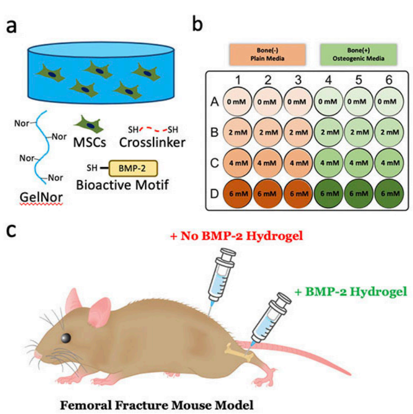
TEAM MEMBERS
Alicia Coombs, Cameron Burns
PROJECT MANAGER
Dr. Vince Beachley



Extracellular matrix (ECM) hydrogels are a useful biomaterial in the tissue engineering field used for injectables in drug delivery systems, wound dressing, tissue regeneration and many other applications. One major limitation of ECM hydrogels is that they are structurally weak and have a much lower elastic modulus when compared with many human tissues. It was hypothesized that the mechanical properties of ECM hydrogels could be enhanced via crosslinking. In this work, genipin was evaluated as a crosslinker with decellularized tendon ECM hydrogels. Genipin is a natural crosslinker found in gardenia fruit extract that is known for turning blue when it has reacted with amino acids and proteins. Genipin has a low toxicity that is reportedly 10,000x less than that of glutaraldehyde.

Gelatin-Based Bioactive Hydrogels for Bone Tissue Engineering Applications

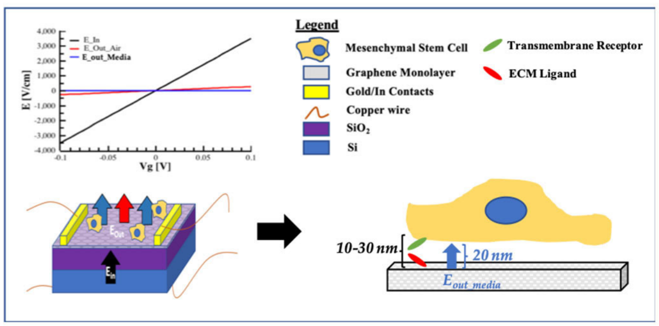
TEAM MEMBERS
Roshni Gandhi, Khushi Sarin, Kirstene Gultian
PROJECT MANAGER
Dr. Sebastián L. Vega and Dr. Tae Won B. Kim
(Cooper University Medical School)
SPONSOR
Rowan University -
Camden Health Research Initiative



Osteoporosis is a condition in which bone density and quality are reduced, increasing the risk of fragility fractures. Current treatment options for osteoporosis are invasive and result in the need for long-term post-operative care. Taken together, the objective of this project is to develop a hydrogel-based platform to locally strengthen bone in regions prone to fragility fractures. Mesenchymal stem cells (MSCs) are adult stromal cells with the ability to differentiate into bone-producing osteoblasts. Seminal studies have identified substrate stiffness, dimensionality, and biochemical signals as important factors for MSC osteogenic differentiation. Herein, hydrogels amenable to osteogenesis and 3D cell culture were created using norbornene-modified gelatin (GelNor) macromers and protease-degradable crosslinker peptides, with the inclusion of a BMP-2 peptide motif to promote MSC osteogenic differentiation (Fig. 1a). To determine the optimal BMP-2 peptide concentration, MSCs were cultured atop (2D) stiff (20 kPa) hydrogels biofunctionalized with varying concentrations of BMP-2 peptide, either in the presence (Bone+) or absence (Bone-) of osteoinductive growth media (Fig. 1b). To evaluate MSC osteogenic differentiation in vitro, the expression of osteogenic biomarkers (Runx2, osteocalcin, alkaline phosphatase) are being evaluated, with plans of testing bioactive hydrogels in vivo using a femur fracture mouse model (Fig. 1c).

Graphene-Based Microdevices to Study Electrical Stimulation on Stem Cells

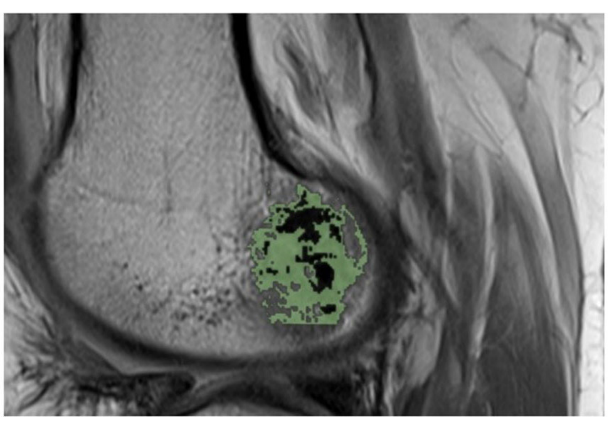
TEAM MEMBERS
Sebastian Naranjo, Katie Driscoll, Kirstene Gultian
PROJECT MANAGER
Dr. S L. Vega, Dr. D. Jariwala, Dr. T. Arinzeh
SPONSOR
Center for Engineering MechanoBiology (CEMB) Pilot Grant Award, University of Pennsylvania, New Jersey Institute of Technology



Mesenchymal stem cells (MSCs) are an exciting cell source for tissue engineering and regenerative medicine due to their ability to differentiate into a variety of cell types. While the effects of biochemical and biophysical signals on MSC differentiation have been studied, MSC responses to applied electrical stimulation remain poorly understood. Electrical field stimulation regulates interactions at the cell-ECM interface, which can affect numerous MSC functions, including morphology, mechanosensing, and differentiation. Current in vitro systems produce cytotoxic byproducts, are non-specific, and are inadequate at specifically targeting the cell-ECM interface. To investigate the effects of applied electrical stimulation on MSC behavior, a graphene monolayer-based microelectrode was developed. In the presence of applied voltage, the graphene monolayer transmits physiologically relevant applied electrical stimulation spanning 20 nm above its surface. This provides an opportunity to specifically target and probe cell-ECM junctions, which span between 10-30 nm (Fig. 1). Currently, cell culture conditions and stimulation parameters (t, v, f) are being optimized to develop a cytocompatible graphene-based microdevice. Using live cell microscopy and fixed, immunostained samples, this platform will be used to study the effects of applied electrical stimulation on MSC morphology, mechanosensing, and osteogenic differentiation.

Informed Delivery Strategy for Percutaneous Fixation of Bone Marrow Lesions

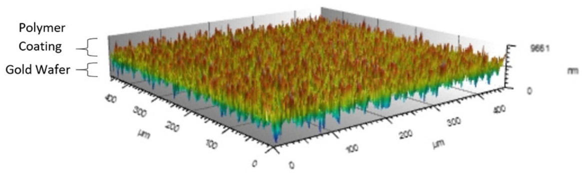
TEAM MEMBERS
Olivia Palino, Alex Juall, Marie Green
PROJECT MANAGER
Dr. Erik Brewer and Dr. Sean McMillan (Rowan SOM)
SPONSOR
Lourdes Health System



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 surgeonâ€™s perception for when it is complete. Furthermore, under or overfilling of the site, which is estimated to occur in 30% of injections, can result in either incomplete restoration of the bone and further progression of the disease or osteonecrosis and pain to the patient, ultimately requiring a corrective total joint replacement procedure. There are currently no other procedures or devices that can stop this disease or improve the BML injection procedure. Rowan engineering, along with collaborators at Lourdes Medical Center, have developed a solution that fulfills this unmet need by providing a controlled injection monitoring system that provides instantaneous feedback to the surgeon on both the injection rate and risk of overfilling.

Integrating Macromolecular Memory into Thin Polymer Films for Rapid Biosensing

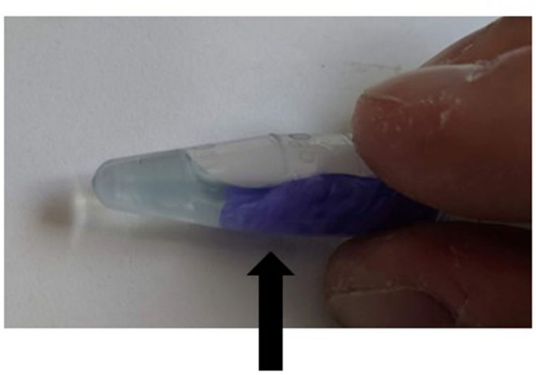
TEAM MEMBERS
Ankit Singh, Julia Bally
PROJECT MANAGER
Dr. M. Byrne, Dr. E. Brewer, R. Mosley, and R. Akers
SPONSOR
Akers Nanotechnology



For the study of medical endocrinology, it is important to obtain a precise detection of testosterone levels. There are several methods that have been utilized to detect testosterone, including enzyme-linked immunosorbent assay (ELISA) techniques, radioimmunoassay (RIA), high performance liquid chromatography (HPLC), gas chromatography-mass spectrometer (GC-MS), and liquid chromatography-mass spectrometry (LC-MS). However these procedures are time consuming, and require specialized personnel and expensive instrumentation, limiting them from being used more extensively. Thus, there is a need for rapid, small scale testosterone sensing. Akers Nanotechnology, based in Sewell, New Jersey, tasked Rowan University engineering students to help develop and meet the need of a novel testosterone. To accomplish this, students are developing gold wafers coated with polymers that are potentially capable of detecting testosterone. The group's current work focuses on the optimization of the polymer coating process. The polymer has been successfully coated onto the wafer at an approximate average of 950 nm.

Investigating the Crystallization Kinetics of Electrospun Nanofibers for Controlled Drug Delivery Applications

TEAM MEMBERS
Kerri N. McBride, Matthew Flamini
PROJECT MANAGER
Dr. Vince Beachley
SPONSOR
National Science Foundation

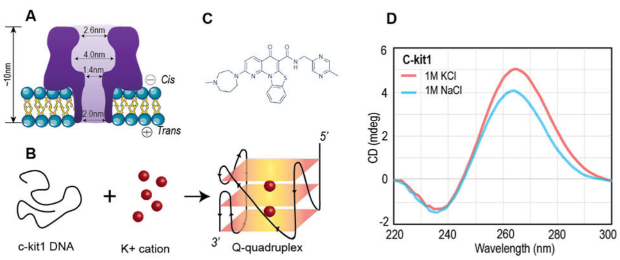


PCL nanofibers containing dye

Since polycaprolactone (PCL) nanofibers are biodegradable they are useful for numerous biomaterial applications, such as drug delivery, however there is insufficient research surrounding nanofibers on the molecular level. Drug release occurs through PCL degradation through hydrolysis as well as diffusion. The drug may diffuse faster out of amorphous regions compared to crystalline regions of the nanofiber therefore controlling the crystallinity is essential to effective drug release. In this experiment, Dimethyl-Methylene blue was the model drug used. The objective of this project is to determine how the crystallization of the nanofibers impacts the rate of drug released. Greater crystallinity resulting in higher molecular alignment in the polymer chain was hypothesized to result in a more controlled and delayed drug release.

Investigation of C-kit1 G-quadruplex stability using nanopores

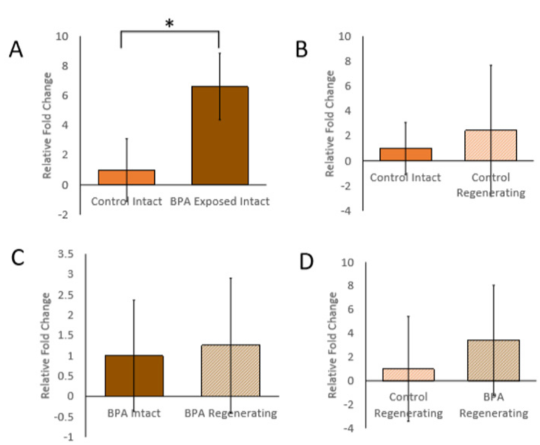
TEAM MEMBERS
Trang Vu, Christopher Moran, Mohammed Mannan, Angelo-Jesus Pingol, Lance Guzman, Colleen Grehlinger
PROJECT MANAGER
Dr. Jiwook Shim



We investigate the C-kit1 promoter of which sequence plays an important role in several human malignancies. C-kit1 is a guanine-rich sequence that can form stable G-quadruplex structure in the presence of cations, causing gene downregulation and leading to suppression of cancer cell proliferation. Our study is to evaluate C-kit1 G-quadruplex structural stability dependence on cations and CX-5461. Conventional methods often uses fluorescence spectroscopy and circular dichroism to study CX-5461 efficiency on stabilizing G-quadruplex. However, these method cannot provide real-time molecular dynamic sensing of the structure folding/unfolding behavior. Our lab utilize the nanocavity of a biological nanopore as the main tool for single-molecule analysis of C-kit1 G-quadruplex. Specifically, C-kit1 G-quadruplex formation and stability with and without CX-5461 presence will be analyzed using biological nanopore, circular dichroism and thermal denaturation. We expect that nanopore-based study can reveal the cation-dependent G-quadruplex stability and enhancement of stability when binding with CX-5461. Also, we will employ machine learning models to predict C-kit1 G-quadruplexes formed in different experimental conditions for accuracy and sensitivity.

Measuring Transcriptional Patterns in Head-Regenerating Planaria

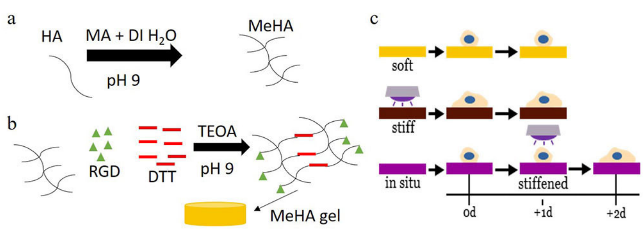
TEAM MEMBERS
Brianna Rodriguez, Johnathan Morris
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
National Institutes of Health



Bisphenol A (BPA), a chemical compound that is commonly used in plastics, has been linked to fertility issues and birth defects, but these effects are difficult to study in humans. Schmidtea mediterranea (Smed) planaria are used as a model due to their highly regenerative properties and similar genomic makeup. Genes found in both species were chosen for experimentation based on their role in cellular component, biological processes or molecular function. For experimentation, ten planaria were starved for one week prior and homogenized in TRIzol. RNA isolation, cDNA synthesis, and reverse transcription were conducted following established methods. Smed-CHD4, a gene similar to the CHD4 gene in humans, was chosen for experimentation because it is known to be required for planarian regeneration and tissue homeostasis. Worms were tested under BPA and control solutions, as well as intact and regenerating worm conditions. Statistical significance was observed only in the group comparing intact worms in the control and BPA solutions. These results suggest that BPA exposure increases the expression of Smed-CHD4, while regeneration alone may not. This work begins to unravel the effects of BPA in Smed worms, specifically in the expression of genes responsible for their ability to regenerate.

Mechanically Dynamic Hydrogels to Investigate Substrate Stiffness on Stem Cells

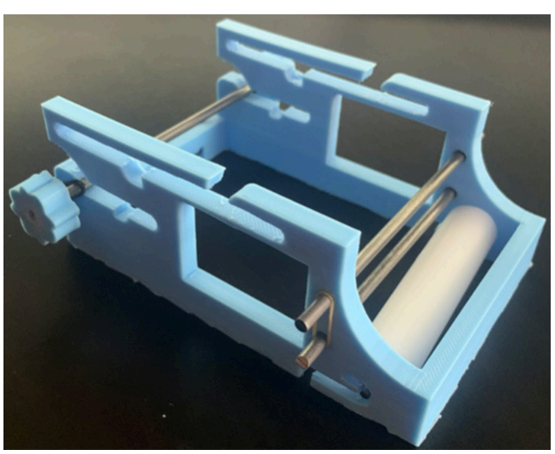
TEAM MEMBERS
Matt Lowe, Katie Driscoll, Mehdi Benmassaoud
PROJECT MANAGER
Dr. Sebastián L. Vega
SPONSOR
The New York Stem Cell Foundation Research Institute



Although the effects of substrate stiffness on mesenchymal stem cell (MSC) morphology and differentiation are well documented on static materials, there is a limited understanding of MSC responses to dynamic environments. In this study, MSCs were cultured on top of static and in situ stiffened hydrogels formed with methacrylated hyaluronic acid (MeHA) macromers (Fig. 1a). To form soft hydrogels (~2 kPa), a Michael-type addition polymerization reaction was performed by mixing macromers (MeHA, 3 wt%), crosslinkers (dithiothreitol (DTT), 5 mM), and cell adhesion peptides (Arg-Gly-Asp (RGD), 2 mM) in a triethanolamine (TEOA, pH 9) solution for 3 hours (Fig. 1b, 1c top). To form stiff hydrogels (~20 kPa), soft hydrogels were cultured in a PBS solution with photoinitiator (I2959, 0.05 wt%) and irradiated with UV light (10 mW/cmÂ², 10 min) (Fig. 1c middle). Using this same process, soft hydrogels can be stiffened in situ to investigate how MSCs respond to dynamic mechanics (Fig. 1c bottom). As expected, MSCs on soft hydrogels are small/round, whereas MSCs on stiff hydrogels are large/spread. Surprisingly, MSCs on in situ stiffened hydrogels adapt to their new environment at different rates, depending on how long they were on soft hydrogels prior to stiffening.

Mesh Rolling and Implantation Device for Laparoscopic Hernia Repair Surgeries

TEAM MEMBERS
Valerie W. Cross, Chirag Patel, Nicholas Reed, Eric Williamson
PROJECT MANAGER
Dr. E. Brewer, Dr. D. Mazzucco (ZSX Medical), and Dr. Elizabeth Renza-Stingone (Temple Health)
SPONSOR
ZSX Medical, Temple Health



Over 1 million minimally invasive hernia repair procedures are performed annually in the U.S., 80% of which utilize surgical mesh to cover the defect in the abdominal wall, minimizing recurrence rates. However, surgery staff struggle to roll hernia meshes small enough to fit through delivery trocars of 8mm or smaller during surgery, often delaying the process longer than ten minutes. This is a significant amount of unnecessary time in an operating room, and can indirectly correspond to later complications (e.g., infection, higher surgery cost). Therefore, a more efficient mesh insertion method for hernia repairs is needed. Rowan University engineers, in collaboration with Dr. Mazzucco and Dr. Brewer, and user input from Dr. Renza-Stingone, developed a mesh rolling and insertion device to enable a professional in the operating room to more quickly roll the mesh and insert it into a trocar of 8mm or less. The time of rolling and administration of the rolled mesh was observed and analyzed through a 5mm trocar (the optimal size restraint) as well. Final device materials have been selected and preparation for the development is in progress.

Novel Thin Film Biomaterials for Ocular Drug Delivery: Therapeutic Contact Lenses

TEAM MEMBERS
Ashleigh Jankowski, Alyssa Robbins, Sarah Libby, James Malta, Liana Wuchte, Stephen DiPasquale
PROJECT MANAGER
Dr. Mark Byrne
SPONSOR
Gelest Inc. & OcuMedic, Inc.

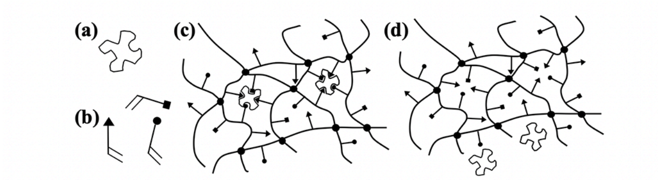
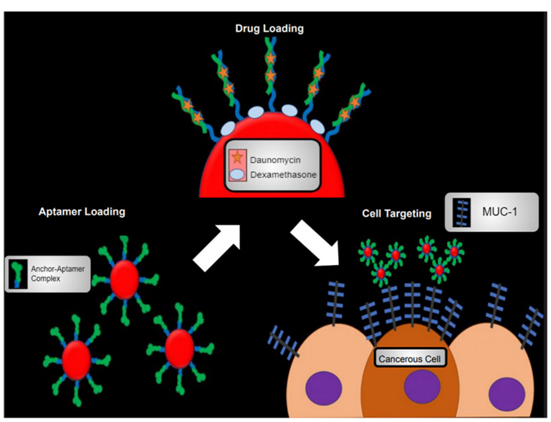


Figure 1: Macromolecular memory. (a) A biomolecule to serve as a template molecule. (b) Functional monomers matching template functionality. (c) Polymer network formation. (d) Biomolecule release from polymer. Memory sites remain.

