Senior Design

DEMONSTRATION DAY 2021

UCONN | SCHOOL OF ENGINEERING

seniordesign.uconn.edu

Economic Impact Starts Here

The capstone Senior Design Project Program is a hallmark of success for engineering seniors. In this one or two-semester course, senior students are mentored by faculty and industry engineers as they work to solve real-world engineering problems for company sponsors. Students learn about the principles of design, how ethics affect engineering decisions, how professionals communicate ideas and the day-to-day implications of intellectual property.

Each year, dozens of leading manufacturing companies, pharmaceutical and medical firms, consulting practices and utilities present the School of Engineering with design challenges or problems they are encountering in their business. For a modest fee, the companies suggest a particular problem and assign a technical representative from their company who will help guide and mentor the senior engineering students as they work to properly frame the problem and develop meaningful solutions.

The students research and analyze the problem, conceptualize alternate solutions, design and refine one device or method, construct a working prototype, and provide the sponsoring company with regular reports plus a working prototype. This true design experience allows the students to apply the technical skills they have acquired during their undergraduate years, and to stretch their abilities in analysis-based innovation and decision making.

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Address a Challenge or Explore a New Idea
Sponsoring a Senior Design project allows sponsors to address a problem without the large investment.

Strategic Recruiting
Sponsors have nine months to collaborate with, cultivate and evaluate undergraduate students as prospective employees.

Access to UConn's Unique Resources
Senior Design Projects also give you access to UConn faculty, who have expertise and state-of-the-art laboratories and equipment.

Visibility
As student teams and faculty gain exposure to your organization's resources, products/processes and culture, they will spread awareness of your organization.

Value
Business and organizations have meaningful access to talented engineering students who provide high-level insight and innovative technological solutions, for a small financial investment.

Greetings and Welcome to Our Senior Design Demonstration Day!

Senior Design is the final experience of our students' undergraduate career, a year-long process that provides a hands-on application of the principles and theories they have spent the previous three years honing. Students learn and apply the principles of design; the complex interplay among engineering solutions and societal, environmental, economic and ethical considerations; the language of industry; and the power of engineering to catalyze new solutions to entrenched problems such as sustainable energy, access to clean water, agriculture, transportation and health.

Each and every year, 75-plus organizations, large and small, partner with the UConn School of Engineering to not only fund projects, but also donate valuable mentorship time, as well as solidify the unique information-sharing pipeline that the School and University has with the engineering community. With the generous support of all of our sponsors, seniors get direct access to talented engineers in the industry, as well as valuable hands-on experience in a group setting. Additionally, by solving real-world problems, and creating innovative solutions for companies, the School of Engineering, and its students, drive significant economic impact towards the sponsoring companies and the state of Connecticut as a whole.

These students will be graduating shortly. They will soon embark on the next portion of their engineering journey, whether that be graduate school or the beginning of their careers. They are the future of our discipline, and I am both proud of the role UConn has played in their development and humbled at the thought of what they can achieve.

Cordially,

Kazem Kazerounian
Dean, UConn School of Engineering

BIOMEDICAL ENGINEERING

TEAM 1

Mikayla Garcia
Patrick Hocking
Fawaz Mohsin

ADVISORS

Patrick Kumavor

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TEAM 2

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Samuel Dailey
Jessica Tang

ADVISORS

Patrick Kumavor

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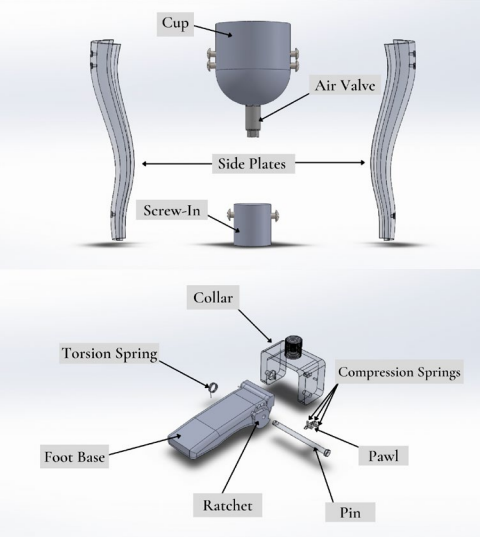
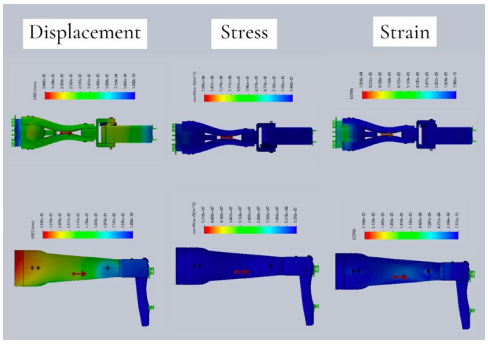
UCONN HEALTH

Prosthetic Leg for Dancers

Prosthetics have come a long way since their largely cosmetic beginnings. Now, they are able to give independence back to amputees by performing basic skills required for activities of daily living. However, prosthetics for specialized functions are rare, especially for something as intricate as dance. The current state of the art dance leg prosthetic lacks the adequate mechanisms to allow a performer to change her stance. The products which can change the angle of the ankle are expensive and their complexity creates the possibility for more things to break. The goal of our project is to create a simple lightweight below the knee prosthetic leg for dancers with the capability to change foot stance. Our design works to combine art and science to develop a low cost, high function lower limb prosthesis to put amputee dancers back on stage.





BIOMEDICAL ENGINEERING

TEAM 4

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Teagan Driscoll

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Patrick Kumavor

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defibtech

Mechanical Human Thorax Model for Automatic and CPR Device Testing

Cardiopulmonary resuscitation (CPR) is an emergency lifesaving procedure that is performed on patients whose hearts have stopped beating until medical personnel arrives on the scene. If the quality of CPR is poor, the patient may not survive cardiac arrest. These subpar skills could be caused by a variety of reasons; most commonly either inadequate execution of the procedure or rescuer fatigue. A mechanical CPR device can eliminate and avoid these problems and can be applied to sudden cardiac arrest (SCA). In order to test the CPR device for success and train individuals on CPR, a prototype that simulates a human thorax and chest is necessary. To make this possible, a mechanical human thorax model that easily allows for benchtop testing of automatic and mechanical cardiopulmonary resuscitation (CPR) devices that treat cardiac arrest for Defibtech, LLC must be constructed. It is known that the human thorax has both elastic and viscous features, so the design model should replicate both features with a high degree of accuracy and efficiency. To improve market success and the overall user quality, the new design added pneumatic dampers to the springs that create the element of nonlinearity. It also included mechanical, electrical, and software components. The mechanical component focused on recreating the mechanical characteristics of the chest. The electrical component included sensors to collect data on the forces acting on the chest model and its displacement from the rest position during CPR. And the software component entailed programming a microcontroller for use as a feedback system to automatically control the damping coefficient of the pneumatic piston so as to obtain the desired hysteresis. Sensors were also integrated into the system to collect force and displacement data. This provided feedback on the chest compressions and information for a feedback system that could change the damping coefficient in real-time.

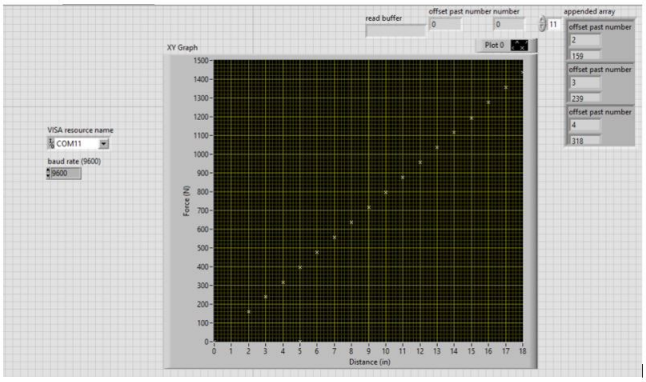
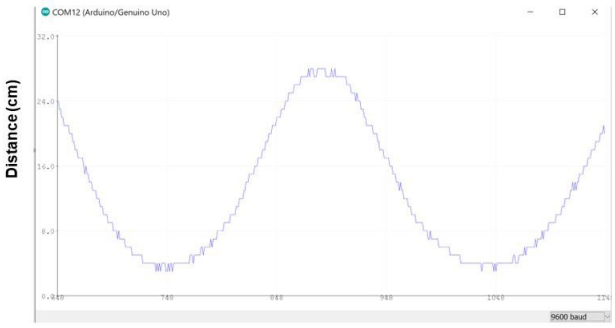


Figure 2: Sample Front panel of linear data collected from ultrasonic sensor



Time (ms)

Figure 1: Ultrasonic sensor reading with up and down motion

BIOMEDICAL ENGINEERING

TEAM 6

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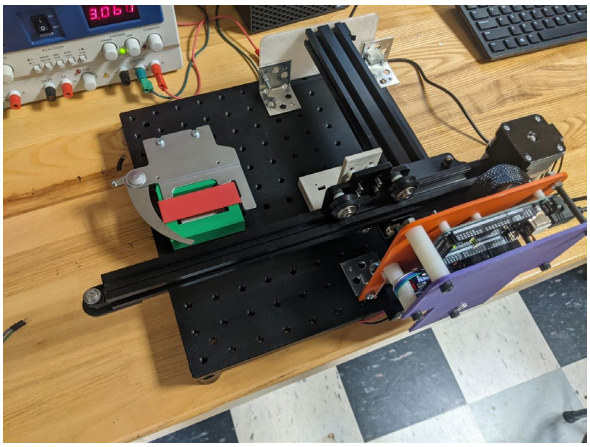
UCONN HEALTH

Develop a Scanning Platform for Digital Pathology

The development of a digital pathology scanning platform based on the original problem statement needs to be enhanced, as additional features and methods will be required to create a final product. The first area of improvement necessary is the use of lensless camera technology. Instead of using a traditional microscope with multiple objective lenses, a lensless camera will be used to streamline the overall design. This will simplify the technology needed for imaging, as the camera will be able to capture the slide with any desired level of precision along with an increased level of detail. Another revision to the original description is the inclusion of image processing to rapidly identify tissues and any abnormalities. Using the processed images will allow for better clinical application, as doctors can rapidly distinguish any issues in a slide sample. Additionally, the platform will be constructed from an inexpensive CNC or similar machine that allows for automated movement of a slide in an x or y direction on a small platform. Lastly, a mobile app could be developed to accompany the platform and imaging system to create a seamless transition from viewing the slides to the digital reproduction. Overall, a more cost effective digital pathology scanning platform will be designed and created from an affordable CNC or related machine that includes on-board lensless imaging, imaging processing and analysis, and a possible easy-to-use mobile application.



BIOMEDICAL ENGINEERING

TEAM 7

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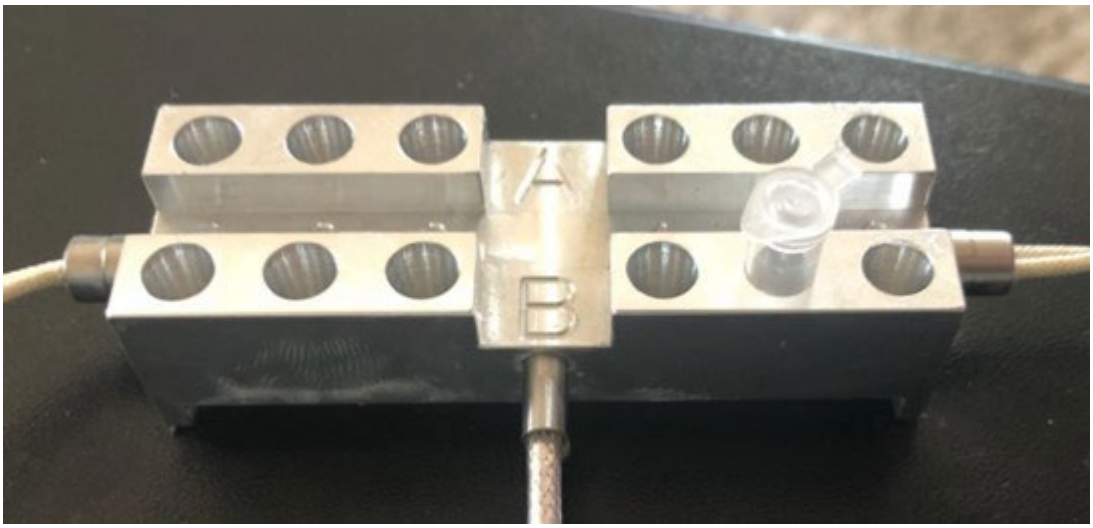
Inexpensive LAMP Reaction Device

The goal of this project was to develop a low cost alternative to traditional PCR machines, which cost several thousand dollars on the market. The PCR process as a means to amplify target DNA or RNA sequences is vital to disease testing (such as COVID-19) and in school settings when studying biological sciences. By providing a low cost and portable alternative to standard PCR machines, this project has the potential to increase access to disease testing in developing nations and can be used in underfunded school environments.

This project utilizes Loop-Mediated Isothermal Amplification, which unlike traditional PCR only utilizes one temperature and can run reactions in thirty minutes. Using colorimetric reagents, allows for a user to see their test results without any extra equipment. This is extremely critical in diseases testing, when getting results to a patient without needing a lab-technician provides greater access in developing nations. Each LAMP unit costs just under $250, and a each rapid COVID-19 test costs $7.86. These low price points help to increase access to consumer home testing, as well as public health departments to disperse testing materials. The device can run 12 tests every 30 minutes and does not require any advanced knowledge to operate. This project has helped to remove the monetary barrier of research, testing, and education in DNA and RNA amplification.



BIOMEDICAL ENGINEERING

TEAM 8

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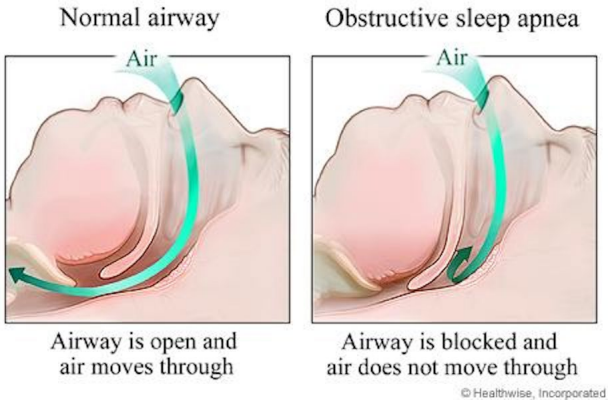
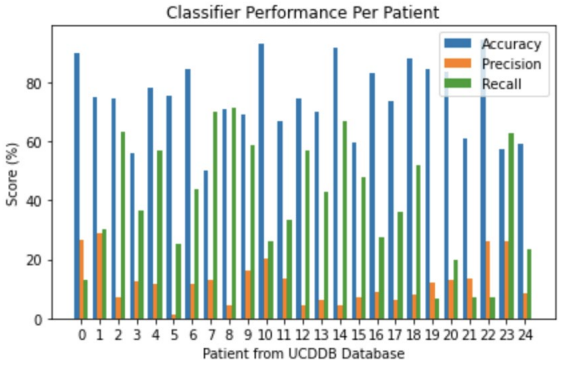
EEG-based Sleep Apnea Detection

Obstructive sleep apnea is a sleep disrupting condition impacting up to 7% of adult men and 5% of adult women which is linked to the exacerbation of several severe health conditions including cardiovascular disease, Alzheimer's disease, and stroke. Current detection methods, most importantly overnight polysomnography, are invasive and time demanding of sleep specialists. This leads to long waiting lists for screenings and decreased rates of diagnosis. The purpose of this study is to design a minimally invasive method for the automatic detection of obstructive sleep apnea using a computational machine learning pipeline which uses features computed from EEG data obtained from overnight PSG studies available on Physionet. This computational method will enable at-home diagnosis and reduce the labor and equipment involved in moderate to severe OSA diagnosis. The energies of EEG frequency bands and interband energy ratios are promising features to use in a classifier for the detection of OSA. Application of Random Forest Classifier provides a satisfactory accuracy of 75% but poorer than expected precision and recall. The classifier results show a tendency of the algorithm to detect most windows as non-apnea meaning the true-positive rate for detecting an actual apnea event is lower than expected. Future refinements aim to improve precision and provide better detection of apnea events to give patients better awareness of their sleep patterns and recommend treatment as needed.





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TEAM 9

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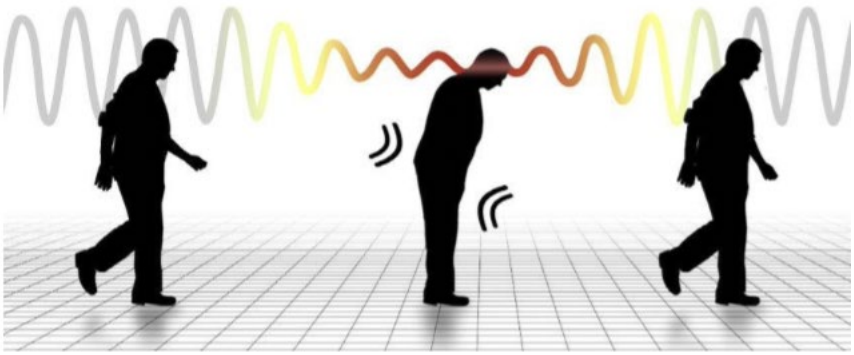
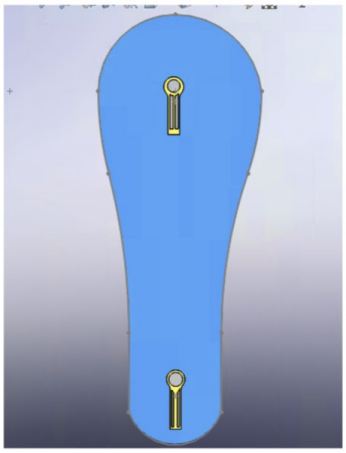
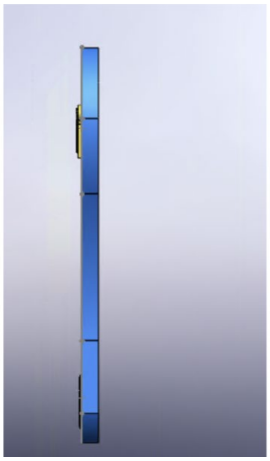
NSEC Lab
Neural Systems Engineering and Control Laboratory

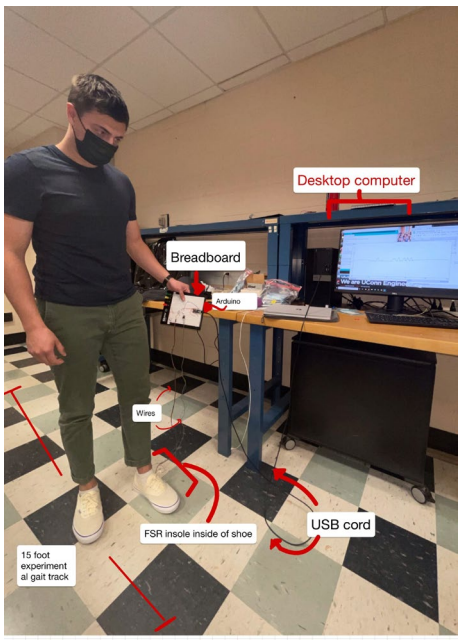
Smart Insole for Freezing of Gait Suppression



The objective of this project is to design, prototype, and test a smart insole to detect FOG and provide relief for patients affected by Parkinson's disease, as well as to analyze the walking cycle to detect and suppress the Freezing of Gait (FOG) episodes before impacting a patient's quality of life. The insole is composed of PLA base with a top layer of EVA material. Two FlexiForce A201 force-sensitive resistors sensors (FSRs) are positioned underneath the insole, specifically in the forefoot and heel areas. The computational unit, which analyzes the gate in realt time and detects FOG, is secured to the ankle with a velcro adjustable elastic strap. Upon detection of FOG, the unit will activate an audio cue to aid the patient overcoming freezing. This design improves upon state of the art alternatives seeing as it is discrete, light-weight, and uses event-triggered sound cues for the most efficient correction of FOG symptoms. Lastly, the additional EVA layer serves to shock absorb any harsh force thus providing patients with maximum comfort.







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TEAM 10

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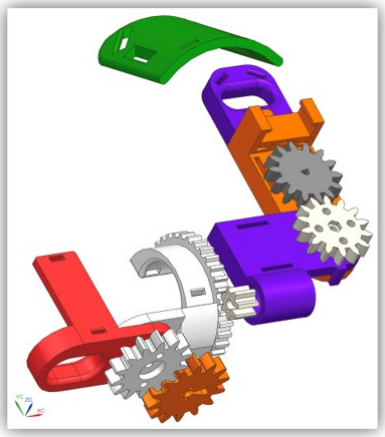
Arm Exoskeleton for Restoring Wrist and Elbow Control for Patients with Stroke

Every year, more than 795,000 people have a stroke, which may result in paralysis or weakness in about 80% or patients. The purpose of this project is to create a wearable exoskeleton for the upper extremities of an individual who is suffering paralysis or loss of movement due to a stroke. The team has created a complete orthotic casket for the actuation of the forearm, wrist, and elbow through the process of additive manufacturing. This was accomplished by 3-D printing, and mechanically testing a wearable orthotic, including motors, that can flex the forearm, wrist, and elbow of a patient recovering from a stroke. The device includes an exoskeleton combined with actuators to control the flexion and extension of the wrist and elbow, along with the supination and pronation of the arm. These combined movements provide for 4 total degrees of freedom. The design also includes an optimized wearable holder to carry the batteries and microcontroller. The device is designed to allow the adjustment of the torques with minimal intervention by having interchangeable gears with varying gear ratios. The benefit of this is it allows for the customization of the orthotic for different types of patients with different needs, and it is amenable to combine and integrate adaptive control strategies in the future.



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TEAM 11

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ADVISORS

Bin Feng

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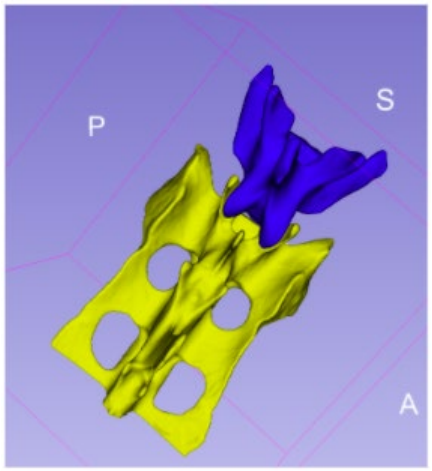
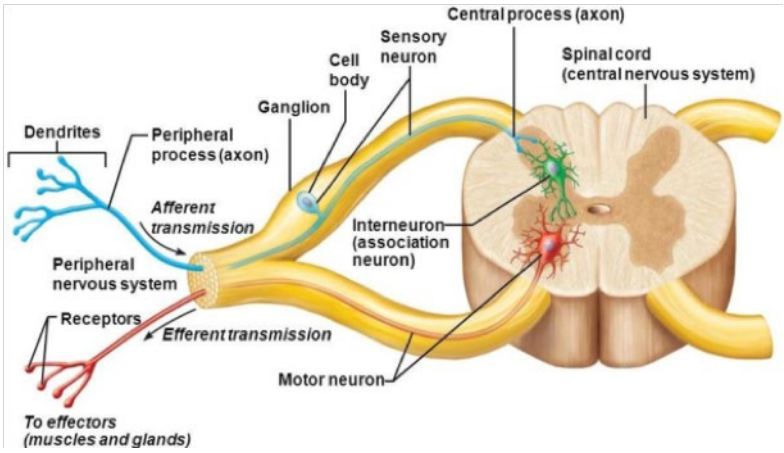
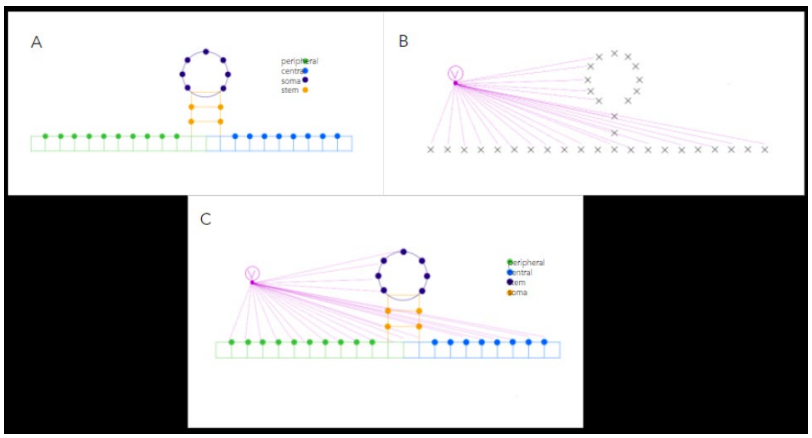
3D Reconstruction of Sensory Neurons and Their Axons in the Dorsal Root Ganglion

Chronic pain is a debilitating condition that often relies on prescribing powerful opioids for treatment. These pain signals travel through a group of sensory nerves in the Dorsal Root Ganglion (DRG) located adjacent to the spinal cord. While electrical stimulation of the spinal cord has been proposed as an alternative treatment for chronic pain, the DRG is a recent and more promising target for chronic pain management since it can reach a wider range and is more effective in decreasing pain. Our project was an investigation of these sensory nerves responsible for the transmission of pain signals in the DRG, with the goal of improving current approaches to DRG stimulation. Our group took three different approaches towards this goal that included optical clearing and confocal imaging of harvest murine DRG, 3D modeling of DRG-housing vertebral sections for finite element analysis, and computational modeling of the sensory nerves' response to stimulation. The combination of these three processes will eventually allow for the construction of a morphologically-accurate 3D computational model of these nerves that can be used to investigate novel approaches for pain management.







BIOMEDICAL ENGINEERING

TEAM 12

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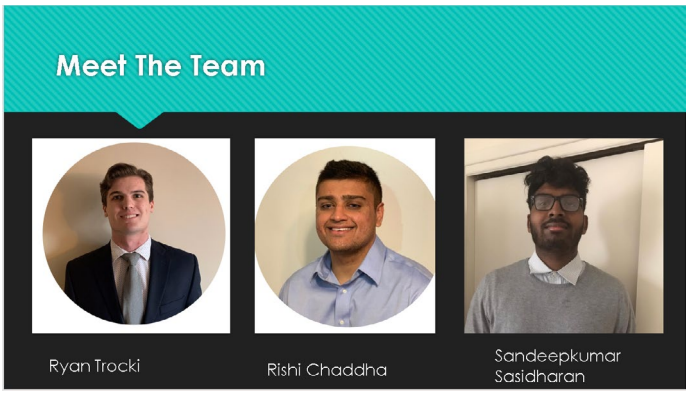
UCONN HEALTH

An Alternative Method of Designing Accurate Pulse Oximeters for Covid-19 Patients

The purpose of this study is to observe pulse oximeters of different price ranges and to test the accuracy between commercial oximeters and FDA-approved ones; to provide an adequate recommendation for the patient. From this information, it can influence a potential design that can be used to make a pulse oximeter that is cheaper and that is able to record information for the duration of the incubation period of COVID-19. Most pulse oximeters in the market had inaccuracies greater than the manufacturer claim (>4%). To overcome the accuracy of most pulse oximeters we plan on using a hospital-grade device as the standard for testing. We will feel comfortable giving a recommendation to a commercialized product that falls within or below 2-3% accuracy of the actual reading and if the commercial product is just as comparable to that of a hospital-grade device. This recommendation should allow for infected patients or potentially infected patients with a way to monitor the progression of the disease and identify potential severe episodes before they can occur. Allowing patients, the ability to seek proper medical care early.



Average Percent Differences Amongst at Home Pulse Oximeters

	Wellue/ Clinical guard	Wellue/ Baseline	Wellue/ Walmart	Clinical Guard/ Baseline	Clinical Guard/ Walmart	Baseline/ Walmart
Average % Difference	0.666975946	0.646973201	1.088212234	0.566766584	0.993977081	1.015932826
Standard Deviation	0.610687991	0.725899627	1.319806854	0.611794571	1.167825669	1.219828861

	Wellue % Error	Clinical Guard % Error	Baseline % Error	Walmart Fingertip Pulse Oximeter % Error
Average % Error	0.630668736	1.03508634	0.934270279	1.232236061
Standard Deviation	0.726478443	0.774049274	0.83589646	1.240028569

BIOMEDICAL ENGINEERING

TEAM 13

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Austin Mott

ADVISORS

Yazeed Maghaydah

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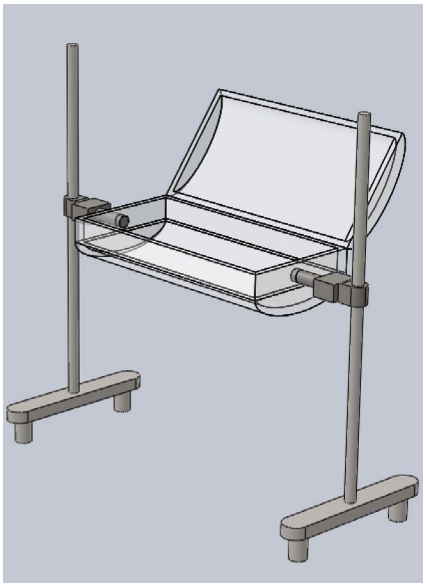
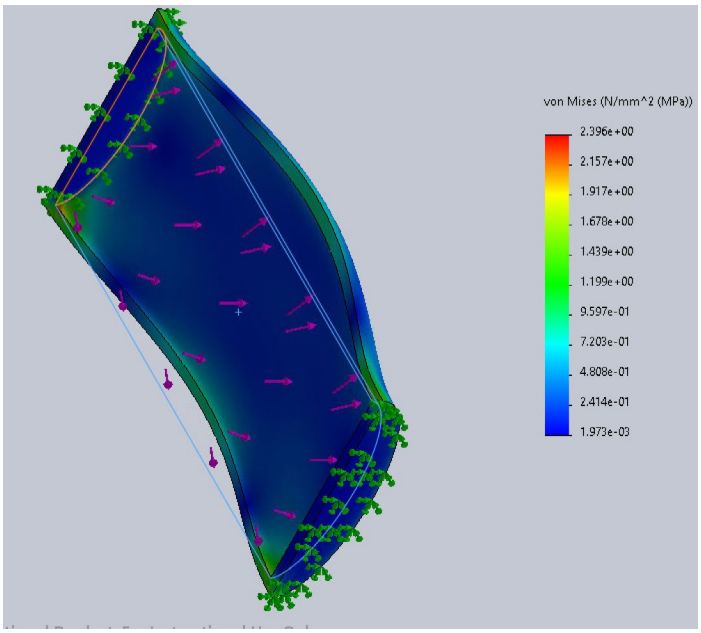
UCONN HEALTH

Clinical Prone Positioning Bed to Help ARDS and COVID-19 Afflicted Patients

We are busy working on a solution that can drastically increase the number of recoveries as well as the rate of recovery with the method of pronation. Our solution can pronate patients at a quicker rate, without it being at the cost to the safety, health, and transmission to staff.