There is a significant unmet need in ocular therapy today. Eye drops currently dominate 90% of the ophthalmic drug market despite being highly inefficient. When applied, only 1-7% of drug content in an eye drop is productively absorbed. A more effective, efficient treatment method for ocular disease is necessary. This research focuses on the development of a therapeutic contact lens platform utilizing a strategy called macromolecular memory. Macromolecular memory involves the careful selection of functional chemistry with a high affinity for the chosen template drug via non-covalent, reversible interactions. The chemistry forms memory sites within the polymer architecture, providing highly specific points of interaction within the lens to delay drug release with highly controllable rates from the contact lens into the eye. For over a decade, our group has shown successful in vivo and in vitro release of ocular therapeutics at extended and controlled rates with macromolecular memory. Recent work from this team explores new macromolecular lens species as well as demonstrates the first successful, in vivo experiments with constant drug release duration and constant therapeutic drug concentrations for more than 1 week (8days) from a lens with optical, mechanical, oxygen transport, and all other properties that compare to conventional silicone hydrogels on the market today.

Novel, Biohybrid, Dual-Drug Delivery System with Aptamer Specific Targeting of MUC1-overexpressing Cancer Cells

TEAM MEMBERS
Matt Grisley, Brendan Rucci, Laura Osorno, Robert Mosely
PROJECT MANAGER
Dr. Mark Byrne
SPONSOR
Cooper Foundation



Cancer therapies are often hindered by off-target toxicities and evolving tumor drug resistance. To combat this, we have developed a novel, dual drug delivery system with the potential to selectively target tumor cells with high affinity. First, DNA aptamers are conjugated to a functional, oligonucleotide-linked gold nanoparticle (AuNP) through complementary base pairing. Oligonucleotides can be conjugated to the AuNP surface at a high density by using a simple salt-aging procedure, leading to significant loading of aptamers. Next, dexamethasone is bound to the surface of the AuNP through electrostatic interactions and held by the presence of the dense DNA array. Finally, daunomycin is bound to the double-stranded DNA regions through its natural tendency to intercalate into the minor groove of DNA duplexes. Our chosen aptamer sequence specifically targets extracellular mucin-1 proteins (MUC1) which are commonly overexpressed in adenocarcinomas. This platform utilizes simple chemistry and synthesis methods to provide a programmable and personalizable therapeutic platform without the need for excessive or complex modification. In this work, a platform is being created in order to optimize drug loading of our AuNP platform while implementing an active targeting mechanism towards cancer cells and other cell types involved in inflammation.

Optimization of Breast Cancer Cell Line Exosome Isolation

TEAM MEMBERS
Avi Patel, Sam Ricci
PROJECT MANAGER
Dr. Mary Alpaugh and Dr. Peter Galie

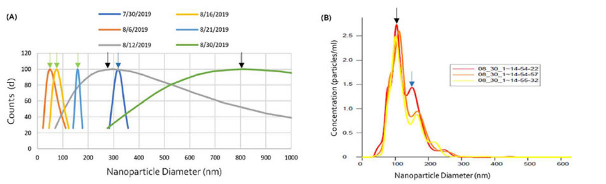
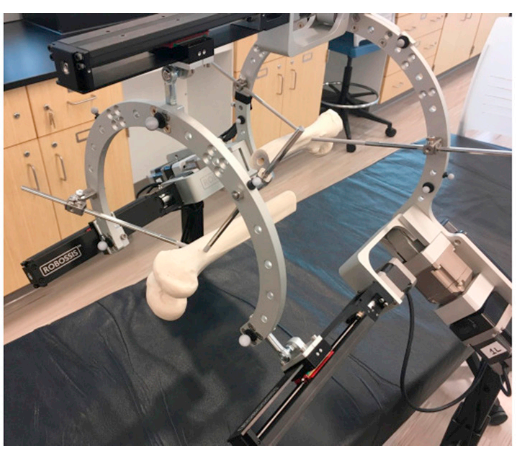


Figure 1. Samples tested for size distribution of nanoparticles using A) Dynamic light scattering (DLS) and **B)** Nanoparticle tracking analysis (NTA).

Breast cancer is the most common form of cancer in women, even after stratification of race and ethnicity. Emerging evidence shows that extracellular vehicles (EVs), especially exosomes, have been implicated in facilitating progression of metastatic disease. With the intent of understanding their role in communication, studies have analyzed the molecular cargo within these nanovesicles (30-120nm). Content, i.e., proteins, RNA and DNA have been identified to be packaged in the vesicles. In this study, we focused on optimizing the protocol for exosome isolation, and obtaining total protein values. In this study, we confirmed the presence of exosomes in cell culture medium of MDA-MB 468. Furthermore, we optimized the protocol of exosome isolation, and bilipid membrane disruption. Nanovesicles were identified by their size using DLS and NTA. The total protein obtained from an isolation was an essential parameter for this study. Overall quality of an isolation was directly correlated with the total protein obtained from it. Angiogenesis: growth of blood vessels from the existing vasculature was studied using microfluidic devices. Students aimed to develop a standard protocol of loading the microfluidic device to improve the reliability of data.

Orthopedic Surgical Robot

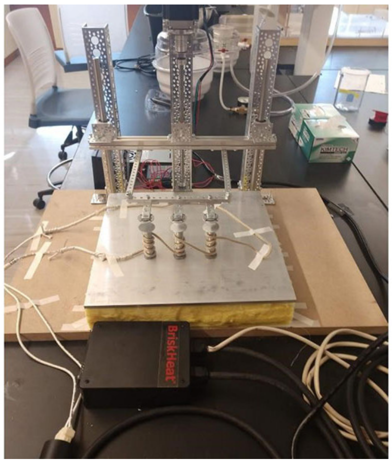
TEAM MEMBERS
Michael Shirley, Ian Moffitt
PROJECT MANAGER
Dr. Mohammad Hossein Abedin Nasab and
Dr. Nourouddin Sharifi



Robossis is an orthopedic surgical robot and a breakthrough development within the orthopedics industry. Robossis will critically enhance fracture realignment surgeries in long bones for surgeons and patients. The goal is to optimize the patients experience while assisting the surgeons execution. A major step is realigning the bone with considerable accuracy. Current surgical methodology for long bone fractures is invasive and brings challenges during both intra and post operation. Radiation exposure brings complications with surgeries involving CT scanning as well as continuous x-ray imaging. More open surgeries will vastly raise the infection rate. With current imaging and surgical technique, the realignment of the bone is done so manually which can cause an increase in malalignment. Through the National Science Foundation, the research study enveloped the team with 100’s of medical professionals which were interviewed, in return giving a plethora of valuable insight into methodology and day to day challenges. Interviewees comprised of trauma surgeons, rad techs, doctors, nurses, PTs, and hospital administration. The results were conclusive, showing that surgeons are looking to reduce malalignment by 90%, along with shorter operation time by 30%, and reducing radiation exposure by 90%. Current steps involve working with a leading trauma surgeon and performing clinical trials on a cadaver.

Polyethylene Solution Production Using Olive and Peanut Oil and Nanofiber Fabrication through Mechanical Methods

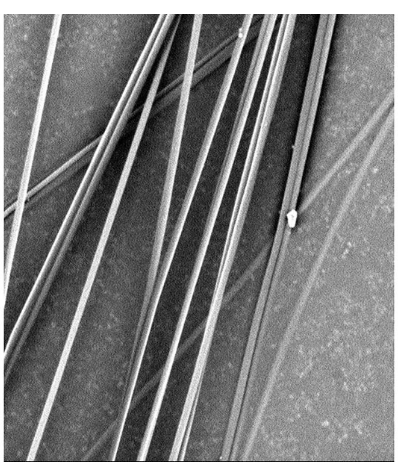
TEAM MEMBERS
Ryan Denny, Dave Jao
PROJECT MANAGER
Dr. Vince Beachley
SPONSOR
U.S. Department of Defense – Army Research Laboratory



The goal of this study is to produce nanofibers from ultra high molecular weight polyethylene using eco- and user-friendly solvents and mechanical spinning methods. This is in pursuit of safer and more scalable nanofiber production methods. Solutions of ultra-high molecular weight polyethylene and olive or peanut oil are being optimized and a mechanical drawing system with controlled draw raw and pre-draw compression was designed and built. Future work includes incorporating antioxidant process-stabilizers and mechanical mixing into solution production, experimenting with new solvents (terpene), and spinning with several mechanical methods.

Post-drawing and Characterization of Electrospun Polyacrylonitrile Nanofibers

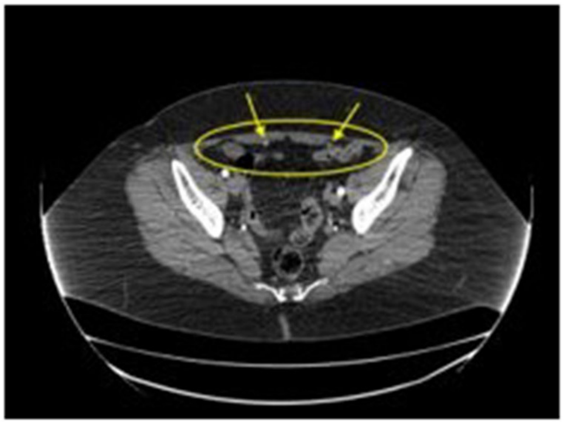
TEAM MEMBERS
Cailyn Rhoads, Adriano Conte
PROJECT MANAGER
Dr. Vince Beachley
SPONSOR
National Science Foundation



Increasing the nanofiber draw ratio (ratio of the final and initial lengths of the stretched fibers) has been shown to produce fibers with a higher tensile strength and increased stiffness. As a result, fibers that undergo post-drawing (elongation of fibers) are especially strong. The improvements in tensile properties associated with post-drawing are due to the rearrangement post-drawing produces in the nanofiber's molecular orientation. The molecular orientation is improved by rearranging the individual polymer chains within the fiber to better line up to the fiber axis. This project is aimed toward determining the best parameters, techniques, and conditions for the fabrication, manufacturing, and processing of PAN fibers in order to further strengthen their tensile properties with the main focus of this project being to narrow down the exact relationship the speed at which fibers are drawn (the draw rate) as compared to the maximum possible draw ratio.

Pre-Operative Scan Modeling for Reconstructive Surgery

TEAM MEMBERS
Kyle Printon, Erin Van Dexter, MaKenna McMichael
PROJECT MANAGER
Dr. Erik Brewer and Dr. Dorothy Bird (Cooper University Health Care)
SPONSOR
Cooper University Health Care



Reconstructive microsurgery is a specialty in plastic surgery that requires precision instruments to transfer and repair blood vessels and nerves when performing tissue repairs in patients suffering from trauma, cancer, and congenital anomalies. Using a free flap tissue transplant from the patient lowers the chances of necrosis and donor site morbidity. However, current applications require surgeons to pre-operatively study two-dimensional CT scans to interpolate a mental three-dimensional image of where the perforating veins intended for transplant are located. As a result, approximately 3% of cases experience permanent flap failure. Rowan Biomedical Engineers have partnered with Dr. Bird at Cooper Health to develop and utilize a pre-operative method involves processing CT scans through a DICOM image reader and tracking the perforating vessels to be utilized in the specific patient's procedure. The model is then 3D printed and used by the surgeon prior to the procedure and in the operating room. Proof-of-concept scans thus far have focused on the deep inferior epigastric perforators (DIEP) in the abdomen for breast reconstruction.

Predicting Neurodevelopmental Toxicity of Exogenous Chemicals

TEAM MEMBERS
Joby Jacob, Hannah Walens, Johnathan Morris
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
National Institutes of Health

Currently, there are numerous chemicals that need to be better evaluated to characterize their effect on humans. New compounds continue to be introduced at an accelerated pace; however, the characterization of these compounds lags, leaving a lack of data to determine the effects of exposure to the chemicals, especially during development. Our approach for addressing this escalating problem is a high-throughput system that allows us to utilize Schmidtea mediterranea (Smed) planaria as an early indicator of neurodevelopmental toxicity. Furthermore, we know that different isomers and configurations can have different therapeutic effects (as shown with thalidomide). With the high-throughput apparatus, we are able to measure cognitive function in planaria exposed to various exposure paradigms, including exposure dose, duration, and timing; yielding a testing battery for each chemical that can be created using statistical design of experiments. The new testing procedure will shorten preliminary assessment of neurodevelopmental toxicity considerably and provide rich data for future analysis and interpretation. By utilizing the planaria's regenerative properties, we have an inexpensive tool to assess the potential toxicity of new compounds. We suggest that the final result will lead to better chemical characterization leading to the ultimate goal of improving human health.

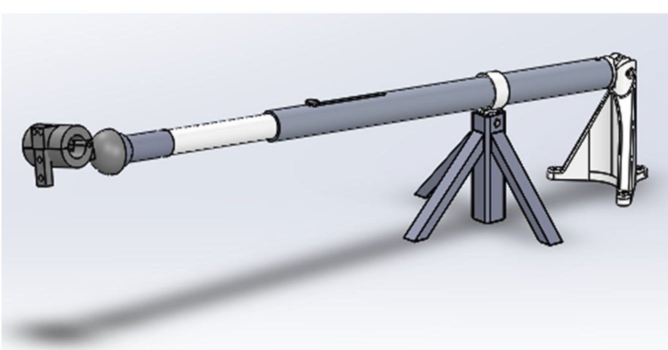
Prophylactic Cap Designed for Multi-dose Vials to Reduce Nosocomial Infections

TEAM MEMBERS
Rebecca Charboneau
PROJECT MANAGER
Dr. E. Brewer, M. Dershem, L. Jaconelli, Dr. G. Captuo, and Dr. P. 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. These infections can be spread through direct patient contact, improper hand washing, and contaminated medical equipment. Recently, multi-dose medication vials have demonstrated significant bioburden, with randomized testing showing that 4.2% of previously used vials tested positive for bacteria. Despite having established disinfection protocols, other studies note that poor aseptic techniques by users are a cause for these results. These observations demonstrate the need for disinfection methods that are less prone to user error or negligence. The goal of this project is to design an innovative device that curtails user error involving multi-dose vials and reduces the risk of nosocomial infections. The current design of the vial cap incorporates a physical barrier that prevents migration of infectious agents, and a built-in chemical barrier responsible for continual disinfection of the vial septum, eliminating the human error of standardized disinfecting protocols. Preliminary studies have shown that the developed vial cap has the potential to be as effective as established safety protocols and required no user-dependent disinfection methods.

QL+ One Handed Kayak Paddle: ROWan Paddle

TEAM MEMBERS
Jason Wilkowski, Aaron King, Jason Muermann, Brittney Nickel
PROJECT MANAGER
Dr. Erik Brewer and Melanie Amadoro
SPONSOR
Quality of Life Plus



According to the 2000 United States census, 19% of the US population is struggling with a disability, 34.2 million people have functional limitations, and 2.2 million people use a wheelchair. In 2017, there were 15.99 million frequent kayakers in the United States. With the high rate of disability and the popularity of kayaking, this yields a market that is overlooked and untargeted: disabled athletes. In collaboration with the Quality of Life Plus organization, this clinic has developed a prosthetic kayaking device to compensate for upper extremity complications. The device has been designed for a veteran with a paralyzed left arm. The input he has provided has given personal insight on the faults with current prosthetic paddle devices: (1) they break easily, (2) restrict normal kayak motion, and (3) are not designed for optimal efficiency or performance while paddling. Steady developments using biomechanics have been made to construct an aquatic kayaking device that will withstand up to 75 lbs of force in any given direction, will resemble an 80% overlap in average stroke profile of the paddle, and will grant an additional 50 N of kayaking thrust on top of user's normal capability.

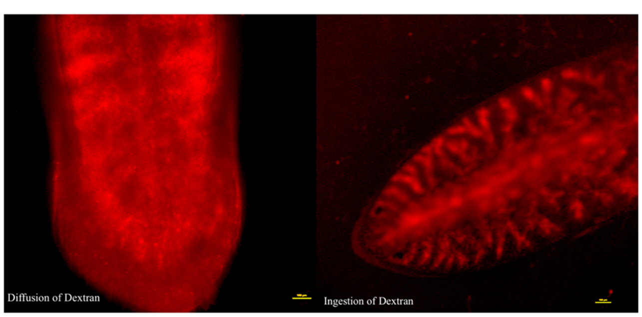
Quantifying Degradation in Omeprazole Oil Suspension

TEAM MEMBERS
Elena Nitting, Amanda Abruzzo
PROJECT MANAGER
Dr. Erik Brewer and Larry Troch
SPONSOR
Wedgewood Pharmacies

Omeprazole, a proton pump inhibitor, is used to treat many gastrointestinal problems such as gastroesophageal reflux disease and stomach ulcers. However, random discoloration in omeprazole injectable oil suspensions has been observed following gamma ray sterilization, often leading to customer complaints and questions regarding drug stability. Regardless, the injectable form of omeprazole is preferred by many veterinarians due to the difficulties regarding the ingestion of oral formulations by horses. Wedgewood Pharmacies, of Swedesboro, NJ, has tasked Rowan University Biomedical engineers with quantifying the influence of excipients and processing parameters on the degradation and stability in order to develop more stable formulations. Under controlled degradation studies, we were able to develop a method to quantify one-razored degradation via High-Performance Liquid Chromatography. Our results demonstrated that gamma radiation of Wedgewood formulations induces a 0.88% degradation of the sample. The new formulation aims to manage excipients to prevent degradation within the solution.

Routes of Administration Affect Dispersion in Planaria

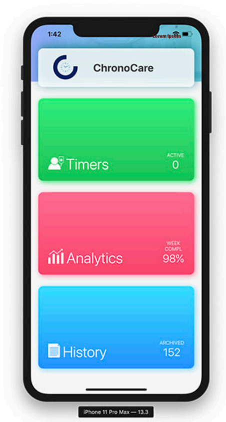
TEAM MEMBERS
Timothy Horchuck, Sarah Krajicek, Johnathan Morris
PROJECT MANAGER
Dr. Mary Staehle
SPONSOR
National Institutes of Health



Schmidtea mediterranea (Smed) planaria are capable of regenerating completely from seemingly infinitesimal fractions in a matter of days1. They have a relatively simple anatomy consisting of a centralized nervous system, which includes a bilobed brain structure and ventral nerve cords, and from which we can observe the toxic effects of certain chemicals on such anatomical structures. 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, an exposure model was developed using dextran conjugated to the TRITC fluorophore. Imaging results show that differences in route of administration result in different chemical dispersion. Dextran administered to planaria via the absorption model appears to have dispersed throughout the entirety of the flatworm, whereas dextran 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.

Software Design for Increasing Sepsis Treatment Compliance

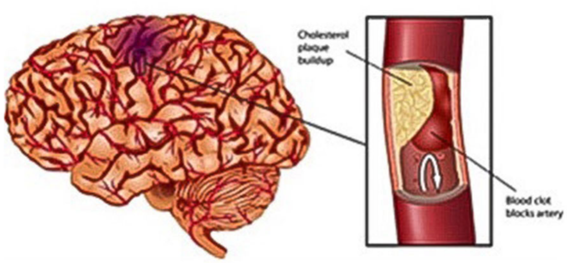
TEAM MEMBERS
Issam Mardini, Christopher Contos, Augustino Scorzo, Liam Cutri-French, Matthew Cangemi, Evan Pierce
PROJECT MANAGER
Dr. E. Brewer, Dr. M. Byrne, Dr. A. Pope (Rowan SOM), Dr. C. Schorr (Cooper University Health System), and Dr. P. Tremoulet
SPONSOR
Lourdes Health System,
Cooper University Heath Care



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

tPA-Eluting Guidewire for Localized Drug Delivery for Acute Ischemic Stroke

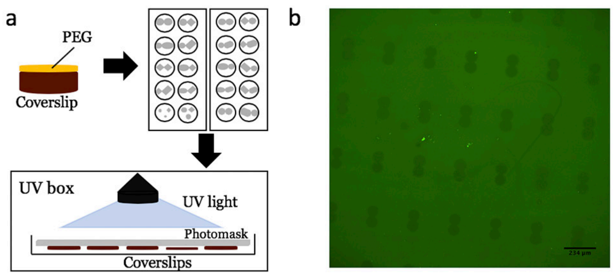
TEAM MEMBERS
Gabby Giacobbe, Gina Sorbello, Conor Magerr
PROJECT MANAGER
Dr. E. Brewer, Dr. H. Shaikh, and Dr. T. Kavi
SPONSOR
Cooper University Health Care



Mechanical thrombectomy is an endovascular intervention procedure involving the manual retrieval of cerebral ischemic strokes using balloon catheters. However, a subset of patients having received endovascular thrombectomy demonstrate poor clinic outcomes, even after complete angiographic revascularization. More localized approaches to delivering thrombolytics, such as intra-arterial tPA administration, allow for higher localized concentration while simultaneously reducing systemic concentration, resulting in more effective clot lysis and reducing adverse events. Therapies combining localized thrombolytic delivery with mechanical clot disruption, thereby reducing the risk associated with high system concentrations of thrombolytics, would thus also prevent reperfusion complications by reducing clot size and strength. This need is fulfilled with the development of an endovascular guidewire coated in a tPA-loaded polymer matrix to then be inserted into the patient. Once this guidewire arrives at the site of the clot, the polymer matrix will degrade and release tPA allowing clot breakdown without retrieval. Preliminary studies determined that solutions mixed in a PVA polymer matrix release quickly in the span of 10 minutes and slowly level off after. With those studies completed, the team is now working on a program to determine the desired thickness of the polymer that coats the hydrogel.

Tunable Hydrogels with Adhesion Sites to Investigate Stem Cell Signaling

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



Cell-cell interactions, cell shape, and substrate stiffness regulate cell behavior; however, the synergistic effect of these interactions on stem cell signaling is poorly understood. The goal of this study is to develop a hydrogel platform to investigate the effects of multifactorial stimuli on stem cell behavior. This hydrogel platform consists of polyacrylamide (PA) hydrogels imprinted with adhesive fibronectin patterns for human mesenchymal stem cells (MSCs) to attach to. We hypothesize that MSCs will attach to the patterns and adopt their shape, either as single cells or MSC pairs. Using AutoCAD, we designed a photomask consisting of a total of 24 (6 single cells, 18 cell pairs) unique shapes. Combinations of three shapes (circle, square, octogen) were chosen in 2 aspect ratios for the patterns. These shapes were chosen for their differing effects on known MSC signaling pathways. To create patterned PA hydrogels, coverslips were coated in Poly (ethylene glycol) (PEG), placed on the photomask, and irradiated with UV light to transfer the pattern (Fig. 1a). Patterned coverslips were then coated with fibronectin and PA hydrogels are polymerized atop the coverslip. Current efforts include visualizing patterns with fluorescently labeled fibronectin (Fig. 1b) and optimizing MSC culture procedures.

Using Artificial Intelligence to Distinguish Benign and Malignant Lung Tumors

TEAM MEMBERS
Kiran Korah, Antonio Abbondandolo, Christina Sunbury, Olivia Scro, Nikolas Koutsoubis, Aymen Zayen
PROJECT MANAGER
Dr. N. Bouaynaya, Dr. G. Rasool, Dr. E. Brewer, and Dr. E. Zachariah
SPONSOR
Oncopath Genomics, LLC

Lung cancer is responsible for 1.38 million annual deaths worldwide. More than 80% of people diagnosed with lung cancer are already in an advanced stage where curative treatments are no longer an option and the 5-year survival rate is only 10%. Thus, there is a need for early screening of lung cancer to improve prognosis in patients. Chest Computed Tomography (CT) is a widely accepted tool for the detection of lung tumors, but is always followed by an invasive, surgically-obtained tissue biopsy, as CT imaging is unable to distinguish between benign and malignant tumors. Rowan engineers, in collaboration with Oncopath Genomics of New Jersey and the Rutgers Cancer Institute, have created a prediction model that was developed for improving identification of malignant nodules from benign nodules in patients who underwent lung screening CT.

CHEMICAL ENGINEERING

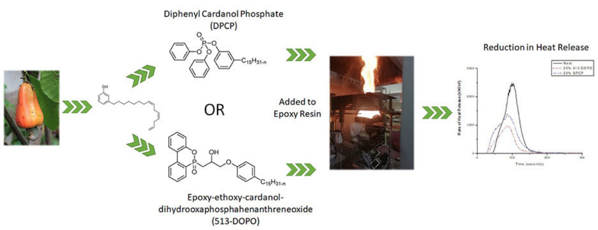
Agitator Power and Torque in Mixing

TEAM MEMBERS
Dylan Geiselman, Tim Laucius, David Ciocco, Chad Cochran
PROJECT MANAGER
Dr. Robert P. Hesketh and
Dr. Arthur E. Etchells III
SPONSOR
North American Mixing Forum

Vortex formation in unbaffled mixing tanks has not been fully characterized in previous literature studies. This project will continue to examine data from DuPont as well as new data obtained in this clinic project. The results of this data will develop a correlation to predict vortex length as a function of fluid and equipment parameters.
In addition, The North American Mixing Forum (NAMF) is publishing a new handbook on mixing and Rowan University has been tasked to co-author a chapter on experimental methods in mixing.

Bio-based Flame Retardants

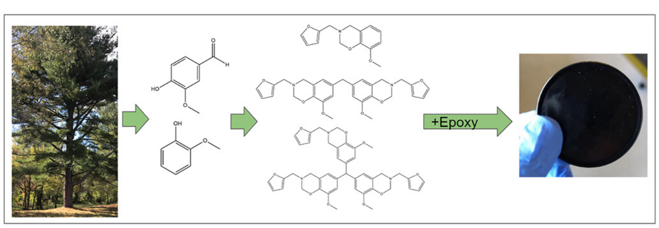
TEAM MEMBERS
Michael J. Ciuzio, William R. Maroney
PROJECT MANAGER
Dr. Joseph Stanzione and
Dr. Kousaalya Bakthavatchalam
SPONSOR
U.S. Department of Defense -
Army Research Laboratory



As the world continues to industrialize, there is an increasing need to produce safe, environmentally-friendly, and sustainable materials, including flame retardant additives. Polymers have a wide range of applications yet their inherent flammability poses a safety hazard. In particular, epoxy resins, used in coatings and electronics, are inherently flammable. Hence, it is important to find bio-based, eco-friendly flame-retardant additives that would enhance their fire resistance without detrimentally affecting their overall performance. In this regard, 9,10-dihydro-9-oxa-10-phosphahenanthrene-10-oxide (DOPO), has been extensively studied in the literature due to its superior flame-retardant benefits. In this work, bio-based flame retardants were synthesized by modifying cardanol [a component of cashew nut shell liquid, a byproduct of cashew production] with DOPO. Two cardanol-based flame retardants were synthesized: (1) 513-DOPO and (2) DPCP. These flame retardants were added into an epoxy resin system at 3, 5, 10, 20 wt.% and mechanical and flame-retardant properties were tested. For the cured epoxy systems, the flexural modulus increased with addition of flame retardant while peak heat release decreased significantly. Not only do these flame retardants show promising mechanical and flame-retardant properties, but they have the potential to be produced on an industrial scale due to precursor selection and availability.

Bio-based Polybenzoxazines

TEAM MEMBERS
Amanda L. McCahill, Sarah Salazar,
Kelly A. Yorke
PROJECT MANAGER
Dr. Joseph Stanzione and Alexandra Chong
SPONSOR
U.S. Department of Defense -
Army Research Laboratory

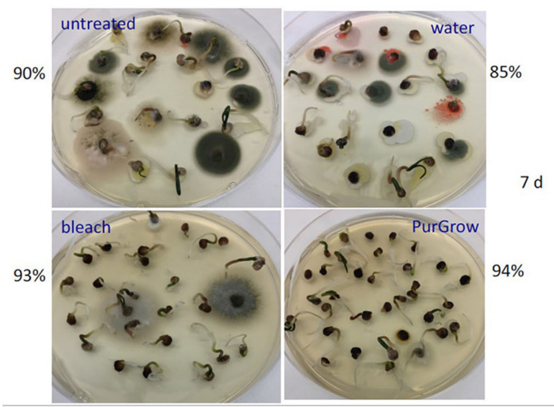


"Polybenzoxazines possess high glass transition temperatures, high char yields, good mechanical properties, and low shrinkage upon curing. In addition, the structures of benzoxazines allow for remarkable molecular design flexibility. Benzoxazines are typically synthesized from nonrenewable petroleum-based chemicals, and are known to produce brittle polymers. Bio-based chemicals have the potential to replace petroleum-based benzoxazine platform molecules such as BPA, which has displayed toxic effects on human health and the environment. Additionally, benzoxazine-epoxy blends have shown to improve mechanical properties of polybenzoxazines.

Higher degrees of oxazine functionality have shown to display better mechanical and thermal properties of polybenzoxazines. Bio-based, mono-, di-, and tri-functional bio-based benzoxazines were synthesized, and their properties were studied. Guaiacol and vanillin were combined with furfurylamine and paraformaldehyde to synthesize benzoxazines with each targeted oxazine functionality. The benzoxazines were blended with different weight percents of an epoxy resin and subsequently cured. These systems were characterized using DSC, TGA, and DMA to understand their structure-property relationships. Overall, bio-based benzoxazines with increased oxazine functionality and their epoxy blends were investigated to produce novel polymers with enhanced thermal and mechanical properties."

Characterization and Scale-up of an Electrochemical Reactor

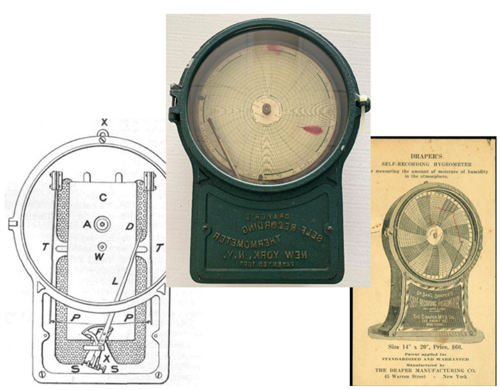
TEAM MEMBERS
Dylan C. Manuguerra, Robert A. Marano
PROJECT MANAGER
Dr. R. P. Hesketh, Dr. G. Thompson,
Dr. C.S. Slater
SPONSOR
PürGrow



PürGrow is a US Patented and USDA qualifying organic pesticide with a broad range of applications on crop yields. The unique formulation process is comparatively inexpensive to other pesticides and is being designed by Rowan University engineering students to run on alternative energy sources. PürGrow's versatility makes it applicable to many types of crop farming, including cannabis, and research shows PürGrow does not leave a chemical residue for consumption. PürGrow will help to reduce the US loss of revenue that the NRDC estimates can be as much as $218 billion annually. PürGrow increases seed germination, crop yields and the shelf life of produce, revolutionizing the agricultural and food safety industries while reducing the high volume of food waste.

Chemical Process Instrumentation Heritage

TEAM MEMBERS
Nicholas Coposky
PROJECT MANAGER
Dr. C. Stewart Slater
SPONSOR
External Private Donor



The project involved developing a display, with supporting documentation, for the history of Chemical Engineering process industry. The use of chemical process instrumentation goes back over one hundred years to the early history of chemical manufacture. Antique process instrumentation was acquired from a variety of sources and can be presented in a "museum" format that allows the viewer to understand more of the history, function, and current state of devices used to measure pressure, temperature, flow, etc in various process industries. In addition the display includes older methods of calculation, i.e., slides rules, that were utilized before modern hand-held calculators. The mechanism and associated patents for each device, along with representative pictures or illustration of the typical use, are also displayed, along with informative placards and booklets.

Cold Spray - Micron-Sized Thermoplastic Particles Team

TEAM MEMBERS
Dylan C. Manuguerra, Robert A. Marano
PROJECT MANAGER
Dr. J. Stanzione, Dr. F.Haase, and T. Bacha
SPONSOR
U.S. Department of Defense -
Army Research Laboratory

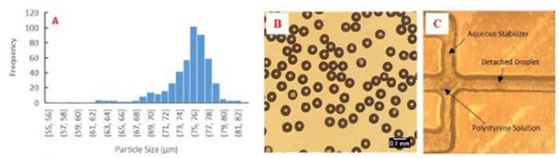
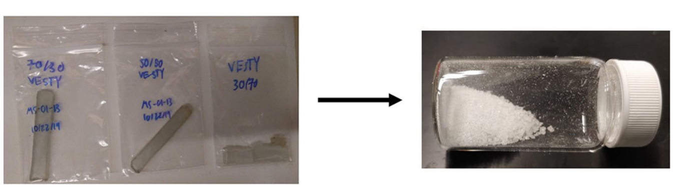


Figure 5. A) Sample particle size distribution of polystyrene particles. B) Optical micrograph of particles. Average particle size = 75.2 µm, standard deviation = 3.16 µm. C) Droplet formation in a 3D printed microfluidic device.

Cold spray technology has developed rapidly in recent years and is utilized to deposit coatings and repair structural parts at high deposition rates. Cold spray avios high processing temperatures of traditional thermal spray processes, minimizing residual stresses in coatings and improving particle-substrate adhesion. This process is particularly attractive for depositing polymer particles, as thermal degradation, oxidation, and use of solvents are avoided. However, few efforts have demonstrated and characterized the deposition of thermoplastic polymers. Thus, the production of polystyrene microspheres was investigated as a feedstock for cold spraying. For fundamental studies of thermoplastic polymer cold spraying, a well characterized and readily available material is desirable. Polystyrene was explored as a feedstock option due to it being inexpensive, thus economically viable in large quantities. In this study, microfluidic devices and unique bulk scale mixing techniques were utilized to produce polystyrene microspheres and the control of particle diameter was explored in order to create a viable polymer feedstock for cold spraying. Produced microspheres were analyzed using optical and scanning electron microscopy techniques and a size distribution program in MATLAB. Successful and reproducible methods for controlling polystyrene particle sizes and distributions were established as a result of this project.

Cold Spray - Micron-Sized Thermoset Particles Team

TEAM MEMBERS
Elizabeth Amory, Christopher A. Strekis
PROJECT MANAGER
Dr. J. Stanzione, Dr. F. Haas, and
M. Schwenger
SPONSOR
U.S. Department of Defense -
Army Research Laboratory



Cold spray technology has developed rapidly in recent years and is utilized to deposit coatings and repair structural parts at high deposition rates. Cold spray avios high processing temperatures of traditional thermal spray processes, minimizing residual stresses in coatings and improving particle-substrate adhesion. This process is particularly attractive for depositing polymer particles, as thermal degradation, oxidation, and use of solvents are avoided. However, few efforts have demonstrated and characterized the deposition of thermosetting polymers. Thus, the production of thermosetting microspheres was investigated as a feedstock for cold spraying. For fundamental studies of thermosetting polymer cold spraying, a well characterized and readily available material is desirable. Thus, an incumbent vinyl ester resin-based thermoset polymer and one containing a styrene alternative were explored as feedstock options. In this study, curing, grinding, and milling techniques were utilized to produce thermoset microspheres and the control of particle diameter was explored in order to create a viable polymer feedstock for cold spraying. Produced microspheres were analyzed using optical and scanning electron microscopy techniques and a size distribution program in MATLAB. Successful and reproducible methods for controlling thermoset particle sizes and distributions are in progress as a result of this project.

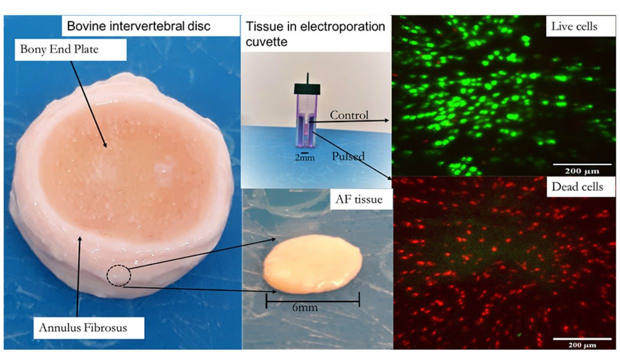
Design of Electrochemical Power Source

TEAM MEMBERS
Alexa Lynch, Montana Carlozo, Bradley Smith, Jordon Holman Gurpreet Singh, Raymond Lewis
PROJECT MANAGER
Dr. Robert P. Hesketh

This team will design, fabricate, test an electrochemical power source combined with a chemical reaction based timing device. The chemical reaction that was chosen for this project is an aluminum-air battery. The project has encompassed a literature review, analysis of several electrochemical power cells and extensive testing of the device. Experimental results and analysis included engineering calculations, experimental data and appropriate graphical representation of data. This device was developed for the 2020 AIChE National Chem-E-Car Competition.

Extraction, Migration, and Survival of Cells from IVD Tissue

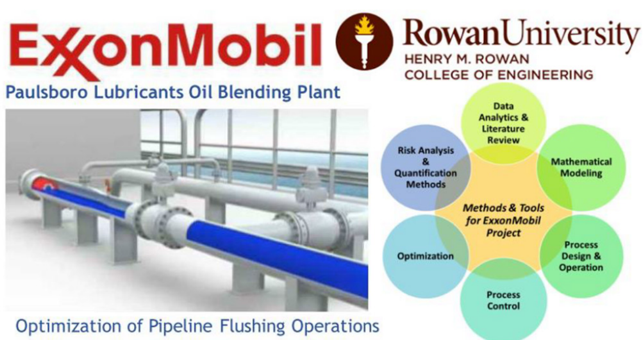
TEAM MEMBERS
Colin McAllister
PROJECT MANAGER
Dr. Gary Thompson



Tissue engineering and regenerative medicine are promising approaches to treating intervertebral disc (IVD) degeneration by replacing damaged tissue with biomaterials and appropriate cells. An ideal scaffold for IVD tissue engineering must have good biocompatibility, porosity and degradation rate similar to natural tissue. The appropriate cells to be seeded onto the scaffold must have good viability, differentiation, proliferation and migration capabilities. Slow proliferation significantly impedes regeneration of tissue. Pulsed electric fields (PEF) have been observed to affect cell migration, differentiation, and increase growth factor release. However, PEF exposure of annulus fibrosus cells (AFC) from IVD tissues has not been studied. In this study, we characterize the effects of microseconds pulse electric fields on AF cells in vitro, to determine the lethal dose parameters and relevant combination of electric field parameters to enhance cell proliferation and migration. Our findings demonstrate that PEF can be applied to decellularize the AF tissue to create a native tissue scaffold and also has useful application in enhancing the proliferation and migration of transplanted AF cells in the AF tissue matrix. Future Clinics will test seeding of PEF-exposed AFC's within IVD tissues.

Optimizing Pipeline Flushing Operations for ExxonMobil LOBP

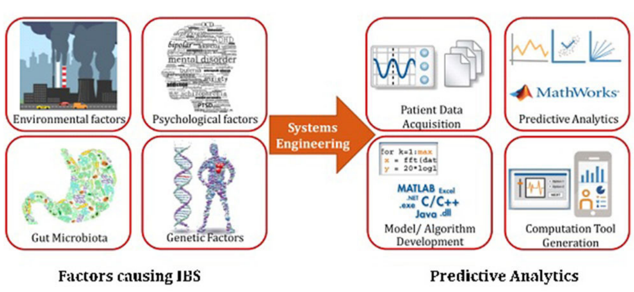
TEAM MEMBERS
Marissa Martine, Spencer Verdoni, Gabrielle Moskalow, Casey Wagner, Swapana Jerpoth
PROJECT MANAGER
Dr. K. M. Yenkie, Dr. R. P. Hesketh, and Dr. C. S. Slater
SPONSOR
ExxonMobil, Paulsboro, NJ



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

Predictive Analytics for Irritable Bowel Syndrome Diagnosis & Management

TEAM MEMBERS
Kiana Ramirez, Brianna Acosta
PROJECT MANAGER
Dr. Kirti M. Yenkie
SPONSOR
Inspira Healthcare



Irritable Bowel Syndrome (IBS) is a chronic gastrointestinal disorder that affects 10-15% of the worldwide population. Although IBS is rather common, a reliable diagnosis and treatment method is not available. Currently, no test exists to characterize IBS subtypes in patients, leaving both patients and doctors with uncertainty in diagnosis and potential management strategy. Gut microbiota can be analyzed using 16S rDNA sequencing to determine bacterial compositions, and this data was gathered by the project collaborators at Cooper Medical School at Rowan University (CMSRU). The purpose of this study was to use machine learning and data analytics to find correlations in the data to accurately diagnose patients with IBS and its subtype, based on their gut microbiome. This information was used to develop a computer application where the user could input the values of their patients for these bacteria and get a prediction for the subtype of IBS the patient could have. With an accurate prediction, doctors would be able to suggest a specific diet and probiotic supplements to their patients to minimize the flare-up of IBS symptoms as well as improve their quality of life.

Process Design and Analytics for Unit Operations

TEAM MEMBERS
David Aguirre, Liam Callahan
PROJECT MANAGER
Dr. Z. Otero Gephardt, PE

This project involved the design and validation of two pieces of unit operations equipment: a heat exchanger and a rotary drum filtration system. Heat exchange and filtration are operations widely used throughout the chemical process industry. The project included the development of equipment specifications, design and validation with analytics allowing for mathematical model development. Data were obtained to investigate the start-up dynamics of both unit operations. The heat exchanger equipment is a two-exchangers in series system. Steady state data were collected, using saturated steam and water, to obtain heat transfer coefficients for the exchangers. For the rotary drum filtration system, preliminary experiments with $CaCO_3$ and sand slurries allowed for the determination of system limits and the understanding of filter cake formation. A bench-scale testing apparatus is currently being designed to test and select filter materials and slurries for use in the rotary drum filtration system. The heat exchanger and rotary drum filtration system are currently part of the Unit Operations Laboratory; a capstone course which includes advanced data analysis, and equipment validation and troubleshooting.