BIOMEDICAL ENGINEERING

TEAM 14

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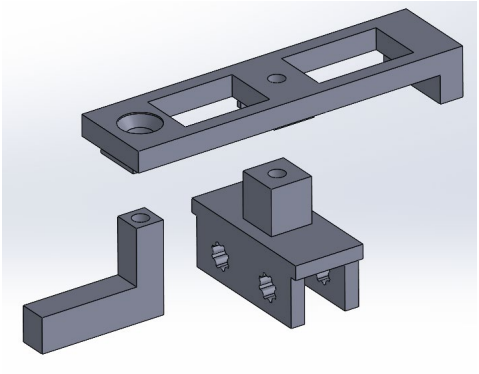
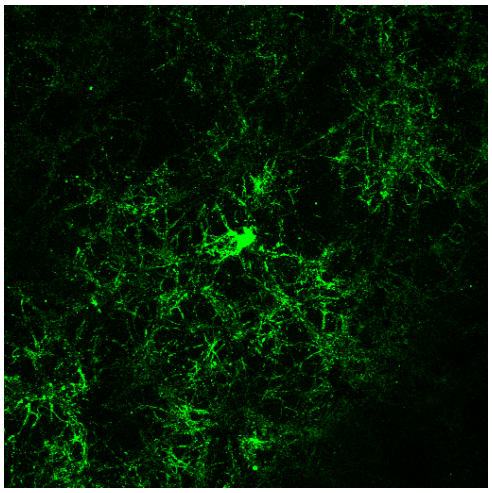
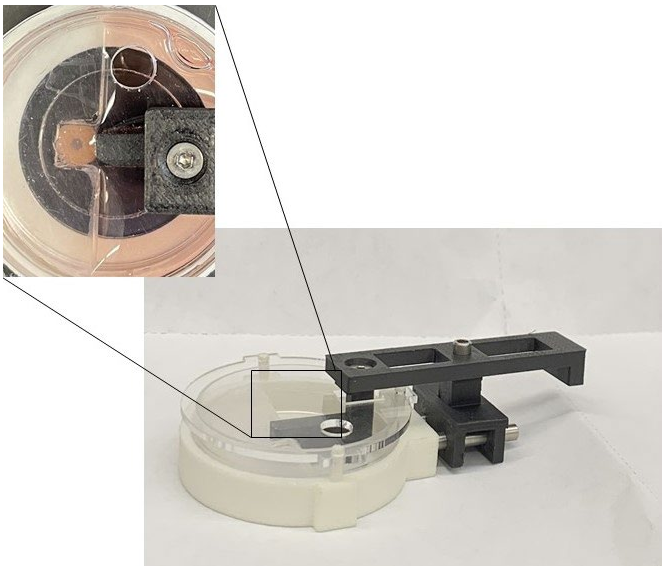
In Vitro Model for Traumatic Brain Injury

This project aimed to continue developments an in vitro model for traumatic brain injury (TBI). Specifically, the group changed designs to the hammer and hammer components, designed a new release mechanism to allow for repeatable and consistent impact forces, and made progress on developing an ANSYS model to provide for a deeper understanding of the mechanics of impact. Additionally, the group researched and utilized a new cell dye for imaging the neural cells and tested the use of dissociated cells. Changes to the design of the apparatus were tested and verified using dry runs conducted with a sponge and wet runs conducted with neural tissue cultured in a scaffold. The different tests allowed for imaging of the impact through camera images and calculation of the force using force measurements. The new cell dye was verified by using hydrogen peroxide to induce apoptosis in 2-D cell cultures before testing with the 3-D. From the data collected, it was shown that the improvements made in this project were valid and made progress towards developing a more realistic in vitro testing device, though there is more work that must be completed in order to fully optimize the model.





The requirement for this design is to develop an in vitro model to simulate traumatic brain injuries. The model should allow for further study of the effect of TBI on neurons in hopes of developing better preventative methods and treatments for TBIs. Improvement to the current model will include a more repeatable application of force on the cells, that is in the range similar to TBIs. The model should also be modified to allow for improved cell growth. Additionally, cell culture and imaging techniques will be refined allowing verification of axon network formation prior to the TBI and quantification of damage to cells post TBI.



BIOMEDICAL ENGINEERING

TEAM 15

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ADVISORS

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Mechanical Characterization of 3D Microtissues

The mechanical properties of a tissue are important biomarkers of its health, but the size of the microtissues limit their ability to be mechanically characterized using current testing methods. So, our goal is to prepare and test 3D microtissues (0.1-2 mm) for high-throughput biomechanical analysis (well-plate and petri dish compatible). We approached this with a two-part design.

The first part of the design entails the staging of the sample. This is done by creating different PDMS stamps. Each stamp is designed for a specific sample in mind, and then the stamp is used to stamp agarose treated well plates. Proper manipulations and mechanical testing requires the sample to be stable and remain in a consistent location, for more accurate measurements.

The second part of the design was optimization of cantilever beams for different samples, based on stiffness. By changing the thickness, width and length, the stiffness of the beam was altered to the respective stiffness of the sample being tested, which results in more effective and accurate mechanical characterization.

This design will be applicable to many different microtissue samples, but our focus is on the successful staging, and testing of tumor spheroids, tumor organoids, as well as embryonic tissues.

BIOMEDICAL ENGINEERING

TEAM 16

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Morgan Neydorff
Will Pawshuk

ADVISORS

Kazunori Hoshino

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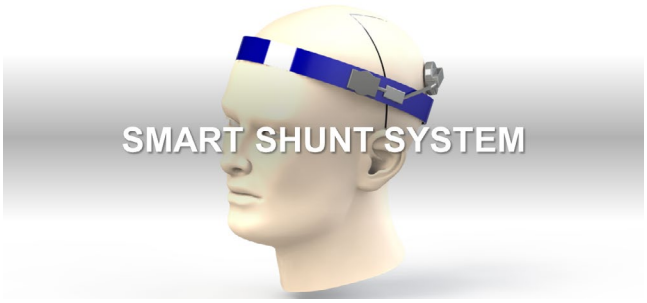
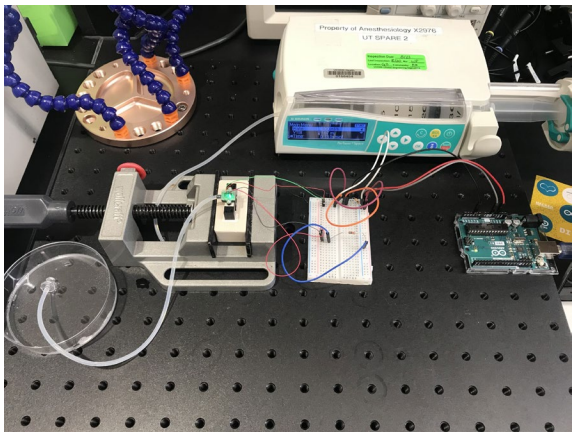
BIOMEDICAL ENGINEERING

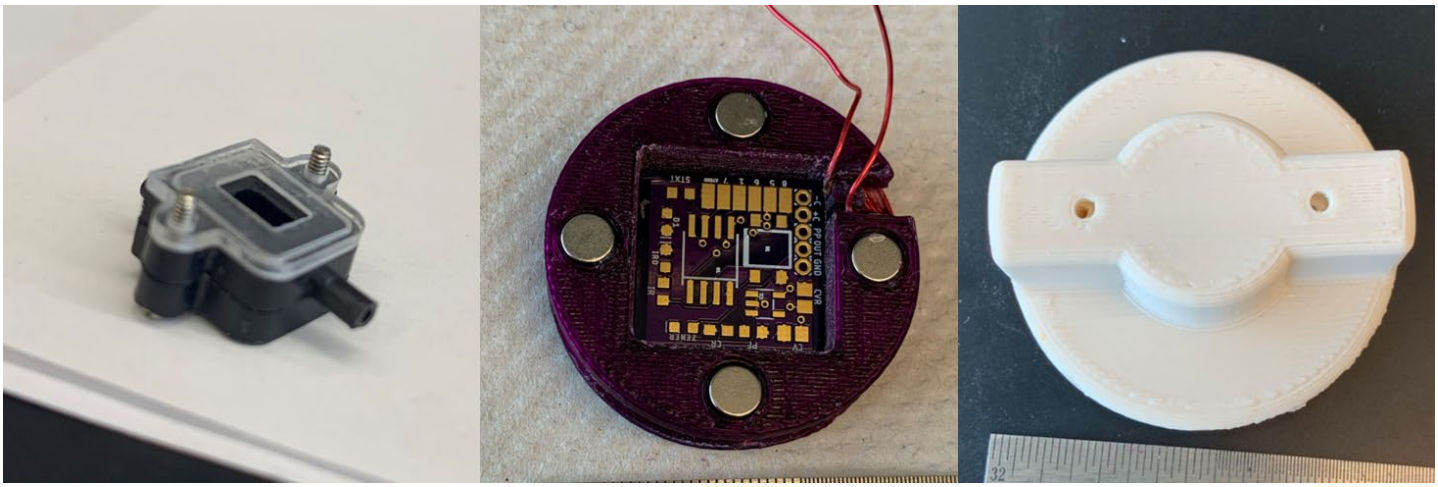
Design of Smart Shunt System

Hydrocephalus is a neurological condition where cerebrospinal fluid (CSF) accumulates in the ventricles of the brain which can lead to death if left untreated. Typically, hydrocephalus is treated using a ventriculoperitoneal (VP) shunt, which drains excess fluid from the ventricles to the peritoneal cavity where the fluid can be properly absorbed. VP shunts are currently monitored for malfunctions using invasive, in-comprehensive, and expensive screening methods; however, only 50% of individuals screened have a shunt malfunction. Thus, a new method is needed to quickly and accurately monitor shunt functionality to prevent individuals from undergoing unnecessary screenings.



In this project, a novel smart shunt system was developed to measure the flow rate of CSF to monitor shunt functionality. The design utilizes a reflective polydimethylsiloxane (PDMS) cantilever beam coupled with an optical detection system. Using infrared communication, the flow rate measurement is wirelessly transmitted through the skin to an external receiver. The external receiver can be connected to a bluetooth device to relay sensor readings to both the patient and physician. The results recorded from lab testing demonstrate that an implantable flow sensor is feasible for monitoring ventriculoperitoneal shunts. This implantable flow sensor can serve as a practical, quick, and less expensive method to monitor VP shunt malfunctions.





BIOMEDICAL ENGINEERING

TEAM 17

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Abigail Phillips

ADVISORS

Krystyna Gielo-Perczak

SPONSOR

HOLOGIC®
The Science of Sure

Project Management of Stress of Patients under Compression of Hologic Paddle Designs for 3Dimensions™ Mammography System

Breast cancer is a disease that affects approximately 1 in 8 women in their lifetime (13%). Additionally, 1 in 39 women will die from breast cancer. Unfortunately, at the time when a tumor is small and easily treated, breast cancer does not have any obvious symptoms. This is why regular screening is important in order for early detection and treatment. The best way to detect breast cancer in its early stages is through a procedure called a mammogram. However, it was found that 88% of women experienced pain during their mammograms, and this experienced pain stops women from attending mammograms in the future.

The goal of this project is to determine ways to examine and quantify the psychological stress felt by women during mammograms. This will minimize the discomfort and anxiety felt by women during the procedure, encouraging them to obtain regular mammograms. A detailed survey will be administered during the study in addition to electrocardiogram (ECG) measurements, electrodermal activity (EDA)/galvanic skin response.

Originally, this study was intended to provide Hologic with comparative data between their Hologic SmartCurve paddle and the conventional paddle. Not only would this data demonstrate the differences between the two paddles, but it would also provide feedback on other aspects of the procedure that can be further investigated and developed to decrease the patients' stress. Depending on the results of the study, these statistics would be used to promote their product and warrant the replacement of the conventional paddles with their own SmartCurve paddles. As one of the largest producers of mammogram machines, this company has a lot of influence in the mammography field. However, due to timeline restrictions created by IRB approval and other various difficulties, Hologic's SmartCurve paddle was not actually used to compress the breast. Instead, data collected during a quiet standing position was compared to data collected during a position mimicking a mammogram.

BIOMEDICAL ENGINEERING

TEAM 18

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ADVISORS

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SPONSOR

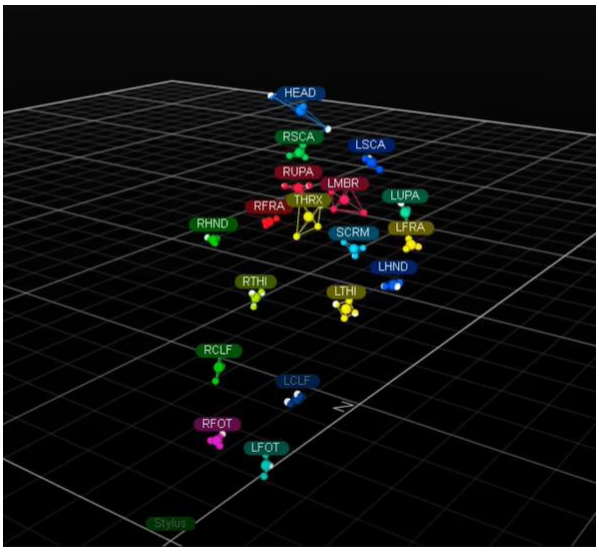
UCONN SCHOOL OF ENGINEERING
BIOMEDICAL ENGINEERING

Multi-Systems Approach in Evaluation of Leg Exoskeleton with Application of Modeling and Simulation

Lower-extremity exoskeletons provide patients the ability to regain motor control and muscle mass. Current exoskeleton designs provide powered assistance via actuators: heavy and expensive, yet necessary mechanical components that contribute to limited portability and accessibility of the device to the general population.

The purpose of this study is to quantify the assistive ability of a lower-extremity exoskeleton design in aiding the sit-to-stand motion. Performance is measured by multiple testing systems synchronously gathering balance, muscle activation, and motion capture data. Readings from the AMTI AccuSway force platform and Delsys Trigno EMG sensors, alongside OptiTrack motion capture recordings, are used to generate C3D files of several dynamic trials of a subject performing the motion without provided assistance. The AnyBody Modeling System is used to optimize the locations of the subject's joint axes, joint centers, and segment lengths as gauged by the motion capture system to generate kinematic joint angle data, ultimately providing a more accurate and subject-specific model.

Subsequently, incorporating the synchronous muscle activity and force data enables an inverse dynamic analysis to be conducted, by which joint reaction forces and moments are calculated. Repeating the procedure with the subject actively wearing the exoskeleton allows for the device's influence on these joint reactions, and thus the physical demand to surrounding muscles, to be quantitatively determined. A successful design will provide stability to a patient's knees while assisting the patient in regaining muscular strength and motor control.



BIOMEDICAL ENGINEERING

TEAM 19

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BIOMEDICAL ENGINEERING

Human-User Interaction with Different Robotic/Exoskeletons Leg Rehabilitation Devices

Our project focuses on the advancement of current leg rehabilitation techniques and technologies. Rehabilitation devices are used to reinforce the ligaments, tendons, muscles, and bones of the knee. During rehabilitation a patient's knee is very susceptible to reinjury therefore creating a device that accounts for the safety of the patient is a top priority. While developing the new device it's important to consider the amount of discomfort the patient is experiencing while wearing it. When the body experiences discomfort it is then translated into a stress response that alters the way the body communicates with itself which ultimately impacts whether the knee is able to heal properly. Research has shown that many patients have difficulty with the 'sit-to-stand' motion in particular. Therefore the goal of this device is to be able to track the patient's response, adapt to their recovery speed, be lightweight, easy to assemble, and low cost all the while being as pain-free as possible. Creating a device that patients can use both at the hospital for physical rehabilitation as well as at home, will allow the patient to maintain their sense of normalcy and independence. This is especially important for senior patients as the psychological toll of constantly requiring assistance can change the way their body responds, hindering the effectiveness of their recovery.

BIOMEDICAL ENGINEERING

TEAM 20

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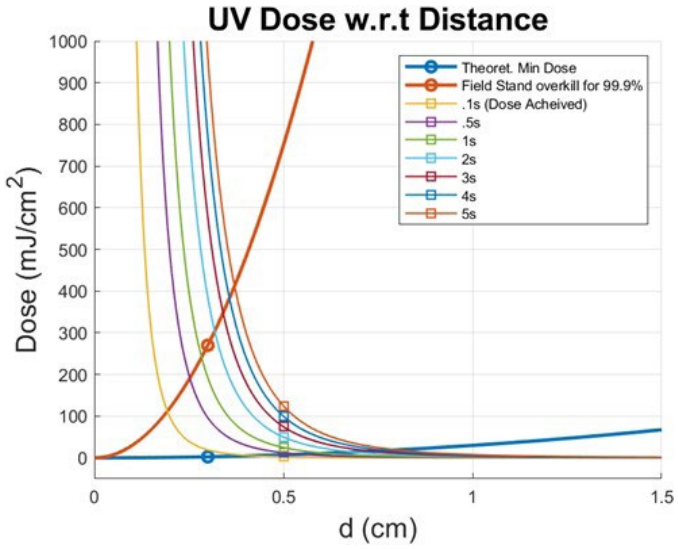
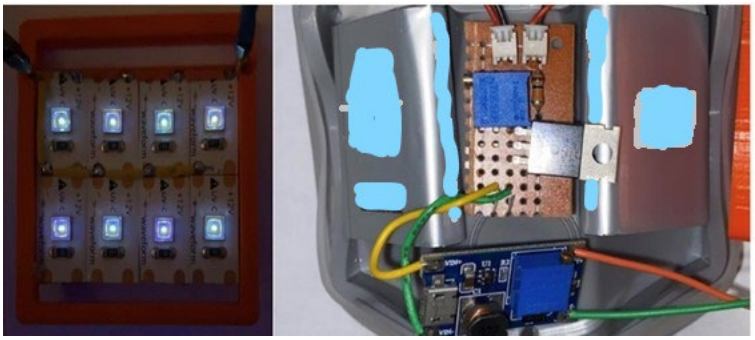
SCHOOL OF ENGINEERING
BIOMEDICAL ENGINEERING

UV-C Active Filtration Device (PPE) for Inactivation of Viruses

With Covid-19 becoming a worldwide pandemic and future threats in the form of harmful biological agents, there is a need for active filtration that inactivates/ sterilizes air that does not currently exist. Current technology does not provide the 99.999% inactivation/ sterilization of virus/bacteria required to prevent spread of disease. Our student-run senior design project focused on developing an active UV-C light filter for use in PPE such as a personal protective mask for use by medical professionals and the public which meets or exceeds this threshold. This internal UV-C filter provides the optimal wavelength for inactivation of virus particles in a manner which provides the required UV dosage and airflow to achieve this rate while maintaining the breathability and comfort for prolonged usage, especially by healthcare professionals who are subject to significant exposure to airborne viral load for extensive durations. Design parameters also allow for active use for a significantly longer duration than that seen by the competition among the relatively new UV-C mask filter technology. Finally, our unique design achieves this goal in a relatively simplistic design to minimize the technical challenge of production and assemble through the use of a simple subunit which can be easily expanded to meet a required increase in overall exposure or a decrease in power requirement. With the tremendous impact that Covid-19 has had on all of our lives, we hope that targeting a significant and immediate need with a technical solution provides future relief to humankind.





BIOMEDICAL ENGINEERING

TEAM 21

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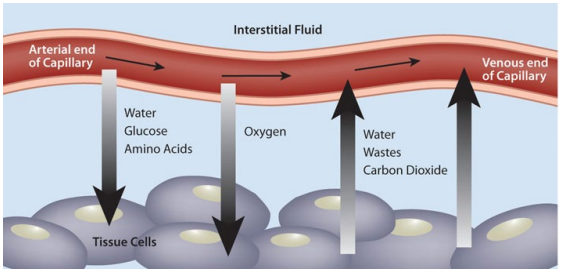
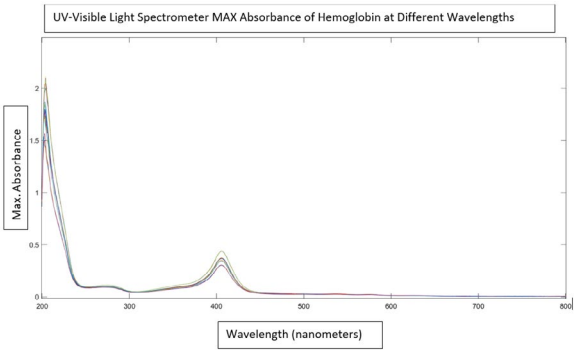
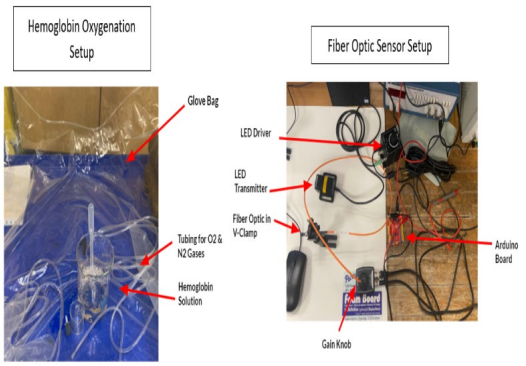
Medtronic

UV-Vis Spectroscopy for Local Tissue Perfusion Detection in the Advancement of Minimally Invasive Surgery

Minimally invasive surgery is a growing branch of the medical field, concerned with operations that lead to decreased trauma to the body. Laparoscopy for example, uses one or more small incision to allow surgical instruments to access the body with the least amount of damage to the tissue. Minimally invasive surgery is a growing field due to its many advantages in comparison with open surgery. It decreases the patient's risk for infection, increases healing rates, physically there is less bleeding and less scarring, and this is all followed by less hospital time. An important component of surgical procedures is the perfusion of biological tissue. Tissue perfusion can be defined as local blood flow through a capillary bed within a tissue. It has been found that good local tissue perfusion helps the success rate and healing of a surgical procedure. This project aims to find a way to quantify local perfusion of tissue. In doing so, the goal is that tissues can be identified as well-perfused or ill-perfused, which would help a surgeon determine the ideal location for incisions. Perfusion can be quantified by the oxygenation of the blood (more specifically the hemoglobin) in a tissue. The overall goal of this project is to evaluate a state-of-the-art perfusion detection method and complete a proof-of-concept study demonstrating the application of UV-Vis Fiber Optic Spectrometry for local tissue perfusion.







BIOMEDICAL ENGINEERING

TEAM 22

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Ngoc Luu

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Thanh Nguyen

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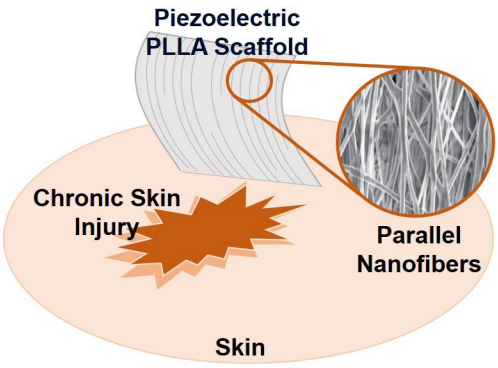
UCONN
SCHOOL OF ENGINEERING

Skin Regeneration on Piezoelectric Polylactic Acid Scaffold

This project was aimed to investigate piezoelectric Polylactic Acid (PLLA) as a biomaterial for skin regeneration, which is translational to clinical therapies to treat chronic wounds in burn patients. Piezoelectric PLLA is fabricated as a fibrous scaffold using electrospinning techniques. The scaffold needs to be characterized to determine its suitability to support cell growth and tissue regeneration. The scaffold also needs to demonstrate via its piezoelectric properties enhancement of cell viability and cell adhesion in order to be effective for chronic wound healing applications. For the purpose of facilitating the wound healing process particularly for 3rd-degree burns, newly seeded fibroblasts cells must be capable of surviving on the surface of the scaffold. For the proper formation of the extracellular matrix (ECM) to support the regenerating cells, cells must be able to grow stably on the scaffold.



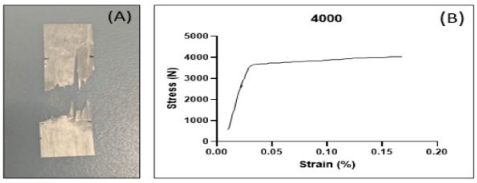


Figure 1. (A) PLLA fracture, (B) Plastic deformation of PLLA film

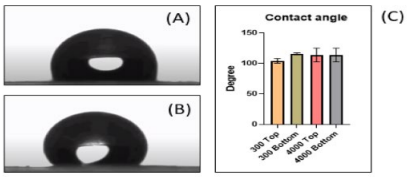


Figure 2. Hydrophobicity of (A) Bottom surface, (B) Top surface, (C) Contact angle

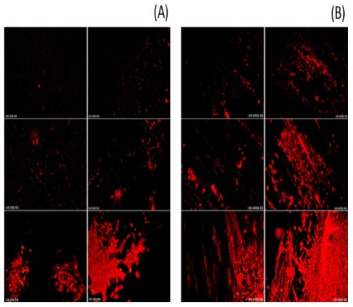


Figure 1. Fluorescent imaging after 6-day sonication of cells on (A) 300 rpm, (B) 4000 rpm film

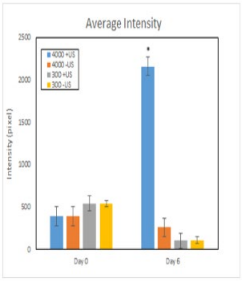


Figure 2. Cell viability quantification

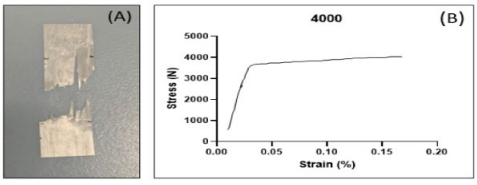


Figure 1. (A) PLLA fracture, (B) Plastic deformation of PLLA film

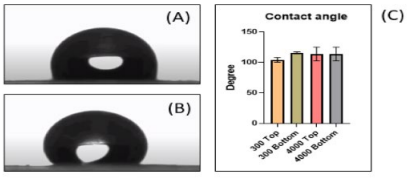


Figure 2. Hydrophobicity of (A) Bottom surface, (B) Top surface, (C) Contact angle

BIOMEDICAL ENGINEERING

TEAM 23

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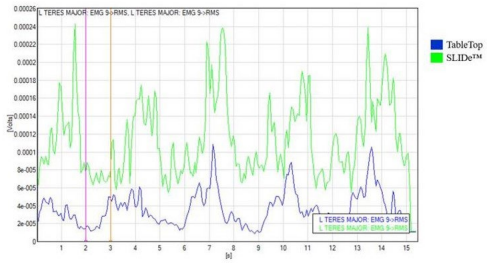
UCONN MSML

Evaluation of Shoulder Rehabilitation Devices for Post-Operative Rotator Cuff Repair

The aim of this project was two-fold: 1.) Develop and implement a biofeedback procedure within a rotator cuff rehabilitation regimen to quantify shoulder rehabilitation progression, and; 2.) Design and validate a biomechanical shoulder rehabilitation device to aid in the transition from an in-office to remote physical therapy modality due to the altering conditions created by the COVID-19 pandemic. To accomplish these aims, literary research was conducted to formulate an experimental rehabilitation procedure. To confirm that the procedure could be safely performed, human models were created using AnyBody Modeling System™ Software to simulate the desired procedure. This procedure consisted of biomechanical testing of two devices, the SLIDe™ Device and the TableTop Device. The SLIDe™ Device was originally designed by a previous senior design team and the TableTop Device was constructed as a redesigned, more compact version of the original SLIDe™ Device design. EMG sensors were placed on the Infraspinatus, Teres Major, Deltoid, Biceps Brachii, and Triceps Brachii, to obtain raw muscle activity data. This data was analyzed, and Root Mean Square (RMS) values were extrapolated to determine which device produced the optimal level of rehabilitation within the bounds of the project. This testing validated the TableTop design as a smaller and more portable version of the original design, capable of assisting in rotator cuff rehabilitation, and confirmed that this was the optimal design suited to fulfill the second aim of the project.

Average RMS Values(μV) of Teres Major for Two Devices During Table Cleaner Exercise

Device	Platform Angle			
	-45°	0°	45°	90°
TableTop	15.07	9.92	---	15.48
SLIDe™	25.89	10.81	---	34.55



RMS Values of Teres Major for Two Devices During Table Cleaner Exercise with Platform at 90°

BIOMEDICAL ENGINEERING

TEAM 25

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Ayushi Agrawal
Katrina Cirilli

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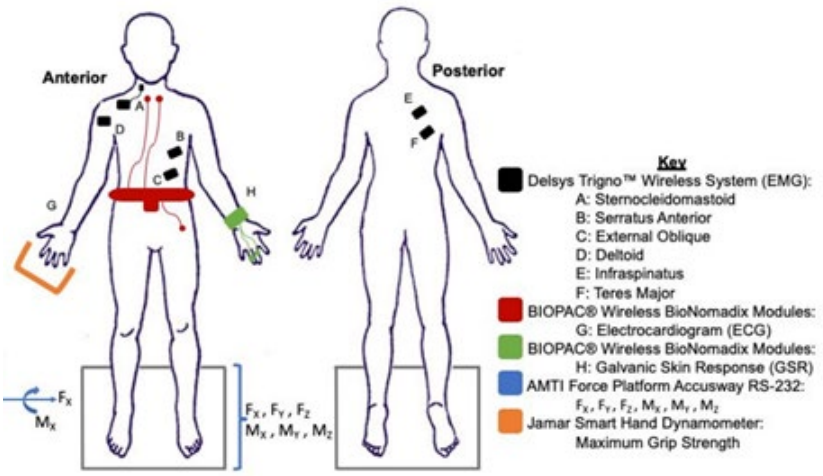
SPONSOR

HOLOGIC®

Measurements of Stress of Patients under Compression of Hologic Paddle Designs for 3Dimensions™ Mammography System

The purpose of this project is to quantitatively assess the physiological responses expressed by a patient while receiving a simulated mammogram using Hologic's 3Dimensions Mammography System. This project is a continuation of last year's efforts to determine if differences in paddle designs have a significant effect on the comfort experienced by the subject. This is an IRB-approved study collecting data from 25 participants to analyze the stress differences between the standard of care (a flat paddle) and the SmartCurve™ paddle supplied by Hologic Inc. Our group focused on the electromyography (EMG) and balance control data measured during the study as indicators of physiological stress.



3Dimensions™ MAMMOGRAPHY SYSTEM

BIOMEDICAL ENGINEERING

TEAM 26

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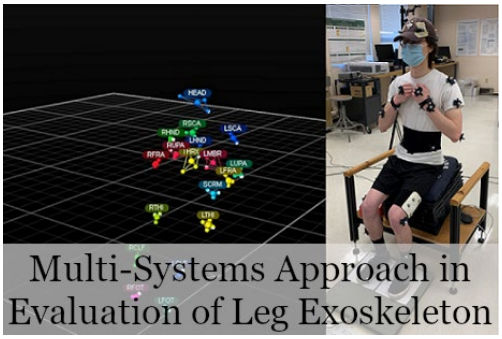
UCONN MSML

Multi-Systems Approach in Evaluation of Leg Exoskeleton

The purpose of this study is to develop a user friendly lower-extremity exoskeleton that will assist in the sit-to-stand motion. The device will be easy to put on, biocompatible, lightweight, and affordable. Sufficient function of the exoskeleton will assist in regaining motor control and muscle mass in order to provide long term solutions to muscle atrophy or neural degeneration. The device has the ability to provide knee stability during appropriate motions as well as analyze body kinesthetics in order to provide real-time assistive forces and moments. The exoskeleton, in its assistive nature, will additionally grant the user full control of their initiated actions at all times, and will not forcefully counteract a user-intended movement to return to a seated position or straighten the leg if a user is falling over. This feature is key to the user's confidence in implementing the device into their daily life. Alongside its ease and comfort of use, adaptability and user-friendliness are effectively prioritized. Success of the exoskeleton design is quantified by the extent of its ability to assist a patient in regaining motor control in performing the sit-to-stand motion. In order to gauge whether the exoskeleton is successful in these regards, synchronous tests are performed using multiple systems. This quantitative evaluation occurs when the three pieces of hardware generate data for the various software components. The AMTI AccuSway force platform measures the weight and force the patient places on it, the OptiTrack Motion Capture cameras use marker oriented tracking to determine locations of body parts in a three dimensional space, and the Delsys Trigno electromyography sensors analyzes muscle usage. These input data into the computer system and the data gets recorded and instantly transformed into a live reading of the patient's current activity, allowing for the evaluation of the device both quantitatively and qualitatively and ultimately improved upon.



CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 1

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Kevin Yang
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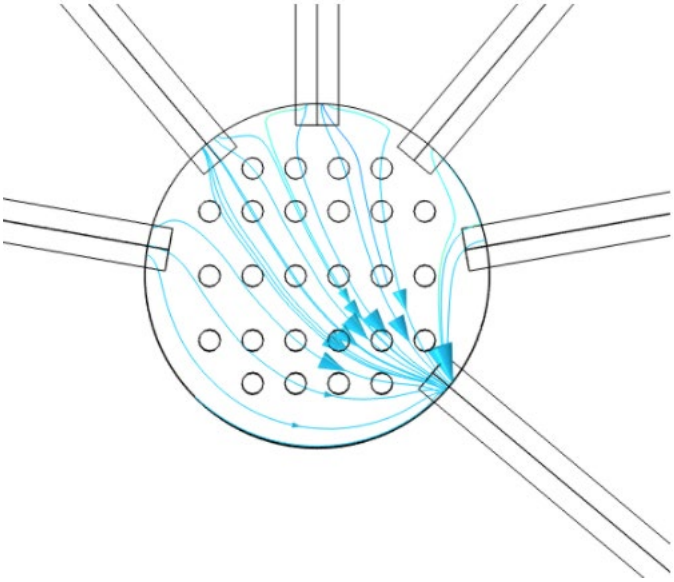
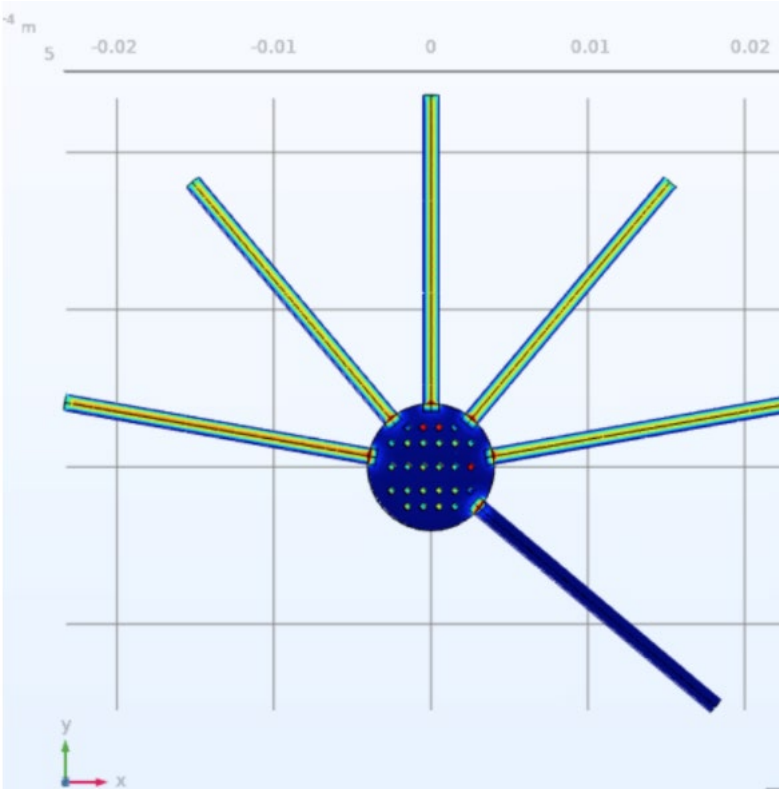
SPONSOR

UCONN
SCHOOL OF ENGINEERING
CHEMICAL & BIOMOLECULAR ENGINEERING

Tumor On Chip Project



In the United States, an estimated 1.8 million people were diagnosed with cancer while approximately 605,000 people died from cancer in 2019. Although the death rate from cancer has declined in the last few decades, drug therapy research is still necessary for improving cancer treatments. There are currently several drugs available to the general population for treating cancer. However, each of these drugs responds differently to various people and types of cancer. One method of developing specialized drug therapies is by modeling nanoparticle diffusion on a microfluidic device known as a tumor-on-a-chip model. In this model, nanoparticles act as drug carriers and the microfluidic device simulates tumors and their extracellular matrix environment. In our simulation, we created five inlet streams into a tumor environment to study the effect of parameters such as flow rate, concentration, and species of nanoparticles at each injection site; this will allow us to predict how each of these drug species would interact with each other in the body to influence nanoparticle uptake in tumors. Then we compared our predictions to experimental values of nanoparticle diffusion on a tumor on a chip. Using this model, we can make specialized drug treatments that maximize the effect of each individual drug in targeting tumor cells to improve future cancer therapies.



CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 2

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Rachel Martineau

ADVISORS

George Bollas

SPONSOR

nel

Computational Fluid Dynamics Analysis and Symbolic Regression of Multiphase Separation

NEL Hydrogen is a global company, delivering hydrogen production technologies such as water electrolysers. This process splits water molecules to produce hydrogen, which can then be used for energy production. Within NEL's hydrogen production process, a downstream, multi-phase separator tank separates oxygen from water and returns a high purity water stream to the production cycle. Our goal was to improve the efficiency of NEL's phase separator using computational fluid dynamics. We used ANSYS Fluent to simulate oxygenated water flow and study the effect of varying separator geometries on separation efficiency. Using the simulation results and Alamo's symbolic regression software, our group created an algebraic model to correlate the phase separator geometry with separation efficiency. The application of this model would provide NEL Hydrogen with a tool for designing efficient phase separation units for their water electrolysis processes.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 3

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ADVISORS

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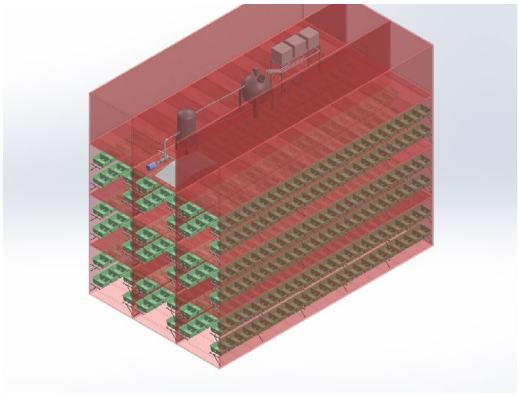
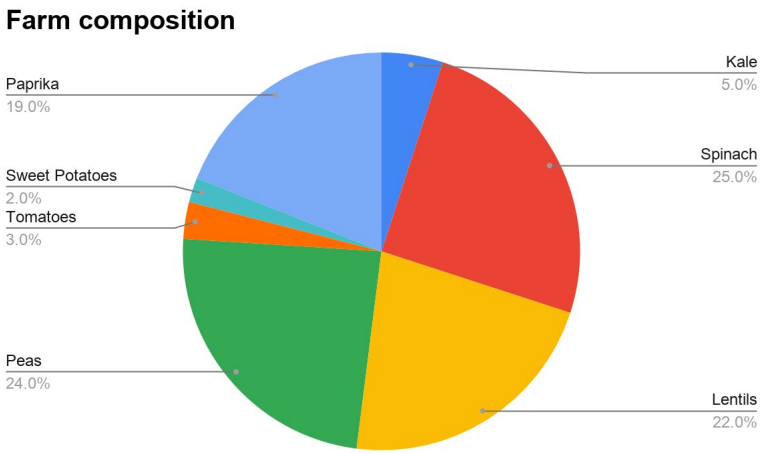
UCONN SCHOOL OF ENGINEERING
CHEMICAL & BIOMOLECULAR ENGINEERING

Optimal Design of Agricultural Systems

Current farming tactics are not sustainable. Today's industrial farms deplete both the groundwater and the nutrients within soil. This approach to farming cannot meet local food demand in other parts of the world due to the restricting climate and growing season there. Our project offers a solution to these problems by creating a net-zero emission and sustainable farming system for world-wide use. The new farms will meet the dietary needs of people anywhere while remaining a profitable business model that current farmers would be willing to adopt. Instead of soil methods, this project uses aeroponics, which cuts water usage by 98% and nutrient usage by 70%. In addition, the project will use green-energy credits to offset its power use. The project uses upcycled materials, such as shipping containers, in its build to reduce its ecological impact. In addition to having a low carbon footprint, the agriculture system's controlled climate allows for it to perform in any condition at any time. The project's model focuses on growing healthy foods to meet dietary needs while offsetting costs with a cash-crop. Also, the project plans to teach others about both the environmental and societal impacts of farming through an outreach program. With the combination of these elements, the world will be one step closer to achieving sustainable food production.





CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 4

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Allyson Barrett

ADVISORS

Ioulia Valla

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UCONN
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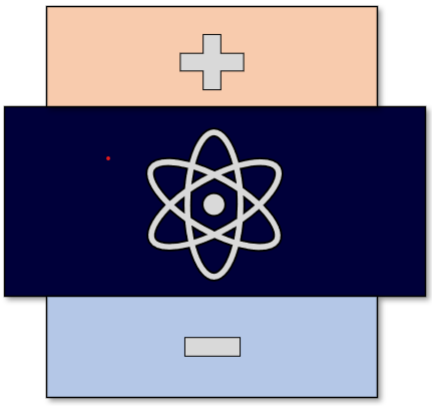
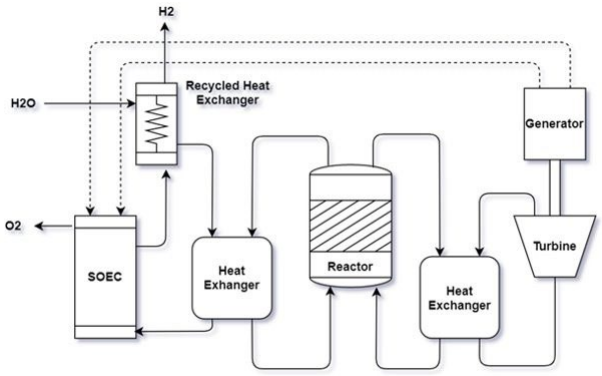
CHEMICAL & BIOMOLECULAR ENGINEERING

Renewable Hydrogen

Hydrogen is a highly efficient energy carrier and has the potential to be a sustainable replacement for conventional gasoline. Currently, the primary method for commercial hydrogen production is steam methane reformation, a process which relies on unclean and unsustainable fossil fuel–derived resources. The future of hydrogen production depends on a cleaner and more reliable method using renewable resources. The goal of this project is to perform a techno-economic analysis of hydrogen production from a renewable resource for fuel cell applications. We chose nuclear-powered high-temperature electrolysis as the technology for hydrogen production. High-temperature electrolysis is a process that splits water into hydrogen and oxygen using a solid oxide electrolysis cell, and can achieve up to 90% electricity-to-H2 production efficiency with zero greenhouse gas emissions. Nuclear energy provides power and heat to the electrolysis cell to facilitate water splitting maintain a constant temperature throughout the cell. We optimized the process by investigating how temperature, voltage, and current density affect the power requirement to the cell and the hydrogen output. As the world turns more towards alternative energy sources, the demand for hydrogen production is predicted to increase and our process provides an efficient and sustainable way to produce clean hydrogen and help meet societal energy demand.





CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 5

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Carolyn Costa
Jeremiah Famor

ADVISORS

Ioulia Valla

SPONSOR

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Renewable Hydrogen Production via Electrolysis for Fuel Cell Vehicles

Greenhouse gas emissions from transportation in the United States account for 28% of the country's total emissions. The growing fuel and energy demand in the United States represents a challenge to the production of clean, renewable energy. Hydrogen gas connects clean energy produced in a plant, to usable energy in everyday life. The goal of this project is to propose a solution to the production of hydrogen gas through PEM electrolysis, a water-splitting method. Working through the constraints of supplying electricity to the electrolysis system, the team proposes fully renewable resources consisting of photovoltaic solar panels and offshore wind turbines. The project explores methods to maximize the efficiency of the renewable energy system and to re-use resources in order to obtain high amounts of hydrogen gas output. By incorporating innovation to push the efficiency of the system to the theoretical maximums, we will reduce the burden of energy requirements on our project's infrastructure. The effects of climate change are long-lasting and with the hydrogen fuel cell proposal, carbon emissions will decrease. This project brings us a step closer to saving the planet from irreversible damage due to greenhouse gas emissions.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 6

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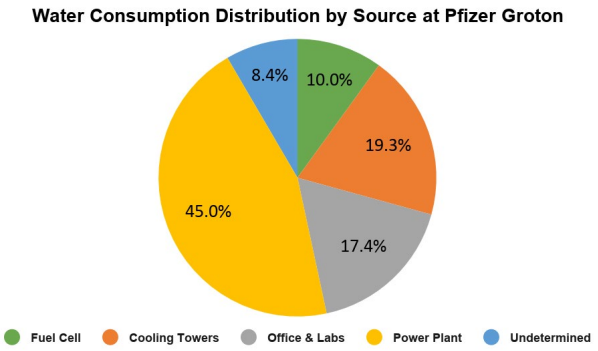
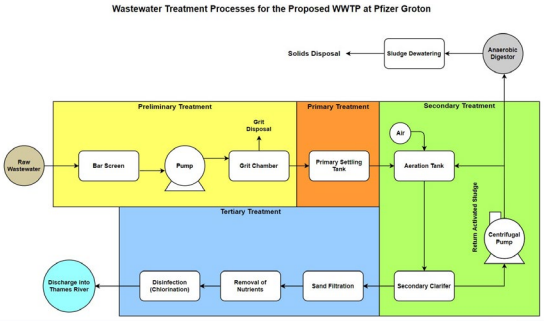
Pfizer

Water Consumption Analysis and Reduction for Pfizer Groton

Over the past five years, the 160-acre Pfizer Groton site used a large amount of water that comprised approximately 225 million gallons per year to meet the site's demand for consumption. The goal of this project was to assess the water usage at Pfizer and identify improvements that would create water consumption reductions and cost savings for the facility. To do this, the team evaluated water usage on a building level perspective, formed a comprehensive water balance for the entire campus, and identified opportunities for water reuse. Based on this investigation, the team's proposed technical solution was the design and construction of an on-site wastewater treatment plant (WWTP). The purpose of building this plant would be to treat wastewater on-site rather than sending the discharge to an external public treatment facility. After construction, Pfizer could then discharge the treated water into the Thames River at no charge, saving money on off-site treatment costs. Based on the wastewater discharge to the sewer system in 2019 being almost 650,000 m3, using the team's proposed on-site plant would save Pfizer $1.9/m3. This would total in just under $1.25 million per year in savings on wastewater treatment. An on-site wastewater treatment plant would allow Pfizer to implement a safe and clean solution that reaches their cost and consumption goals.





CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 7

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Joshua Lovett

ADVISORS

Kristina Wagstrom

SPONSOR

Freund's Farm Market
East Canaan, CT
It Grows On You!

Freund's Farm Anaerobic Digester

Manure management is a consistent challenge facing dairy farms across the U.S. The difficulties from excess manure causes farms to seek creative methods for disposing animal waste. One of these methods is the biogas digester. A digester is a large-scale reactor and separator system that processes manure into two usable products: methane gas and a liquid distillate high in nutrient concentration. Because of the economic and environmental pressure manure management puts on small farms, anaerobic digesters are an attractive and profitable solution to process livestock waste.

The goal of this project was to design an anaerobic digester for Freund Farm, and determine its environmental, economic, and logistical feasibility. The team designed the engineering process, including manure collection and transport, the parameters of the reactor chamber, and separation and storage of the final products. Using computer software and hand calculations, the team calculated the theoretical methane production, emissions reduction, and financial viability of the design.

Furthermore, the team considered the environmental, economic, and ethical impacts of a digester. Potential health impacts include the environmental risk to workers, animals, and nearby residential communities. Safety considerations include mechanical malfunctions, chemical exposure, and explosions.

By collaborating with our project sponsor, the team created a design that improves on, and increases the revenue from the farm's manure management process. The results from this project will let the local CT farm to not only digest 100% of their manure, but profit from the biogas production.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 8

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Patrick Paul
Rachel Marchini

ADVISORS

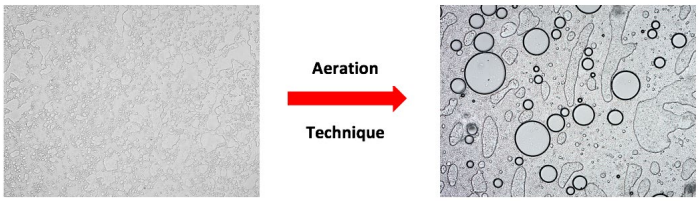
Anson Ma

SPONSOR

Unilever

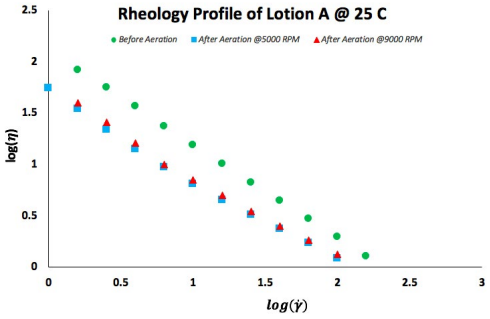
Development of New Skin Care Products by Exploring Different Aeration Techniques

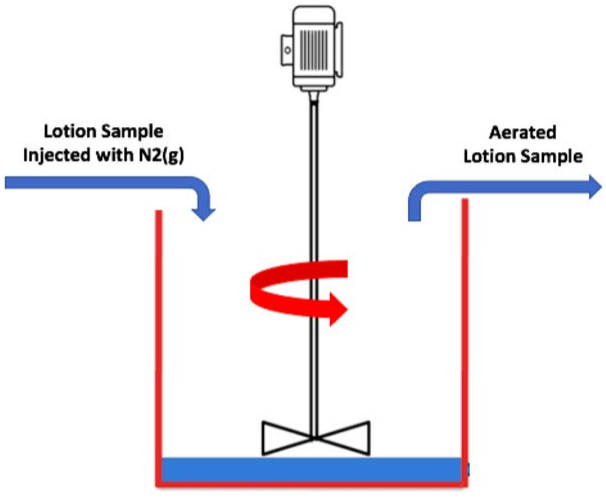
On any day, approximately 2 billion people use Unilever skin variant products such as lotions, cream, gel, etc., to look good, feel good and get more out of life. However, the company faces the challenge of continuously creating products with a unique whipped appearance and feel heavily desired by their customers. Unilever has attempted many different aeration techniques to improve product sensory but has not yet developed a single process that works on several skin variant products. Our project then aimed to expand on current research efforts and develop an aeration process that will lower the specific gravity and guarantee a stable product before it reaches the consumer's hands. Our team designed a robust and scalable aeration method, which incorporates a high shear mixer in conjunction with a nitrogen gas injector, to tighten bubble size distribution and maximize the number of bubbles present in the product. The leading theory behind our design is that bubble breakage occurs once the capillary number of lotion samples exceeds the critical stress for each skin variant with known fluid properties. The team carried out a series of experiments to serve as bench-scale proof of concept for our design. To evaluate our finished product's life span, the team conducted a few stability test methods that looked at the foam's pH, smell, and volume change. Implementing our technical solution will advance Unilever's outlook in the skincare market and thus retain and attract new customers.



Microscopic Image of Lotion A Before Aeration

Microscopic Image of Lotion A After Aeration





Experimental Aeration Technique Design

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 9

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Katyland Facas
Trenessa Rioux

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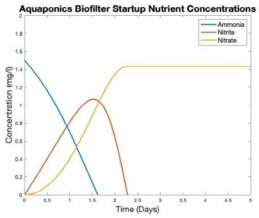
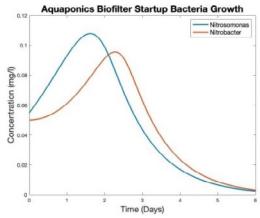
SPONSOR

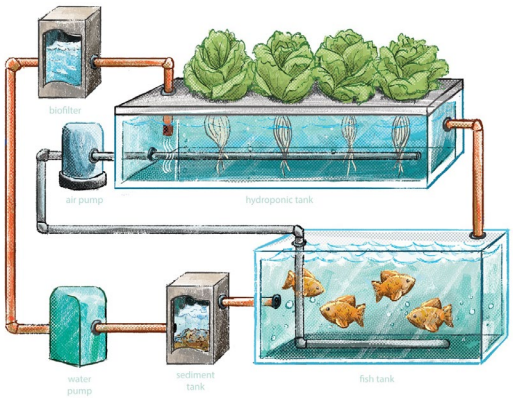
Aquaponics in Rural Uganda: Addressing Nutrient Deficiencies

Guiding Light Orphans (GLO) is a nonprofit organization that serves to bring aid to the rural community of Masindi, Uganda. Currently, many rural Ugandan communities are food insecure, meaning they lack access to affordable, diverse, and healthy foods. In fact, from 2001 to 2017 the percent of the population that was undernourished increased by 14% alongside a decreasing accessibility of fruits and vegetables. As a result, many Ugandans lack essential micronutrients in their diet, which can lead to stunted development, especially in children.

The goal of our project is to design an aquaponics system to bring a wider variety of nutrient dense foods to the community. The design includes fish tanks, a biological filter, a mechanical filter, and nearly 250 grow beds for a variety of plants. Aquaponics combines aquaculture and hydroponics to grow crops in an alternative way to traditional farming methods. The fish waste is converted into essential nutrients for plant growth while the plants filter the water and grow in a soilless closed loop system. A biofiltration system converts the fish waste into bioavailable plant nutrients and is modelled numerically by using concepts from process kinetics. Plants included in the system specifically cater to the local community's nutrient needs. Thus, this design supports a well-rounded, nutrient dense diet. This project will not only help combat malnutrition, but it could also act as a potential source of commerce.







CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 10

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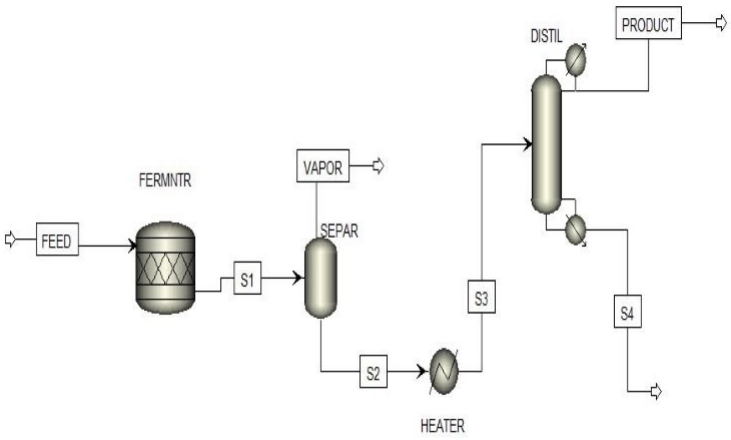
CHEMICAL & BIOMOLECULAR ENGINEERING

Supply Chain Plan for Production and Distribution of Hand Sanitizer

The unexpected and sudden acceleration of the CoVid-19 virus exposed the weakness of the hand sanitizer supply chain industry, especially in the United States. For the first half of 2020, the world was panicking with the onset of the pandemic and there was a noticeable shortage of hand sanitizer supply, which resulted in a significant price gouge. This capstone project contributes to the discussion on supply chain engineering and management, public health, and chemical engineering production by presenting a model for hand sanitizer supply chain production and distribution in response to unexpected market disturbances using the ongoing CoVid-19 pandemic trend in supply chains. The following methods are considered for sourcing alcohol for the production of our hand sanitizer: purchasing bulk ethanol or Isopropyl alcohol, receiving donations for ethanol or Isopropyl alcohol, and manufacturing ethanol or Isopropyl alcohol.



Thorough economic analysis, process feasibility and resource availability for the final product will be the metrics used to determine which of the four sourcing options to use. Further product analysis will be done to determine if carbomers or essential oils will be needed to improve the usability of the final product and whether or not this will be financially feasible. Overall, this model relies on a thorough analysis of existing literature, a methodology for the in house setup of an ethanol production process, a plan for repairing the distillation column, an ASPEN model of ethanol and IPA production, a plan for storing and distributing hand sanitizers and an economic analysis that is potentially adaptable for future service learning projects.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 11

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Emalie Belleza

ADVISORS

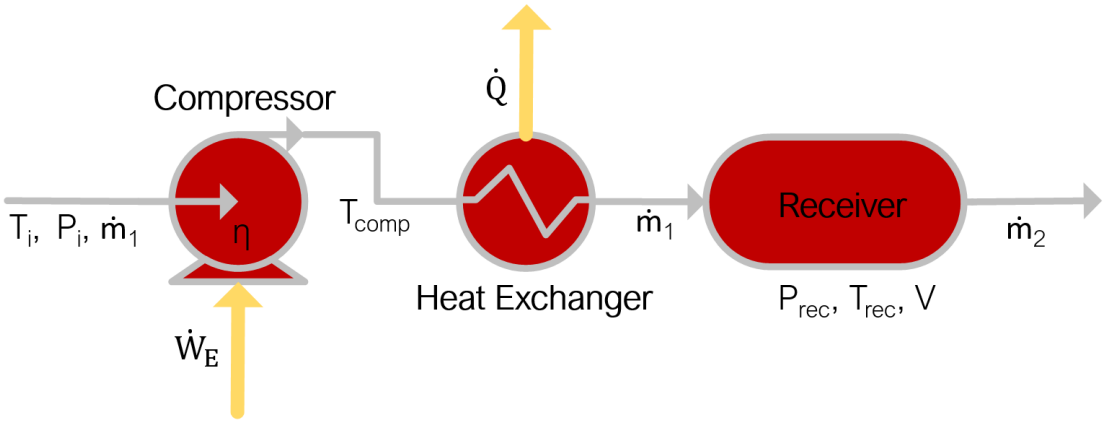
Matthew Stuber

SPONSOR

Collins Aerospace

Optimal Design of Compressed Air Systems

At the Collins Aerospace plant located in Windsor Locks, CT, the facility engineering team has collected a wealth of information on their compressed air system, which is their most expensive utility. This includes power consumption, flowrate, temperature, and pressure data at 5-second intervals in addition to P&IDs and equipment specifications. The goal of our project is to organize and analyze this information, develop a numerical-based model of their air system, compare the results to the data to identify inefficiencies, and make control and design recommendations to improve efficiency and reduce operating cost. We developed our model by creating a process flow diagram of the system and determining the appropriate model equations for each unit operation. Then, we adapted the system for solving in MATLAB. The independent variable in our model is system flowrate, and the dependent variable is system pressure, which is required to calculate other important metrics like compressor power consumption and outlet temperature. Our model is a tool for Collins to analyze various aspects of their compressed air system, including power consumption, inlet conditions, set pressures, and control strategies. It will be adapted as required by the facility engineering team at Collins and has the potential to result in significant performance improvements and energy savings



CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 12

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Ameet Chowdhury

ADVISORS

Luyi Sun

SPONSOR

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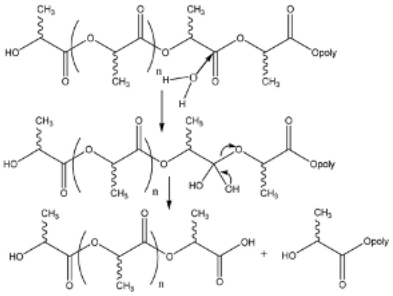
CHEMICAL & BIOMOLECULAR ENGINEERING

Assessing the Compostability of PVA/MMT Coated PLA Films

In the US, plastic waste accounted for 35.3 million tons, or 13.2 percent, of the total 267.8 million tons of municipal solid waste (MSW) in 2017. Plastic films in particular accounted for 1.93% of MSW. Because plastic films are unable to be recycled, it is necessary to find an alternative packaging film to decrease plastic waste. The goal of this project was to design a packaging film that has the same functionalities as regular plastic films but is also compostable. To complete the project, our group conducted background research on compostable films and composting methods, as well as used our knowledge of kinetics and heat and mass transfer to design composting experiments. The base of our compostable packaging film is polylactic acid (PLA) substrate, which is a natural polymer sourced from corn starch. Our group conducted two different composting experiments to track the degradation of PLA substrate coated with polyvinyl alcohol (PVA) that has varying degrees of hydrolysis, or a combination of PVA and montmorillonite (MMT). We conducted one of the experiments outdoors, where conditions are uncontrolled and varying. We conducted the other experiment indoors under more controlled and stable conditions. Through our background research and experiments, we determined the best combination of PLA substrate and coating to produce the most functional and compostable packaging film. By producing and composting compostable packaging films, both individuals and businesses can help produce nutrient rich soil from compost, lower their carbon footprint, and decrease the abundant plastic waste. Compostable packaging films also have the ability to be more cost effective than traditional petroleum-based plastic films.



CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 13

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CHEMICAL & BIOMOLECULAR ENGINEERING

Synthesis of ABS Co-Polymer from Bio-derived sources for use in Plastic Toys

LEGO and similar companies manufacture and sell vast amounts of non-renewable, petroleum-derived plastic toy bricks. These toy bricks are made mostly from ABS (acrylonitrile-butadiene-styrene), a strong and durable polymer. The goal of this project is to develop a theoretical manufacturing process that could sustainably replace 1% of the annual production of the LEGO company's ABS toy bricks. The proposed process must produce the three monomers from sustainable and renewable sources, such as plants or microorganisms. To design an effective solution, the process must yield bio-derived ABS at a cost similar to consumer toy bricks. The team utilized vast amounts of organic synthesis data to develop a unique method to produce each component in ABS. The theoretical manufacturing process was modeled using Aspen Plus to determine the cost and emissions of our proposed reaction pathways. Taking advantage of new research and similar industrial processes, we aim to develop a process that could replace more than 1% of the annual production of petroleum-derived ABS toy bricks at a competitive cost to consumers.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 14

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Bahaulddin Al-Tameemi
Basel Alnajjar

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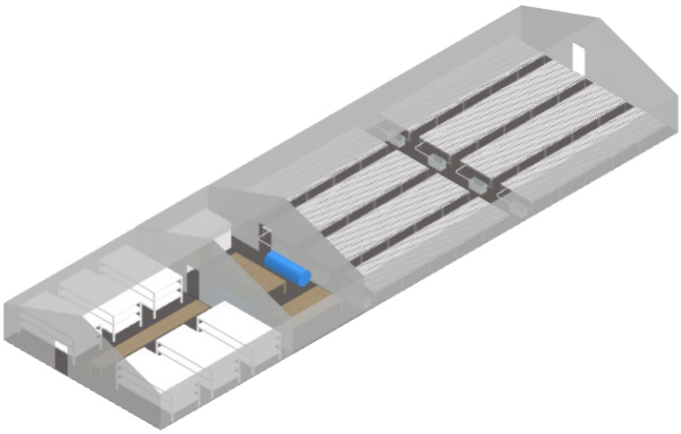
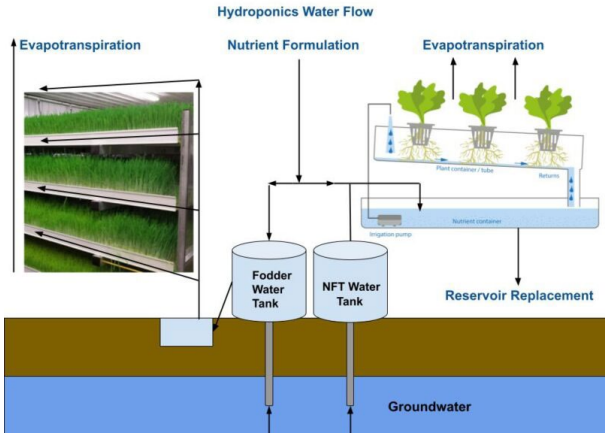
Kristina Wagstrom

SPONSOR

Design of a Hydroponic Greenhouse in Rural Uganda

The community of rural Masindi, Uganda suffers from malnutrition due to an unvaried diet and a lack of an adequate food supply. Partnering with Guiding Light Orphans (GLO), a non-profit charity organization, the goal of this project was to design a hydroponic greenhouse facility which would allow the year-round cultivation of various nutritious vegetables and livestock fodder independently of the poor growing conditions of the region. Hydroponics' core principle involves supplying plants with nutrient-rich solutions containing all of the compounds necessary for growth; these solutions are further tailored to individual plant species growth cycles to maximize agricultural output. By using concepts of fluid dynamics, we modeled the piping and pumping requirements, and calculated the water and solution flow requirements for such a facility based on hydroponic systems we designed, which are constrained by the availability of local materials. This allowed us to calculate the expected agricultural output and the total cost estimate of the facility. The construction of the proposed design would provide the people of Masindi with a high quantity of high quality food.





CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 15

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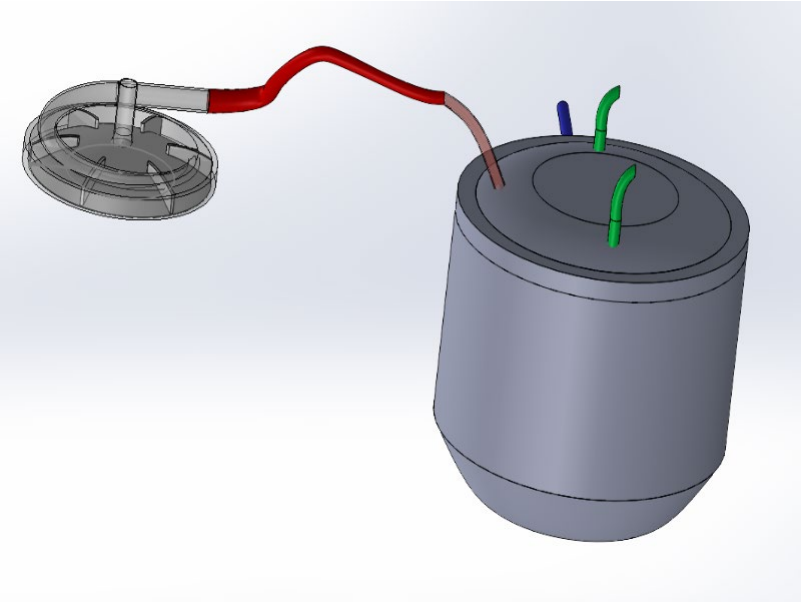
CHEMICAL & BIOMOLECULAR ENGINEERING

Extracorporeal Membrane Oxygenation (ECMO)



Extracorporeal membrane oxygenation (ECMO) is an artificial heart and lung housed outside the human body used to oxygenate and pump a patient's blood under critical circumstances. However, the blood in the circuit can clot and cause blockages due to stresses that build up in the fluid, which poses a life-threatening risk to the patient. This risk is combatted by medical professionals by using blood-thinners which are not fully effective at preventing clotting and can lead to other complications. The goal of this project was to modify the materials along with the impeller blade shape of the pump as a way to limit stresses on the blood and subsequently, the number of clots created throughout the device. Our methods of calculating clot accumulation through quantifying shear stress, diffusion and flow rates were determined through the application of engineering principles and detailed knowledge on the blood clotting pathway. The system was optimized to enhance adult ECMO usage for a short two-week term to reduce the necessity of blood-thinners. This design could be a valuable advancement in critical patient care with successful final evaluations based on clot accumulation and shear stress distribution.

CHEMICAL AND BIOMOLECULAR ENGINEERING

TEAM 16

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Luyi Sun

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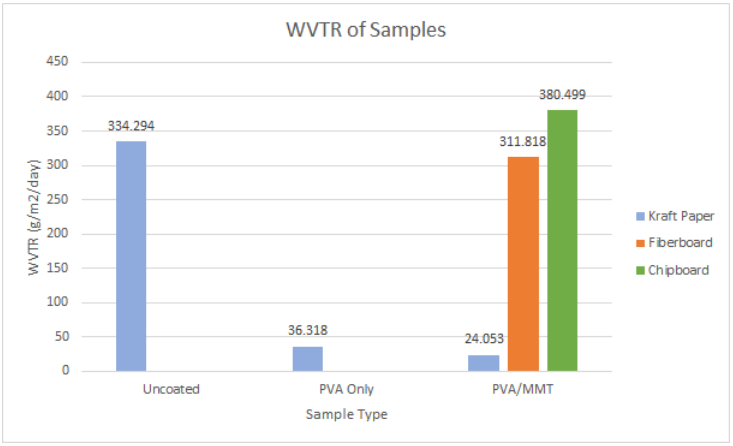
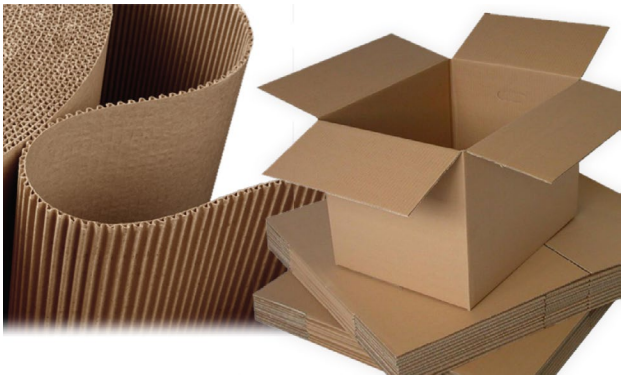
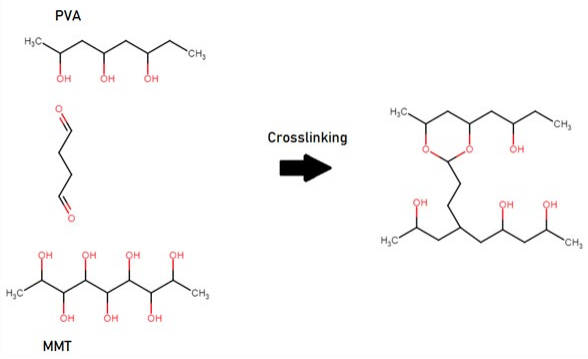
Biodegradable PVA Coatings as a Method to Replace Plastic Packaging

Current food packaging systems are a major contributor to modern waste problems that have negative environmental effects on the world's ecosystems. The goal of this project is to design a food packaging system that is biodegradable, able to be mass produced, and possesses higher barrier properties than current paper packaging. Due to paper's high porosity, it is a weak barrier to oxygen and water vapor, both of which affect the shelf life of food products. Plastic packaging is much better at preventing oxygen and water vapor from permeating, but often either lacks the ability to biodegrade or be recycled. By coating paper packaging samples with Polyvinyl Alcohol (PVA), a biodegradable synthetic polymer, and Montmorillonite (MMT) we can increase the poor moisture and gas barrier properties of the paper packaging. The coating process is performed by dissolving PVA/MMT in deionised water, then stirring to ensure dispersion of the polymer. Paper samples are dried in an oven, dip coated in solution, and then dried again in an oven, turning halfway through to ensure even coating. By replacing standard plastic packaging with a paper packaging of similar abilities can significantly cut down on the waste production and environmental effects of plastics that are not properly disposed of.







CIVIL ENGINEERING

TEAM 1

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Federico Marin
Shiv Patel
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ADVISORS

John Ivan

SPONSOR

Intersection Operational and Safety Improvement Project: Route 85 and Route 161/Deer Run Rd

The safety, capacity and operation at the intersection of Route 85 and Route 161 in Montville, CT is to be evaluated in the project. This location has dealt with crashes and two design alternatives were developed in order to alleviate the problems. The design alternatives were evaluated using VISSIM and MicroStation. The two alternatives compared were a left turn lane and a roundabout. Each alternative for this project will be evaluated with regard to feasibility, impacts on delay, safety, and the cost of implementation. The primary goals are to improve the safety and reduce delays, while having a secondary goal of minimizing the cost. The feasibility will be determined by the space available to implement the alternative solutions.

CIVIL ENGINEERING

TEAM 2

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Jason Rich
Josue Flores
Luis Vega

ADVISORS

John Ivan

SPONSOR

Jacobs

Traffic Safety and Operational Analysis

Our project aims to create and redesign a popular intersection at Lake Avenue and Rock Ridge Avenue in Greenwich, CT. The current layout has visibility issues, and leads to congestion and conflict areas causing crashes. This intersection experiences a high vehicle count, especially during peak hours in the morning and afternoon, and is an important route to many residential and commercial areas, including a school and Greenwich hospital. Therefore, it was imperative that our alternative design enhances safety by improving visibility and reducing congestion. We want to promote a network that encourages pedestrian activity and create an aesthetically pleasing design that fits in the context of the area. Our team has worked on multiple designs, including a roundabout, four way intersection, and a three pronged design that keeps the current layout, but improves upon it. Based on our designs and analyze via traffic simulation and cost analysis, our preferred design is a general four way intersection. The four way intersection removes the center triangle island and improves the ability to turn onto Lake Avenue while keeping traffic flowing. This design requires the removal of utility poles and two columns, but our alternative design incorporates a new spot for these, and also accounts for the need to change the vertical grading in our intersection.

CIVIL ENGINEERING

TEAM 3

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Jacob Dinklocker
Asim Astreya

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CIVIL & ENVIRONMENTAL ENGINEERING

Connected and Automated Vehicle Test Track at UConn Depot Campus

This project utilizes UConn's Depot Campus by converting it into a vehicle testing facility designed especially for automated and autonomous vehicles. At the moment, the UConn Depot Campus is not being utilized for any project and much of the buildings are abandoned. With the creation of a vehicle testing facility, UConn seeks to establish itself as a leader in the rapidly growing industry of automated and autonomous vehicles. Therefore, UConn in collaboration with Dr. Eric Jackson and private investors have tasked us with creating a design of such a facility. In this project we aim to replicate the field conditions of two things: a high speed road design with smooth curves and roadway designs that would exist in a smart city. A few requirements for an autonomous vehicle testing facility include straight tracks that can allow vehicles to reach highway speeds, and smooth curves where the top speed can be maintained. Roads with foliage coverage are required in a vehicle testing facility to test how vehicles perform when GPS signals are blocked off by trees. It is also important that roads can replicate rural and urban designs, and with a few additions of buildings and road designs, this can be accomplished in the Depot Campus. Further important requirements for a testing facility include, parking spaces and road side parking. Some parking spaces already exist in the property and can be used to replicate parking commonly found on a small city or small. Additionally, to replicate traffic conditions of a smart city, there must be traffic signals installed alongside a small 5G network coverage. Also it is important that the test track be in a discreet location, as automobile companies would want to hide their test results, the location of the facility is perfect as there is little traffic in the surrounding roads, with the exception of Route 44. With the guidance of Dr. Eric Jackson, our team is confident that we will be able to design a state of the art autonomous and automated vehicular testing facility.

CIVIL ENGINEERING

TEAM 4

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Mihir Sharma
Tyler Huhtanen

ADVISORS

John Ivan

SPONSOR

STAMFORD
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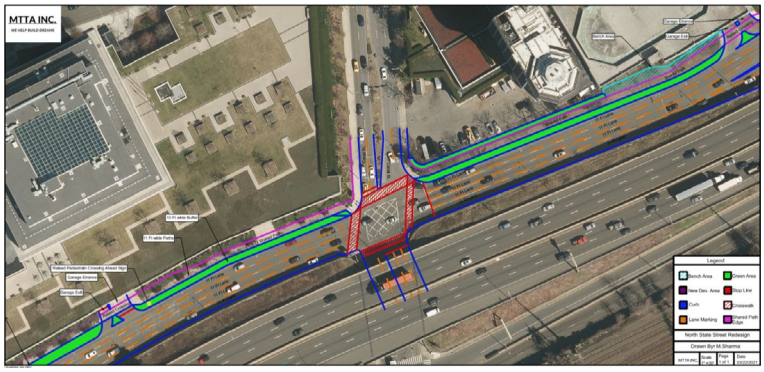
Multimodal Gateway Improvement Project

Before

After

Stamford, Connecticut is home to one of the largest rail stations along the Metro North Rail Line, assisting in the flow of people locally and between larger metropolitan areas. While rail transit is an important stitch in the fabric of Stamford's transportation network, without the support of effective walking, biking, and bus systems throughout the rest of the city, its weave will unravel completely. For this reason, we have been contracted by the Stamford DOT to support their efforts in improving multimodal transportation methods throughout the city by improving walking and biking conditions along North State Street, the entrance to the city from the Stamford Metro Station and I-95. Our role in the project is to improve cyclist and pedestrian conditions on North State Street from Washington Ave to Elm St as well as to implement signage to welcome those entering the city by vehicle. Travelers from the Metro North Station are greeted into the city by beautiful walking conditions, however these ideal conditions quickly deteriorate to an environment that would discourage walkers and cyclists. Additionally, travelers from the highway are not welcomed to the city by any significant signage to influence the character of the city. We will improve the conditions of the corridor through the implementation of a multi-use pathway. This shared bike and pedestrian path, along with other strategic design choices will improve sidewalk conditions for active transport users while also providing a more beautiful entrance into the city for vehicle travelers. Our plan includes drawings of the proposed pathway, a 3D model of the improvements to the street and a total cost analysis of the project.



CIVIL ENGINEERING

TEAM 5

Emma Peak
Emmanuel Adelani
Victor Mata

ADVISORS

John Ivan

SPONSOR

Case Mountain Recreation Area: Trail Erosion Control and Stone Wall Replacement

The Town of Manchester has decided to invest in the Case Mountain Recreation Area. Due to extreme weather erosion and lack of adequate structure of stone walls, there is increasing damage to older structures and to the integrity of the overall composition of the recreational area. Specifically, excess stormwater over the past years has led to surface runoff into channels on the hillsides of the recreation area. This has resulted in erosion of many sections along the older carriage path trails. The overland flow has also washed out some of the original stone walls supporting the carriage paths thereby causing a partial collapse of the wall. The objective of the design project is to address the structural issues of the recreation area while keeping physical, ecological and economic sustainability in mind.

As a group, we identified water erosion control and the areas of collapsed stone wall to be the two focal points of the project. It was then our job to present solutions to the Town of Manchester for those two issues. In our proposal, we provided the Town three alternatives to address the water erosion and three alternatives to address the collapsed wall.

After much consideration, the Town of Manchester decided to use all three water erosion alternatives to address the erosion found on the trails. For the water erosion issues, we will be providing them design plans for a water bar, French drain, and drainage dip to implement on the trails, as well as a toolbox to have as a resource for future issues of water erosion. To address the areas of the collapsed stone wall, the Town of Manchester decided on a steel fence to implement in the areas of the stone wall that have collapsed, and therefore, we will be providing them design plans for a chain-link steel fence.

CIVIL ENGINEERING

TEAM 6

Joshua Connor
Sean Doolittle
Rebecca Feldman
Shalini Shial

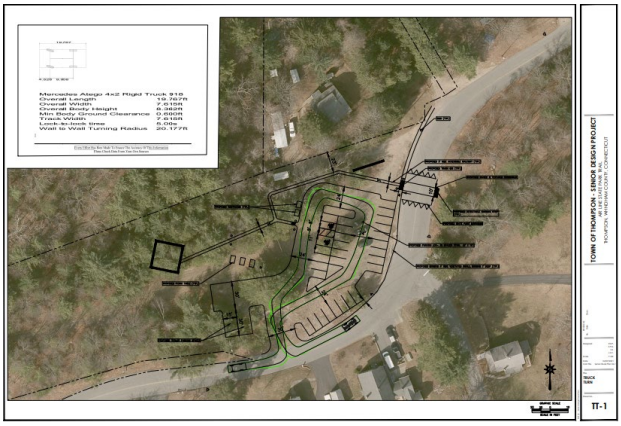
ADVISORS

Nicholas Lownes

SPONSOR

Thompson CONNECTICUT

Recreating East Thompson's Trail Parking Lot



The overall goal of our project is to rework the parking lot area in the East Thompson area near the Air Line State Park Trail, where the Great East Thompson Train Wreck took place. We were asked to provide a general layout for recreating the parking lot near the trail due to the increase in demand during the pandemic and to improve the visibility and design of the area. As engineers, we also wanted to incorporate things we had learned in class, so we also observed how we can improve the safety of the area for pedestrians, how we can deal with some of the water retention problems, and how we should design the parking lot, including location of features and the material used. We were also able to get in contact with engineers who previously worked on a design for the parking lot and an engineer who has experience with improving park design. This helped guide us into the direction of an elevated crosswalk over a speed reduction and sparked our interest to research a material that works for our site, which we found was stamped asphalt bricks. Even though we received help from some professional engineers, this project is meant to be a learning experience for our team and Thompson will likely apply changes to the design in order to better fit their needs. Some topics we researched to help guide our planning include improved stormwater maintenance methods, techniques to improve pedestrian safety, park and design amenities, and grading and material preference in different climates. There were also limitations to the amount of work we could put into this project due to the restrictions of the coronavirus pandemic, so we tried our best and provided what was expected of us from our sponsor's team perspective.

CIVIL ENGINEERING

TEAM 7

Giuliana Marchetti
Matthew Severino
Alexis Decker
Michael Frendo
Akira Dunham

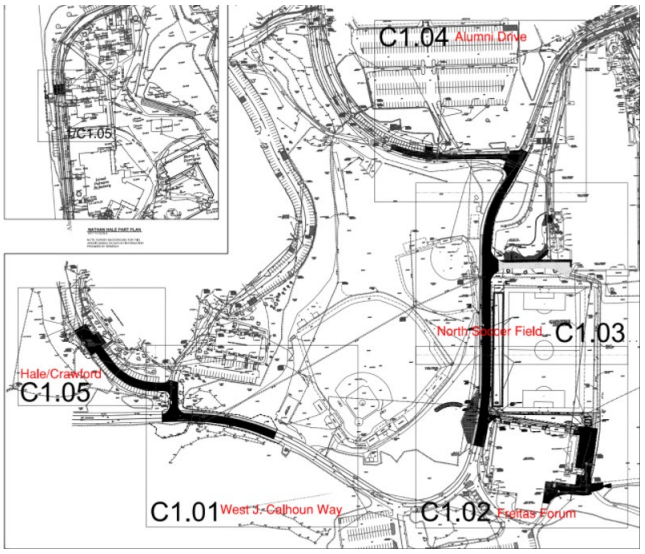
ADVISORS

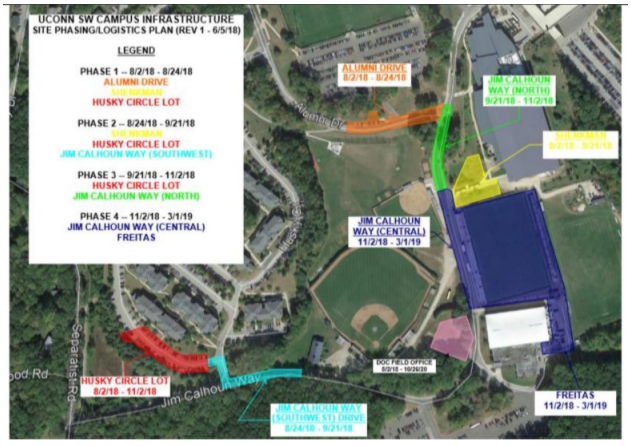
Nicholas Lownes

SPONSOR

Construction Management: Simulation of UConn Southwest Campus Infrastructure Upgrades

The project that has been undertaken is under the guidance of and in partnership with Manafort Brothers, Inc. and pertains to the Southwest Campus Infrastructure upgrades at the University of Connecticut. This project is an existing project with plans that were originally designed by Langan Engineering in 2018. Since the project has already been completed, the goal of the project was to simulate construction management tasks as if the project was being prepared and completed in real time. During the fall semester, our group worked to formulate a bid package that is competitive against actual bid packages that were presented for this project. In order to accomplish the creation of a bid package, steps we took included utilizing quantity estimation software such as Bluebeam to itemize, and then quantify materials, labor, and equipment. Using an RS Means book, base unit cost values for all work breakdown items were derived in order to estimate a final quantity. Following a mock bid, the objective during the spring semester shifted to creating the final deliverable, which includes the addition of a resource loaded schedule via Microsoft Project, a submittal log, and the inclusion of sponsor-chosen material submittals. From these items a work plan was formulated to provide instructions for the general sequence of pre-construction, construction, and post-construction activities and summarize all required resources and safety measures.





CIVIL ENGINEERING

TEAM 8

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Marissa Mottolese
Lauren Romeo

ADVISORS

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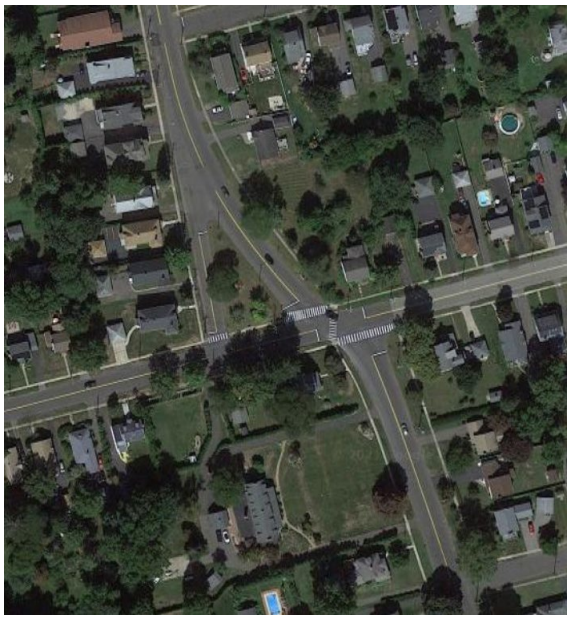
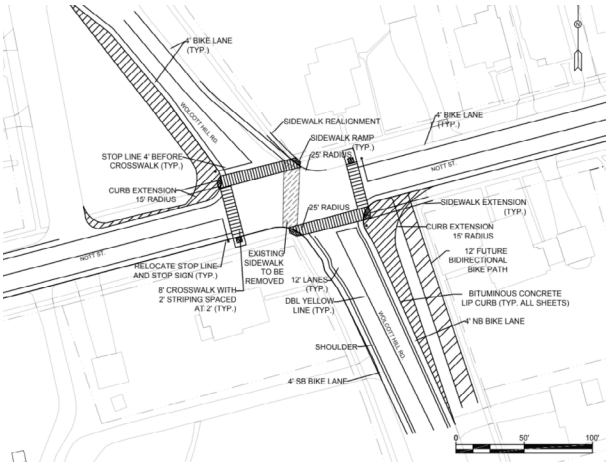
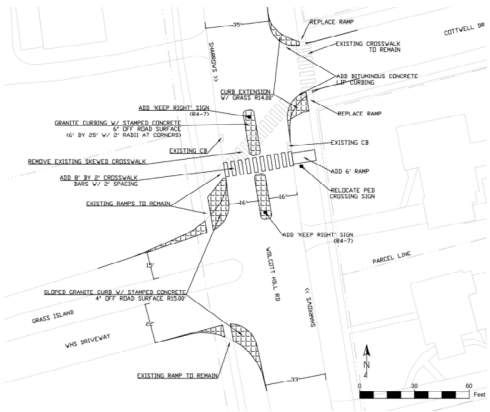
SPONSOR

Town of Wethersfield - Intersection Safety Improvements

The Town of Wethersfield identified fourteen intersections that pose safety concerns to vulnerable road users, including pedestrians and cyclists. Our senior design team was tasked with presenting design solutions to improve the safety conditions at these locations. For each location, we used CAD software to create plans and cost estimates, with the town's feedback implemented. The locations vary from unsafe midblock crosswalks to offset intersections to railroad crossings. Our proposals use a variety of new urbanism tactics to reduce the risk of collisions, especially with pedestrians and cyclists. On many of the roads, bike lanes are proposed as a low budget way for Wethersfield to become more bike-friendly, and pedestrian islands have been recommended to shorten crossing distances. Our plans also address ADA compliance of sidewalks, noting ramps that are too steep or lacking crossing pads. Each location has presented its own unique challenges to the team. In conclusion, these improvements will create safer and more accessible roads for all users in the Town of Wethersfield.







CIVIL ENGINEERING

TEAM 9

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ADVISORS

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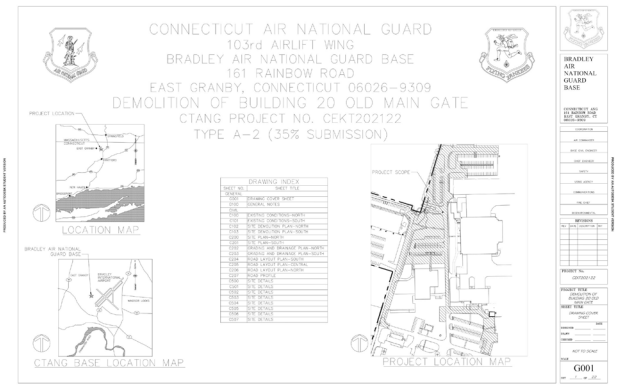
SPONSOR

Old Main Gate Demolition and Site Restoration at the CT Air National Guard

The Connecticut Air National Guard's 103rd Airlift Wing is located in East Granby, Connecticut. Due to the opening of a new entrance at the southern boundary of the base, the Old Main Gate (Building 20) was closed. This closure caused the road network throughout the base to become discontinuous, inefficient, and unsafe. The CT Air National Guard requested a plan to redesign the existing site to ensure connectivity from the newly opened southern entrance to the remainder of base. Survey data was collected to develop a topographic map of the existing conditions. The road network was improved by designing a new continuous main road throughout the base using a horizontal alignment that satisfies AASHTO standards for specific design speeds. Parking lots were expanded to maintain a one-for-one parking spot exchange while meeting ADA compliance, and the existing main road was converted to a pedestrian only zone. Turning radii throughout the base were tested with design vehicles to ensure accessibility. The new main road and parking lot were graded to allow for proper stormwater drainage. A rough order of magnitude cost estimation was developed using data from past projects and RSMeans. A basis of design was created to outline the limitations with the current project scope. The final deliverables included a partially complete 35% design drawing set, cost estimation, and basis of design report to be used for the A/E design service who continues this project once it is sent out for bid.



CIVIL ENGINEERING

TEAM 10

Steven Porter
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Sarah Verity
Nicholas Schiro

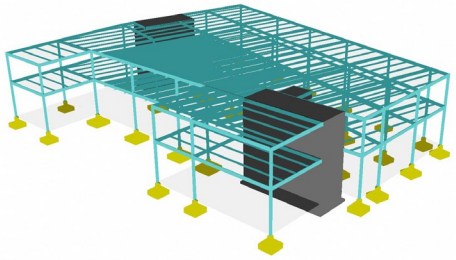
ADVISORS

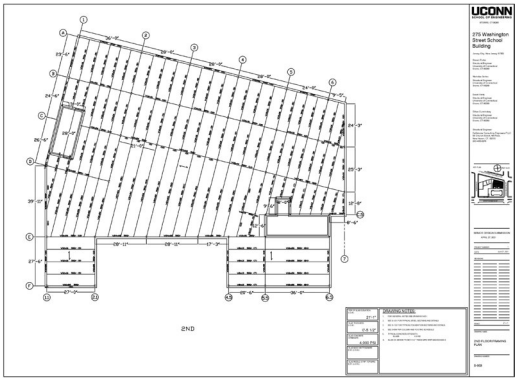
Shinae Jang

SPONSOR

DESIMONE

Steel Frame Design of 275 Washington Street, Jersey City School District





The designed structure is a two-story, 36,850 square foot school building located at 275 Washington Street in the Jersey City School District of Jersey City, New Jersey. This structure is connected to a larger, 53-story residential tower next to the school that has been constructed using a cast-in-place concrete design. The general contractor for the project requested that the school should be built using the same design system for ease of construction. DeSimone requested that the project team use a structural steel approach to create an alternative design to the school in order to compare the economical efficiency with that of the cast-in-place design. The team was tasked with designing all of the gravity members including the foundation, beams, columns, decks, and slabs. For design purposes and for the sake of simplicity, it was assumed that the building stands alone on the construction site and is not connected to the adjacent tower. Geotechnical reports and architectural plans were provided to aid in the design of the structure. The final deliverables of this project include a set of floor plans showing the final designs of the structural members along with the design criteria and assumptions for each section of the project. Furthermore, a takeoff comparison was performed to show the economic efficiency of the steel design when compared to the cast-in-place design requested by the general contractor. The final cost comparison of these two structures show that the construction costs of the Cast-In-Place model would be approximately $863,777.67 while the steel structure designed by the team will cost $743,694.92. This steel frame will not only cost less than the accepted concrete design, but will allow for several advantages in the development of the structure, such as a need for fewer columns which increases the square footage of the entire project, allowing for more freedom in the design and an increase in overall value.

CIVIL ENGINEERING

TEAM 11

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Rinchen Sherpa
Cayla Keenan
Andrew O'Reilly

ADVISORS

Shinae Jang

SPONSOR

3D Modeling and Load Rating of Bridge No. 06053

The goal of this project is to create 3D model of bridge No. 06053 located on Old Pumpkin Hill Road in New Milford, CT. This bridge allows vehicles to pass over the Housatonic railroad. The bridge structure is a 3-span continuous composite rolled steel beam bridge on concrete abutments and steel pier columns. The superstructure of the bridge consists of six steel girders and five steel diaphragms that support the cast-in-place deck. The substructure of the bridge has two pier columns, that consist of steel columns and bracings, that are responsible for distributing all the bridge loads. The 2018 Average Daily Traffic record for this bridge is 644,4% of which are trucks. For this project, our team was required to use the inspection reports, as-built drawings, design codes, and sample calculations to create a 3D model and run a load rating analysis. Using MicroStation we created a 2D drawing of the superstructure (girders, end and intermediate diaphragms, deck) of the bridge and then imported it into MIDAS Civil 3D where we added the substructure (pier caps, pier columns, bracings) and then ran the load rating analysis. In this procedure, we were required to perform dead and live load calculations by hand and write up a load rating report that contains the results of our 3D analysis and hand calculations all of which were validated by our sponsor, who is a load rating engineer. Lastly, this project required the design of a new pier column section which was necessary to have bridge No. 06053 in compliance with section 1.3.7 Minimum Acceptable Rating Factors from the CT bridge design manual.

CIVIL ENGINEERING

TEAM 12

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Hernan Cortez Jr.

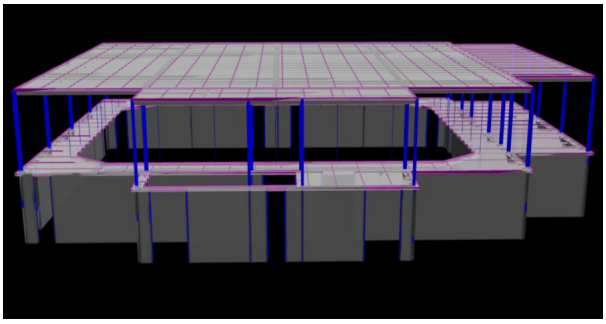
ADVISORS

Shinae Jang

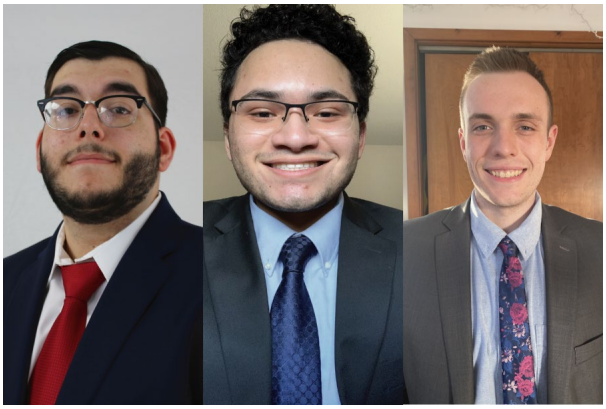
SPONSOR

Conlon Engineering, LLC

Superstructure Design - St. Matthew's Recreation Center - Norwalk, CT



St. Matthew's Recreation Center (SMRC) is an 8000 square foot gymnasium and community recreation center built as an addition to St. Matthew's Parish on Scribner Avenue in Norwalk, CT. The structure was originally designed by Conlon Engineering, LLC and features 2 basketball courts, a floating track, weight room, and full locker rooms. St. Matthew's Parish hopes that this new space will provide a place for healthy community engagement activities for its 3000 parishioners. Civil Engineering Team 12 was tasked with designing the superstructure of SMRC and performing a cost analysis on the proposed design. All structural steel beams and columns were modeled and designed using RAM Structural System and critical sections were checked by hand to affirm the software output. Reinforced concrete masonry walls, wall footings and isolated column footings were designed by hand using information compiled from geotechnical reports as well as loading outputs from RAM. The roof system is a traditional gabled beam-rafter system, with ridge and valley beams supporting sloped rafter beams. The lateral wall system is composed of grouted, reinforced concrete masonry walls surrounded by a steel frame made of W-section beams and Square HSS tube columns. The floating track was attached to the Masonry walls on its outer edge and hung from the roof system using hanging columns on the inner edge. The structure was designed using the Connecticut 2018 IBC and AISC LRFD load combinations for all steel members. Masonry walls were designed using ASD load combinations. All members were designed to achieve about a 70% utilization of total capacity in strength and deflection to produce a safe design and to allow for future modifications to be made to the building without drastically changing the superstructure.