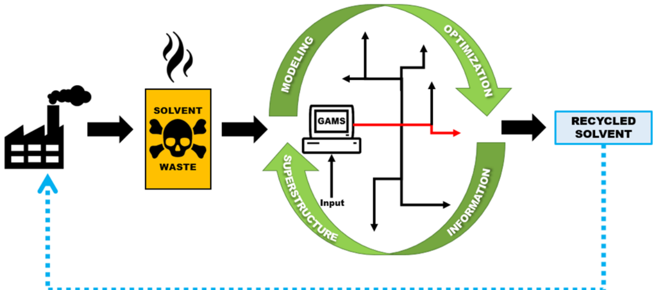
Smart Tissue

TEAM MEMBERS
Caleb Miller, Rohan Zia, Akshar Patel, Jean Han, Victoria VanDuren, Philip Konrad
PROJECT MANAGER
Dr. I. Noshadi, Dr. A. Masoumi, and V. Krishnadoss
SPONSOR
NJ Health Foundation, National Science Foundation

Despite advantages proffered by hydrogels, there remains a paucity in cytocompatible conductive versatile biopolymer platforms for 3D printing tissue engineering scaffolds. We present a tailorable, conductive, visible light photocurable hydrogel platform for scalable engineering of direct 3D printed tissue engineering scaffolds. Here, a methacrylated gelatin polymer backbone was functionalized with an acrylated choline bio ionic liquid. The tailorable physicochemical, electrochemical, antifouling and rheological properties are incumbent on ratios of Gelatin Methacrylate and the Bio Ionic Liquid. Cell viability was up to 98%±1%, 0.279±0.02 S cm^{-1} conductivity, and 34.3±1.9 kPa adhesive strength was obtained. Compositions could be directly 3D printed on the skin in complex structural designs. We propose this method as a general approach to producing bioink material platforms by functionalizing biopolymers and biocompatible synthetic polymeric with bio ionic liquid modifications that render them as versatile and tailorable compositions for direct in situ 3D bioprinting of conductive, adhesive and antifouling tissue engineering scaffolds.

Solvent Recovery Roadmap for Industries

TEAM MEMBERS
Austin Lehr, Jake Stengel, John D. Chea, Emmanuel Aboagye
PROJECT MANAGER
Dr. K. M. Yenkie, Dr. C. S. Slater, and Dr. M. J. Savelski
SPONSOR
U.S. Environmental Protection Agency



With the rapid expansion of the chemical market over the next decade, concerns for environmental sustainability have increased due to excessive disposal of chemical solvents. To date, there is no effective mitigation plan to handle the inevitable rise in waste volume. Chemical solvents are typically used as extraction, cleaning, and purification agents and account for up to 90% of the process by mass. Conventional processing of these solvent wastes typically includes incineration or direct release. However, these disposal methods are not "green" because of the potential detrimental effects to the environment. A superstructure-based solvent recovery framework has been developed that considers multiple separation technologies simultaneously to recover and purify valuable solvents. Solvent recovery from multi-component waste streams was modeled as mixed-integer nonlinear programming problems and solved through the general algebraic modeling systems (GAMS). Techno-economic analysis and life cycle assessment were performed to assess the viability of solvent recovery processes. We demonstrate the capability of the solvent recovery framework to obtain environmentally friendly and economically viable pathways as an alternative to conventional waste disposal methods.

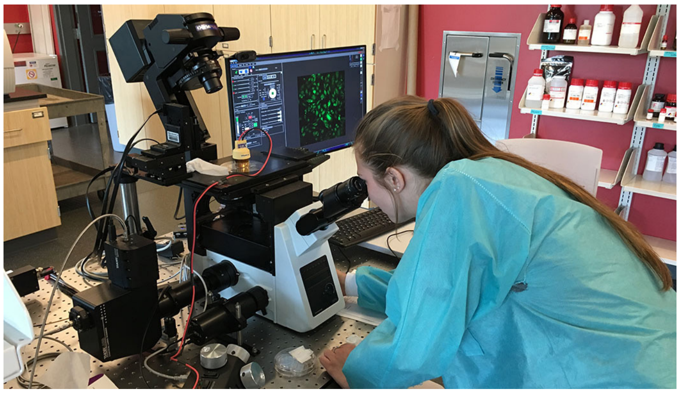
Sustainable Membrane Separations for Coffee Extract Processing

TEAM MEMBERS
Carly Jankowski, Benjamin Kayhart, Michael Vincent O. Laurio, Adam Niznik, Matthew Razze, Jacqueline Sheaffer
PROJECT MANAGER
Dr. C. Stewart Slater and Dr. 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 of overall operations. A shear-enhanced vibrating nanofiltration membrane system was compared with a thermal process for concentrating a coffee stream. Parametric studies were performed to determine optimal operating conditions. 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 based on representative yearly operational projections. Conservation of both fresh water supply and energy are achieved, along with wastewater reduction. This research is supported in part, by a grant from the U.S. Environmental Protection Agency, NP-96271316.

Switching Off Breast Cancer

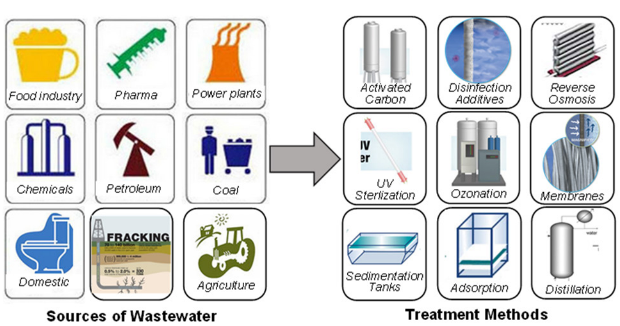
TEAM MEMBERS
Maria Bednar, Phuong Le
PROJECT MANAGER
Dr. Gary Thompson



More than 600,000 people in the United States die from cancer yearly. Because of the complexity of this disease, more effective methods for treating cancer continue to be needed. Pulsed electric fields (PEF) with duration of micro- or nano-seconds can cause biological effects with negligible heat deposition. Given a threshold dose of PEF, each cell within the locally treated region of tissue is impacted by PEF treatment. This complements chemical and systemic treatments that depend on sufficient mass transport to cells. Cell types can be selectively targeted with PEF via several factors, such as cell size, location and mechanics. Exposure to PEF increases the permeability of cellular membranes to small molecules. Among such small molecules, ionized calcium (Ca2+) plays a key role in numerous cellular functions. For example, high intracellular concentrations of Ca2+ can initiate cell death by apoptosis-like mechanisms. Apoptosis is a controlled and desirable route of cell death for regeneration of tissue that harbored the tumor. Finally, nanosecond PEF has been shown to elicit an immunoprotective response within animal models. Yet, the mechanisms underlying this immunoresponse still need to be determined. The results of this project show a first step in the mechanistic pathway toward tumor cell death caused by PEF. Future Clinics will further elucidate the mechanisms of PEF-induced tumor cell death.

Systematic Synthesis and Design of Wastewater Treatment Networks

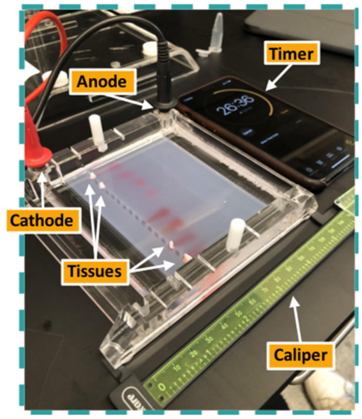
TEAM MEMBERS
Maya Desai, Carley Tran, Emmanuel Aboagye
PROJECT MANAGER
Dr. Kirti M. Yenkie



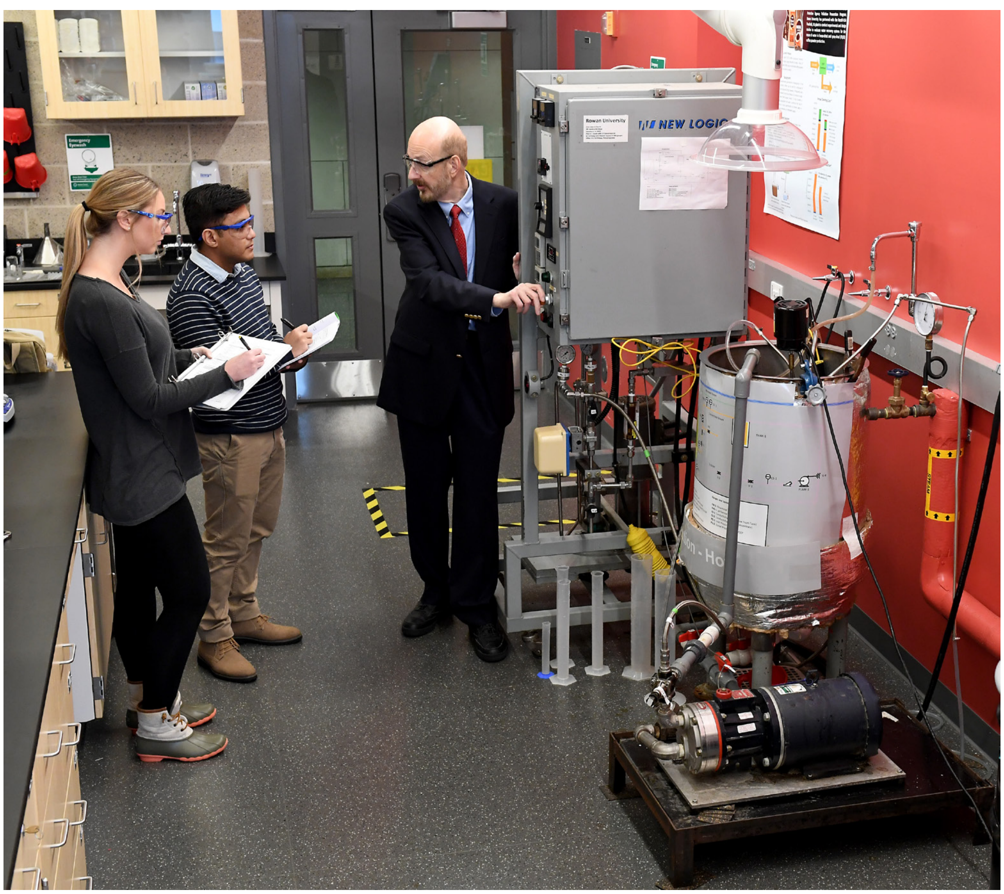
A steady growth in the world population and industrialization has led to an increased demand for water. With such a limited supply, but a growing need for water, we must explore methods for wastewater treatment. There are various available treatment methods to purify water. Treatment methods are most effective when applied in series with other treatment technologies to meet purity standards. However, applying different technologies gives rise to a large number of possible treatment pathways. In this work, by using optimization, we identified treatment networks that meet purity requirements while minimizing the cost of purification using the P-graph approach. This was done by building up a case study using a municipal wastewater source. Through the generation of a superstructure containing all possible treatment technologies organized into a four-stage process, we simplified and formulated a mixed-integer nonlinear programming (MINLP) problem. Using the advanced branch and bound (ABB) solver in P-Graph we generated a list of all feasible treatment networks ranked from the least to the highest cost of purification. Using this software, we can find treatment solutions for different wastewater sources. It can be as basic as municipal wastewater to more complex sources, such as tannery wastewater.

Tissue Engineering with Electrophoresis

TEAM MEMBERS
Eunice Nepomuceno, Zachary Nicolella
PROJECT MANAGER
Dr. Gary Thompson



The goal of this project is to create cartilage implants from natural tissue, which preserves native structural networks and properties. To prevent implant rejection, cellular components such as DNA will be removed from cartilaginous, bovine intervertebral disc (IVD) tissue using extraction accelerated by electric field exposure. During this project, electrophoretic and electroosmotic mobilities of small molecules through the IVD tissue were empirically determined, showing that extraction of nucleic acids and other molecules by this method is feasible. The skills learned during this project are commonly encountered in engineering and biotechnology fields. Safe setup and operation of isolated electrical stimulators and oscilloscopes was learned first. Preparation and characterization of aqueous solutions and agarose hydrogels were followed by performing electrophoresis with IVD tissue in agarose gels. The movement of small molecules through the hydrogel and tissues exposed to various electrical waveforms was measured using image analysis software, Image J. Finally, electrotransport mobilities were calculated and statistically analyzed, including comparison to published results in the literature. Future Clinics will perform further processing to confirm clearance of DNA and lipid molecules before cell seeding.



CIVIL & ENVIRONMENTAL ENGINEERING

A Novel Approach To Identify Distracted Drivers In New Jersey

TEAM MEMBERS
Jarod Sims, Brian Jackson,
Ahmed Sajid Hasan
PROJECT MANAGER
Dr. Mohammad Jalayer

It is far too common to see someone driving, which is more focused on their cell phone than they are on the road. Distracted driving is defined as any activity that distracts the driver's attention from his primary activity of driving. Identifying people and preventing them from being distracted behind the wheel is one of the primary goals for highway safety agencies. The National Highway Traffic Safety Administration (NHTSA) reported 2,841 fatalities in the USA due to distracted driving in 2018. More specifically, the New Jersey Division of Highway Traffic Safety (NJDHTS) reported between 2012-2016, 800,000 crashes happened in New Jersey due to distracted driving. The purpose of this study is to conduct a comprehensive review of state-of-practice and art in identifying and evaluating distracted driving. Information on laws related to distracted driving, like texting and driving laws, was also explored for all states to understand current policies and approaches to countering distracted driving. Based on the results, using a camera inside a car, equipped with eye-tracking technology, is the most common type of capturing drivers' behaviors. Concerning data analysis, Convolutional Neural Network (CNN) is a suitable method to analyze visual imagery to identify distracted drivers.

Applications of Virtual Reality in Reducing Wrong-Way Driving Incidents

TEAM MEMBERS
Quang Nguyen, Michael Del Vecchio
PROJECT MANAGER
Dr. Mohammad Jalayer

Wrong-way driving (WWD) occurs when a driver, either inadvertently or deliberately, drives in the opposing direction of traffic along a high-speed, physically divided highway or its access ramp. Based on data from the NHTSA, an average of 355 deaths occur in the U.S. each year due to WWD, necessitating further investigation. There are a number of reasons a driver may go in the wrong direction, including but not limited to driving under the influence of substances (i.e., alcohol and/or drugs), fatigue, lack of experience, and inappropriate geometric roadway design. 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. It is easy to argue that VR can be applied to many branches of study. For instance, this technology has been useful for numerous educational activities, forecasting trends, military drills, personal leisure, etc. Specifically, in transportation engineering, VR can be implemented in design models, training programs, and many other areas. The objective of this study is to explore the applications of Virtual Reality in reducing wrong-way driving incidents. To do so, the study team will develop multiple scenarios to capture the behaviors of drivers with respect to different traffic control devices, lighting conditions, geometric design features, etc.

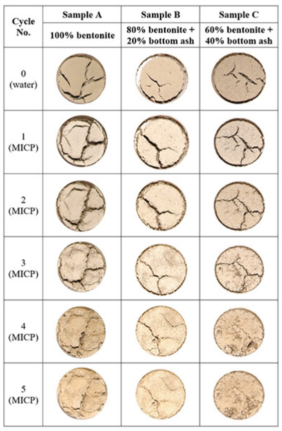
Behavior of Rebar at Cold Temperatures

TEAM MEMBERS
Ian Burgess-Linden, Jacob Dicks, Jed Vergara, Will Weise
PROJECT MANAGER
Dr. W.T. Riddell, Dr. D.B. Cleary, and Dr. G.R. Lomboy
SPONSOR
U.S. Department of Defense - Army Corp of Engineers

The design of infrastructure for construction and operation in the cold-weather conditions encountered in the Arctic must account for the effect of temperature on material behavior. The design of reinforced concrete structures is based upon a balance between the strength of concrete and reinforcing steel to ensure adequate ductility, so the effect of temperature on these structures is a particular concern. While there is a general expectation that steel will lose ductility and possibly gain strength as temperatures decrease, there have been few studies to quantify these behaviors, especially below -40°C. This study evaluates four types of ASTM standard steel: A615 GR60, A706 GR60 steel, A995 GR75 steel (stainless steel), and GR100 A1035 steel (chromium) at temperatures ranging from +20°C to -60°C. Stress strain behavior, Impact energy and the resulting fracture surfaces are used to quantify the material behavior.

Bio-Cemented Clayey soil Through Microbial Induced Calcite Precipitation

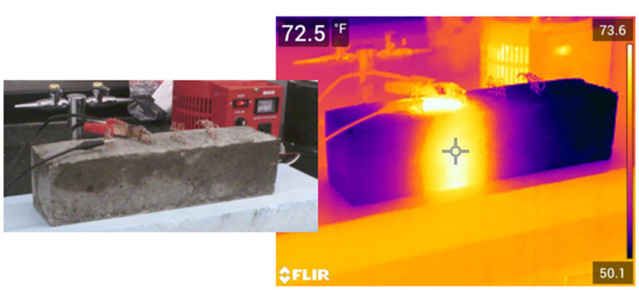
TEAM MEMBERS
Luke Anderson, Michael Moroski, Nate Maute, Jiwon Yang
PROJECT MANAGER
Dr. Cheng Zhu
SPONSOR
Lindback Foundation



Desiccation cracking in clayey soils due to moisture loss over time weakens the bearing capacity and lowers the stability of the soil, which may lead to catastrophic geotechnical failures. Microbial Induced Calcite Precipitation (MICP) is used as an environmentally friendly soil stabilization technique, and is known to increase bonding strength between particles to remediate desiccation cracking. The reaction requires a mixture of bacteria, calcium chloride and urea solutions. Urea acts as a food source to the bacterial strand and is a catalyst to the reaction between the bacteria and calcium chloride to create a calcium carbonate precipitation. Four clayey soil samples were prepared by mixing bentonite and sand with 100% moisture content of deionized water, MICP solution, bacteria solution, and pure cementation solution, respectively. The cracking process was observed under a high-resolution camera and underwent image processing to analyze the area, length, and width of each crack segment, and the total crack area percentage for each sample. Test results showed that soil treated with MICP resulted in less desiccation cracking and higher bonding strength than untreated soil. This study provides a new possible approach for desiccation cracking remediation.

Cold Weather Conductive Concrete

TEAM MEMBERS
Eduardo Almaraz Beltran, Daniel Rubin, Christian Elimanco, Eric Sanchez, Noah Linden, Dominic Lepone
PROJECT MANAGER
Dr. G.R. Lomboy, H. Pandya, and Dr. S. Abubakri
SPONSOR
U.S. Department of Defense - Army Corp of Engineers



This project aims to develop a conductive concrete suitable for cold weather concreting (CWC). CWC is a type of cementitious based mixture that can be mixed, cast and cured at subzero temperatures without the risk of frost damage. This is achieved by using accelerator and antifreeze admixtures. Also, electrically conductive materials can be added to make CWC mixtures conductive. This results in developing conductive concrete with low resistivity. One of the main advantages of such concrete is the fact that it will generate heat when it is subjected to a potential difference. This heat can be used to remove/melt snow or ice. For this study, cold weather conductive concrete (CWCC) has been developed by the inclusion of conductive admixtures such as carbon fiber, nanofiber and steel fiber. The process of mixing, casting and curing is done at a temperature of -5 °C (23 F) without signs of frost damage. Long term durability of CWCC is currently investigated. This includes the assessment of mechanical properties such as compressive strength, flexural strength, shrinkage, conductivity, freeze-thaw durability and bond between concrete substrate and CWCC.

Cold Weather Reinforced Concrete

TEAM MEMBERS
Mario Romano, Adam Cavallaro, Christopher Kaminskas, Andrew Atienza, John Restrepo
PROJECT MANAGER
Dr. G. R. Lomboy, Dr. D.B. Cleary,
Dr. W.T. Riddell, and Dr. S. Abubakri
SPONSOR
U.S. Department of Defense -
Army Corp of Engineers

The setting and hardening of conventional concrete tend to be delayed in cold temperatures. Furthermore, there is a risk of frost damage for fresh concrete exposed to freezing temperatures at an early age leading to permanently weakened concrete. One solution is to use accelerator and antifreeze admixtures to accelerate the setting time of concrete and reduce the freezing point of water in the concrete mix. Cold Regions Research and Engineering Laboratory (CRREL) has developed cold weather concrete (CWC) mixing technology to depress the freezing point of water. For this project, cold weather concrete mixture is further developed for cold weather concrete in structural applications. Different types of aggregates and admixtures are used to cast and cure concrete specimens at a temperature of -5 ºC (23 F). Results show that the developed cold weather concrete mixture prevents frost damage. Currently, the mechanical properties of CWC such as compressive strength, elastic modulus, shrinkage, flexural and shear strength are investigated.

Conversion of Winery Waste Products to Biofuel via Hydrothermal Liquefaction

TEAM MEMBERS
Alexa Aulicino, Remo DiSalvatore,
Rebecca Gavin, Connor McCafferty,
Oluwayinka Adedeji
PROJECT MANAGER
Dr. Sarah K. Bauer

The management of clean energy and water is a pressing societal challenge modeled by the Water-Energy Nexus relationship. As cognizance grows around high energy demands and dwindling fossil fuels, research has spiked in sustainable energy sources. In Southern NJ, there is an abundance of wineries 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 winery waste feedstock into liquid biocrude through HTL processing. Winery waste in the form of red lees and white lees were used in this research. The methodology behind the work involves initial measurements of physico-chemical concentrations of the feedstocks. In the HTL reactor, the digestion of each 100-gram sample lasts for 30 mins with 90% moisture content under high temperature (300°C) and high pressure (1500 psi) conditions after which the digested sample was characterized into the biocrude, biochar, and wastewater.

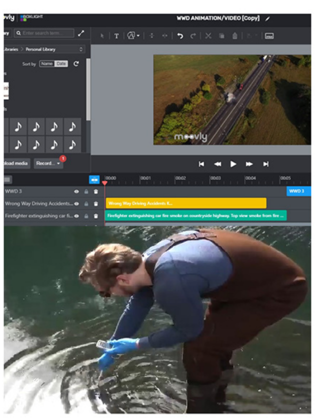
Deck Truss Bridge Span Project

TEAM MEMBERS
Ariana Dadyan, Delanda Dixon, Muhammad Akhtar, Michael Mosely, Marc Gernhardt
PROJECT MANAGER
Dr. Ralph Dusseau
SPONSOR
Delaware River and Bay Authority

Accurate modeling systems can greatly reduce the difficulty of analyzing existing structures, or even assessing future structures. In order to create an accurate modelling system, it is crucial to compare 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. Three deck truss spans of the bridge are being modelled in RISA 3D, two on the east side of the main river span and one on the west side. Each span is made of steel I-beams and box beams. Currently, two dimensional segments of the bridge have been modelled and include calculated dead loads as well as live loads. The bridge has been modelled in 3D and all subjected loading is being calculated and applied. Resulting deflections under solely dead loads were found to accurately match the expected deflection in the given bridge design plans camber diagram with less than a five percent error for 2D models and less than three percent error for 3D models. Once RISA 3D is correctly calibrated to model the bridge including loading, frequency analysis can be performed on the Betsy Ross Bridge as well as other bridges.

Developing Innovative Video Learning Modules for the Civil Engineering Classroom

TEAM MEMBERS
Victoria Barry, Travis Bate, Filianna Zarifis
PROJECT MANAGER
Dr. S.K. Bauer, Dr. M. Jalayer,
Dr. G.R. Lomboy, and Dr. C. Zhu
SPONSOR
Rowan University Faculty Center



"The use of educational videos and animations not only enhances student learning, but reinforces difficult subject matter and increases 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 to mitigate the chances of such accidents.

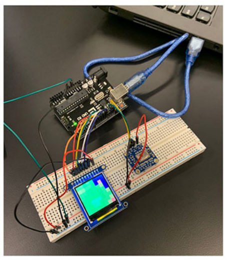
Environmental Engineering: A large component of Environmental Engineering is performing water quality assessment/monitoring. To ensure students' understanding of the procedures of in-class laboratory experiments, visual modules were developed to demonstrate field-testing of water quality parameters.

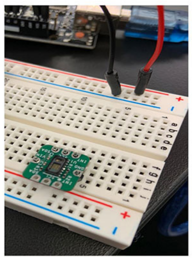
Geotechnical Engineering: Real world applications of geotechnical engineering can be at times difficult to understand. Videos were developed to display the application of geotechnical engineering in both foundation designs and retaining wall systems.

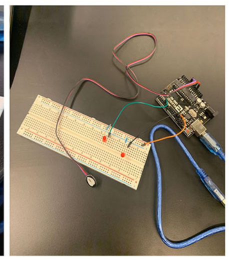
The implementation of technology-based learning modules offers new opportunities to teach students through visual aids. The implementation of these learning modules will demonstrate the application of contemporary engineering technologies in the visualization of traditional CE concepts."

Driver's Health Sense in Autonomous Cars

TEAM MEMBERS
Nicholas Schlageter, Ryan Logar, Anicia Colon, Jack Schaefer
PROJECT MANAGER
Dr. Mohammad Jalayer


Thermal Camera Sensor & Display

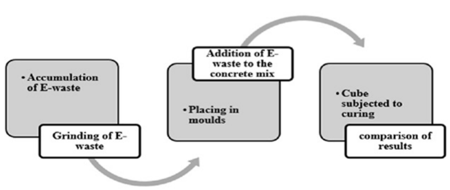

Oximeter & Heart Rate Monitor


Pulse Sensor

Advancements in recent technology have served a pivotal role in the lives of many people around the globe. At the forefront of connecting humans and technology is the implementation of new technology within vehicles. Connected vehicles and autonomous vehicles are remarkable tools that are being created by major companies to bring solutions to the faults and problems of manually controlled vehicles. With this innovation, connected and autonomous vehicles are becoming extremely popular and will be manufactured extensively in the upcoming years. The concept of monitoring the driver's health conditions in real-time is also becoming a key component in the development of such a technology-driven future. To bring purpose to this notion, the research team is developing and experimenting with possible ways the driver or passenger's health can be monitored through the technology of health sensors within connected and autonomous vehicles. Through sensors placed within the vehicle, such as in the steering wheel or in the driver's seat, it will be possible to detect abnormalities within a driver's ECG heart rate, body temperature, and oxygen levels in the blood. Through these measurements, proper measures could then be taken to accommodate passengers' needs, such as automatically pulling the car to the side of the road to avoid potential collisions or notifying local emergency care officials for assistance.

Electronics Waste Concrete Aggregates

TEAM MEMBERS
Eric Benyon, Vincent Musanti,
Francis Warburton, Gillian Castaldo
PROJECT MANAGER
Dr. Gilson Lomboy and Harshdutta Pandya



Increasing production of electronics is leading to an overabundance of Electronic waste (E-waste) being stored in landfills or improperly disposed of. This E-waste poses a major risk to the environment and the public health. Global studies have shown that there is a possibility to substitute conventional aggregates with the components of E-waste in concrete, which may help increase durability and compressive strength of concrete potentially. This study involves a proof of concept to successively replace fine aggregates and coarse aggregates with the non-biodegradable components of E-waste. Use of these components into concrete would help giving a greener alternative to this E-waste and also reducing storage in landfills. Mix design for concrete with the non-biodegradable components of E-waste was developed by undertaking a sieve analysis of crushed components. Concrete cube samples were cast and tested and assessed to show how replacing fine aggregates and coarse aggregates consecutively in concrete mixes affected its durability and mechanical properties.

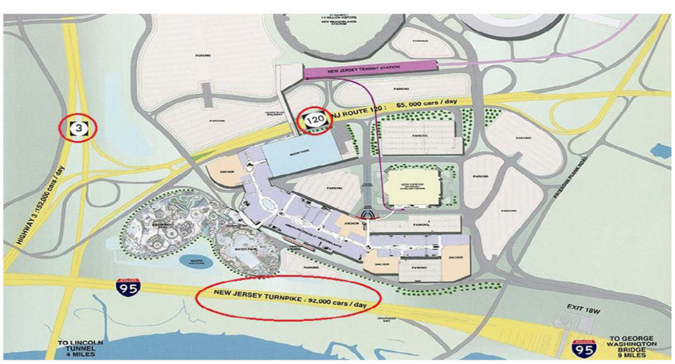
Evaluating Effectiveness of Roadway Warning Signs for Autism Spectrum Disorder

TEAM MEMBERS
Brian Mulligan, Zachary Lubelski, Jake Guertin, and Justin Hillman
PROJECT MANAGER
Dr. Mohammad Jalayer

In 2014, the New Jersey Academy of Science reported that 1 in 34 eight-year-old children was diagnosed with Autism Spectrum Disorder (ASD). New Jersey has the highest rate of ASD diagnoses in the country, which raises concerns about interactions between autistic children 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. While the Manual on Uniform Traffic Control Devices does not recognize disability roadway warning signs partly due to liability, local authorities allow signage to be installed under given circumstances. This study evaluated the effectiveness of these signs in the state of New Jersey. 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. In addition, interviews and questionnaires were conducted with transportation authorities and autism research agencies to understand professional perspectives on this matter. The results of this study provide valuable information for engineers, policymakers, and public health officials to enhance the safety of ASD on our roads.

Evaluating the Safety and Mobility Impacts of American Dream Complex

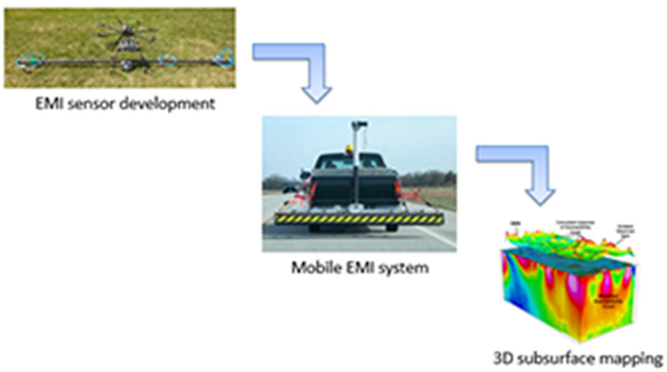
TEAM MEMBERS
Michael D’Orazio, Adam Kaczorowski, Michael Lionikis, William Reichard
PROJECT MANAGER
Dr. Mohammad Jalayer
SPONSOR
U.S. Department of Transporation - University Transportation Center Region 2 Consortium



Traffic congestion and traffic safety are becoming increasingly difficult to manage, particularly in high-density urban areas. Alleviating traffic congestion and improving user safety on roadways are top priorities of the USDOT. New Jersey is home to the worst traffic bottleneck in the country, according to the American Transportation Research Institute (ATRI). New Jersey also holds the second-highest ratio of pedestrian fatalities to the total number of motor vehicle deaths of all American states. American Dream is a retail and entertainment complex located within the Meadowlands Sports Complex in East Rutherford, New Jersey. With a building footprint exceeding 3 million square feet, it is the second-largest retail and entertainment complex in the nation, and it is located within five miles of New York City. The complex officially opened in October 2019 and is expected to attract over 40 million annual visitors. This will potentially result in substantial mobility and safety issues for pedestrians and motorists in the area. This study aims to investigate the mobility and safety issues related to American Dream Complex. To achieve this goal, traffic data indicating the existing traffic issues of this complex will be collected, and an analytics framework will be developed by employing modern machine learning algorithms to identify conflicts between the different road user groups in the vicinity of this complex.

iFrost Mapper

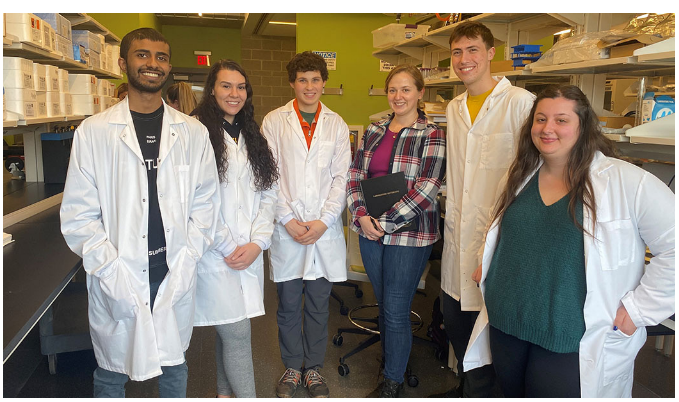
TEAM MEMBERS
Chris Haugland, Ryan Gordon
PROJECT MANAGER
Dr. Cheng Zhu
SPONSOR
U.S. Department of Defense - Army Corp of Engineers



The engineering behaviors of soils under freeze-thaw cycles are critical to the stability and serviceability of infrastructures in cold regions. Electrical resistivity measurement has been recognized as an effective technique for soil characterization under various environmental conditions. Key factors that control the changes in resistivity values under low temperature regime remain poorly investigated. In this study, we carry out electrical resistivity measurements of frozen clayey soils, with focuses placed on three major influencing factors including unfrozen water content, soil density, and temperature. Frost-susceptible clayey soils are chosen as experimental materials. Soil columns are made following the Wenner four-electrode method, and then set up in an environmental chamber for freezing and thawing processes. Continuous electrical resistivity measurements are made with a portable resistance meter, while soil temperature and unfrozen water content values are measured with thermal couples and TDR sensors, respectively. Experimental results indicate that the electrical resistivity of frozen soil decreases with increasing unfrozen water content, bulk density, and temperature. Comparative analysis further reveal that unfrozen water content is the most critical factor, highly dependent on the transitional phase change process.

Implementation of a Grit Removal System in the ACUA WWTP

TEAM MEMBERS
Samantha Andeer, Jeffery Dobkowski, Connor Mack, Leo Thottumari, Gina Venuto-Gabriella, Tetiana Kolosovska
PROJECT MANAGER
Dr. Sarah K. Bauer



The objective of this research is to analyze the solid fraction of the wastewater samples from six stages of the Atlantic County Utilities Authority (ACUA) Wastewater Treatment Plant, and three locations in the facility's collection network. This is done to evaluate its constituents, in terms of grit, which is known to have adverse effects on wastewater facility infrastructure. The goal of the project is to determine a feasible grit removal technology for the plant. Tests performed include: total suspended solids (TSS), total organic carbon (TOC), microscopic examination of grit particles, size gradation, and settling velocity experiments. Preliminary results indicate grit particles in a wide range of sizes (e.g. sand, seeds) are present in the samples. The duration of the project is one calendar year, with samples collected on a monthly basis allowing for evaluation of seasonal and weather effects on the composition of the influent. Comparison of 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 foresight into the quality and quantity of grit in systems, preventing future damages to wastewater treatment infrastructure.

Innovative Techniques and Materials for Preventing Concrete Shrinkage Cracking

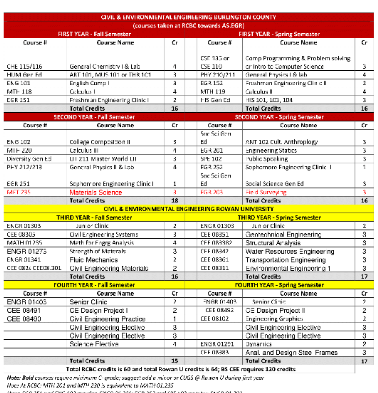
TEAM MEMBERS
Seth Wagner, Benjamin Chan, Jason Grasso, Brett Hughes, Quinn Collins
PROJECT MANAGER
Dr. Douglas Cleary and Dr. Gilson Lomboy
SPONSOR
NJ Department of Transportation

"In the state of New Jersey, high performance concrete mixtures used in transportation infrastructure have high cementitious contents, fine portland cement, and low water-to-binder ratios. These attributes result in a concrete material that is highly susceptible to shrinkage cracking, leading to corrosion of reinforcement steel and early deterioration. The problems with shrinkage cracking typically appear in bridge decks and large scale concrete pours. The goal of this research is to increase the lifespan of New Jersey transportation infrastructure and develop methods to combat shrinkage cracking and lower cracking potential.

The proposed research will observe the impacts of shrinkage reducing admixture, shrinkage compensating admixture, internal curing, surface coating, and fibers. The effectiveness of each of these materials in preventing shrinkage cracking will be investigated. Their effects on fresh concrete properties, short and long term hardened properties, durability, and performance in New Jersey field conditions will also be studied. Concrete mechanical properties and shrinkage parameters will be analyzed in order to provide specific recommendations for adoption of shrinkage control methods within New Jersey Department of Transportation practice."

Left Behind: Solutions to the Challenges of Being a Transfer Student

TEAM MEMBERS
Brian Groot, Michael Dubroski, Jonathan D'Amico, Brandon Hayes, Andrew Fuzesi
PROJECT MANAGER
Dr. Ralph Dusseau and Dr. Jagadish Torlapati



CIVIL & ENVIRONMENTAL ENGINEERING BURLINGTON COUNTY (courses taken at RCBC towards AS.EGR)					
FIRST YEAR - Fall Semester			**FIRST YEAR - Spring Semester**		
Course #	Course Name	Cr	Course #	Course Name	Cr
CHE 115/116	General Chemistry I & Lab	4	CSE 135 or CSE 110	Comp Programming & Problem solving or Intro to Computer Science	3
HUM Gen Ed	ART 101, MUS 101 or THR 101	3	PHY 210/211	General Physics I & lab	4
ENG 101	English Comp I	3	EGR 152	Freshman Engineering Clinic II	2
MTH 118	Calculus I	4	MTH 119	Calculus II	4
EGR 151	Freshman Engineering Clinic I	2	HIS Gen Ed	HIS 101, 103, 104	3
	Total Credits	16		Total Credits	16
SECOND YEAR - Fall Semester			**SECOND YEAR - Spring Semester**		
Course #	Course Name	Cr	Course #	Course Name	Cr
ENG 102	College Composition II	3	Soc Sci Gen Ed	ANT 102 Cult. Anthropology	3
MTH 220	Calculus III	4	EGR 201	Engineering Statics	3
Diversity Gen Ed	LIT 211 Master World Lit	3	SPE 102	Public Speaking	3
PHY 212/213	General Physics II & Lab	4	EGR 252	Sophomore Engineering Clinic II	1
EGR 251	Sophomore Engineering Clinic I	1	Soc Sci Gen Ed	Social Science Gen Ed	3
MET 235	Materials Science	3	EGR 203	Field Surveying	3
	Total Credits	18		Total Credits	16
CIVIL & ENVIRONMENTAL ENGINEERING ROWAN UNIVERSITY					
THIRD YEAR - Fall Semester			**THIRD YEAR - Spring Semester**		
ENGR 01303	Junior Clinic	2	ENGR 01303	Junior Clinic	2
CEE 08305	Civil Engineering Systems	3	CEE 08351	Geotechnical Engineering	3
MATH 01235	Math for Engrg Analysis	4	CEE 083382	Structural Analysis	3
ENGR 01275	Strength of Materials	3	CEE 08342	Water Resources Engineering	3
ENGR 01341	Fluid Mechanics	2	CEE 08361	Transportation Engineering	3
CEE 082: CEE08.301	Civil Engineering Materials	2	CEE 08311	Environmental Engineering 1	3
	Total Credits	16		Total Credits	17
FOURTH YEAR - Fall Semester			**FOURTH YEAR - Spring Semester**		
Course #	Course Name	Cr	Course #	Course Name	Cr
ENGR 01403	Senior Clinic	2	ENGR 01403	Senior Clinic	2
CEE 08491	CE Design Project I	2	CEE 08492	CE Design Project II	2
CEE 08490	Civil Engineering Practice	1	CEE 08102	Engineering Graphics	2
	Civil Engineering Elective	3		Civil Engineering Elective	3
	Civil Engineering Elective	3		Civil Engineering Elective	3
	Science Elective	4	ENGR 01291	Dynamics	2
			CEE 08383	Anal. and Design Steel Frames	3
	Total Credits	15		Total Credits	17
Total RCBC credits is 60 and total Rowan U credits is 64; BS CEE requires 120 credits					

Note: Bold courses require minimum C- grade; suggest add a minor or CUGS @ Rowan U during first year
Note At RCBC: MTH 201 and MTH 230 is equivalent to MATH 01.235
Note: EGR 251 and ENG 102 matches ENGR 01.201; EGR 252 and SPE 102 matches ENGR 01.202
Note: Courses in red are recommended but not required for Burlington Associate's Degree

Transferring from a community college into a four-year university provides a unique set of challenges for students. The method by which these challenges were to be remediated was to narrow the scope of work to eight community colleges located in the southern part of New Jersey. The major considered for the project was Civil and Environmental Engineering at Rowan University. The three parts of the project focused on determining which community colleges were not offering classes that were needed, what credits transferred from the community college to the university, and which classes were needed to fulfill the university requirements. The matrix provides the students a semester sequence of classes to take in order to graduate from Rowan University in four years. This resulted in no more than two laboratory classes, and no greater than seventeen credits during any one semester. The research has shown that the challenges of classes not being offered and university requirements not met does not have to add time to students' career. The results prove that the possibility exists for completion of a degree in Civil and Environmental Engineering in four years even with challenges associated with transferring.