CIVIL ENGINEERING

TEAM 13

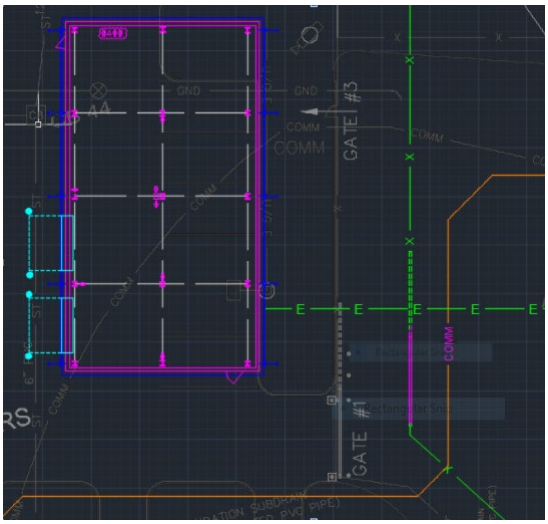
Lariab Afzaal
Diego Rivera
William Pappas

ADVISORS

Shinae Jang

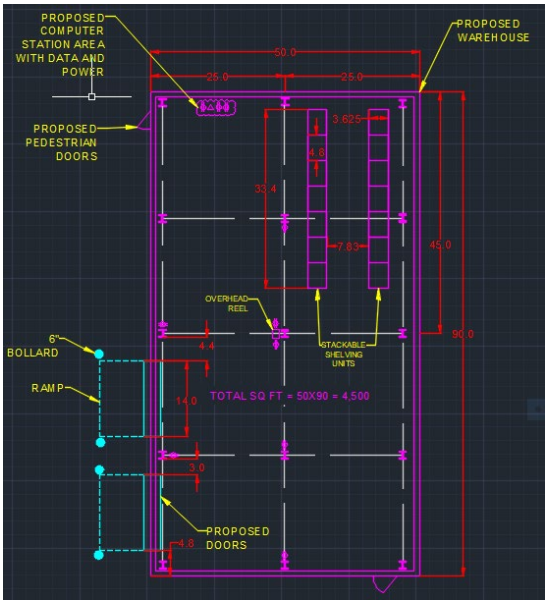
SPONSOR

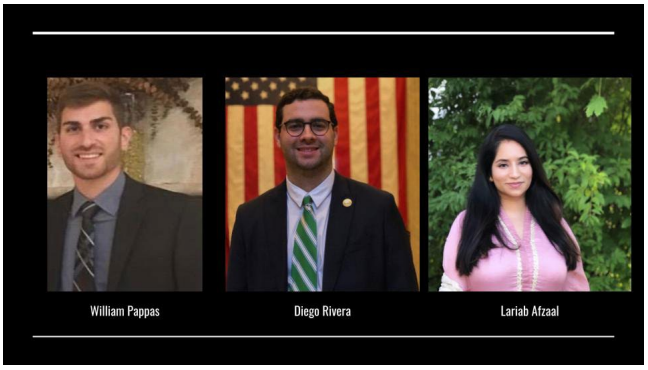
Base Supply Warehouse



The goal of this project is to build a new warehouse for the 103d Air Control Station to facilitate the Air Force team in Orange, CT. The warehouse will be used to store equipment and to maintained vehicles. Currently, large quantities of readiness equipment and materials are stored outdoors or in temporary locations due to the lack of space. These current methods of storage reduce the functional lifespan of the critical equipment. Therefore a new improved warehouse facility can produce a return on investment by extending the equipment service life and reducing maintenance costs.

Our team designed a 50'x90' warehouse based on design constraints of the Air Force code. The warehouse has a stackable shelving unit for the storage of equipment and 2 roll up doors for the entry/ maintenance of vehicles, with two pedestrian doors. Inside the warehouse are a set of outlets which can be used to power desktops and also power the crane being used in the shelving unit. In addition, the team proposed the relocation of a communications line, which runs right underneath the proposed project site and new fencing placement for security The design includes a new drainage line to dispose of the wastewater to the nearest catch basin, and downspouts to eliminate water runoff on the pavement. A new electrical conduit line will be run from the base transformer. The warehouse is proposed to be built adjacent to the communications tower to mitigate disturbance and to ensure an ample amount of space. A demolition plan shows the area being disturbed, including five parking spaces being affected and the curb in front of the communications tower, along with the wire fencing used alongside the tower. The roof will be sloped and need metal paneling to accommodate the heavy snow loads. A SAP2000 model was used to assess wind, dead, and live loads. A door schedule is included with the plans which shows the dimensions of the doors being used. A cost estimate was also provided for building expenses.





CIVIL ENGINEERING

TEAM 14

Michael Vaccaro Jr.
Garrett Collins
Matthew Luddy
Mateo Arias

ADVISORS

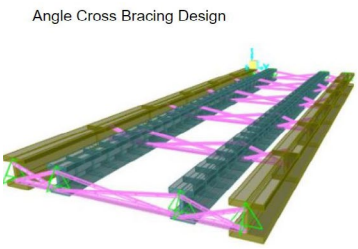
Shinae Jang

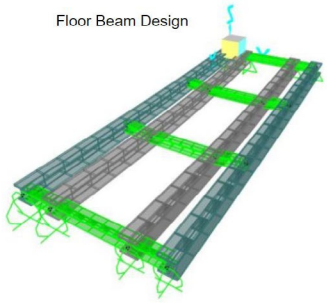
SPONSOR

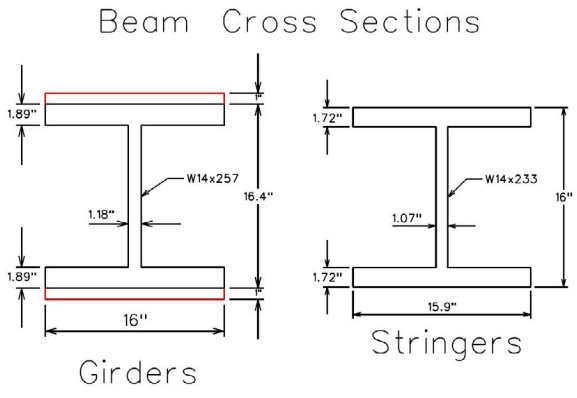
Replacement of Railroad Bridge 08077R Over Bruce Avenue in Stratford, CT

The Connecticut Department of Transportation (DOT) has identified a three-mile-long section of track between Bridgeport and Stratford, CT where several track improvements will be made to increase the maximum allowable speed from 70 mph to 90 mph. To accommodate this speed increase, the DOT aims to replace existing open deck bridges with ballasted decks, providing a more consistent environment with the adjacent tracks. To this end, our team designed a ballasted deck bridge to replace one of the open deck bridges passing over Bruce Avenue in Stratford, CT.

Bridge 08077R, the current structure, carries six tracks across a 32.5-ft span and serves as one of the critical links for Amtrak. Of these six tracks, one is not currently in use, but we have considered this track to be live to provide the DOT with the flexibility of using the extra track in the future. The DOT challenged our team to complete a full analysis of the dead, live, wind, and impact loads, as well as the design and selection of the main load-carrying elements of the structure.
All structural members, including the stringers and girders, were designed following the American Railway Engineering and Maintenance-of-way Association's (AREMA) design manual. Furthermore, we provided our sponsors with the expected moments and reactions, a cost estimate, and a load rating report. Our team used Microstation to draw the framing plan of the current structure, SP Beam to aid in the concrete design process for the bridge deck, and SAP2000 to check the accuracy of our hand calculations and fine-tune our member selections. Throughout the design process, our team was careful to keep the overall depth of the bridge consistent with the original structure to maintain the clearance below the bridge and to preserve the current vertical track alignment. With these criteria in mind, we have created two models for a ballasted deck bridge using both a floor-beam layout and a more cost-effective lateral bracing solution.







CIVIL ENGINEERING

TEAM 15

Matteo Coletta
Jucar Lopes
Kevin Morales
Chris Rojas

ADVISORS

Richard Christenson

SPONSOR

wsp

Type Study Report for Replacement of Bridge No. 023008 in Canton, CT

WSP has been retained by the town of Canton, CT to perform a bridge replacement project for Bridge #023008. Our senior design group was tasked by WSP to complete a type-study report with different alternatives that could potentially be used to replace the current structure. The existing structure has a steel arch with a span length of 16'-4", curb-to-curb roadway with 18.0' and out-to-out width of 26'-3". The type study will incorporate preliminary design of civil, environmental, hydraulics, and structure alternatives as required to complete the type study. The project will follow the latest state and federal codes/standards, including Connecticut Department of Transportation Bridge Design Manual and AASHTO LRFD Bridge Design Specifications. The scope of the project will consist of two phases; investigation phase and type study development. The investigation phase will consist of gathering all required resources, such as, federal and local design standards and manuals relative to the completion of a structure type study. Our team will obtain an adequate understanding of the requirements to determine the best structure type depending on the location and geometry of the bridge. The type study development will consist of creating a structure type study with three alternatives to determine a preferred structure type relative to each of these alternatives. They are going to be carefully analyzed and we will have to take into consideration the dimensions, parameters, and quantities for each bridge alternative for the location and size of the bridge. The studies should also consider the safety, serviceability, maintainability, constructability, permit requirements, economics and aesthetics of the proposed structures. The type study will be presented in a professional format and incorporate preliminary structural analysis of the alternatives.

CIVIL ENGINEERING

TEAM 16

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Francisco Fadhel
Harren Mistry
Andrew Nyman

ADVISORS

Richard Christenson

SPONSOR

CTDOT Bridge Design and Replacement

For our team's project, we have been working with the Connecticut Department of Transportation on the redesign and replacement of a bridge that is currently in disrepair, located in Thompson, CT. The constraints of this project included the ability for a community-serving detour to be put in place during construction, as well as being able to effectively divert water using a cofferdam along with a sufficiently large culvert pipe and water pumps to ensure a dry work area. For this project, our superstructure designs were created by utilizing AASHTOWare software, and our abutment sub-structure was analyzed using Staad.Pro. Especially when putting together the various components of the superstructure such as the deck, parapet, and girders, a vast database of pre-made components were available. It also allowed for load analysis to be far more streamlined and efficient since it cut out a large portion of any potential hand calculations. Ultimately, our group gained a rudimentary understanding of some of the potential applications of AASHTOware within the realm of bridge construction.

A big decision that was made in order to complete the design for the bridge were two design alternatives of either: a concrete box-beam support or a rolled steel beam support. Ultimately, we decided on a final design of a steel girder bridge as it is much easier to design and implement a rolled steel beam than a reinforced, pretensioned concrete beam. In addition to this, our design will use an integral bridge abutment in order to protect the beams from degradation in their structural integrity, therefore extending the service life of the bridge. The design also includes piles placed in the ground that will act as reinforcement for the precast abutment blocks. Once these are in place, the steel girders can be seated atop the abutment, where their ends will be cast into the abutment to complete the integral abutment.

CIVIL ENGINEERING

TEAM 17

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Melanie Makula
Jacob Mele

ADVISORS

Richard Christenson

SPONSOR

NATIONAL INSTITUTE FOR UNDERSEA VEHICLE TECHNOLOGY

NIUVT Retrofit Project

The basis of the NIUVT Retrofit Project is an old Facilities Operations Building located on the University of Connecticut's Avery Point campus. This building was constructed in the same era as the ornate Branford House located on the other side of the Avery Point campus, but was not maintained to the same standard as the Branford House. Due to its current usage as a garage for Avery Point Facilities Operations, NIUVT saw potential in the building for a research and collaborative facility for aquatic projects in cooperation between UCONN, the University of Rhode Island, and the U.S. Navy. This group's task was to research the building and the codes associated with the renovation of a historic building, and redesign the layout of a building to become suitable lab space on the first floor, and a flexible collaborative space on the second floor. The attached reports will detail the process of designing the new interior of the building, as well as the different obstacles that shaped our design in both the constraints of the building, the budget, and the regulations that must be upheld by this design. Included in the reports are three different iterations of the design that handle the requirements of the design similarly yet differently, while making use of the same space.

CIVIL ENGINEERING

TEAM 18

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Collin Davis
Eric Dewitt

ADVISORS

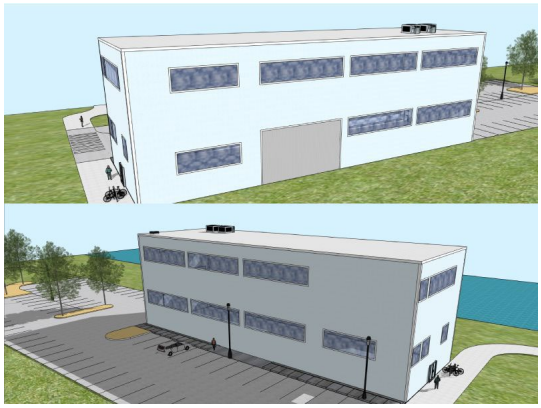
Richard Christenson

SPONSOR

NATIONAL INSTITUTE FOR UNDERSEA VEHICLE TECHNOLOGY

NIUVT Research & Innovation Center - New Construction

The National Institute for Undersea Vehicle Technology (NIUVT) at the University of Connecticut (UConn) is exploring the development of a potential Undersea Research and Innovation Center at UConn's Avery Point Campus, to support the development, acceleration and commercialization of technologies for use in both the undersea vehicle and offshore wind industries rapidly developing in Southeastern Connecticut. This project included an investigation phase to determine the most appropriate and cost-effective location and type of facility for the Undersea Research and Innovation Center. A development phase to create a conceptual design including a preferred structure type and design with cost estimate was also completed. In this new construction project, identification and comparison of different feasible locations on the UConn Avery Point campus have been considered. As a result, our team has developed a building design that is feasible, cost effective, and meets necessary requirements given by the client. In addition to this we have provided three alternative options of roof types that can be implemented with the design, including a simple flat roof, an extensive green roof, and a pitched roof.



NIUVT: RESEARCH & INNOVATION CENTER - NEW CONSTRUCTION

CIVIL ENGINEERING

TEAM 19

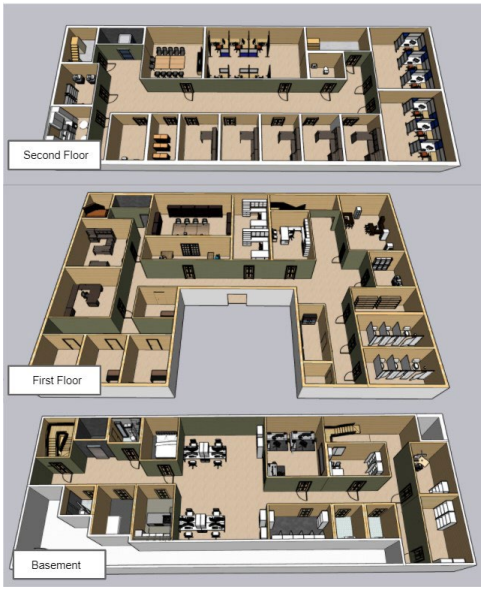
Liam Hanley
Kwadjo Bedjrah
Sovannarith Touch
Ben Schade

ADVISORS

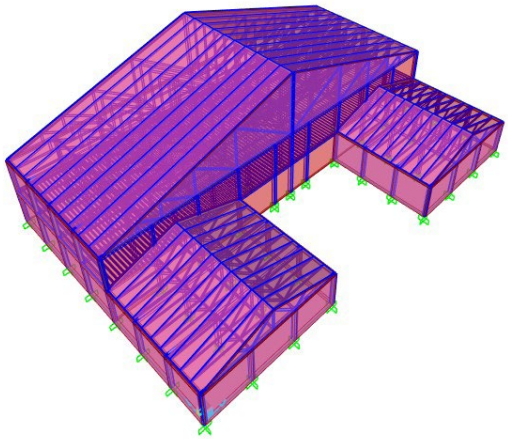
Alexandra Hain

SPONSOR

Bolton Town Hall Expansion



Civil Engineering Team 19 was tasked with developing a preliminary design of an addition to the Bolton Town Hall. The increasing working occupancy of the building and lack of space have been problematic for the town employees. These suboptimal working conditions cause disorganization and a lack of proper movement. Due to the building's age and previous use, it is not ADA accessible. This prevents some town residents from conveniently visiting their Town Hall. In addition, the town hopes to incorporate a FEMA compliant Emergency Operation Center in the new building to handle communicating with the town in major storm events and emergencies. The main goal of our team is to provide the Town with a preliminary design that is economical, accommodates their needs, and can be used as a springboard for a final design. Town leadership expressed their interest in keeping the current structure on the National Register of Historic Places, which meant very minimal work could be done to the face of the current Town Hall. The town opted for a design of a new standalone building located on a parcel of land west of the original Town Hall. Planimetric maps and SketchUp models were created to show the imagery aspects of the project. SAP2000 was used for structural analysis in order to make sure the building can safely withstand the snow, seismic and wind loads that Connecticut structures experience.



CIVIL ENGINEERING

TEAM 20

Brian Lassy
Christian Mack
Enrique Cubillas
Ethan Hoffman

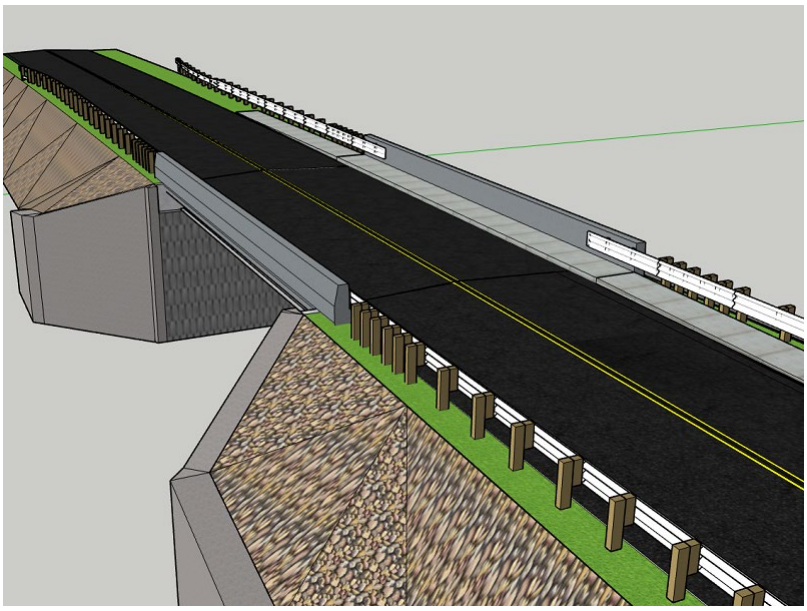
ADVISORS

Alexandra Hain

SPONSOR

CHA

Superstructure Redesign for Jordan Cove River Bridge



Civil Engineering Senior Design Group 20 has been tasked with the evaluation, selection, and completion of a type-study for the replacement of the superstructure of the Jordan Cove River Bridge in Waterford, CT. After the original concrete T-beam bridge, built in 1936, was deemed structurally deficient, CHA Consulting delivered a final design for a prestressed concrete bridge to the Town of Waterford in 2013. This senior design project focused on furnishing CHA with a type-study design of the same bridge using steel plate girders. The team provided an evaluation of environmental and social impacts for the bridge construction, including stormwater runoff, utility management, and road closure safety concerns. An in-depth design was conducted for the superstructure using design standards such as AASHTO, AISC, ACI, and the Connecticut Bridge Design Manual. The overall design process followed the Federal Highway Administration guidelines for a single-span steel girder bridge. Structural design software including SIMON and SPBeam were utilized for generating loading plans and designing the preliminary elements. These designs were then analyzed with hand calculations to provide a quality control check. Modeling was finalized in AutoCAD, SketchUp, and SolidWorks for visual representations of the superstructure. The team employed management and budgeting techniques for the engineering design phase, developing a schedule that provided an accurate timetable for the entirety of the project.

CIVIL ENGINEERING

TEAM 21

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Robert Watson
Lang Cao

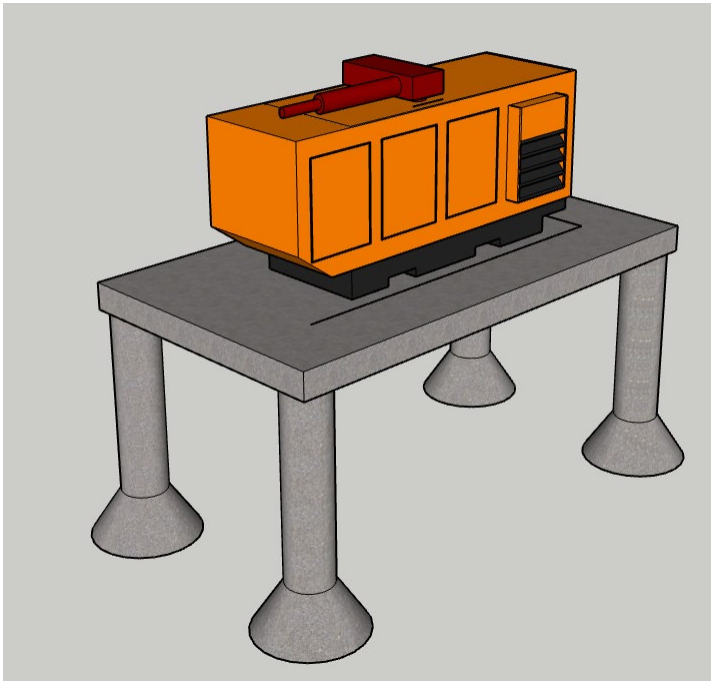
ADVISORS

Alexandra Hain

SPONSOR

Replacement of the Uninterruptible Power Supply at the Wallingford Train Station

Civil Engineering Senior Design Team 21 was responsible for designing the site for an alternative emergency power supply for the Wallingford, CT Train Station to replace the aging Uninterrupted Power Supply. This power supply allows fire suppression, emergency lighting, and electric features of the station such as elevators, signs, ticketing booths, and speakers to remain active during power loss. Considerations for the project included allowing full access to the train platform and keeping handicap accessible entries open during and after construction. Additionally, the power supply must be able to power the station for up to a week. The team explored numerous options for a power supply including a new Uninterrupted Power Supply, several types of generators, and a hybrid combination of the two. Multiple factors were explored to consider economic and environmental drawbacks when making this selection such as power capacity, fuel sources, and lifespan of the unit. Multiple locations were considered to place the power supply, each with their own benefits and drawbacks. Structural load calculations were performed with the provided geotechnical data to design the foundation. Construction staging plans and schedules were created, as well as a thorough project cost estimate including materials, labor, and equipment fees. The project will go to construction in 2024 where the CTDOT will use Team 21's design package for reference while reviewing contractor bids.



CIVIL ENGINEERING

TEAM 22

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Kevin Mulumba
Hazem Salem
Thomas Majchrzak

ADVISORS

Alexandra Hain

SPONSOR

MOHAWK NORTHEAST, INC.

Design of Deck Demolition Plan for a 110-ft Span on the Arrigoni Bridge

Due to corrosion of reinforcement and deterioration of concrete, the Arrigoni Bridge in Middletown, CT is in need of bridge deck repairs. The replacement of the concrete deck requires a demolition plan for the existing structure. To develop the plan, Team 22 considered alternative methods for deck removal and performed structural analysis to ensure stability of the bridge and the safety of its users during demolition. The methods considered include jack hammering, hydrodemolition, and saw cutting. After review of the cost and environmental impacts, saw cutting was selected. This method allows for a quick and easy penetration of the concrete deck that requires less than jack hammering and is less costly than hydrodemolition. Hydrodemolition also produced water runoff that could impact the river below. The demolition plan allows for continued use of the bridge for vehicle drivers and is pedestrian, worker, and environmentally friendly. Sidewalks will remain open for the duration of the project to maintain access for pedestrians. The structure was analyzed at multiple points to ensure stability of the bridge was maintained once the deck is removed.

CIVIL ENGINEERING

TEAM 23

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Marissa Mastrianni
Eric Piccolo
Bret Achin

ADVISORS

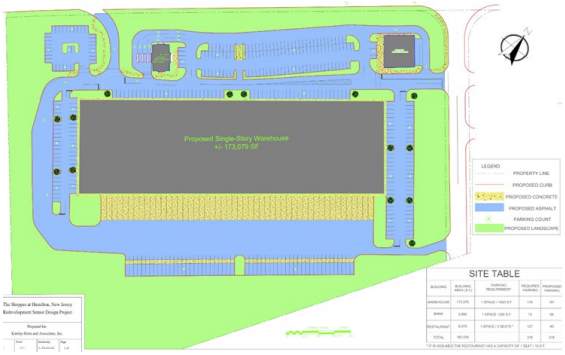
Manish Roy

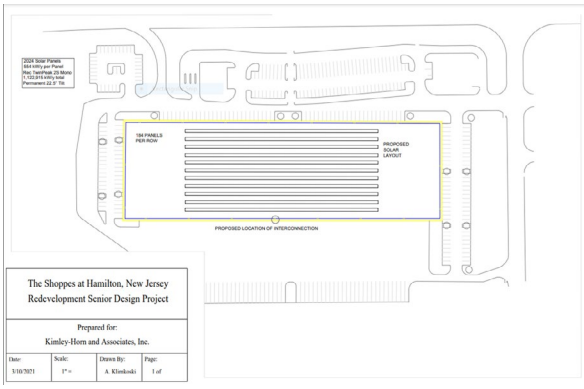
SPONSOR

Kimley»Horn

Shoppes at Hamilton Industrial Redevelopment Project

The University of Connecticut's Senior Project Inc. has been contracted by the sponsor Kimley-Horn & Associates to prepare a full solar & land development design in Hamilton, New Jersey. The property is currently home to The Shoppes at Hamilton, comprising 120,000 SF of retail space with two pad sites (a bank and a restaurant). The Shoppes at Hamilton opened for business in 2009, but the shopping center had issues immediately. One of the biggest issues this site faced was particularly due to a lack of direct access to the site from Route 130 South. While a jug handle and traffic light have since been implemented in an attempt to provide better access, the shopping center has still struggled to maintain tenants over the years. As a result, our indirect client, Metrix Real Estate Services, would like to redevelop the retail portion of the site to replace it with a +/-170,000 SF solar powered industrial warehouse. A project team has been assigned to work with Kimley-Horn & Associates to design and develop a plan of action for this site.





CIVIL ENGINEERING

TEAM 24

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Domenica Lopez
Benjamin Koss
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ADVISORS

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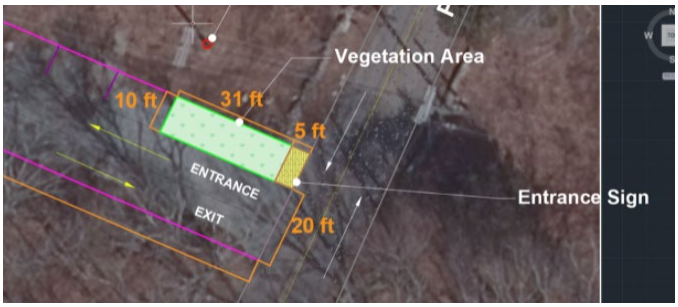
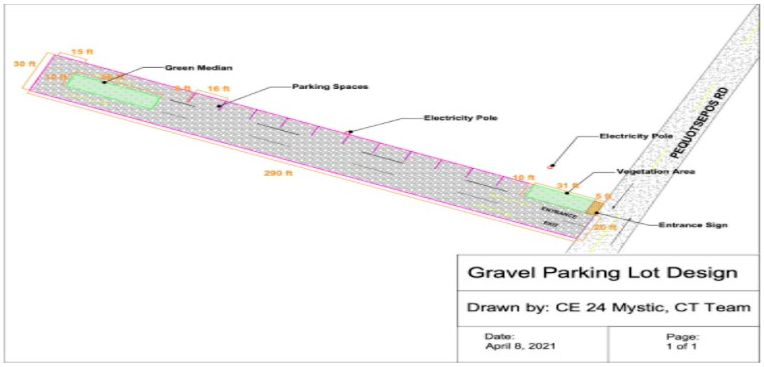
SPONSOR

STONINGTON CONNECTICUT

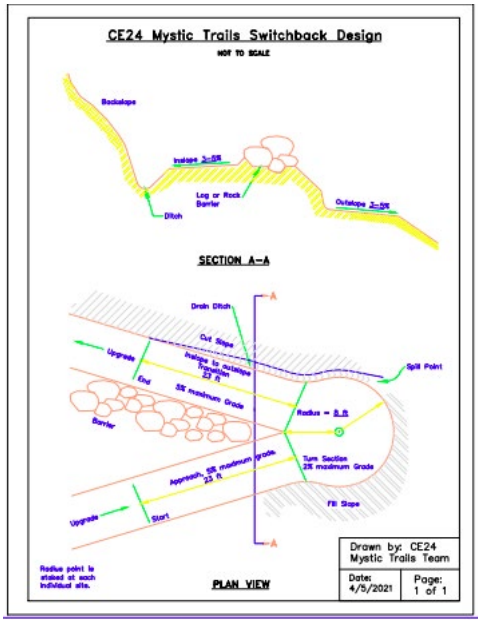
CE24 Design of Off-Road Trails as an Alternative Transportation Network in Stonington (Mystic Trails)



Our project's overall goal was to develop a network of off-road trails that would essentially serve as an alternative transportation network to link both the bicyclist and pedestrians in the town. We focused primarily on promoting access and commuter safety for non-automobile users while also establishing certain procedures that don't interrupt the existing landscape. We advanced the prior recommendations made including specific trail locations, wetland and road crossings, trail signage, permitting, cost estimates, parking lot recommendations, and long-term maintenance considerations. Overall the goal was to create better access by building off the Eversource electric transmission line right of way that cuts through Denison Homestead property.



To solve the problem of a lack of access, a simple yet effective solution could be bridging the gap between Pequotsepos Rd and the River to Forest Trail, as the Denison Homestead and Nature Center are easily accessible from near the road. In order to create access, a trail switchback following the path cleared out by the Eversource ROW could serve as this connector trail. In order to solve the problem of steepness, we designed switchbacks that would allow for a greatly reduced slope by using the zig-zag design. This ultimately allows for an increase in net trail distance allowing for an increase in accessibility to the walking path. A gravel parking lot off of Pequotsepos Rd would also contribute to access by allowing cyclists to park at either Coogan farm or the end of this proposed trail switchback. The close proximity between the two helps bridge any disconnect there may have been before. In addition to increasing the connectivity and improving the accessibility of the trail, we also designed a single unified system throughout the trail. These signs will allow for a better understanding of both the background of the trail and how all these locations interact with each other in terms of walkability, connectivity, and history.



CIVIL ENGINEERING

TEAM 25

Connor Glassel
Karriem Folger

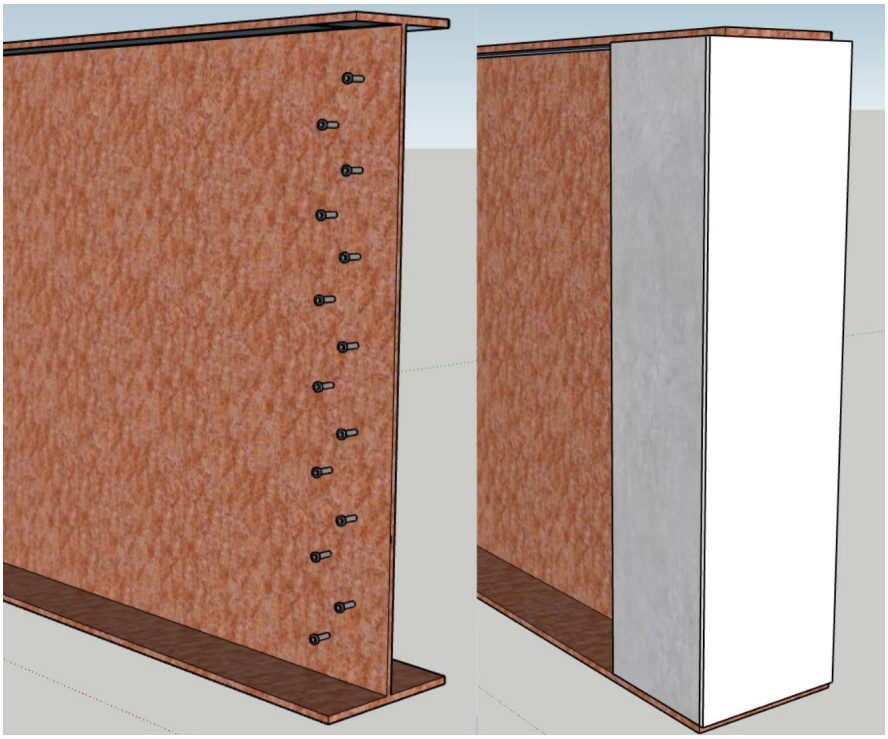
ADVISORS

Alexandra Hain

SPONSOR

UCONN
SCHOOL OF ENGINEERING
CIVIL & ENVIRONMENTAL ENGINEERING

UHPC Beam End Encasement for the Construction of Maintenance Free Steel Girder Bridges



Degradation of beam ends on simple span steel bridges is a recurring issue for the Connecticut Department of Transportation. Corroded beam ends present safety concerns for the travelling public as section loss reduces the capacity of the beams, and is costly to repair. To mitigate these costs, bridge designers have begun gravitating towards maintenance free designs. This project primarily focuses on the viability of Ultra High Performance Concrete (UHPC) encasement as an efficient alternative for the design and construction of maintenance-free steel bridges. In this design, a UHPC bearing column replaces the typical steel bearing stiffener. UHPC is used to encase the beam ends over bearings and shear studs welded to the web, transfer the load from the beam to the UHPC column, and finally to the bearing. A traditional bearing stiffener design using AASHTO LRFD was compared to a UHPC encased design using the UConn guidelines for beam end encasement for a sample single span bridge. To obtain unfactored loads and assess necessary demands, LRFD Simon was utilized . With the final design complete, the team will perform a cost analysis of the encased design compared to currently used methods to reduce corrosion including weathering steel, galvanization, and metalization.