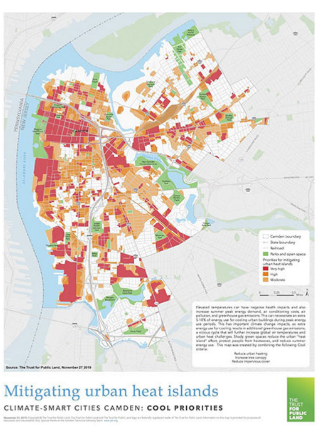
Mechanical Behavior of 3D Printed Polymers

TEAM MEMBERS
Alex Guzman, Brian Hlifka, Spencer Hoffman, Eric Stiner
PROJECT MANAGER
Dr. William Riddell and Dr. Joseph Stanzione
SPONSOR
U.S. Department of Defense - Army Research Lab, subaward from PPG

The purpose of this project is to investigate how the orientation of print layers for SLA-printed polymers affects mechanical behavior, with goal of identifying mechanisms for failure or undesirable behaviors. Once these mechanisms are identified, resins and printing techniques can be improved to allow for improved mechanical performance of 3D printed components. The first part of this project involves several commercially available resins. Tensile tests have been performed on standard coupons printed such that the principal stresses act at different angles to the print layers. The resulting failure surfaces have been studied using scanning electron microscopy. The results of these tests suggest undesirable behaviors are more common when stresses act perpendicular to the print layers. The next steps in this project are to incorporate fracture mechanics testing into the evaluation process, and to apply the lessons learned characterizing commercially available resins to characterize custom resins developed at Rowan University.

Mitigation of Urban Heat Island Effect through Green Infrastructure in Camden

TEAM MEMBERS
Kira Rose, Yu Chen, Brendan Chiappa
PROJECT MANAGER
Dr. Sarah K. Bauer and Dr. Mahbubur Meenar
SPONSOR
Camden County Municipal Utilities Authority



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 study aims to identify specific UHI hotspots and populations that are most vulnerable to heat in Camden City and to examine trends within the city between UHI risk and green infrastructure abundance. Using this data, the researchers will then propose strategies to mitigate negative impacts by analyzing the temperature reduction benefits of urban greenspace and green infrastructure. Anticipated outcomes of this research include recommendations for the betterment of UHI conditions within Camden City and the usage of this research as a reference, which may aid in future attempts to protect the public health of the city by alleviating the detrimental effects of the UHI effect.

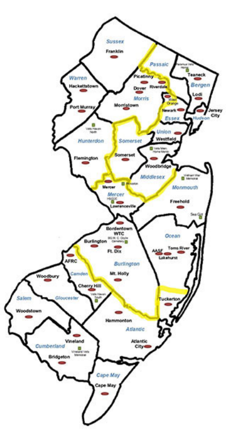
New Jersey Underserved Communities Electric Vehicle Affordability Program

TEAM MEMBERS
Samuel Mossop, Zachary Hyson
PROJECT MANAGER
Dr. Mohammad Jalayer

Millions of American's cannot afford to pay for their transportation, especially those who live in underserved communities and have low incomes. In this study, we aimed to develop a sustainable transportation system for these people, which are affordable as well as environmentally friendly. For affordable transportation options, shared mobility has the potential to increase access to the poor people. With increased awareness and demands for environmentally friendly and energy-efficient solutions, shared mobility using Plug-in Electric Vehicles (PEVs) emerged. PEVs draw electricity directly from the grid and do not produce greenhouse emissions; thus, making such vehicles a feasible option for increasing the benefits of shared mobility. This paper aims to explore the feasibility of applying for the Electric Vehicle sharing program in New Jersey. First, we summarized the details of the existing shared mobility programs, focusing on EV, in underserved communities. Second, we listed the incentives for EV across the nation provided by the public and private agencies. Third, we developed a survey questionnaire form to gather information from three townships (Newark, New Brunswick, Washington Township) in New Jersey on how people feel about shared mobility programs as well as EV. Factors such as car ownership, geographic location, convenience, travel time, fare policy, and incentives for using the service are included in the survey.

NJARNG Energy/Water Resiliency Planning

TEAM MEMBERS
Jennifer Nissa Crown, Samuel Ramos
PROJECT MANAGER
Dr. Jess Everett and Rachel Margolis
SPONSOR
NJ Army National Guard



The Rowan University Sustainable Facilities Center assists the New Jersey Army National Guard (NJARNG) to improve mission capability. The Energy/Water Resiliency Clinic helps NJARNG reduce energy & water consumption, increase efficiency and renewable energy usage, reduce building and fleet greenhouse gas emissions, write federally mandated energy conservation and power resilience documents, research innovative technologies, conduct life cycle cost assessments (LCCAs), assist with energy project development, and develop education/awareness materials. For the Spring 2020 semester, this clinic focused on writing an Army Installation of Energy and Water Plan (IEWP) and conducting an analysis of boiler conversions. The IEWP will assist the NJARNG to achieve increased security, resilience, readiness and mission assurance while becoming more sustainable. This document will consist of plans, policies, improvement recommendations, facility analyses, etc., all forming a guideline that enables the mission-critical installations to continue their mission readiness, acting as a contingency plan. The second project is to perform LCCAs and make recommendations to convert existing fuel oil burning boilers at NJARNG Readiness Centers (RCs) to more energy-efficient models that burn natural gas. Natural gas-fired boilers emit fewer GHG emissions and can have economic advantages over oil-fired boilers.

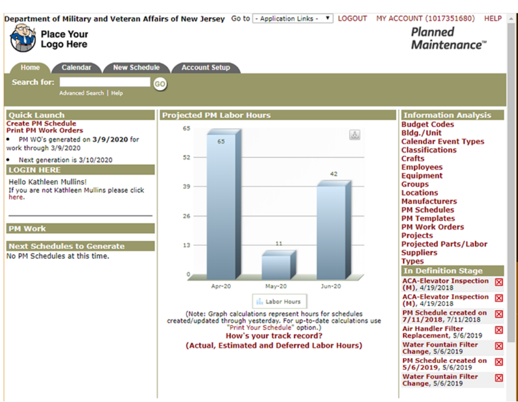
NJDMAVA Building Audits

TEAM MEMBERS
Christopher Amling, Alex Clemick, Devlin Cox, Melissa Green, Matthew Jenkins
PROJECT MANAGER
Dr. W.T. Riddell, Dr. R. Krchnavek, Dr. F. Haas, Dr. J. Everett, N. Nocco, and R. Margolis
SPONSOR
NJ Department of Military and Veteran Affairs

Student working in the Sustainable Facilities Center at Rowan University carried out energy and water building audits for the NJ Department of Military & Veteran Affairs (NJDMAVA). The audits were conducted for three NJ Army National Guard (NJARNG) armories located throughout New Jersey. The three facilities that were examined for the project were the Jersey City Armory, the Riverdale Armory, and the West Orange Armory. Students used field measuring equipment such as light meters, kilowatt meters, ballast detectors, thermal cameras and laser measures to find light levels, light ballast types, temperatures, power use, and heat exchange points. The students then compiled their data to use software for the modelling of energy consumption and heat flow, including eQUEST & Excel. These models were used to compare the facility's predicted consumption to the actual consumption obtained through the examination of utility bills. At the conclusion of the semester, the students will deliver a final report to each facility that can be used by the client to make their facility more cost-effective, sustainable, and environmentally friendly.

NJDMAVA Sustainable Facilities

TEAM MEMBERS
Wyatt McCart, Paul Reiff, Grace Watson
PROJECT MANAGER
Dr. W.T. Riddell, Dr. J. Everett, and Kathy Mullins
SPONSOR
NJ Department of Military and Veteran Affairs



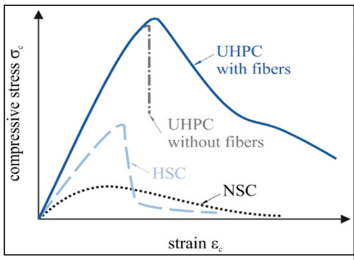
"Through the use of a computerized maintenance management system (CMMS), NJDMAVA plans to improve the readiness of their armories and associated buildings, lower costs of repairs, improve the lifespan of equipment and assets, and reduce corrective maintenance tasks.

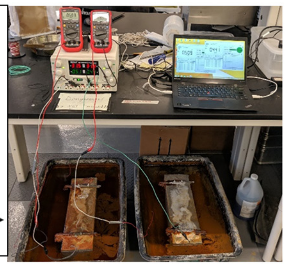
The CMMS currently in use by NJDMAVA is called Facility Dude. The scope of work includes the development of a generalized Level I Planned Maintenance Plan (PMP) schedule that is usable at all armories in New Jersey. The recommended tasks in the Level I PMP will be phased-in over a 3 year period.

In addition to this universal plan, Level II Planned Maintenance Plans are being developed for the Woodbury and Woodstown installations. These Level II PMPs will be planned maintenance tasks that are site specific to building systems and equipment and scheduled per either manufacturer requirements or industry standards. This Level II PMP will provide a template that future locations can follow for the creation of their own Level II PMPs. "

Properties of UHPC-HPC Composites

TEAM MEMBERS
Randall Sivak, Greg O'Donnell, Steve Plamer, Patrick Goode, Alex Vaporis
PROJECT MANAGER
Dr. Gilson Lomboy and Harshdutta Pandya





Ultra-high performance concrete (UHPC) is a portland cement based composite with very low water-to-cement ratios, optimized gradation, and short discontinuous fibers. The mixture has a high flowability and has compressive strengths greater than 22 ksi. The present work is to develop a UHPC mix design using local materials available in New Jersey, gather flexural strength data on corroded rebar reinforced HPC beams, and model corroded rebar reinforced HPC beams with UHPC used as a repair material as well as simulate their flexural strength performance. The current composition is Keystone Type I portland cement, undensified silica fume, Sika ViscoCrete 2100 high range water reducer, silica aggregates from New Jersey, and 12 mm steel fibers. Current results show strengths of 21 ksi at 28 days. Further improvements for the UHPC mix design are being made on optimizing gradations to increase the composite strength. Additionally, the corrosion process for the HPC beams is being improved for increased accuracy and reliability.

Recycled Concrete Aggregates

TEAM MEMBERS
Matthew Dreisbach, Timothy Osgood, Christian Dvorak, Max Rafael, Anthony Havens
PROJECT MANAGER
Dr. G.R. Lomboy, Dr. D. Cleary, M. Motlagh, T. Khan, A. Aragoncillo, and Dr. S. Abubakri
SPONSOR
U.S. Department of Defense - Army Corp of Engineers

Recycled concrete aggregates (RCA) can be produced by crushing the old concrete. With the supplies of aggregates from natural sources is rapidly reducing, there is great interest in using crushed concrete as a replacement to virgin aggregates. The goal of this project is to provide guidance for classifying and producing recycled concrete aggregates based on the crushed concrete or parent concrete properties. It will also study mitigation measures from unfavorable effects of using RCA if present. The project will evaluate the properties of the concrete by replacing the virgin aggregates with 100% RCA which will provide environmental and economic benefits. The parent concrete is crushed and graded at different nominal maximum size to determine the RCA production effects on new concrete. Six procured RCA will be obtained. The nominal maximum sizes of the procured RCA are 1 and 0.075 inches. To know the strength, density, durability and absorption characteristics of the RCA, tests have been done based on the mechanical and physical properties. Physical properties tested in the lab include bulk density, specific gravity, absorption, residual mortar, sulfate soundness, resistance to degradation, resistance to alkali reactivity, resistivity test and density, absorption, and voids in hardened concrete.

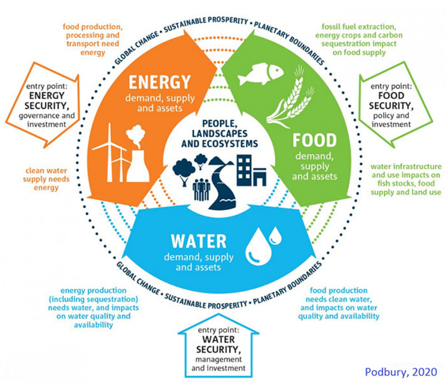
STEM Demos for Engineering Outreach

TEAM MEMBERS
Sydney Iatarola, John Mazzagatti,
Jake Nugent, Kareem Pitts, Kevin Purcell,
Veronica Summers, Brian Thatcher
PROJECT MANAGER
Melanie Besantis

"The STEM Clinic Team has empowered and positively impacted over 1200 middle and high school students exploring engineering this 2019-2020 year. Visiting students work in teams to tackle engineering projects while also developing a better understanding of basic engineering principles. An overview is provided along with a tour of the engineering buildings. Functional input on college life and preparing for the transition to collegiate engineering is provided by the Clinic team.
New this year, the STEM Clinic Team used Kahoot!, an online game-based learning platform, to create a quiz that culminates the students' Rowan engineering experience in a fun, competitive manner. This quiz, played in teams, reiterates the day's engineering principles and gauges what was retained by the K-12 students.
Also new this year and with the help of a College of Education intern, an iRB-approved survey was developed to assess K-12 students' interest in the Engineering Experiences program. Overall, 78% of the middle-school students identified that engineering has become more interesting to them because of this clinic program and 83% indicated they had fun. When asked, if the students learned anything new, 74% of them replied yes with such comments as "Concrete can float", "That everything basically uses engineering", "how to work with arduinos" and "Engineering is in your everyday life."

The Potential of HTL Processing of Waste Feedstocks for Clean Energy Production

TEAM MEMBERS
Ryan Rorick, Shane D. Kelly, Anna Kalogiratou,
Patrick Hall, Jason S. Russack,
Mohammed K. Chowdhury
PROJECT MANAGER
Dr. Sarah K. Bauer



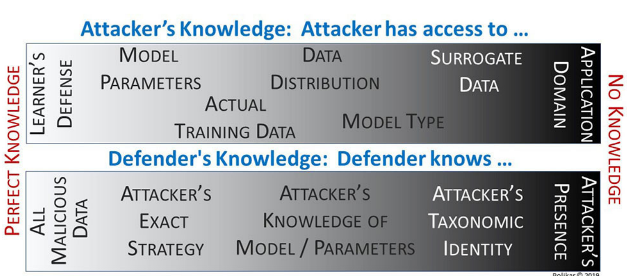
Research into balancing the conservation and consumption of both clean water and energy is expanding, a concept known as the Water-Energy Nexus. In recent decades, research into reusing or reclaiming wastewater and waste products to offset the use of nonrenewable resources has increased. The U.S. produces high quantities of waste in the form of biomass which is often seen as an environmental and economic liability. Breweries contribute to this growing waste in the form of spent grains, spent hops, trub, and yeast. However, this waste has the potential to be reused in the form of biofuel. This research uses hydrothermal liquefaction (HTL), a means of converting wet, organic biomass into liquid biocrude, to convert brewery waste feedstocks into liquid biocrude. Preliminary characterization of raw brewery waste suggests that high carbon and water content makes brewery waste suitable for biocrude conversion. All feedstocks processed produced viable quantities of biocrude. Biocrude was separated from reaction by-products, biochar and wastewater, and by-products were characterized for quantity and quality. Further work includes examining the ratio of biocrude-to-biomass in order to provide insight into the feasibility and sustainability of waste-to-energy systems utilizing the waste generated from the brewery industry.

ELECTRICAL & COMPUTER ENGINEERING

Adversarial Machine Learning

TEAM MEMBERS
Daniel Juliano, Ryan VanWerner, Chris Dellisanti, Muhammad Umer, Glenn Dawson

PROJECT MANAGER
Dr. Robi Polikar



"As the prevalence and everyday use of machine learning algorithms,along with our reliance on these algorithms grow dramatically, so do the efforts to attack and undermine these algorithms with malicious intent,resulting in a growing interest in adversarial machine learning. A number of approaches have been developed that can render a machine learningalgorithm ineffective through poisoning or other types of attacks. Machine learning algorithms are now routinely used to detect and guardus against cyber attacks, but what is guarding the machine learning algorithms themselves from such attacks? To protect these algorithms, it is important to evaluate what kind of attacks are possible and which ones can be easily detected. While the impact of malicious poisoning attacks on some popular algorithms, such as deep neural networks, has been well researched, the vulnerability of other approaches has not yet been properly established. In this effort, we explore the vulnerability of a variety of different machine learning algorithms, including those used for domain adaptation, lifelong learning, and learning in nonstationary or streaming data environments. We show that the algorithms used in these type of environments are particularly vulnerable to poisoning attacks. If machine learning algorithms are to be more secure, they need to have smart detection mechanisms against an increasingly sophisticated attack mechanisms."

Camden SAFE: Developments of Distributed Smart Sensor Nodes and LoRa Network

TEAM MEMBERS
Jordan Alberico, Cameron Bendzynski, Nicholas Coppola, William Cronin, Nicholas Klein, Alexander Marino, Eric Matos, Jacob Weber

PROJECT MANAGER
Dr. S. Shin, R. Trafford, Dr. R. Krchnavek, and Dr. J. Schmalzel

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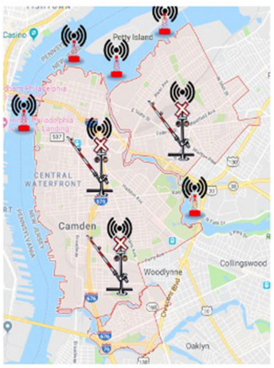
Camden Health Research Initiative

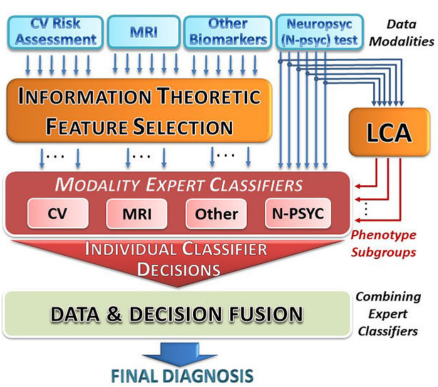


"Camden SAFE project aims at developing a smart city platform that integrates distributed smart sensor nodes and a hybrid wireless network that connects the distributed sensor nodes. For the wireless smart city project, Camden SAFE, this clinic research team specifies and designs distributed sensor nodes which continuously sense/monitor area safety events, e.g., flooding estimation and detection, along with other environmental factors. These sensor nodes communicate using Bluetooth/LoRa to provide both the long range coverage and low-power data links. These nodes will need to be powered off of battery for roughly 1 month on battery without any solar harvesting.
This clinic team also investigate simple yet highly functional wireless network protocols, exploring LoRa network standards as well as the emerging IoT standards (such as IEEE 1451). Particular research focus is on developments of our own protocol for on campus uses and eventually in the City of Camden."

Objective Automated Diagnosis of Early Dementia

TEAM MEMBERS
Jeremy Decker, Zachary Golieb, Neeve Kadosh, Rana Dhera, Muhammad Umer, Victor Wasserman

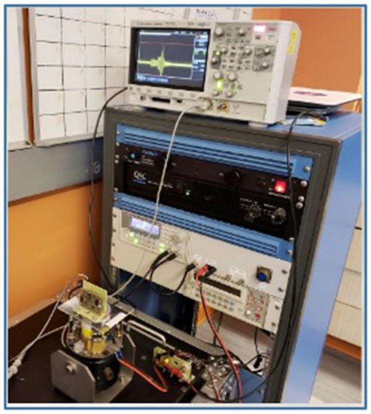
PROJECT MANAGER
Dr. Robi Polikar and
Dr. David Libon (Rowan SOM)



"Mild Cognitive Impairment (MCI) is an early state that often progresses to Alzheimer's disease (AD). AD is the leading cause of death among elderly, with no definitive mechanism for diagnosis and no cure. The most common approach for diagnosis uses a series of memory tests evaluated by neurologists. Misdiagnosis is not uncommon, and the decision is often subjective. More recently, machine learning has emerged as a powerful mechanism to help with automated and objective diagnosis of neurological disorders in general, and AD in particular. In this project, we join forces with Rowan School of Medicine in analysis of vast amounts of data collected through behavioral tests, such as clock drawing test, as well as data collected through the Framingham Heart Study (FHS). FHS is the oldest community-based epidemiological study in existence, and now includes detailed neuropsychological assessment, MRI data, and other biomarkers that can all be used to develop synergistic and complementary machine learning models to characterize and classify early dementia syndromes, including differentiating MCI from AD. Our goal is to determine the most relevant features, and develop appropriate machine learning algorithms to obtain a diagnostic accuracy that is as good or better than current state of the art."

Piezoelectric Cantilevers for Micro-Energy Harvesting Systems

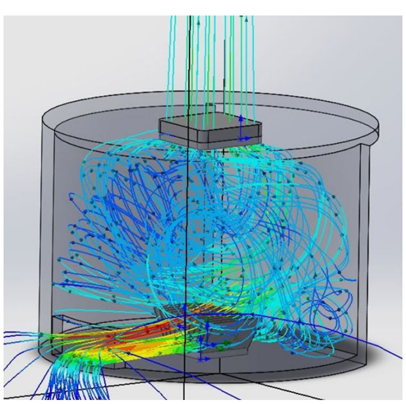
TEAM MEMBERS
Ryan Baker, Colby Clark, Dylan Dancel, Elisabeth Davis, Jan Gracia, Sean Johnson, David Russo
PROJECT MANAGER
Dr. S. Shin, A. Fifth, R. Trafford, Dr. R. Krchnavek, and Dr. J. Schmalzel



This research investigates a method of harvesting energy using piezoelectric cantilever beams in order to power sensors in areas where other means of energy harvesting are not feasible. Piezoelectric cantilevers convert mechanical deflection to electrical energy which can be stored and used to energize remote sensors. Potential sensor applications include the recording of environmental data such as temperature, structural safety, and event sensing. Cantilevers are known to have naturally high quality factor, implying that tuning the element for a specific narrow bandwidth is vital for the overall efficiency of the energy harvester. In an example application, roadway data has been gathered to determine the effectiveness of this type of energy harvesting for traffic induced vibrations. We present the preliminary results of a two-cantilever energy harvesting system which shows the effectiveness of this approach. Future work includes collecting different vibration data along multiple types of roadways, and quantifying and designing application specific piezoelectric cantilevers for differing resonance frequencies.

Product Development

TEAM MEMBERS
Gabriel Bateman, Armando Briscella, Timothy Gayed, Timothy Hollabaugh, Anwar Hussein, Julia Konstantinos, Jonathan McAvoy, James Merrill, Karlie Naphy, Noah Ng, Caroline Thistle, Sara Toner, Kimberly Tran
PROJECT MANAGER
Karl Dyer, Mario Leone

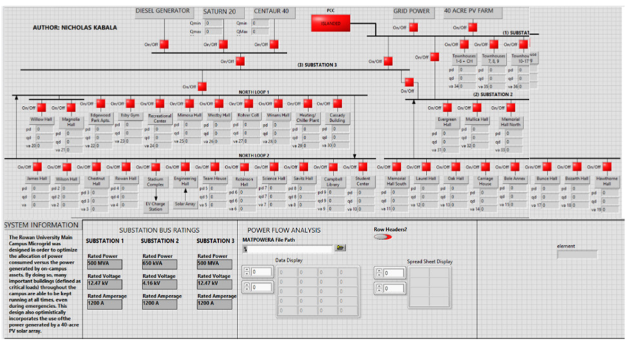


In product development it is most important to approach a project through a customer-centric lens, taking the time to understand the “why” of the project before engineering a solution. This clinic focuses on humanistic design to maximize user pleasure while interacting with a product and pumps the brakes on an engineer’s tendency to focus only on the technical aspects of a problem. This year, the clinic group was challenged to design a stylish and unconventional dual temperature, hot and cold side, environmental chamber to store solder paste, applicator syringes, and FR1 protoboards.

Rowan Campus Microgrid Research

TEAM MEMBERS
David Russo, Patrick Wilk, Nicholas Kabala, John Henley
PROJECT MANAGER
Dr. Jie Li

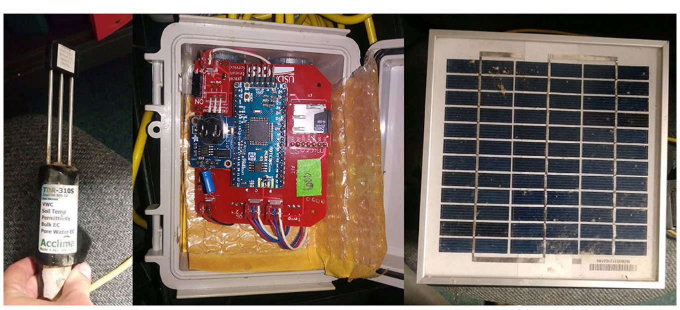
The purpose of this project is to conduct a feasibility study and engineering design on implementing a campus microgrid to serve Rowan University, while illustrating the potential economic, environmental, reliability, and resiliency benefits of the proposed microgrid. This project primarily looked into integrating Rowan's existing 4.7 MW co-generation sources, proposed 10-MW PV farm, existing power distribution systems, and critical buildings loads to minimize campus energy cost during normal operation status and maximize energy safety during natural disasters. Detailed economic dispatch and rigorous power flow analysis are conducted to confirm the functionality of the design. LabVIEW based interactive software fronts are created to assist in visualization of the microgrid operation results. Future work can be done to expand the scope of the campus microgrid to serve the local communities and introduce more smart meters for advanced load-side management.



Soil Properties Data Logger

TEAM MEMBERS
Michael Malony, Timothy Jensen, Forest Hinds
PROJECT MANAGER
Dr. Mahmoud Al-Quzwini

"The data logger will provide efficient and cost-effective data logging for soil properties. It will be used for research in the field of Weed Science with cooperation from Rutgers University. A microcontroller with attached sensors is designed and implemented. A Bluetooth module is added for contactless and efficient communication with the data logger. The system is optimized for low power operation, it uses a solar panel and a battery unit as sources of power."



Wireless BUS for Small Satellite Systems

TEAM MEMBERS
Jake Matteo, Timothy Roche, Kenneth Wagner
PROJECT MANAGER
Dr. S. Shin, A. Fifth, R. Trafford,
Dr. R. Krchnavek, and Dr. J. Schmalzel
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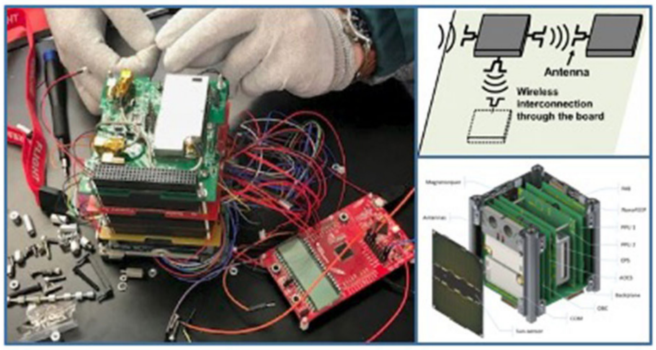
NJ Space Grant Consortium



"In this research, we propose a Bluetooth Low Energy (BLE) based wireless interface technology to enable post-deployment reconfigurations of in-system interfaces. The wireless interface technology will improve system reliability while enabling ad hoc system level changes and reducing the probability of subsystem failure. Though with the beneficial features, the wireless interconnects may also raise potential technical challenges including additional power consumption, data latency, interference with main satellite communication systems, susceptibility and emissions.

This work presents the concepts of wireless interface technologies and the proof-of-concept analysis/experiment results of the BLE-based wireless interface system, discussing effective solutions for the aforementioned technical challenges. By limiting the RF power of the wireless interfaces and by using proper shielding techniques, the susceptibility, emissions and power consumption will be made minimal. The latency and interference can also be minimized with optimizations of software codes and error correction techniques. Proof-of-concept demonstrative prototype lab experiments show the feasibility and adaptability of the proposed technology with much increased functional reconfigurability over traditional wire-based interconnects."

EXPERIENTIAL ENGINEERING EDUCATION

An Automated System to Measure Students Motivation

TEAM MEMBERS
Ryan Federline, Jacob Hunt, Nathan Narbone, Matthew Schmitt
PROJECT MANAGER
Dr. Juan M. Cruz

The purpose of this project is to create an automated system for professors to easily assess the academic motivation of students in a class. Professors will receive an automated report with the assessment and research-based suggestions on how to improve the students' academic motivation. The model that informs the development of this system is called the MUSIC Model of Motivation. It suggests that by enhancing five motivation-related perceptions (empowerment, usefulness, success, interest and caring) the willingness to engage in the learning process will increase. All assessment process and suggestions developed in this project are informed by this theory. Motivation is assessed by the use of a validated survey that measures each of the motivation-related perceptions.

Curriculum Design for Diversity and Inclusion

TEAM MEMBERS
Richard Dell, Sean Prendergast, Nicholas Riggins, Carla Silvestri
PROJECT MANAGER
Dr. Kaitlin Mallouk

“Studies have shown that diversity and inclusion practices have positively benefited the workplace and classroom. This clinic aims to find ways to implement diversity and inclusion activities in the First-Year Engineering Clinic curriculum and raise students’ awareness of equity issues. Over the course of this project, several homework assignments and in-class activities were developed to be implemented in the classroom during the upcoming school year. Each assignment and activity was designed to help the first-year students achieve five learning objectives. These learning objectives encompassed different aspects of diversity and inclusion such as the importance of diversity and inclusion in engineering, recognizing personal biases, understanding privilege, cultural awareness, and institutional inequality and under-representation. Looking towards the future, this clinic aims to spread awareness about diversity and inclusion to the whole college of engineering. By introducing these topics to first-year students, we hope to encourage an open mindset and awareness about diversity and inclusion that they can carry throughout the rest of their time at Rowan University.“

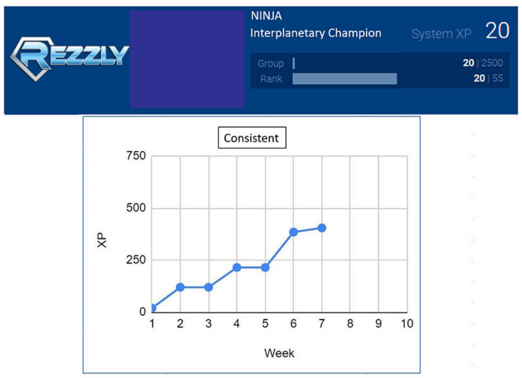
First-Year Students Self-Perception as Teammates and their Team’s Dynamic

TEAM MEMBERS
Abigail Brown, Barbara Cerefin, Lauren Gallo, Sarah Ramsey
PROJECT MANAGER
Dr. Kaitlin Mallouk

First-semester, first-year engineering students are required to take a multidisciplinary introduction to engineering course that is offered in sections of 20-24 students. Approximately 28 percent of these students are members of the Engineering Learning Community (ELC), which provides housing in a common location as well as additional supports in the form of weekly group meetings with a student mentor and access to tutoring. Another 12 percent of students were in sections designated as Honors. In Fall 2017, reflections were implemented in this course as a way of encouraging students to explain past experiences and learn from their mistakes. The weekly reflection prompts were reduced to biweekly reflections, one of which required students to reflect on themselves as teammates and their team’s dynamic. This study used provisional and in-vivo coding to analyze paired reflections from 166 students. Twelve total themes were identified and used to characterize each reflection. The top themes for each group of students (ELC, Honors, and Non-Honors & Non-ELC) were determined and the representation of this data discussed. Results showed “Management” was the top theme and “Positive Atmosphere” was the second most recurring theme for all three groups of students.

Mapping Homework Strategies

TEAM MEMBERS
Alexandra Jackson, Matthew Strauss, Samantha Resnick, Alex Ventura
PROJECT MANAGER
Dr. C. A. Bodnar, Dr. J.M. Cruz, and C. Mawson



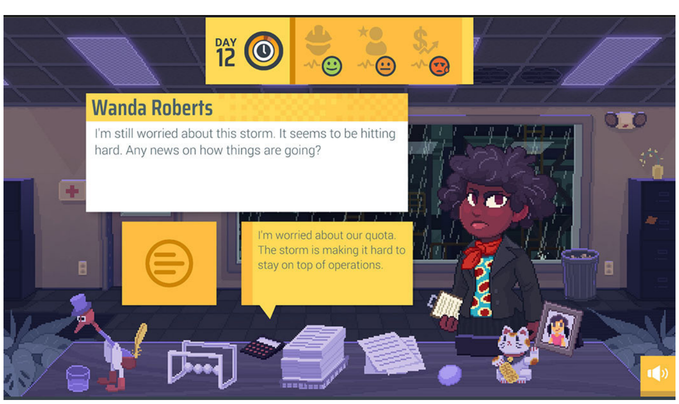
"The purpose of this project is to investigate how students approach online gamification platform activities (i.e., Rezzly) in first-year engineering clinics (i.e., FECI and FECII). We want to determine what specific approaches students are taking to complete their homework within the Rezzly platform, how gamification elements have contributed to their pathways, and how these approaches change during their academic year.

This yearlong project seeks to evaluate trends in the number of points students obtain week by week on the online platform to allow categorization of the students into gamification profiles (i.e., achiever, disheartened, strategic, late awakener, and consistent). From a random sample of 100 students in the first semester, our results have shown that the majority (67%) match the category of consistent and that students are most likely choosing their quests based on key topics, reported time required to complete the task, and overall rating given to the quest. The Rowan Experience focused quests were, by far, the most popular topic choice.

Currently, the team is gathering and analyzing data for the same students during the start of the second semester of their academic year (FEC II)."

Process Safety Decision Trends in a Digital Immersive Environment

TEAM MEMBERS
Jacob Hunt, Anton Parriski, Veronica Summers
PROJECT MANAGER
Dr. Cheryl Bodnar and Jeffrey Stransky
SPONSOR
National Science Foundation



Engineering institutions have incorporated process safety education in accordance with ABET requirements. However, process safety incidents continue to occur as a result of the alignment of failures in decision making. Literature suggests this takes place as an individual's behavior differs from their predictions in testing environments. To address this problem, a web-based simulation called Contents Under Pressure is used to study the impacts of digital immersion on decision-making. Here, the user enacts the role of senior plant manager with the responsibilities of balancing key plant metrics such as time, reputation, safety, and productivity. Data was collected from chemical engineering seniors at three institutions. This clinic specifically sought to understand (1) the relationship between the types of decisions being made and the length of time spent on the decision-making process, and (2) changes in decision-making when faced with recurring decisions involving competing demands of safety and productivity. Results suggested the types of decisions had no impact on the time necessary for making a decision. Additionally, students were observed to increase their prioritization of safety upon sequential exposure throughout the simulation's narrative. The program was supported by the National Science Foundation's Improving Undergraduate STEM Education, Division of Undergraduate Education awards #1711376, 1711644, 1711672, and 1711866.

MECHANICAL ENGINEERING

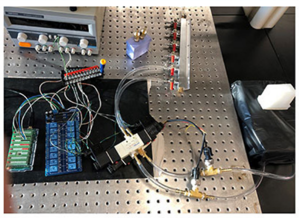
AIAA Design/Build/Fly

TEAM MEMBERS
Cory Adler, Dylan Bendzynski, Andrew Biss, Ryan Boylan, Frank Cianciotta, Matthew Guardiani, Michael Guardiani, Zak Hammel, Olga Koturlash, Michael Lampasona, Matthew Mazalewski, Nicholas Munier, Justin Reuter, Noah Rodums, Pietro Sparacio, Spenser Stark, Alexander Tenerelli
PROJECT MANAGER
Dr. Ratan Jha
SPONSOR
Solidworks, Spectrum Design

To compete in the 2020 AIAA Design/Build/Fly competition, a multipurpose bush style aircraft within the specific size requirements that can successfully perform multiple flight and ground missions was built. DBF goes through iterative design stages, strategic planning, and testing phases. Rowan University's 2019- 20 DBF team consists of 17 Rowan Mechanical and Electrical Engineering students, each with specific roles and responsibilities to ensure individual and overall success. The flight objectives to be met were the ability to carry model passengers and luggage, along with deployment, tow, and release of a banner. Function of banner mechanisms and passenger loading must be demonstrated during the ground mission in under 5 minutes. Along with a comprehensive design report, mission totals from ground and flight missions are used to evaluate flight performance. Applying concepts learned from the ME curriculum and engineering clinic experience, a mission capable aircraft was manufactured and successfully flown.

Autonomous Soft Robotic Pad

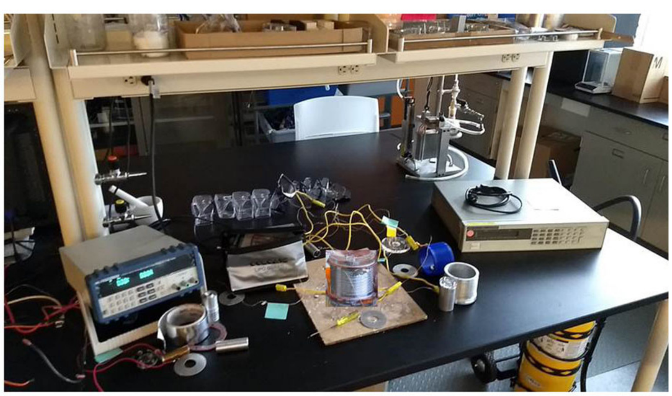
TEAM MEMBERS
Dan McMullen, Mike Ravaschiere, Patrick Frangie
PROJECT MANAGER
Dr. Mitja Trkov



The goal of this project was to design and fabricate an autonomous soft robotic instrumented support pad for the application of preventing pressure injuries. The system is intended to be used in hospitals or home care settings. Pressure injuries, also known as pressure ulcers or bed sore, are caused when a person is bed ridden for an extensive amount of time. They can develop on a patient's buttock tissue and thighs and other locations depending on the position of the patient. The specific objectives for this clinic project were to design and fabricate soft inflatable domes made of silicone material and use electro-pneumatic system to control the air pressure supply to actuate the domes. Sensing capabilities were added by integrating force sensitive resistors on top of the domes to enable measurement of the applied external load on the individual domes. The students had the opportunity to obtain hands-on experiences in soft robotics through all stages from conceptual design, development, and testing and performance evaluation.

Battery Thermal Management (BTM)

TEAM MEMBERS
Mark Alexander Udowiczyk, Jason L Shanley
PROJECT MANAGER
Dr. Nourouddin Sharifi and
Dr. Smitesh Bakrania



Lithium Ion batteries are widely used in automobile industry. Their performance decreases as their temperature increases during operation. To prevent this issue, different phase change material (PCM) based cooling strategies for these batteries are investigated. Some of them have been investigated in our previous clinic. In this clinic, we specifically focused on Battery test, CAD Model of heat pipe-fin-PCM module and COMSOL numerical simulation.

Design of a Master-Slave Robotic Device (MSRD)

TEAM MEMBERS
Ian James Moffitt, Michael Thomas Shirley
PROJECT MANAGER
Dr. Nourouddin Sharifi and
Dr. Mohammad Hossein Abedin Nasab

Kinematic, dynamic and control relations between the master (Falcon) and the slave (a robotic arm) will be investigated and embedded in a software to couple the intuitive movements of the hand to the robotic device. The Falcon is a haptic device which can provide the user with 3 Degree-of-Freedom (DOF) control and 3 DOF force feedback. It has 3 sensors to read the position, and 3 actuators to insert the force feedback.

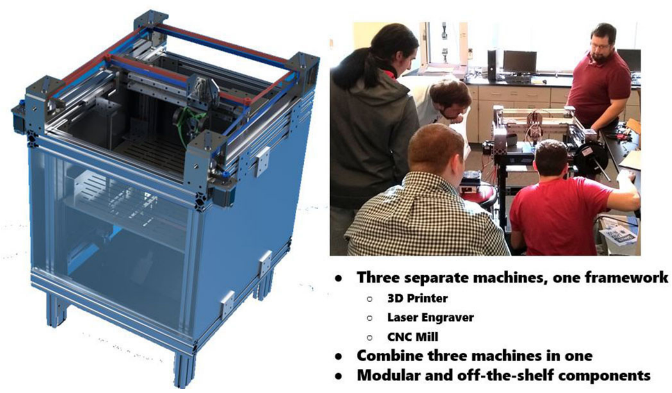
Design, Build, Test of Baja SAE Vehicle

TEAM MEMBERS
Jamie Cadle, Chris Ferry, Jason Ippolito, David Grosmick, Nicholas Sancilio, Anthony DiAntonio, Jacob Jackson, Tyler Smalley, Nathan Bell, Matthew Olsack, Adam Korb, Matthew Rizzi, Matthew Reingold, Zack Johnson, Matthew Snyder, Travis Berner, Nicholas Lepold,
PROJECT MANAGER
Dr. Anu Osta and Dr. Nourouddin Sharifi

The Society of Automotive Engineers (SAE) hosts yearly competitions in which “Mini Baja” vehicles are designed and fabricated by participating engineering colleges. The objective of the competition is to produce a reliable, safe, off-road vehicle for recreational use. Design of the Rowan Motorsports 2020 Baja Car began in the summer of 2019 with the goal of producing a lightweight car without sacrificing strength or reliability. The 2020 car also competed in Epreuve du Nord, a competition at Université Laval in February - this allowed the team to test, identify design flaws and redesign. 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.