COMPUTER SCIENCE AND ENGINEERING

TEAM 1

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Seth Fortin
Brandon Mello
Qianlong Wu

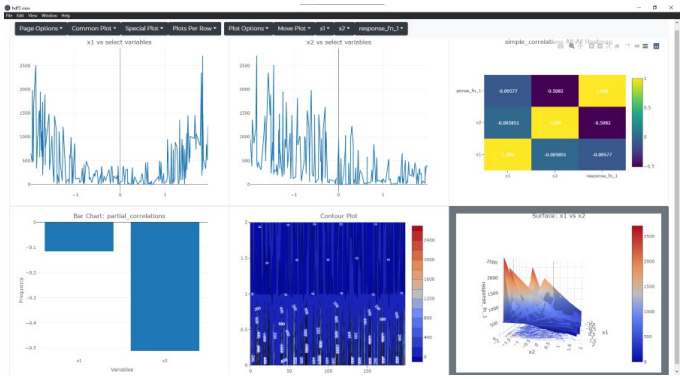
ADVISORS

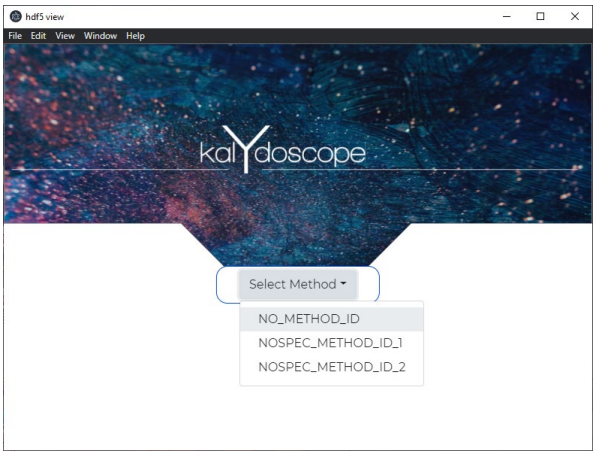
Yufeng Wu

SPONSOR

Carrier

HDF5 Interpretation and Visualization





The sponsor of this project, the Carrier Corporation, uses state-of-the-art technologies for model-based systems engineering (MBSE) of complex systems. One of the model-based design toolkits employed by Carrier is a software called Sandia Dakota. The Dakota software uses a file format known as HDF5 to contain the outputted information from the analysis results. Dakota's HDF5 output files have a difficult structure to follow, in turn producing results which are difficult to interpret. Carrier is looking to develop a method by which they can automatically process such HDF5 files and make more efficient use of the information contained within them. Leading into the project which the team has been presented by the company: develop an application which can seamlessly parse an HDF5 file produced via the Dakota application, and use the information contained within the file to provide the user with an interface in which they can better analyze and visualize the information contained within. The application is a desktop application which is capable of reading and processing HDF5 files and utilizes web-based technologies in order to create a pleasant and intuitive interface allowing users to extract significant information from HDF5 files through producing versatile plots and visualizations of the data contained in various ways. The application will allow the Carrier team to easily visualize the results of methods, compare and contrast variables, find optimal values, and more. The application grants users the ability to create a variety of custom visualizations from the datasets contained within a wide-array of user provided HDF5 files. This application was developed using the Electron software framework, React and Bootstrap components, as well as the H5PY and Plotly libraries for data processing and visualization generation.

COMPUTER SCIENCE AND ENGINEERING

TEAM 2

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Eric Hilhorst
Paul Zaffetti
Michael A. Taylor

ADVISORS

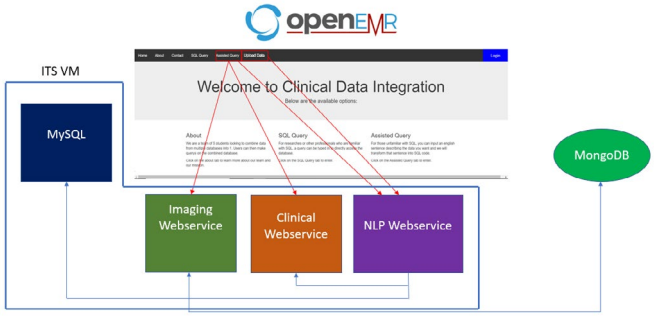
Dong-Guk Shin

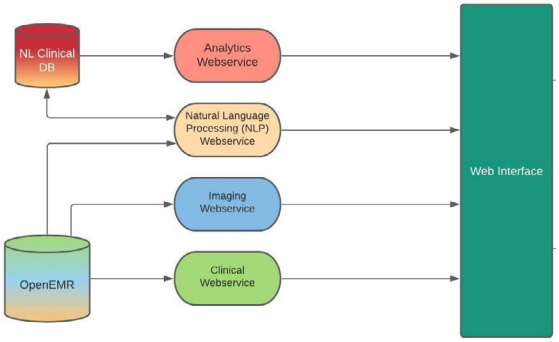
SPONSOR

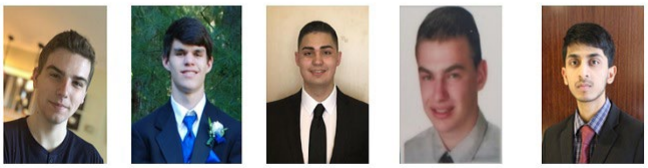
UCONN
SCHOOL OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING

SmartEMR Using Clinical Data Integration

SmartEMR is a web-based application designed to empower doctors, nurses, and other healthcare professionals to gain better insights into stored electronic medical records, or EMRs. *SmartEMR* leverages powerful machine learning tools to provide analysis on key free-form data types, including clinical notes and medical images. The system is implemented through a microservice architecture and exposed to the user through a secure web interface. The frontend for *SmartEMR* is built from the ground up for usability, security, and scalability. The site uses a simple tab-based navigation scheme to access various data analysis services, minimizing the learning curve for users to begin analyzing their patient data. The first of the system's microservices is a natural language processing service. The service is mainly accessed via the *SmartQuery* engine, which prompts the user for plain-English input queries and converts them to formalized SQL statements that are then executed and displayed. In addition, the service can tokenize, or parse, key prescription information from free text. The key function of the analytics web service is to create insightful data visualizations from plain-English queries. This service works in tandem with the natural language processing service to create the user-experience present in the *SmartQuery* engine. The imaging microservice is responsible for storing, updating, classifying, and returning relevant medical images. The site uses several established endpoints to allow for the uploading of medical images to new or existing patient profiles, to query images using natural language, and to classify medical images and return their relevant descriptors. The final microservice in the *SmartEMR* architecture is a clinical web service designed to generate sophisticated sample patient data. The service uses an algorithmic data creation scheme designed to produce extremely realistic patient histories that use genetics to predict physical attributes.







COMPUTER SCIENCE AND ENGINEERING

TEAM 4

Prithvi Guddera
Justin Gallicchio
Junkai Wu
Anthony Doyle
William Hemingway

ADVISORS

Phillip Bradford

SPONSOR

Phillip Bradford, Gideon Samid, Stephen Rust, Steve Davis, and Daniel Schwartz

Unary Cipher

The unary cipher shown in this application is a variation of the very popular Vernam Cipher or One-Time Pad. This ciphertext is absolutely secure, no matter the strength of the computer trying to crack it. This is because the ciphertext does not commit to the plaintext. As an example, if a message of “Hello World” is sent, the Unary Cipher may create a ciphertext that when deconstructed with the wrong key, will result in the message “I’m hungry”. Due to the number of different keys that can be used to decrypt to meaningful plaintexts, even if a computer were to find every possible key, there is no guarantee that the one chosen will even be the correct plaintext. The best part of Unary, is that the same key can be used over and over again. This cipher is convenient, useful, and most of all, very secure.

To learn more about Vernam: https://en.wikipedia.org/wiki/One-time_pad

To learn more about the cipher, you can read the full paper here: https://eprint.iacr.org/2020/389/20200524:211603

COMPUTER SCIENCE AND ENGINEERING

TEAM 5

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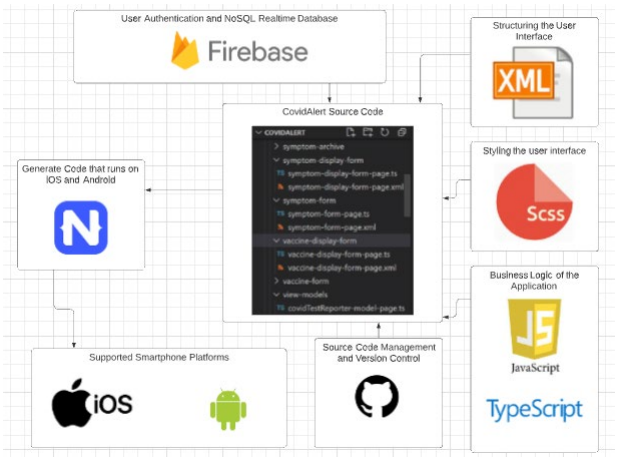
Hanna Aknouche-Martinsson

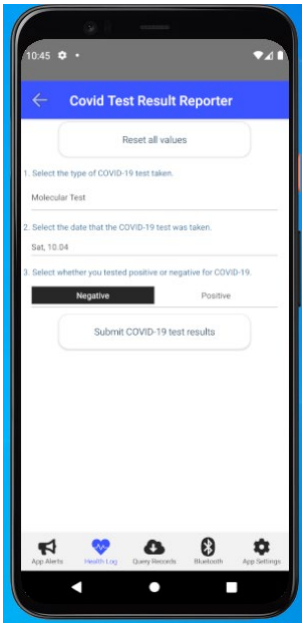
SPONSOR

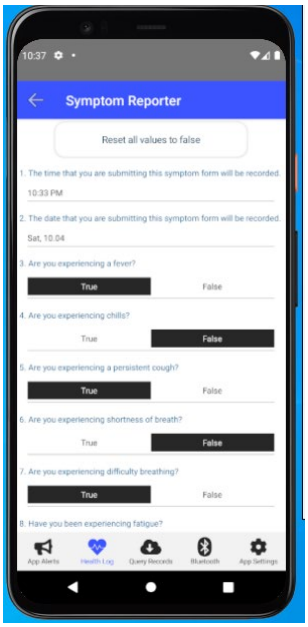
UCONN SCHOOL OF ENGINEERING
COMPUTER SCIENCE & ENGINEERING

Covid-19 Contact Tracing and Stochastic Risk Analysis App



Our group sought to develop a Contact Tracing and Risk Analysis application that was aimed at providing a community like a university with a tool to combat the spread of Covid-19. To achieve this objective and lower the barriers to adoption, the application was designed to work on both Androids and Apple iPhones. Rather than writing two separate sets of code, our group used an open-source framework called Nativescript that is used to develop mobile apps on iOS and Android simultaneously. The application was written in Typescript, JavaScript, XML, and SCSS. The group also used the Google Firebase platform for user authentication, and as a NoSQL Realtime database. User authentication pertains to verifying the identity of a user through account creation and login. In terms of what was accomplished by the team this semester, users are able to submit a variety of data forms that ask about their Covid-19 and flu vaccination status, Covid-19 symptoms as outlined by the CDC, and the results of any Covid-19 tests taken. Users are able to query these data forms by specifying a maximum quantity of data forms to retrieve, the type of data form to retrieve, and a date and time range between which to query the database. Users are then able to review the results of these queries. Accounts are associated with a unique ID generated by Firebase. All data in the database is stored with the ID as part of the path. This was done to make it efficient to perform a query. The entire database is not searched when a query is performed. The query is localized to a region of the database using the unique user id. A logical next step for the project would be to use Bluetooth to log when two authenticated users are in close proximity for a duration of time above a threshold such as 5 or 10 minutes. Then users can be informed at some point in the day that they have been in close proximity to someone who has been exhibiting symptoms of Covid-19 or who has self-reported a positive Covid-19 test.





COMPUTER SCIENCE AND ENGINEERING

TEAM 6

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Keegan Yao
Soumya Potu
Sohum Patel

ADVISORS

Ion Mandoiu

SPONSOR

CGI

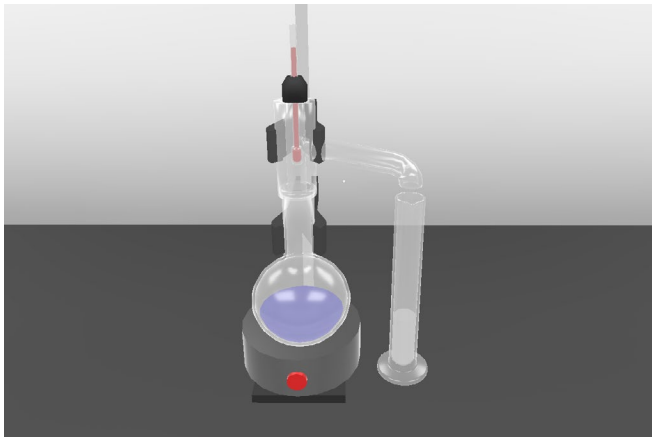
AR/VR Training [Lab Training Simulation]

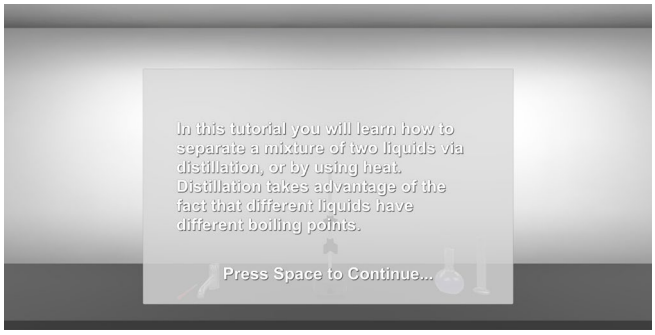
Our project, Lab Training Simulation, is a virtual reality lab environment where users can perform either of two labs. We implemented two different experiments. The first was a Biology lab: *Transpiration & Photosynthesis* that allows users to learn the process of photosynthesis. We also implemented a Chemistry lab: *Distillation of Cyclohexane-Toluene* from which users can learn how a mixture of two different solutions can be separated by heat.

To implement this project, we mainly used Unity, an established, free platform for XR development and Blender, a free and open-source program for building 3D models from scratch. In Unity we were able to create a lab environment, add our assets (lab equipment) and write scripts to take the user through the steps of the lab. We used blender to make specific lab equipment that was not already available to us in Unity's free asset store. We also used Windows Standalone as our platform to export our project. Users are able to download the executable from a website and then run the program locally on their device.

We wanted to make this project the best possible learning experience it could be for the user, so we focused on making it interactive and adding different learning components. These learning components included two different modes: a tutorial mode and a quiz mode. In either mode the user would be able to interact with the lab equipment and complete the steps themselves. The tutorial mode outlines the steps for the user to follow. The quiz mode allows the user to complete it themselves and tells the user if they've made an error and need to start over.

Apart from just making our project a quality learning experience, we found a couple of key benefits to the virtual reality lab setting including. These benefits include visualization of safety protocols and lab procedures, speedup of long experiments or slowdown of fast experiment, and studying how modifying the procedure impacts the experiment without risk of causing harm.





COMPUTER SCIENCE AND ENGINEERING

TEAM 7

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Danny Zarate-Romero
Azlan Sarwar
Tyler Barry

ADVISORS

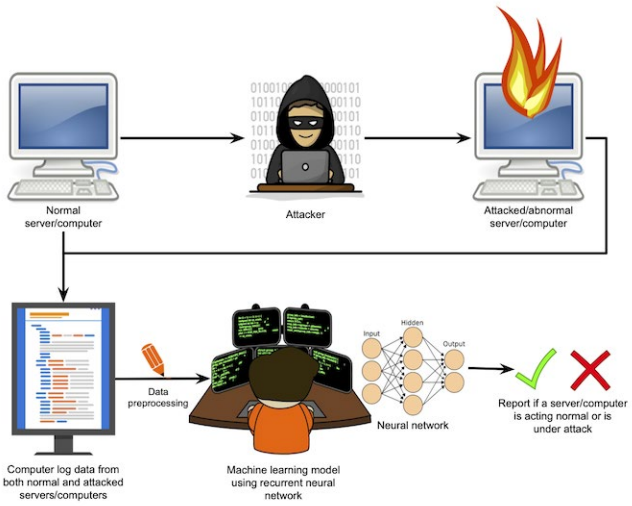
Mukul Bansal

SPONSOR

NAVSEA WARFARE CENTERS
NEWPORT

Machine Learning for Cybersecurity Applications

In this project we created a machine learning algorithm that, when given the log files from a server, can tell if a server is under attack from certain cyber security threats. The cyber threats our model can detect are SQL injections and Denial of Service attacks. Our project has potential to link two important and growing fields within computer science.



For our project we set up a Tomcat Apache server running a simple pet clinic website. This website allowed users to enter data in a database, such as the name and address of clients, and search that same database. We then attacked this website using Kali Linux tools and had python scripts running to simulate normal usage. During both attacks and simulated normal usage, JavaMelody was used to capture the server logs to feed to our machine learning algorithm.

We preprocessed our data to only contain what we found to be the necessary attributes from the server logs. Doing this helped the model not be distracted by attributes that had no correlation with being in an attacked state or normal state.

Once data was generated and preprocessed, we trained a Long Short Term Memory (LSTM) model to identify whether the server was in an attacked state or normal state. A LSTM model is a recurrent neural network which will hold onto a data point for an arbitrary amount of time depending on the specific cell in the network. This is great for our project since it is important for the model to remember what attacks which took place a long time ago look like and what recent attacks look like.

Finally, after data is run through the model, we scored how the model performed using a variety of methods, such as the receiving operator characteristic (ROC) curve and F1 Score, and visualized it using principal component analysis (PCA) so that it could be viewed in two dimensions despite having over 20 dimensions. When our project is running in real time, it can deliver a notification of when a server is under attack based upon our pre-trained model.

COMPUTER SCIENCE AND ENGINEERING

TEAM 8

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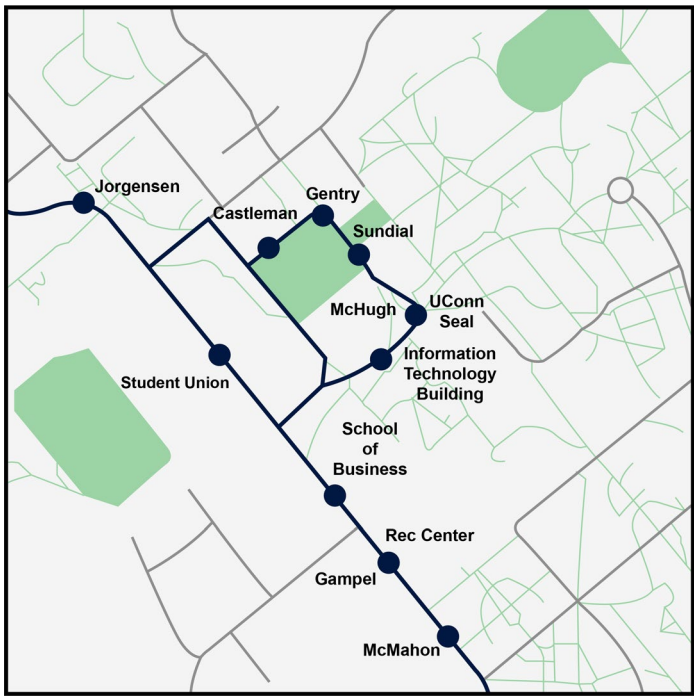
Cigna

Enhanced Campus Tour

Touring a college campus can make or break a prospective student's decision to attend a university. With the COVID-19 pandemic, it is harder for those students to go out and visit the university they dream of attending. With the Enhanced Campus Tour, it is easier for students to view the UConn campus from the safety of their home. Using virtual reality technology, students will receive a similar experience as if they were participating in person. The user will be able to tour campus and view popular buildings through a web application developed in Unity. Throughout the tour, when you look at a building or structure that is commonly used, an informational display will appear where you can learn more about that building. This application allows the user to be able to access the tour on any device and anywhere with an internet connection. The Enhanced Campus Tour will allow students to experience life at UConn while remaining socially distant and keeping our fellow Huskies safe.



COMPUTER SCIENCE AND ENGINEERING

TEAM 9

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Shubham Pai

ADVISORS

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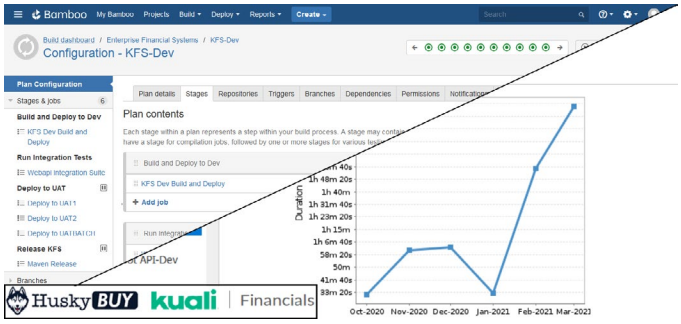
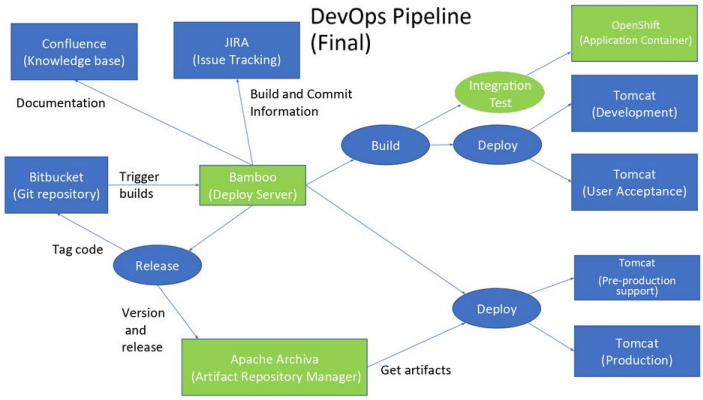
SPONSOR

UCONN
INFORMATION TECHNOLOGY SERVICES

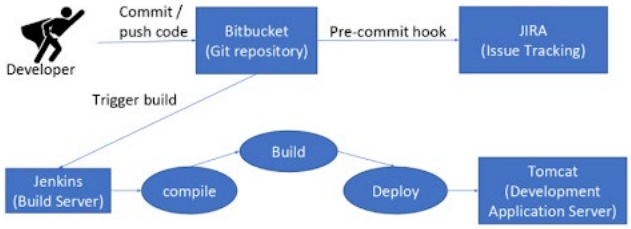
DevOps Pipeline for Kuali Financial Systems

Our project for UConn Information Technology Service (ITS) focuses on their Development and IT Operations (DevOps) pipeline for Kuali Financial Systems (KFS). KFS is a suite of financial software built on open-source platforms for higher education. The ITS DevOps team manages and modifies the KFS environment by tracking issues, programming features, and then the final step of deploying these features using a pipeline. The pipeline begins with code in a central repository and an automated job that then compiles, builds, and deploys the updated repository to their application server. The goal of this project will be to enhance this pipeline to include unit and integration testing, issue tracking, artifact management, and automation. These changes will deploy code versions in a more stable manner as well as automate the entire process to faster deploy and/or troubleshoot upcoming changes. The DevOps Team's motivation behind this project was to merge technologies within the Atlassian Suite, though some other open-source technologies will also be seen integrated within this pipeline. Merging functionality across Atlassian products allows the DevOps team to more comfortably connect and manage their code pipeline.





Current Development Environment



COMPUTER SCIENCE AND ENGINEERING

TEAM 10

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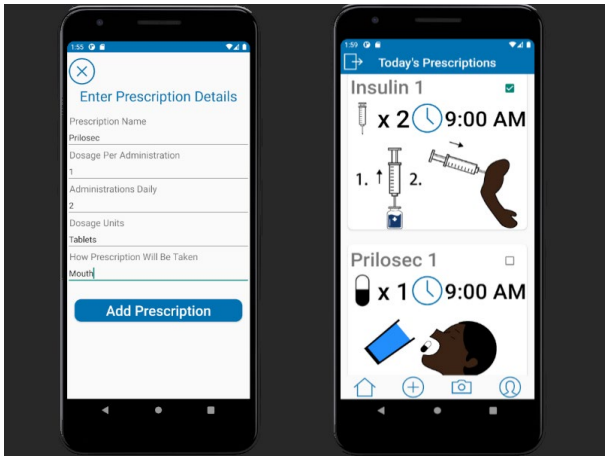
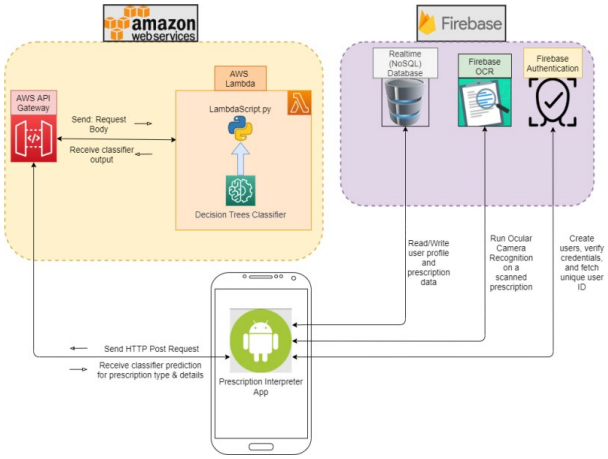
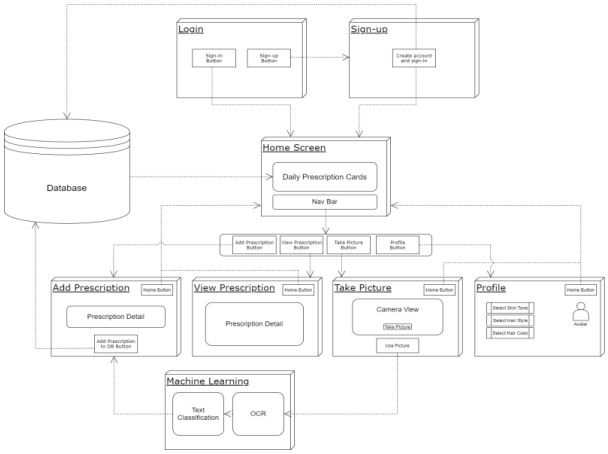
Cigna

Cigna Healthcare Literacy Enhancement

The goal for this project, as presented by Cigna, was to create a digital solution to increase healthcare literacy and/or digital engagement, especially among underserved, low income populations. Our team developed the Prescription Interpreter, an Android mobile application which scans prescription labels utilizing the mobile camera, translates the image to text using a custom made machine learning algorithm, and displays visual medical adherence instructions. The Prescription Interpreter was designed to emphasize clarity, ease of use, accessibility, personalization, and diversity. Complex medical terminology is avoided in favor of visual icon-based directions. To promote personalization and inclusion, the visual directions feature an avatar which can be customized for skin tone, hair color, and hair style, so that users will feel represented regardless of their background. Lastly, our application's most innovative feature separates it from other applications on the market with an ability to automatically interpret how and when a user should take their prescriptions via machine learning solely based on a picture of the prescription's written directions, even when the directions contain some degree of spelling errors.







COMPUTER SCIENCE AND ENGINEERING

TEAM 11

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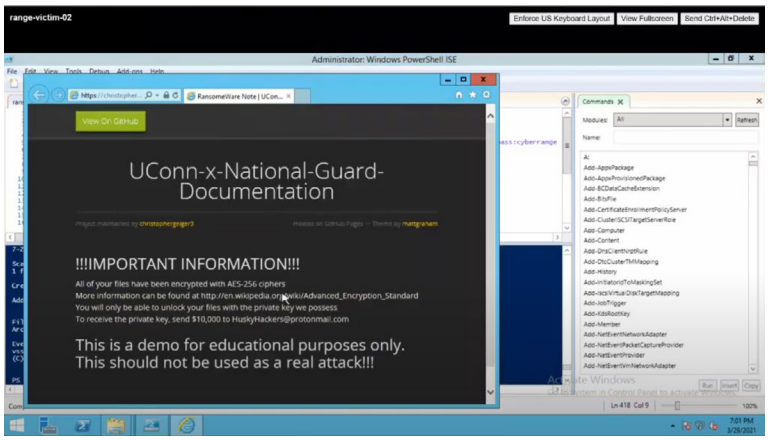
Connecticut National Guard Cyber Range

The Connecticut National Guard (CTNG) Cyber Range is a cloud-hosted cyber range to facilitate training for its personnel and partners. In this environment, the CTNG must be able to create a scenario to faithfully replicate either a critical infrastructure or local municipality's network and provide either hosted or remote-connected adversaries. (i.e. the CTNG provides the threat, Red Team, or facilitates bringing a Red Team via remotely connected systems). The range must provide a realistic set of threats, vulnerabilities and exploits that mimic real-world attacks and provides a means for "blue team" systems to be added to the network, post exploitation, simulating a cyber incident response. The end state is a well-orchestrated storyline that ties into a realistic set of attacks that mimic threats from script kiddy, Low Level hackers through advanced persistent threat and nation-state actors.



COMPUTER SCIENCE AND ENGINEERING

TEAM 12

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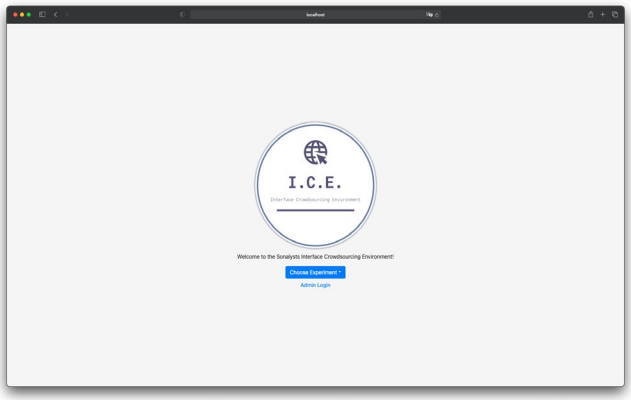
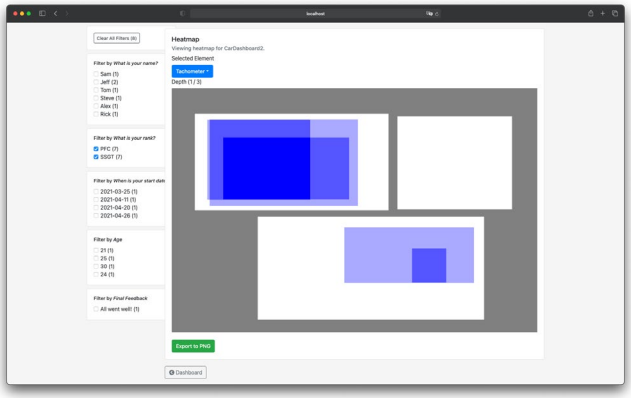
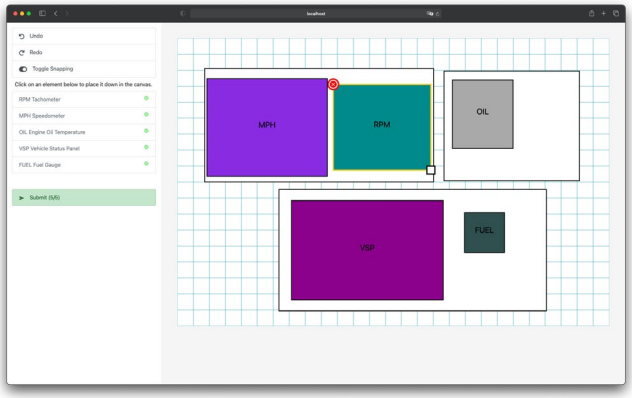
Sonalysts Interface Crowdsourcing Environment



The Sonalysts Human-Autonomy Interaction Laboratory (HAIL) conducts research, development, test, and evaluation of Human-Machine Interfaces (HMIs) for a variety of systems for the Navy, Space Force, Air Force, Army, and more. The UConn student team developed the Interface Crowdsourcing Environment (ICE) to digitize the crowdsourcing of HMIs and enable more rapid processing and analysis of design data from diverse groups of participants. The result is better HMIs for applications such as mission-critical Department of Defense systems.



A multitude of methods are used to design HMIs, including interviews, focus groups, surveys, and job observations. One additional method is to 1) provide end users a blank paper outline of the displays and a list of HMI components that must be included and 2) have users draw how they would ideally like the HMI to look. Analysts then manually recreated each paper drawing in PowerPoint and manually assigned colors to different components. Finally, they adjusted transparencies until heatmaps are generated showing where each HMI component should go. While this manual approach yielded valuable insights, it was labor intensive, error prone, and could not explore differences across demographic groups.



ICE is a web-based platform that consolidates and automates the planning, collection, analysis, visualization, and exploration of this information crowdsourced from a large and diverse group of users. ICE enables simpler and more cost-effective data collection at greater scale, drastically increasing the quality of analytics and design of HMIs. ICE fully removes the need for paper/pen data collection, automatically processes and analyzes data based on common methods, and gleans insights through interactive visualizations, where analysts can rapidly toggle data on or off based on demographic features of users or other parameters. This application will greatly improve analyst workflows and empower analysts to design better HMIs.

COMPUTER SCIENCE AND ENGINEERING

TEAM 13

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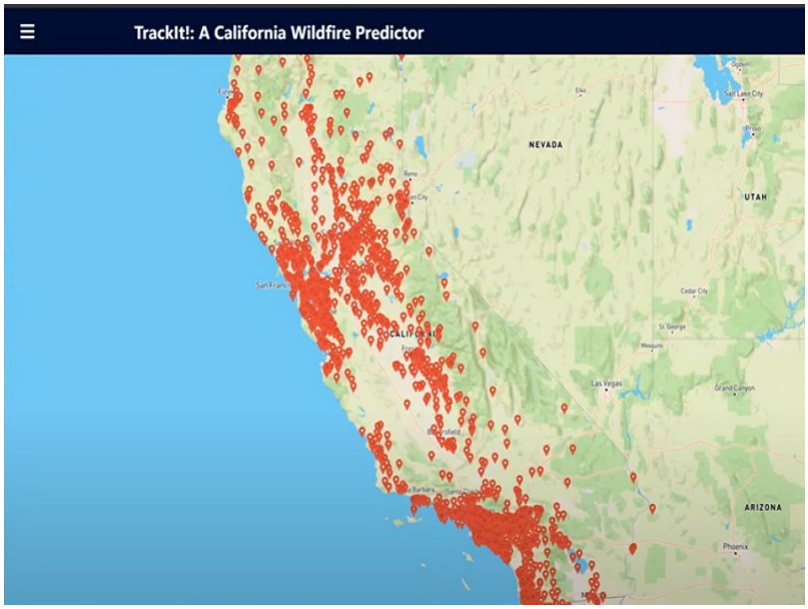
COMPUTER SCIENCE & ENGINEERING

Trackit!



Wildfires are a destructive force that can be created by humans and nature. They are challenging to predict, although they are most likely to occur in areas that are very dry. For this project, we are going to focus on wildfires in California because they are common in that area, and due to climate change, they are occurring more frequently and are spreading over larger areas.

This project, Trackit!, is a web-based wildfire predictor application. It allows users to interact with a machine learning model that predicts the likelihood of wildfires in California. Users will click on a location marker pin on our interactive map, and a pop up will alert the user of the risk level of a wildfire in the selected area in the next two weeks. They can use this to help ensure their safety when traveling to or within California. We trained a deep neural network using historical wildfire data its associated weather data to predict the probability of a wildfire occurring. The weather data was web scraped from the Farmer's Almanac website, which provides accurate historical data. The wildfire data was exported from the National Oceanic and Atmospheric Administration (NOAA) website.

COMPUTER SCIENCE AND ENGINEERING

TEAM 14

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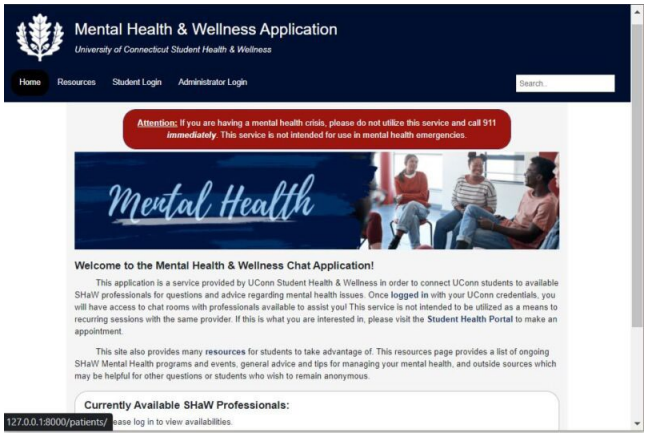
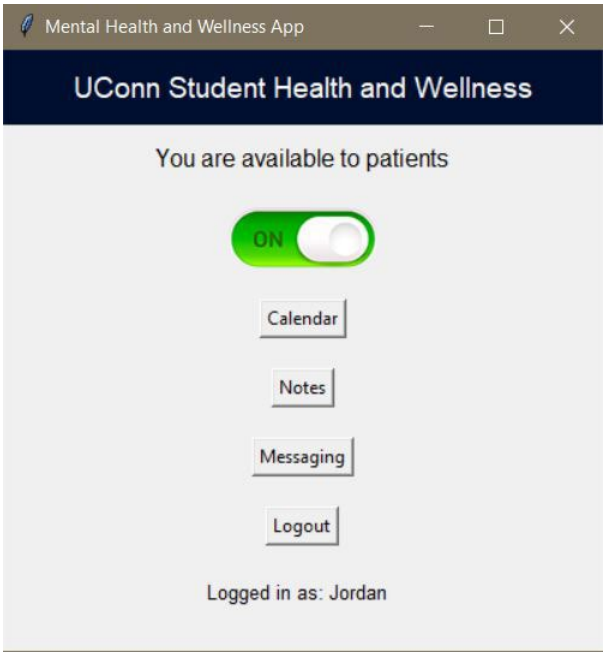
Mental Health & Wellness Application

The Mental Health & Wellness Application was created to provide easier access to SHaW's Mental Health Services for UConn students. The application primarily features a chat service, allowing UConn students to connect with SHaW professionals through messaging at any time. This service is targeted towards those looking to seek advice not warranting a full session with a therapist. Due to COVID-19, it has become more difficult to seek help in person. The alternatives (over the phone and Zoom calls) can also be extremely daunting. This can result in less individuals seeking help when they need it the most.



The project consists of two parts: a patient website and a therapist program. The patient website will be utilized by UConn students and was created using the Django framework and Python for its backend programming. In order to chat with therapists, users of the site have to be registered to ensure that they are UConn students. Once logged in, the user will gain access to links to the chat rooms of all available therapists. When not utilizing the chat rooms, users can find articles, programs, and other useful services in the resources section of the site.



The therapist program will be utilized by SHaW mental health professionals. The Graphical User Interface (GUI) for this program was created through Python's Tkinter module. When the program is opened, the therapist user is prompted to either log in or register a new account. Once logged in, the therapist can indicate their ready status to the site through a toggle button at the top of the screen. Once they indicate they are ready, the therapist can open up their chat room using the messaging button. When they are not chatting with patient users, the therapist can utilize the calendar feature to input their availability and view times they have previously indicated to be working. During sessions, the therapist can also utilize the notes functionality to write down important information they may need in the future.

COMPUTER SCIENCE AND ENGINEERING

TEAM 15

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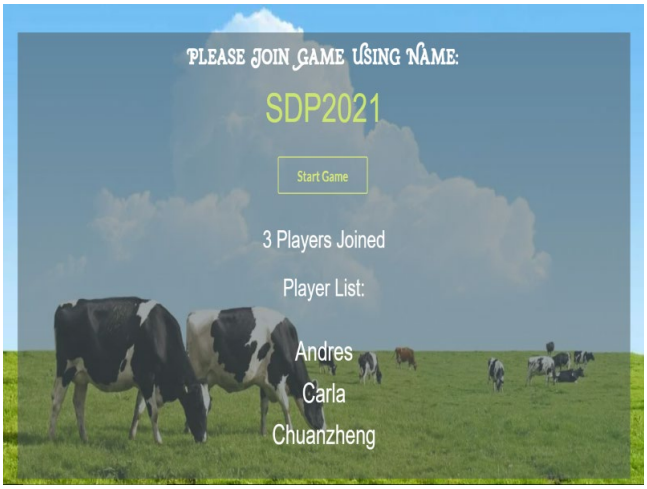
COMPUTER SCIENCE & ENGINEERING

Tragedy App

The Tragedy App is an interactive web game accessible through internet browsers that is meant to allow individuals to learn and experience an economic problem known as The Tragedy of the Commons. In this game, users can become either a host or a player. Hosts are in charge of administering games, while players join the games created by the host and play the game. During each round of the game, each player is given a set number of resources that they are supposed to allocate between “Farming”, and “Pasturing”, with any unallocated resources sent to the “Reserve”. At the end of each round, each player is scored based on their choices. However, in the event that the cumulative allocations to “Reserve” pass a certain amount, they could lose points instead.



COMPUTER SCIENCE AND ENGINEERING

TEAM 16

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GENERAL DYNAMICS
Electric Boat

Communication Protocol with Reed Solomon Error Correction

The team was tasked by General Dynamics Electric Boat to develop a communication program that would be used to achieve underwater wireless data transfer. The team elected to leverage the Transmission Control Protocol, also known as TCP, to transmit data. TCP allows the program to form a connection between two hosts. Once this initial connection is made, data can continue to be exchanged over this connection. The team knew security would be a top priority and to ensure that the data being exchanged between the two hosts couldn't be accessed and read by a third party we implemented TLS or Transport Layer Security on top of TCP. TLS uses two personalized keys and certificates which are used to encrypt the data being sent. This encryption is the key to the security of the program. With a secure connection, the team then focused our attention on potential data errors that would occur from transmitting data underwater. To combat this, we implemented Reed-Solomon error correction into the connection. This detects and corrects errors in the data so that the receiving party gets the correct data even in error prone environments.

COMPUTER SCIENCE AND ENGINEERING

TEAM 17

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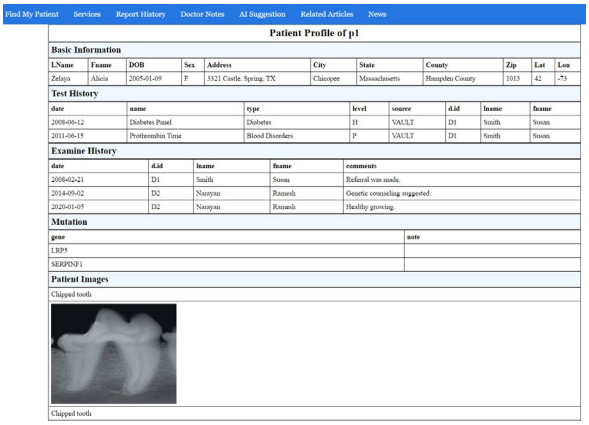
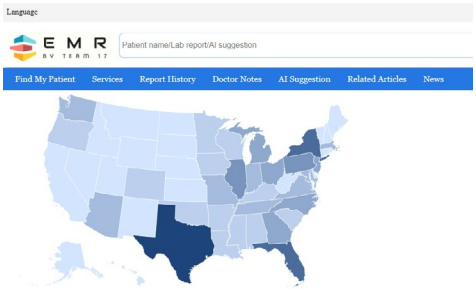
Dong Shin

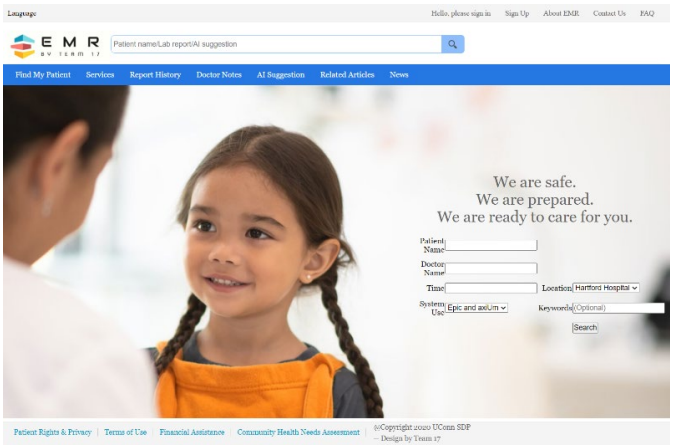
SPONSOR

The Shin Lab

Smart EMR







An Electronic Medical Records (EMR) is a collection of digital medical information corresponding to a patient from various clinics. The goal of this project is to integrate clinical data from Epic and dental data from axiUm into an open source EMR management program called Smart EMR. The clients are clinical researchers who will have access to Smart EMR with a key for both axiUm and Epic in order to retrieve information corresponding to different patients. These researchers will be able to access the data within Smart EMR through a user-friendly web User Interface (UI). Additionally, researchers can query the data through regular sentences which are parsed with a natural language parser. The resulting data is examined by an AI model that creates suggestions and different visualizations corresponding to the type of data returned. This way, researchers have an easier time creating inferences and finding associations between diseases and genes that may have been missed otherwise.

The data for this project has been managed to meet various constraints and to handle various types. Privacy has to be maintained due to HIPPA compliance rules within the medical field, thus all of the test data is fake. Current biological data sets are based around dental and skeletal features, but our system is extensible and implementation of other biological sets is still possible. Unstructured and structured data, such as a doctor's narrative or lab data respectively, have been considered and handled too through the usage of MySQL and MongoDB. All structured patient information such as lab data and gene mutations are stored within MySQL. All unstructured data types, such as DICOM images or doctor notes, are stored within MongoDB. Finally, all forms on the web pages check for validity in order to remain secure and prevent cyber-attacks.

COMPUTER SCIENCE AND ENGINEERING

TEAM 18

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ADVISORS

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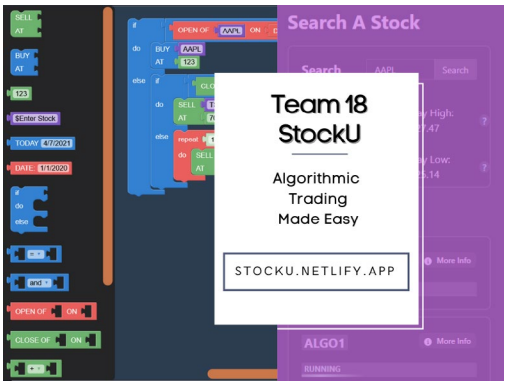
STOCKU

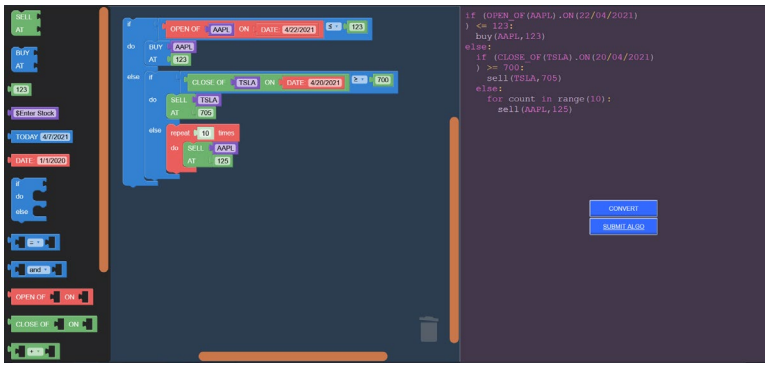
StockU - Algorithmic Trading Made Easy



Team 18's Senior Design Project is a functional implementation of an educational algorithmic stock trading platform called StockU. This platform brings the benefits of algorithmic trading to the average person, without a need for coding. StockU features a no-code algorithm builder, live stock data feeds, and an easy to navigate UI for a quality user experience. The brokerage service and API used for live stock data comes from Alpaca LLC, which is a FINRA licensed brokerage service and data provider. Through OAuth verification, we are able to have users sign in using their Alpaca account and maintain secure user data retrieval.

In the algorithm maker, users are able to drag and drop blocks which allow them to construct conditional statements. An example of a conditional statement would be "buy stock in AAPL if the closing price is 5% higher than the opening price, and sell if the closing price is down 10%." Users can make up to five algorithms like this, save them to their profile and receive email notifications if an algorithm is triggered and makes purchases. As this is just a prototype, all purchases and sales are done through a "paper trading account", meaning that they will be treated like a real account, with balances adjusting and transactions going through, but no real money will be spent. However, Alpaca does give us the capability of accepting real transactions in the future if this prototype is taken into production.

This application was developed using a MERN stack (MongoDB Atlas, Express, React.js, and Node.js). The database itself is accessed using a Python API developed using Flask while the OAuth system is built on NodeJS. Using Netlify and Google Cloud, these APIs and the front-end are publicly hosted for a fully functional application.



If you have any questions feel free to email us:

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COMPUTER SCIENCE AND ENGINEERING

TEAM 19

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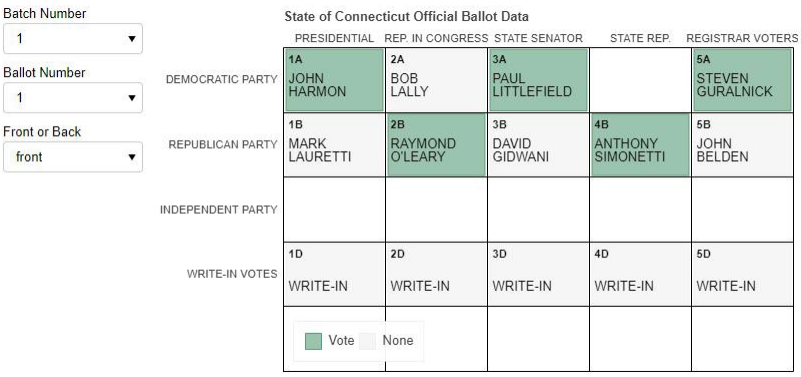
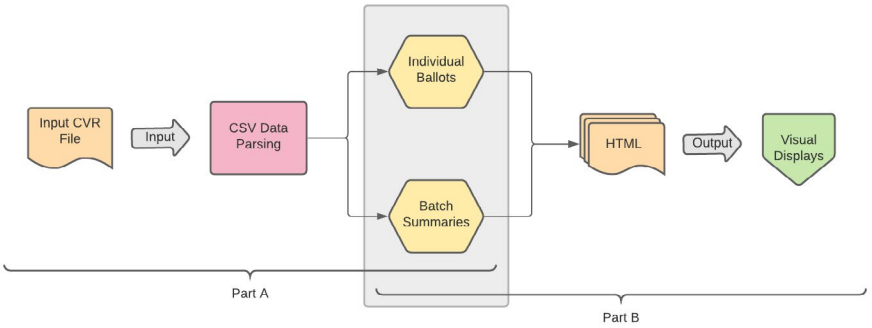
UCONN VOTING TECHNOLOGY RESEARCH

High Confidence User Interface for Voting Records

The purpose of our project was to create a piece of software that displayed voting record information in such a way that had high confidence, easy readability, and was user-friendly. Before the completion of our software, the UConn VoTeR center used a large CSV file to audit ballot results which was very difficult to read, but our software was designed to fix this. As a group, we designed a product that allowed the user to read in a ballot, parse the data, and display the information in both a graphical format, as well as a table format. We employed the use of drop-down menus to allow the ballot information to be split up into different batches which are pre-defined groups of ballots, as well as individual ballots to allow easy readability of confirmed and questionable votes in each race or even for each candidate. Our product will be delivered to The UConn Voting Center at the end of the semester and will be incorporated this summer to be used by staff and interns.





COMPUTER SCIENCE AND ENGINEERING

TEAM 20

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Cory Harrington

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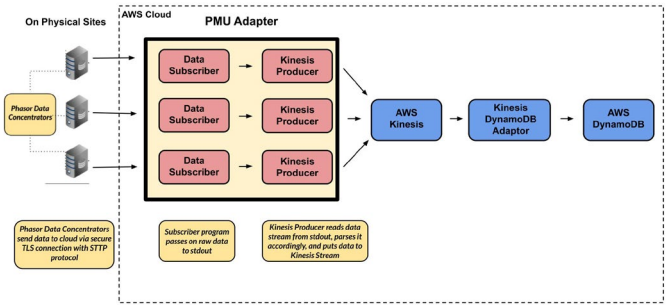
SPONSOR

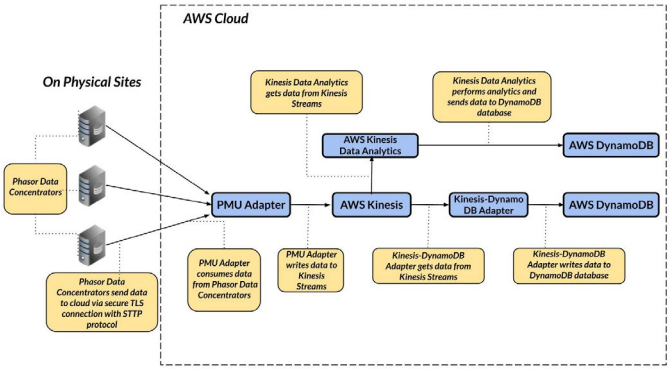
ISO new england

Securely Streaming PMU Data To The Cloud

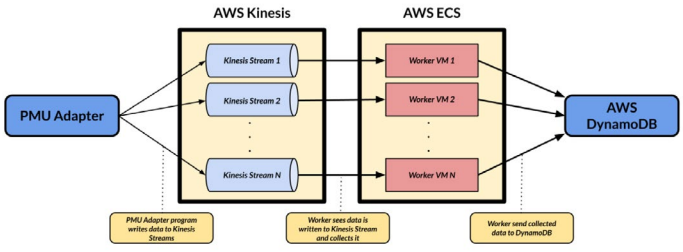
We worked with ISO-NE for our senior design project. ISO-NE is a non-for-profit organization responsible for managing the power grid in New England. To give a little background, ISO-NE has on-premise systems that their control centers rely on for real-time operation. These systems are currently configured for failover, however they may still be subject to system failures, thus a cloud based backup solution was needed. The data that control centers rely on is called PMU data, which are sourced from Phasor Measurement Unit (PMU) devices located on the electric grid throughout New England. They provide time-stamped measurements of voltage, current, and frequency and are important because they reflect real system states.



Our group was tasked with securely moving this PMU data to the cloud from the on-premises infrastructure. For security we utilized the TLS protocol and for our cloud service we used Amazon Web Services (AWS). Our project can be divided into 4 components, the PMU Adapter, the Kinesis-DynamoDB Adapter, the Database, and Kinesis Data Analytics. The PMU adapter receives data from the PMU devices, parses the data accordingly and pushes it to a Kinesis stream. The Kinesis-DynamoDB Adapter processes the data from the Kinesis stream and writes the data to DynamoDB, which is where the PMU data ends up being stored. This is our main workflow. For deployment, the PMU Adapter and Kinesis-DynamoDB Adapter are written in C++ / NodeJS and Java respectively, both have a Docker image, and both will be deployed using the ECS container service on AWS. Kinesis Data Analytics is integrated with the Kinesis stream, performs analytics, and sends them to another DynamoDB table. This allows us to monitor system status and detect issues in real-time.



The featured image is a diagram of our whole workflow, figure 1 expands on the PMU Adapter workflow, and figure 2 expands on the Kinesis-DynamoDB Adapter workflow.



COMPUTER SCIENCE AND ENGINEERING

TEAM 21

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Hanna Aknouche-Martinsson

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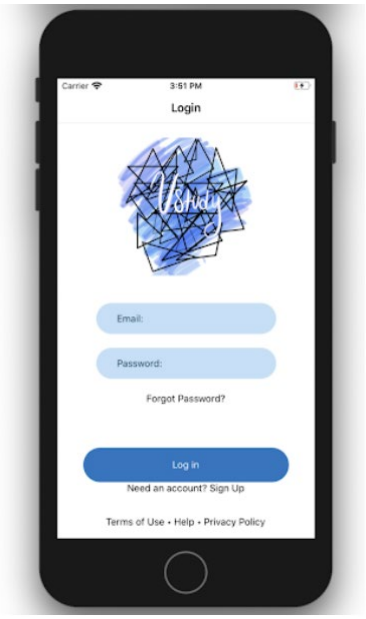
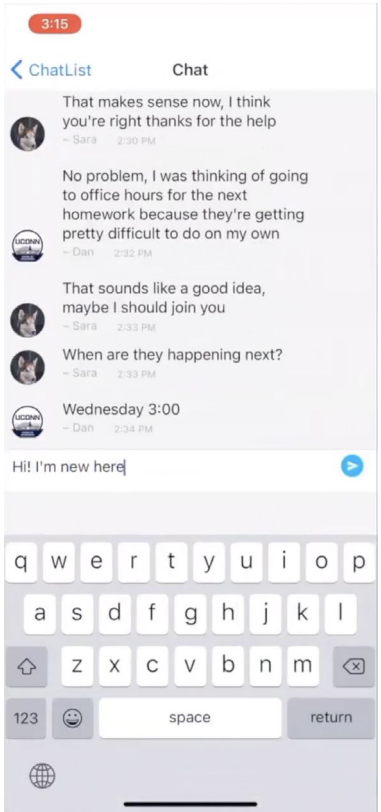
COMPUTER SCIENCE & ENGINEERING

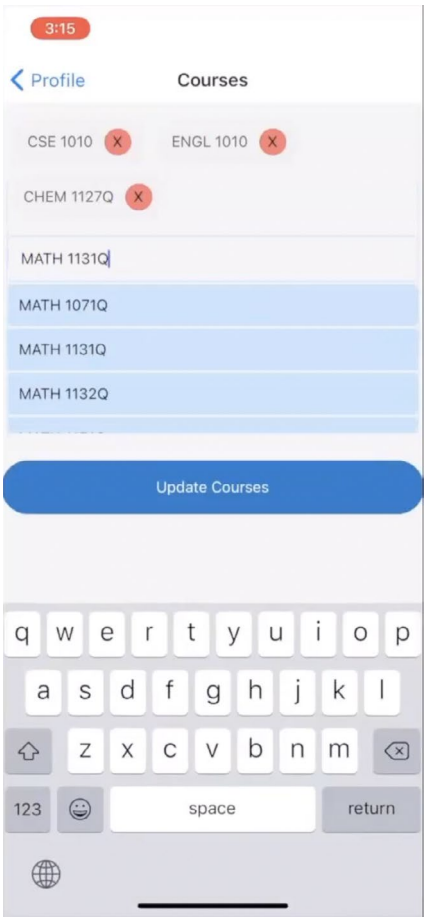
UStudy Smartphone Application

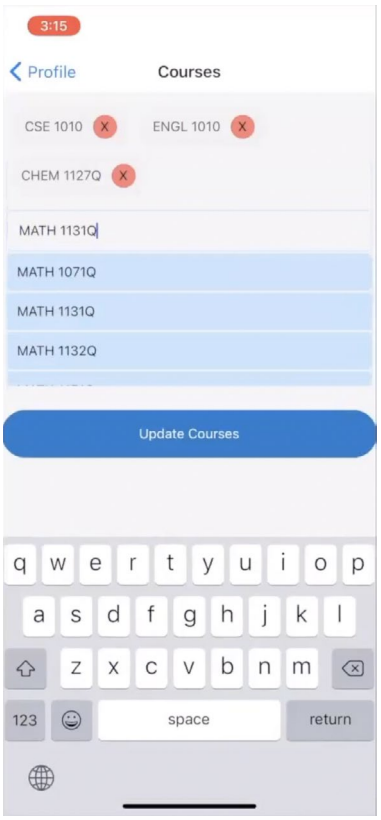
The current COVID-19 pandemic has displaced us from our classrooms to our homes while relying on our smartphones to stay connected. Transitioning to distance learning has interrupted our ability to make new connections that are essential to our college experience.

Our UStudy smartphone application facilitates social interaction and connections between students on the UConn campus. The UStudy platform allows each student to enter course-specific chat rooms to ask questions, make study groups, and remain united as a classroom again from virtually anywhere.









COMPUTER SCIENCE AND ENGINEERING

TEAM 22

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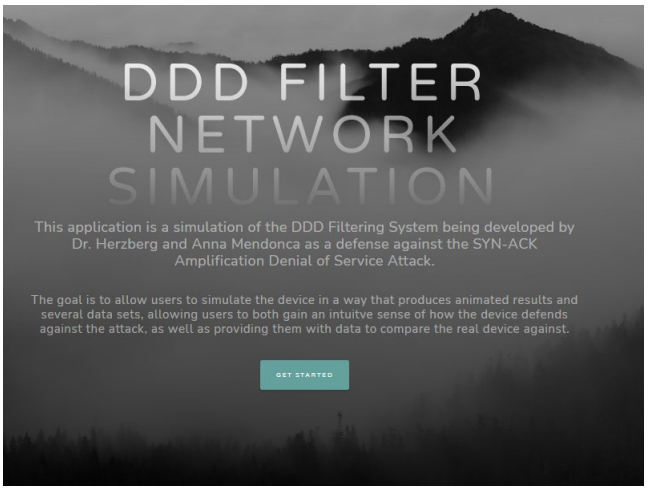
Herzberg Denial of Service De-Amplifier



The goal of this senior design project is to create an interactive simulation of a SYN-ACK flood denial of service attack on a network topology where a defense mechanism being built by Doctor Amir Herzberg and doctorate student Anna Mendonca has been deployed. Their defense mechanism, consisting of a DDD filter, control mechanism, and port changer, relies on changing the client's source port as it appears on outgoing packets to hidden ports. The goal of the simulation is to provide a proof of concept to demonstrate that such a design would successfully be able to mitigate the attack, provide data about the attack as it progresses in the simulation, and make it accessible to a broader audience, such as students and other interested researchers, by providing both an animation of the flow of data in the simulation and a few graphs showing the behavior of the simulation over time. Users can specify almost all attributes of the topology, such as the bandwidths between all of the network devices, the sizes of their queues, data transmission and retransmission rates, and whether the defense mechanism is active or not to allow for comparison between the attack being execute with a defense and without a defense. The goal is for this simulation to provide both an educational opportunity to help individuals learn about the defense mechanism, as well as to provide useful data for when the system is complete.