Developing a Modular Fabrication System

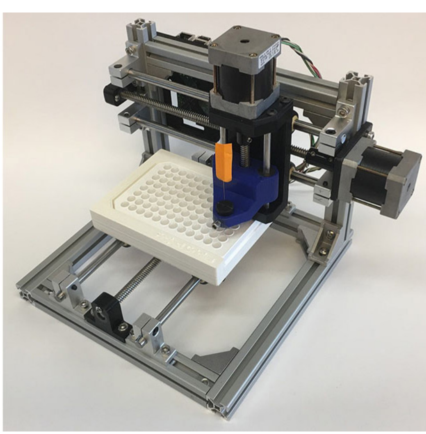
TEAM MEMBERS
Delaney Sheppard, Alex Steel, Patrick Sellers, Matthew Traina, Mike Stefanov, Alex Hess, David Adelsohn, George Baals, Daniel McMullen, Christian Webster
PROJECT MANAGER
Dr. Anu Osta
SPONSOR
Constellation, Rowan Venture Fund



Engineering as a whole has seen a revolution in the last decade as the “Maker Movement”. At the heart of this movement was the advent of consumer-grade 3D printers, Laser engravers and CNC milling machines. A system that encompassed all three devices was conceived. This modular fabrication system would consist of a robust frame and quick-swap tool head that would allow the user to rapidly and easily transition between these various devices. Additionally, the system would be modular in such a way as to allow to the user to configure the physical dimensions of the machine to best fit their needs. A rigid fame was constructed from 8020 extrusions, a common structural component that is easy to use and modify. To this was attached two motion systems. One moves a build plate in the vertical (Z) direction using ball screws for precise yet forceful movement. The other motion system controls the movement of the head in the XY direction, using a configuration of belts and pulleys known as CoreXY, which allows a more even distribution of loads to the drive motors than a traditional single-motor, single-axis system. A quick-swapping head mechanism is mounted to the CoreXY motion system to allow the user to swap end effectors. 3D printer and laser engraver heads have been fabricated. Finally, the electronic control system has been integrated with the frame, and we can currently jog all three axes of motion electronically.

Development of an Open-Source Instrument

TEAM MEMBERS
Greggory Murray
PROJECT MANAGER
Dr. Wei Xue and Dr. James Grinias

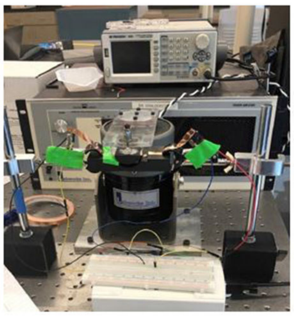


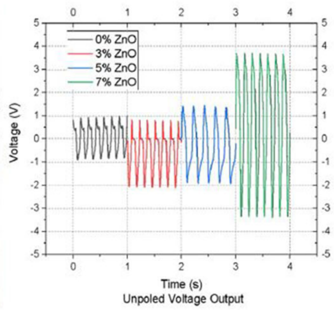
Building off previous development of a single-board computer data acquisition system and three-axis robotic sampling system, the next step towards a low-cost, open-source chemical analysis instrument is the development of a flow-based system flush and integration of a high voltage power supply. The goal of this clinic is to develop a Raspberry Pi-controlled system that allows a fluid reservoir to be flushed based on a gravity-fed reservoir and solenoid valves. This reservoir will be connected to a 10 kV power supply on a single 3D-printed module mounted on the 3-axis sampling system. A previously developed data acquisition system will be coupled to the device and initial testing on chemical separations using the whole platform will be conducted.

Electronic Skin Sensor Patch

TEAM MEMBERS
Michael Katz, Giselle Onofre
PROJECT MANAGER
Dr. Wei Xue

We aim to develop an electronic skin sensor patch for distributed pressure sensing. The sensor patch will be based on piezoelectric polymers for enhanced biocompatibility and flexibility. The team has been involved in the design, fabrication, and characterization of the sensor patch using functional polymers. In addition, the data acquisition and/or readout circuit of the sensor patch is under development. The sensor patches have great potential in future wearable technology for physical activity tracking and medical applications.

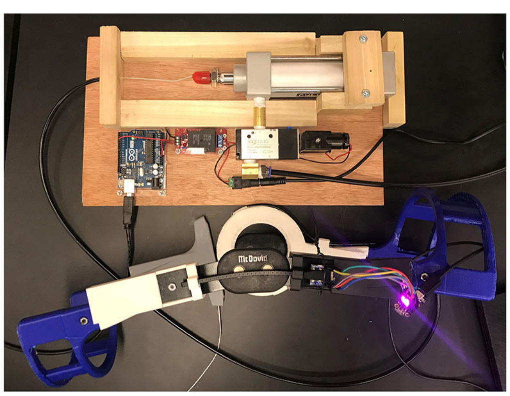




Exoskeleton for slip-and-fall prevention

TEAM MEMBERS
Duncan Stevenson, Sean Van Dongen, Melissa Green, Ben Magee, Austin Taylor, Eric Seyfried
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. Therefore, the goal of this project was to develop an exoskeleton device that augments human bipedal gait capabilities and enhances safety during gait perturbations. Throughout the project, students designed the device using computer-aided design (CAD) software to revise and optimize the design and fabricated parts using 3D printing. Compressed CO2 gas and cable driven mechanics were used as the actuation methods. Off-the shelf electronics and micro-controller were selected and integrated to control the electro-mechanical prototype device. Bench testing was performed to characterize the device and evaluate its performance. Students had an opportunity to go through all the stages of design, build and test of the electro-mechanical device gaining valuable hands-on experience.



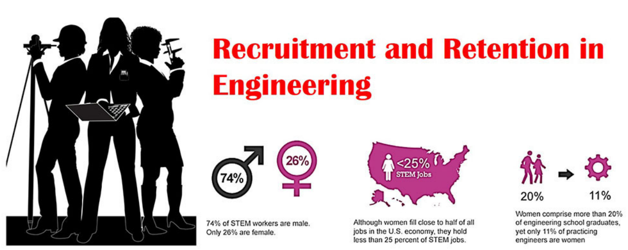
Explosive Detection Wand for the Transportation Security Agency

TEAM MEMBERS
Alexander Bruman, Mathhew Fontanez
PROJECT MANAGER
Dr. Anu Osta
SPONSOR
Constellation, Princeton Security Technologies

In response to increased terrorist threats the world over, the US Transportation Security Administration (TSA) was formed. They use a hand held wand to screen passengers and luggages for trace explosive particles that might be left on the clothing or luggage of the passengers. The existing explosive detection wand used by the TSA has been proven to be unreliable, with a 25% failure rate, is extremely overpriced costing approximately $400 per wand and ergonomically inconvenient to use. The goal of the Explosive Wand Clinic is to design and fabricate a wand that would compete with the existing devices in the market. The prototype must hold a swab that is able to collect the explosive particles as well as include a trigger design to mechanically hold the swab in place. The electronics of the detection wand includes a pressure activated sensor which alerts the user that optimal pressure is being applied, a mini LED flashlight, and a rechargeable lithium-ion battery. The swab can be tested in ion spectrometer based chemical analyzers. The team utilized Solid Works to optimize the design through several iterations and then fabricated each iteration using PLA 3D printing. The final prototype will be tested at airports and the research labs.

Female engineering undergrad challenges

TEAM MEMBERS
Alissa Papernik, Amanda Dias-Liebold
PROJECT MANAGER
Dr. Anu Osta and Dr. Jennifer Kadlowec
SPONSOR
Engineering Information Foundation



While women make up 56.8% of the total U.S. workforce, only 8.5% of the country's engineers are women and women continue to be underrepresented in university engineering programs. However, studies have shown that diversity within an organization or team, including gender diversity, is necessary as it is associated with improved productivity, creativity, and organizational profitability. This highlights the crucial need to increase women's representation and improve gender balance in engineering. The purpose of this research study is to determine factors that influence recruitment and retention in undergraduate engineering. An IRB approved protocol and survey have been developed to collect data on a variety of experience to determine effects on recruitment and retention in engineering. The survey questions involve family support, attitudes about engineering, engineering support resources, classroom experiences, mentorship, and engineering activity involvement. Interview questions will be asked, allowing the research team to further probe reasons for recruitment and retention through conversation and key phrases and ideas described by participants. Data results will be used to correlate factors, which influence recruitment and retention and find solutions on how to mitigate factors that may hinder female recruitment and retention.

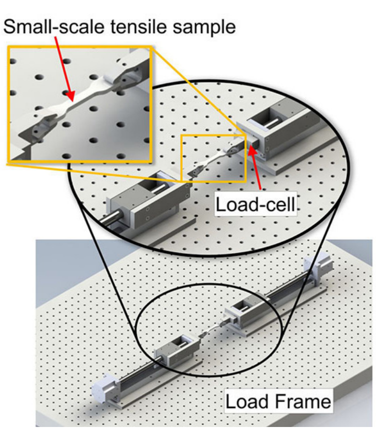
Formula Electric SAE Design Competition

TEAM MEMBERS
Jason Fisch, Andrew Galloway, Julie Keelan, John Sparks, Merve Sadak, Matthew Rinderer, Hunter Cundiff, Aaron Genova, Joseph Christopher, Eric Wolan, Jacob Molinaro, Matthew Fucci, Michael Adams, Brian Foley, James Porskievies, Corey Orlovsky, Victoria Falkenstein, Thomas Fritz, Brian Chesko, Vincent Borgia, Tyler Lee Ziegenbein, Alexander Hess, Matthew Shulman, Maurice Finnerty
PROJECT MANAGER
Melanie Amadoro
SPONSOR
Institute of Electrical and Electronics Engineers (IEEE), SAE International

The Formula Electric Competition is an interdisciplinary design and engineering challenge for undergraduate and graduate university students. This project was founded in the fall of 2018 at Rowan University and will take approximately 2 years to complete the first car! The team consists of 2 faculty advisors and more than 30 engineering students from multiple majors including, Mechanical Engineering, Electric & Computer Engineering, and Chemical Engineering. To make this project run smoothly, the Formula Electric SAE design team was split up into 2 clinic projects, one for the Mechanical Engineering tasks, and the other for the Electrical and Computer Engineering domain. The car has been funded from a multitude of sponsors including internal sponsors like Rowan University College of Engineering, and the Rowan University Student Government, and has received support from companies like Pep Boys, TE Connectivity, Stanley Black & Decker, Microchip, OZ Racing, Emrax, UniTek, Lamatek, Wilwood, VR3 Engineering, Solidworks, Optimum G, KHK-USA, and Metlab. Not only is the team of students building and testing the vehicle, but they have been given free reign to innovate and design new systems.

Load frame for micromechanics testing

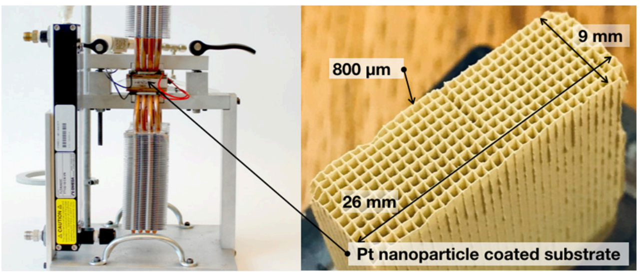
TEAM MEMBERS
Brandon Criss, Nicholas Pagliocca, Benjamin Taylor
PROJECT MANAGER
Dr. Behrad Koohbor



Macroscopic load-bearing and failure characteristics of engineering materials are controlled by their microscale deformation mechanisms. Certain test instruments facilitate the characterization of deformation at small scales. A small-scale load frame is one of the most widely used equipment for this purpose. This test equipment can be coupled with high magnification optical and/or electron microscopes to allow for in-situ characterization of materials under different loading conditions. The main objectives of this clinics project are: (1) Develop an understanding of the fundamental concepts of mechanical testing, and (2) Design and fabricate a small-scale table-top load frame with measurement capabilities comparable to the available commercial units.

Microcombustion-Powered Thermoelectric Generator

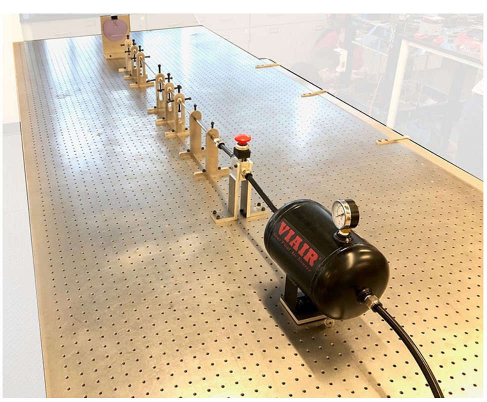
TEAM MEMBERS
Jack Camins, Nathan Damian,
Matthew Klinger, Duncan Stevenson
PROJECT MANAGER
Dr. Smitesh Bakrania



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 function at thermoelectric operation temperatures. Existing micro-reactor designs have shown high efficiencies, but have yet to demonstrate truly portable and functional devices 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 micron wide square channels act as a catalyst bed. The heat generated by the reactor is converted to electrical power using two thermoelectric modules in series. The recent work focusses on managing the temperature distribution within the substrate and across the device for improved device performance. Several avenues were explored this year including a phase-change material to maintain the cold junction at a constant low temperature. The combination of exhaust recirculation, preheating, and catalyst distribution resulted in a greater temperature gradient across the TEG modules. The combined efforts have yielded marked improvements in device performance that will be guide future efforts.

Miniature Hopkinson bar for impact tests

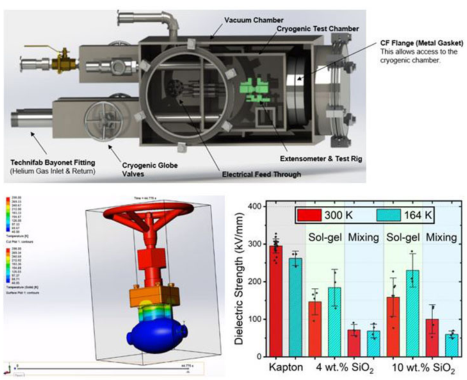
TEAM MEMBERS
Ridwan Alaoudi, Harveer Bains,
Patrick Frangie, Matthew Gartland
PROJECT MANAGER
Dr. Behrad Koohbor



Engineering materials are often subjected to impact or high strain rate loading conditions. Therefore, dynamic stress-strain data are required for the reliable design of materials and structures that experience high strain rate deformations. Split-Hopkinson bars (a.k.a Kolsky bars) are widely used to determine material constants, e.g. Young's modulus, ultimate stress/strain, etc. in the strain rate range of 100-10,000 (1/s). The main goal of this clinic project has been to design and develop a table-top Hopkinson bar unit that can be used for dynamic material testing of small-scale samples. The main project goals are: (1) familiarize the students with fundamental concepts of dynamic materials testing and wave propagation in solids, (2) design and fabricate a miniature table-top Hopkinson bar apparatus, and (3) Perform controlled dynamic tests on small-scale soft materials (polymers, foams, tissues, etc.) and extract dynamic stress-strain curves.

Polymer Composite for Navy Applications

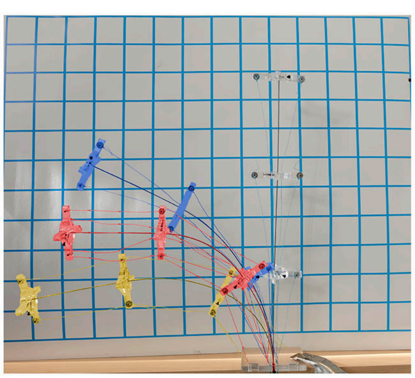
TEAM MEMBERS
Matthew Chin, Mark Hausman, Bradley Smith, Jacob Mahon, Aleksandr Velez, Matthew Barrasso, Jesse Brinskelle, Richard Chao, Tanner Coles, Madison Buck, Jonathan Yi, Thomas Bielicki, Matt Schillaci, William Emmerling, Andrei Creanga
PROJECT MANAGER
Dr. Wei Xue and Dr. Robert Krchnavek
SPONSOR
U.S. Department of Defense - Naval Surface Warfare Center, Naval Engineering Education Consortium



The primary objective of this clinic is to study the potential of nanocomposite materials as dielectrics in high-temperature superconducting (HTS) cables for the United States Navy. The material team aims to investigate polymer-silica nanocomposites as cryogenic dielectrics. The design team aims to design and build a cryogenic testing chamber that would allow material testing down to 40 K. The two teams are working together to provide detailed measurements of new nanocomposites. Using polyimide (PI) as the host polymer, the behaviors of PI/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.

Soft Robotic Manipulator

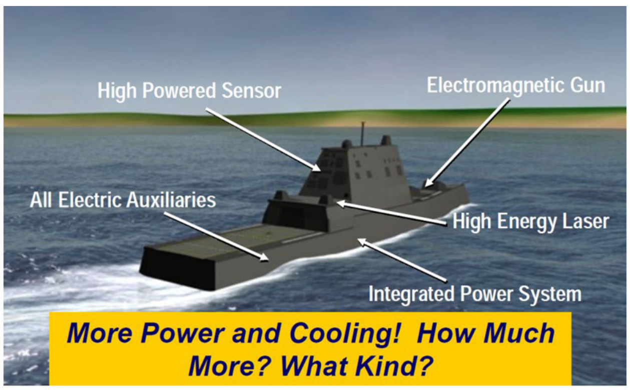
TEAM MEMBERS
Tim Broderick, Owen Cesarano, Robert Kallok, Kevin Meglathery, Zachary Wagner, Benjamin Wechter
PROJECT MANAGER
Dr. Mitja Trkov



Soft robotic technology generally relies upon one of the two primary methods of actuation: pneumatic/hydraulic actuation, and cable-driven actuation through the use of internally routed cables. Cable-driven robots have an advantage in the fact they are easily scalable and rely upon relatively uncomplicated subsystems. However, precise control of the individual segments of the manipulator requires complex internal cable configuration and precise control. Our clinic project focused on the design and testing of novel actuation methods for a continuous soft robot. Our design consists of a flexible backbone with vertebrae spaced evenly along its length. The vertebrae are cable actuated at different points to deform the structure. Our proposed novel cable routing was compared of two existing configurations for total manipulator deflection and the ability to isolate deflection to actuated segments. Additionally, a mathematical model was developed to analyze the manipulators. It was found that our cable configuration could achieve the highest deflection in a single segment, the second highest overall deflection under an applied load, and the greatest degree of isolated deflection.

Thermal Management on Naval Platforms

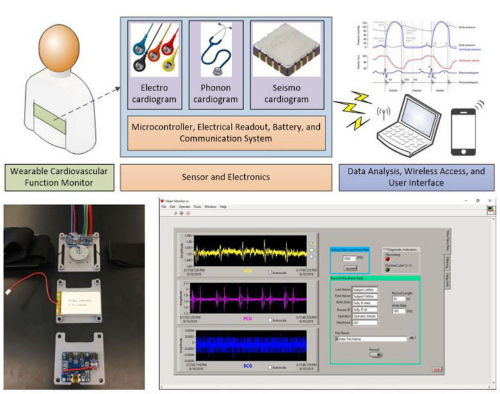
TEAM MEMBERS
Josh Nastarowicz, Cody Prichard
PROJECT MANAGER
Dr. Wei Xue and Dr. Jacob Kephart (Navy)
SPONSOR
U.S. Department of Defense - Naval Surface Warfare Center



This project is focused on developing a notional shipboard thermal management system model and exercising the model with dynamic and transient thermal loads. Advances in solid-state electronics has enabled efficient and compact power conversion that will result high power devices, systems, and power distribution architectures to bring greater flexibility and capability to the fleet. Future platform loads will increase in dynamic and transient nature and will place unprecedented demands on the shipboard thermal management system. Our approach utilizes MATLAB Simscape to generate multi-domain models of a notional shipboard thermal management system. The thermal management system will ultimately couples the source the thermal load (electrical / mechanical device, personnel, or HVAC load) to the ultimate heat sink, seawater. The interconnected network may be tortious with multiple stages of heat transfer such as device to air, to fan coil unit, to chilled water system, to chiller to seawater.

Wearable Heart Health Monitor

TEAM MEMBERS
David Gaffney
PROJECT MANAGER
Dr. Wei Xue and Dr. Francis (Mac) Haas



Cardiovascular diseases are the leading cause of death in the US. The current medical practice is not suitable for long-term, out-of-hospital use. This project aims to investigate a wearable heart monitor, which will provide sensing and learning abilities for detecting abnormal cardiac rhythms in real time. The team has focused on the following tasks: improve the current wearable heart monitor design; integrate three sensors, used for electrocardiogram (ECG), phonocardiogram (PCG), and seismocardiogram (SCG) measurements, with electronics and wireless communication into a wearable system; analyze the sensor data and correlate the signals to cardiovascular activities; develop algorithms that can perform time series analysis of correlated, complex electrical and mechanical physiological events; use publicly available MIT-BIH Arrhythmia Database before our dataset becomes available.

External Sponsor Index

External Sponsor Index (continued)