COMPUTER SCIENCE AND ENGINEERING

TEAM 23

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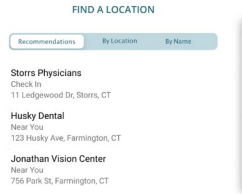
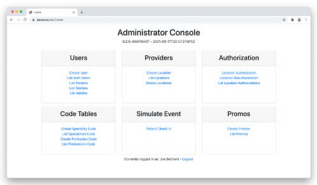
synchrony

Synchrony POST

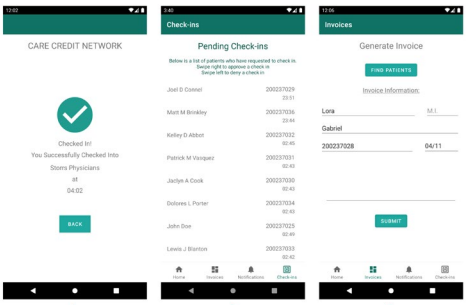
The Synchrony POST project entails a proof-of-concept application designed to streamline the functionality of Synchrony's existing CareCredit mobile application by simplifying patient-provider interactions. For context, CareCredit is a credit card that allows patients to finance expensive medical expenses. The accompanying CareCredit mobile application provides customers with a digital credit card for making secure payments to their health care providers. This project aims to prototype and develop potential enhancements to this application. One such enhancement includes adding the ability for users to check in to their providers using Near-Field Communication (NFC) and geolocation technology to allow for easy and secure hands-free billing. Currently, the CareCredit app is designed to primarily be used by end-users, so to facilitate the enhanced check-in and payment process, an accompanying interface for CareCredit health care providers was developed. Additionally, to help promote usage of CareCredit, a machine learning capable recommendation algorithm was developed to predict which CareCredit providers a user would be most likely to be interested in. To accompany all of these proposed features to the CareCredit mobile application, a full set of backend services were architected and developed. Considering the sensitive nature of payment data, a fully fleshed-out security implementation was also developed as a core feature rather than an afterthought. In addition to being secure, all backend services follow a microservice architecture pattern to ensure the scalability of all proposed functionality.



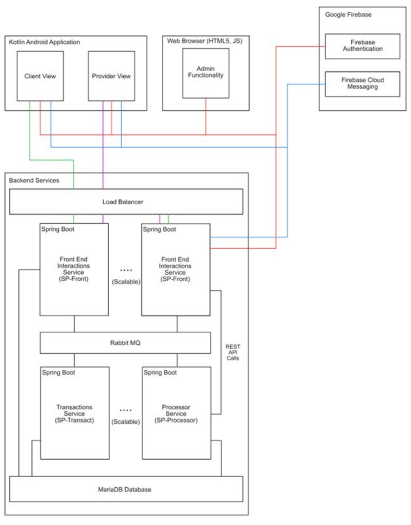
CLIENT-SIDE RECOMMENDATIONS



MANAGEMENT INTERFACE



1 PATIENT CHECK-IN
2 PROVIDER APPROVAL
3 GENERATE TRANSACTIONS



SCALABLE BACKEND

COMPUTER SCIENCE AND ENGINEERING

TEAM 24

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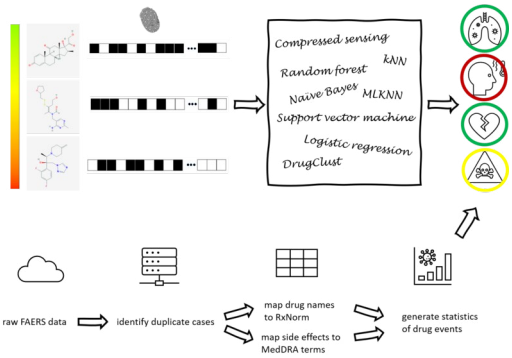
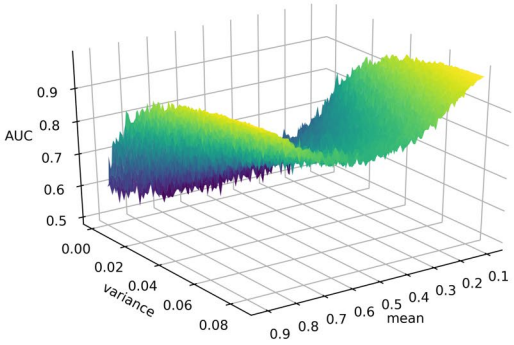
Pfizer

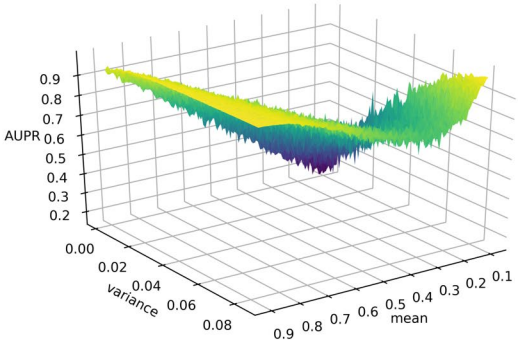
Predicting Drug Side Effects from Chemical Signatures

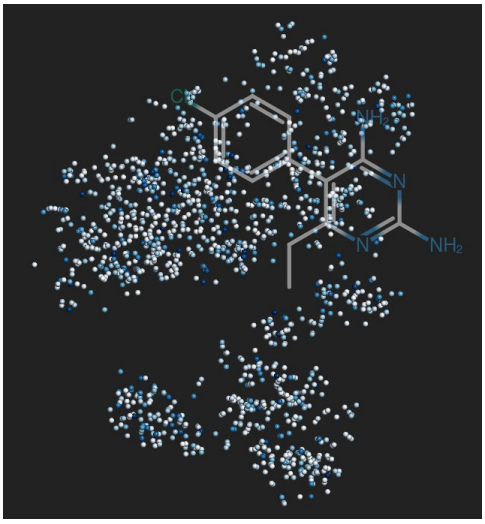


Drug development is an expensive process that requires major investments of time and resources in drugs that may turn out to exhibit severe side effects during clinical trials. To accelerate drug discovery, many machine learning methods have been developed to predict side effects of candidate drugs. However, available data processing pipelines are difficult to execute, evaluations of methods are opaque, and comparisons between them are sparse.

In our project, we implemented eight side effect prediction methods and wrapped them into a user-friendly API. To increase the generality of our analyses, we processed two independent datasets. One is the FDA's FAERS database containing clinical reports of adverse reactions to prescribed drugs. Since these data are input by different doctors, the data is unorganized, inconsistent, and incomplete. We created a pipeline to identify duplicate reports, correct invalid entries using string alignment, and summarize the strength of association between drugs and side effects using a statistic that adjusts for biases in case reporting.







We then established a baseline for comparison – a classifier that ignores chemistry and just predicts the empirical frequency of each side effect. Surprisingly, we found that this method is similarly accurate as chemistry-based models as measured by the two most popular metrics in this field. In fact, we developed statistical theory and simulations that explain these results and evaluated our models on other metrics along several different axes.

These results led us to the conclusion that a finer-grained approach must be taken to understand the predictions of side effect models. To aid in this, we created a visualization tool that drug developers can use to interpret chemical spaces and uncover trends in model behavior normally hidden by aggregate scores. In summary, our work increases the quality, interpretability, and accessibility of side effect modeling in the pharmaceutical industry.

COMPUTER SCIENCE AND ENGINEERING

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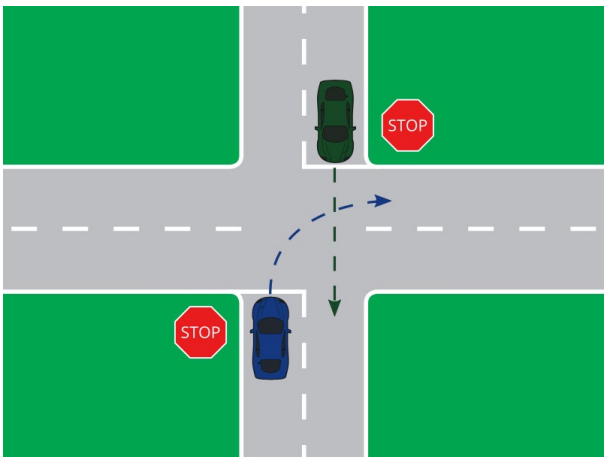
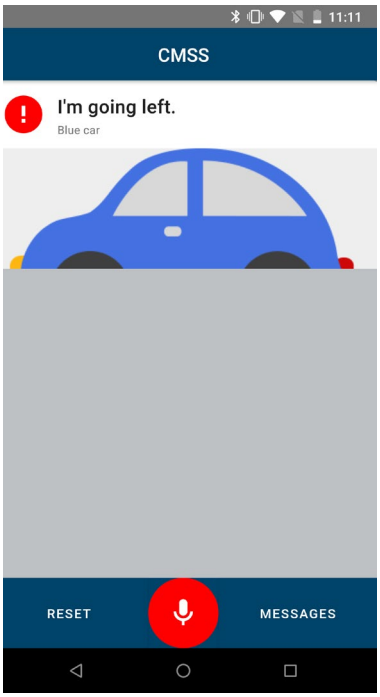
WNS Enterprises, LLC

Courtesy Messaging Signaling System

The Courtesy Messaging Signaling System (CMSS) is a mobile messaging application designed to facilitate communication between people who share the road, such as drivers and pedestrians. The CMSS is intended to make the road a safer place by giving advanced warning about any potential road hazards and allowing drivers to communicate their intentions, among other situations. This project is an extension upon an ECE Senior Design project from last year, where the team created a system where users could send messages to a Raspberry Pi via Bluetooth, which were then routed to an LED panel. The CMSS was transitioned to a system only dependent on a smartphone due to the desire not to have any specific hardware limitations. The app allows users to enter a picture and description of their vehicle which will be used for identification on the road. When active, the app uses Bluetooth to scan for other nearby users and notifies the server when the nearby users change. Upon tapping a button, a user says a phrase they would like to communicate to other users of the app. This phrase is then matched to one of several predetermined phrases to avoid offensive or confusing messages. The message is then sent to a server where the server forwards it to all phones which have been recorded as being nearby. Through use of the CMSS communication on the road will be enhanced, providing a safer environment for drivers and pedestrians.





COMPUTER SCIENCE AND ENGINEERING

TEAM 26

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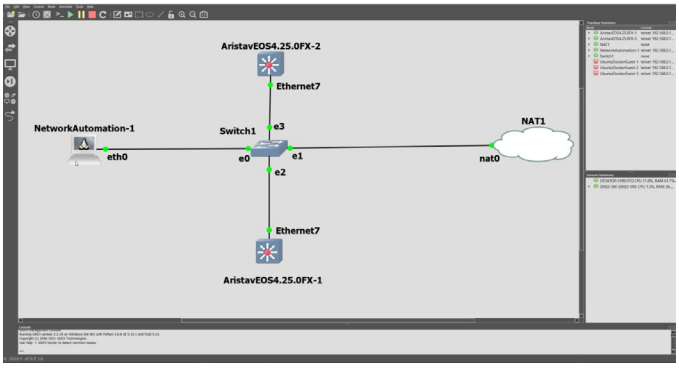
SONALYSTS

Model-Based Systems Engineering Switch Configuration



Sonalysts is a company based in Connecticut that has integrated advanced technology capabilities of a defense research, development, and engineering firm while also providing solutions to services involving graphics design, sound design and set construction or exhibitory business. Sonalysts' goal in sponsoring this system engineering project is to introduce the team upon the subject of model-based systems engineering of complex systems that are built from the synergy of computational and physical components, in this instance, an Arista switch is the main focal point. This exposure increases the awareness of systems engineering while also illustrating its concepts through projects. Another worthy note for the importance of this project is that major changes have been initiated by the Department of Defense which prioritizes the practice of Agile software development process as a means to improve the software quality and speed of delivery.

The goal of the project is to generate Arista switch configurations, which will then be loaded the new configuration onto the switches. Our was tasked with modeling the switch on a systems modeler called Cameo along with the necessary components and possible security features, if necessary, of a nominal target network. Additionally, the model exports all the essential configuration of the switch. The team also developed Python based code to convert the output of the model into configuration files that could be loaded onto the switch. The ultimate goal of this software development is to eliminate any manual updates that occur when configuration files are generated before being loaded onto the switch.

COMPUTER SCIENCE AND ENGINEERING

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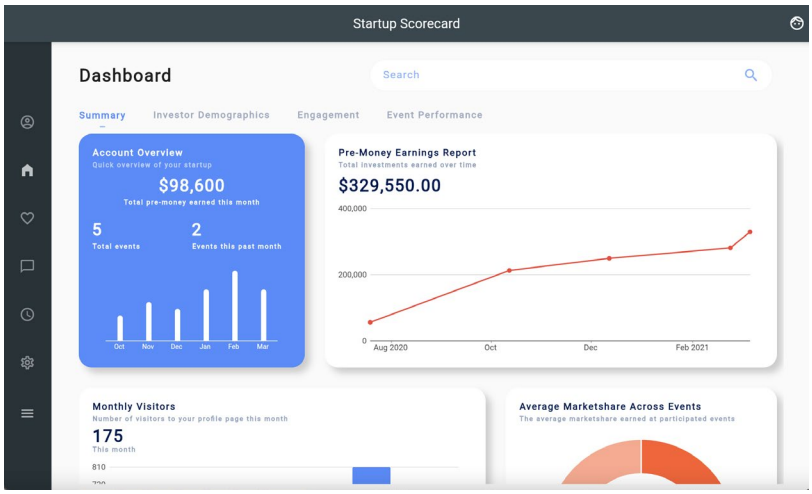
FUNDING FOUNDING

Startup Scorecard: Data Visualization Web App



Startup Scorecard® is a web application designed to provide startups and investors with useful insights derived from data collected in the Pre app. Pre is an application created by Funding Founding that uses gamification to promote engagement between startups and potential investors during pitch events by having audience members make mock investments in participating startups. Startups compete with each other to earn the most investments while investors compete to make smart investments.

Our task was to create a web application that takes advantage of the large amount of data collected by Pre to help startups gain a greater understanding of their strengths, weaknesses, and potential investors while also helping investors make informed investment decisions. We built the web application using Flutter written in Dart, and we used Firebase for features such as Cloud Firestore, Cloud Functions, and hosting.

The data collected by Pre is stored in Firestore. A cloud function triggered by the web app pulls data from Firestore and serves the documents needed to create the various charts and widgets on our dashboard. Using the cloud function along with Firebase hosting allows us to save the static documents in the cache to limit the number of read calls to our database. For features that require real-time synchronization, such as chat, we directly accessed Firestore.

Another purpose of Startup Scorecard is to facilitate engagement between startups and potential investors following the pitch event. This was accomplished by adding features such as messaging and the ability to follow and track the growth of a startup.

COMPUTER SCIENCE AND ENGINEERING

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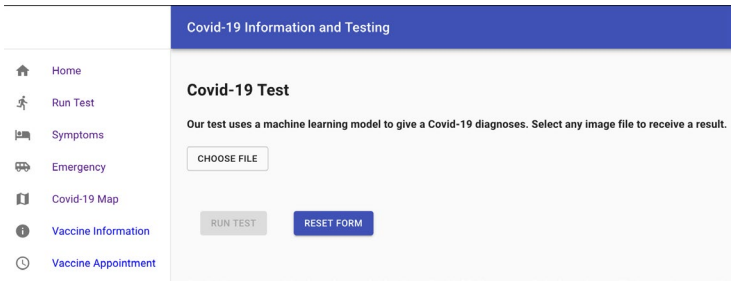
Covid-19 Classification System

The purpose of this project was to abstract away some of the more technical aspects of configuring a neural network for the purposes of image classification. Specifically, our intentions were to create a platform where users could create and manage image datasets, create models from those datasets, and classify images against them. Our final product did not fully realize those goals, but we were able to prove that a scalable, distributed, classification system is possible.



This was accomplished through the development of three pieces of software.

1. The Worker – A thin python program which connects to the data service, to be discussed, in order to fulfill any user submitted classifications. There may be any number of these instances enabled at any moment. No request will be assigned more than one worker assuming the currently assigned worker produces a result within 72 hours.
Github

2. The Data Service. – The core component of the platform. This is the centralized storage location for all of the image classification submissions. There are a collection of operations made available by this service to go about submitting, classifying, and viewing the results of a classification against a specific image.
Github

3. The React Webapp – The user facing web application where images may be uploaded and results obtained.
Github

COMPUTER SCIENCE AND ENGINEERING

TEAM 29

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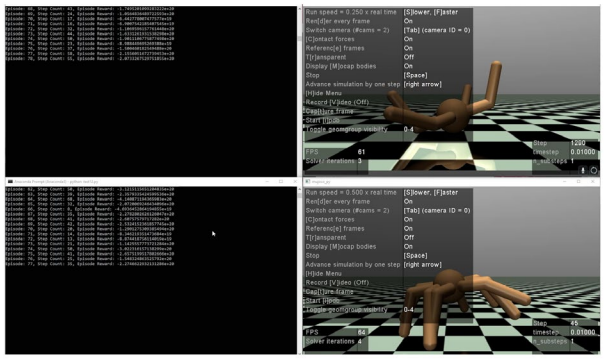
Deep Reinforcement Learning - Humanoid Robot Simulations

"Deep Reinforcement Learning – Humanoid Robot Simulations" is a project that explores the realm of Reinforcement Learning (RL) algorithms and policies for simulating human-like actions. The contributing team utilizes tools including Open AI Gym, Multi-Joint with Contacts (MuJoCo) physics engine, Tianshou RL framework, Tensorflow, Deepmind Control, Pybullet, and Robosumo. Open AI Gym was used as a playground to create environments for XML models designed to perform specific tasks, while serving as the bridge between MuJoCo and Tianshou. The environments define action spaces, steps, rewards used by the agent to control the humanoid model's movement in an attempt to perform tasks such as standing up or walking. Additionally, custom ant, humanoid, and cheetah based models were developed and trained to understand the capabilities of both MuJoCo and OpenAI Gym.



The most successful work was built off of Tianshou, which is a fast-speed modularized framework based on PyTorch, supporting a wide variety of RL policies. The three primary policies used for training with MuJoCo's "Humanoid-v3" model were Proximal Policy Optimization (PPO), Deep Deterministic Policy Gradient (DDPG), and Twin Layered Deep Deterministic Policy Gradient (TD3). Models trained using PPO were incapable of reaching a high enough reward threshold such that the humanoid could sustain a walking motion, while TD3 produced models that stood stably, but moved minimally. The best results have shown to come from DDPG, where the humanoid was able to find a stable "tip-toeing" position by locking the hips and either extending or locking the arms while in movement.

Feel free to send questions to the team!

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COMPUTER SCIENCE AND ENGINEERING

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SIKORSKY
A LOCKHEED MARTIN COMPANY

Sikorsky 720 Customer Hub Web Portal

We developed a feature rich customer portal for users to interact with the products and services provided at Sikorsky. We worked to create new features, along with basic features, that would help in the purchasing process of products and services. More specifically, we added a live chat feature for customer support, a vehicle status widget, and a calendar widget, on top of the usual login, signup, dashboard, and checkout features. Using Java, Spring Boot, Angular, AWS, and Tawk, we were able to create a prototype portal for Sikorsky.

COMPUTER SCIENCE AND ENGINEERING

TEAM 31

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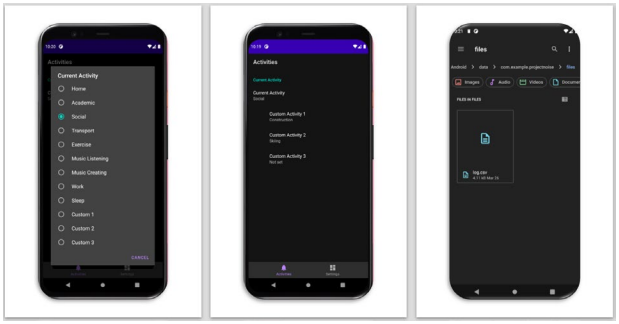
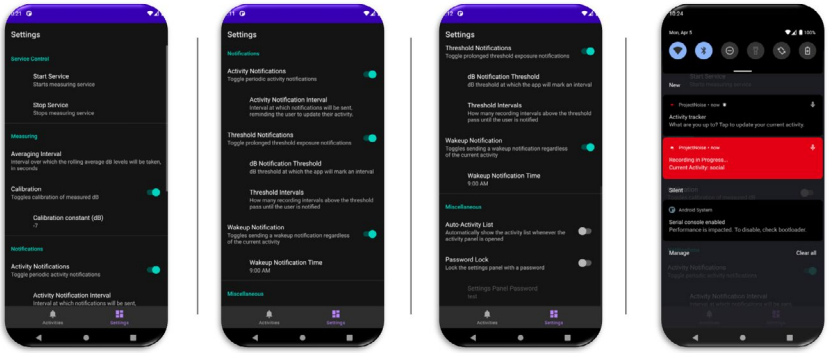
Noise Life



Noise Life is an Android application created for auditory researchers, with the primary goal of being used with research participants to track their daily activities and ambient dB level of their surroundings over a long period of time. Our application prioritizes collecting accurate, meaningful data for the sponsor, providing the functionality to remind the user to update their activity not only periodically, but also when high variances in ambient dB are detected. Our app also offers a lot of customizability for researchers, including a secure settings page where they can start and stop the data recording process, as well as set various parameters pertaining to how often dB data will be collected, how often the user will be reminded to update their current activity, and under what conditions such notifications should be triggered. Our app is built on the Android operating system and will be published as an open-source project on GitHub. This allows other researchers to freely use, improve, or adapt the application to their own needs with relative ease, due to the plethora of resources available on Android development.



Our app is built on 5 core components, sensor data collection, user activity tracking, a notification system, UI and settings, and lastly, data storage and security. Sensor data collection focuses on the recording, averaging, and analyzing of noise data from a microphone connected to the phone. Activity tracking focuses on how we track the participant's activities without being too invasive, while still providing interesting and useable data for the researchers. Another major component is the notification system, which reminds the user to update their activity both periodically, and during periods of high ambient dB, to collect more relevant and interesting activity data for the researchers. Overall, the notification system will allow us to narrow the gap between the sensor data and activity data, resulting in more useful data for the sponsor. For data storage, we had to design our app to never store raw audio data, only the average dB value, to prevent any privacy concerns. Another focus of this component was making sure the data was stored in a clear, readable format, and was easily exportable from the phone for the researchers to analyze.

Our application consists of two main tabs, one which is used by the research participant to input and update their current activity, and the other, securely locked behind a password, containing the settings panel. The first tab allows the user to select between a list of predefined "general" activities that are universally shared across most participants, such as Sleeping, Eating, Studying, Exercising, etc. For more personalized data collection, we have also included some custom activity fields, which the participant can fill in with their own specific activities that do not neatly fit into the other, predefined activities. The settings page, on the other hand, will be exclusively for the researchers, allowing them to stop, start, and tweak many parameters of the recording process. Some of the important options are the dB calibration offset to calibrate the noise data on the fly for different external microphones, as well as the ability to set the interval over which noise data will be recorded, then averaged and stored into one value. Other options include the ability to set the dB threshold at which our application should start notifying the user to update their activity, allowing the researchers to get more recent activity updates when the ambient dB increases beyond that threshold, as well as an option to set a recurring notification interval, periodically reminding the user to update their activity.

COMPUTER SCIENCE AND ENGINEERING

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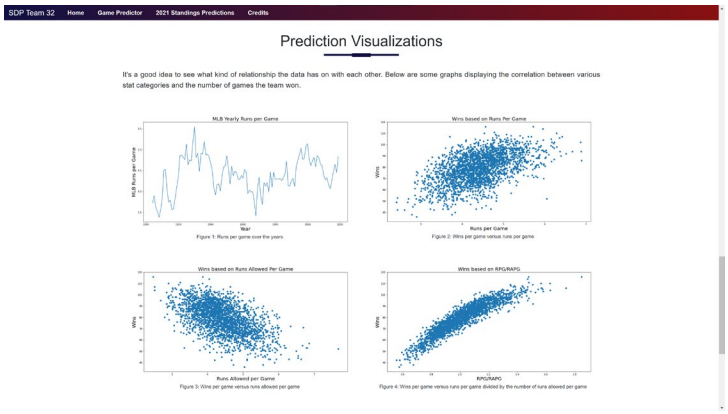
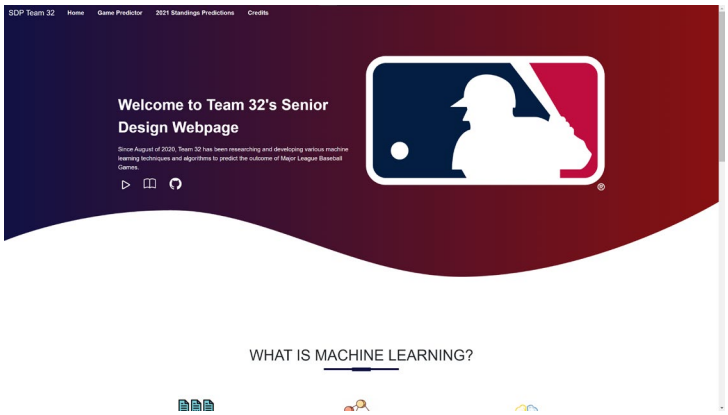
Predicting Outcomes of MLB Games

The sports industry has always relied on statistics and past data to make inferences about future trends and performance. This sector has become so lucrative that the sports analytics market is projected to reach nearly $5 billion by 2021. Major League Baseball is one of the largest consumers and industry drivers of these analytics. Statistical analysis is nothing new in baseball, and has been used to give teams an edge against their competition since its inception. Our team set out to create a predictive model that allows users to select matchups between two different baseball teams. In particular, users can select the away team, the home team, the away starting pitcher, and the home starting pitcher as input to the model and will be presented with the win probability for both of the selected teams. To accomplish this, the group leveraged the power of machine learning and used comprehensive data from Retrosheet to train various models. For the matchup predictions, Random Forest Classifiers gave the best results. The team also used machine learning order to make predictions for the 2021 standings for the end of the season using Ridge Regression. An accompanying webapp was made and can be accessed by anyone by visiting the website: sdpteam32.herokuapp.com. On the site, users can interact with the predictor and find links to see the source code. The data processing and machine learning was done in Python in the form of Jupyter Notebooks, while the webapp used a combination of HTML, CSS, and Python in conjunction with the Flask microframework.





COMPUTER SCIENCE AND ENGINEERING

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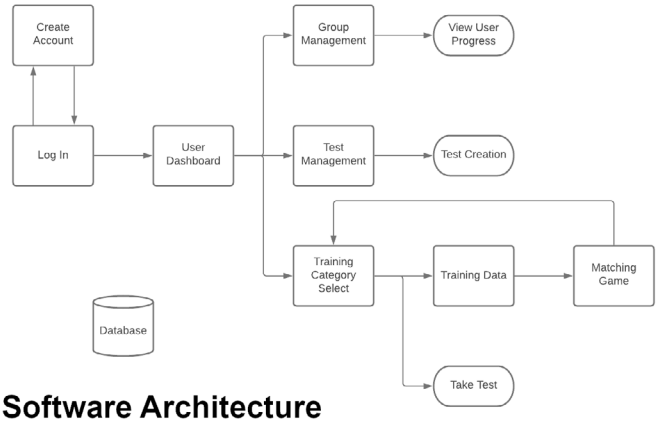
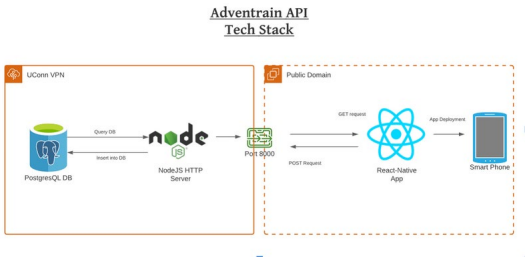
CGI

Gamification of Training ("Adventrain")

Adventrain is a mobile application written using React Native that is designed to enhance the employee training experience through the use of gamification techniques. Instead of the typical training format used in many corporate environments, Adventrain uses AR along with a story-based experience to administer entertaining matching exercises to the user. These training modules are assigned through an infrastructure of user managed groups and tests which are stored in a PostreSQL database backend system. Once a user has been assigned a module, they can access it through a comprehensive, personally tailored user dashboard before they take its associated test. These trainings divide each test's content into stages that the user can complete to gain practice with the material. Users select a specific stage to begin practicing with by finding various virtual objects in a digital or AR space. Once an object has been found, the user is presented with the corresponding training data for that object's category and a matching game that reinforces this information. When the user passes a stage by matching pairs of question and answer cards, they are rewarded with the digital object they selected. Once this process has been completed for all stages of the module, the user is free to begin a traditional testing process in order to meet the training standards of their employer or department head.



Software Architecture



COMPUTER SCIENCE AND ENGINEERING

TEAM 34

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Christopher Jacobs
Alyssa Johnson

ADVISORS

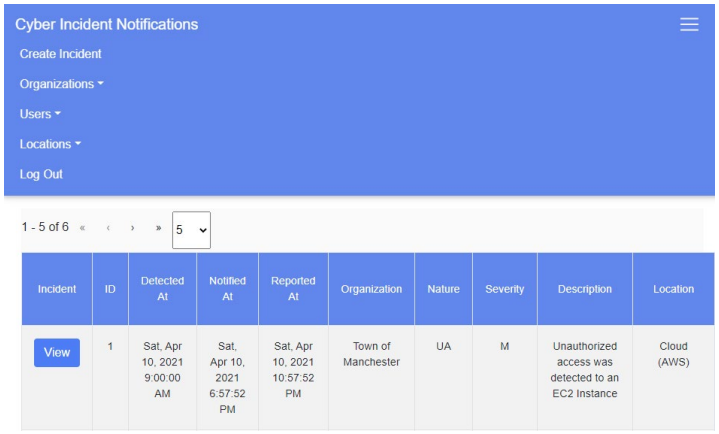
Mukul Bansal

SPONSOR

GMIS® INTERNATIONAL

Rapid Cyber Exploit Reporting via Mobile App

Our team has designed and created a mobile-accessible web application used to report cyber attacks and exploits. The development of this application was sponsored by CT GMIS with the Town of Manchester to facilitate the current cyber exploitation reporting process. Time is of the essence when an attack occurs, yet often the news of cyber exploits doesn't reach technicians and defender agencies until weeks after the attack has been detected. With this application, participating Connecticut municipalities can report cyber exploits in a timely and secure manner. Additionally, technicians can receive notification of cyber incidents in real time, removing unnecessary delays in reporting.



Our application makes use of various frameworks and services to come together and form a complete prototype. We use MongoDB as a database to store records in conjunction with Django to add, archive, or retrieve records as needed for our backend. With Angular, we provide a reactive, accessible frontend interface to display detected incidents, each with running comment chains to keep track of updates or edits. Administrators can also manage organizations and users. Using AWS, our application sends out notifications to all affected users and tagged agencies. This cloud service is also expected to be used by the sponsor for hosting and deploying the final application. Although the original goals of this project were to create both Android and Apple mobile applications, a slight shift in primary sponsorship to CT GMIS during the Spring semester changed our priority to making a single mobile-friendly web application.

COMPUTER SCIENCE AND ENGINEERING

TEAM 35

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Andy Wang
Matthew Zimmer

ADVISORS

Seung-Hyun Hong

SPONSOR

Secure Embedded Architecture

Our team first researched the vulnerabilities that the board may be susceptible to such as Cache Attacks, side channel attacks, electromagnetic attacks, etc. Based on the research, we would come with attacks to attempt on the developmental board. Then we were tasked to gather metrics based on the cryptographic algorithms, AES and RSA, by using a prototype secure boot process by a software only approach and only hardware-assistance to gather the metrics. The metrics gathered were execution times, memory footprint, and level of protection of the board. Levels of protection being how the board would respond to things such as the wrong key given with the data to be encrypted, the key being reversed, or a one-bit difference in the key.

COMPUTER SCIENCE AND ENGINEERING

TEAM 36

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Yun-Hwan Kim

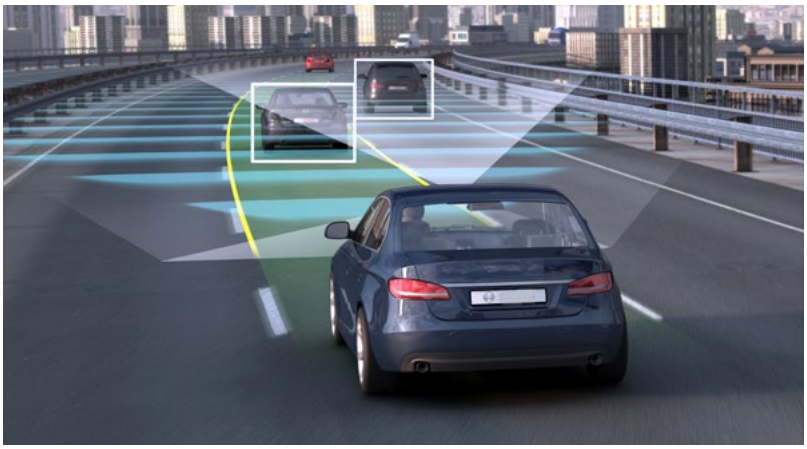
ADVISORS

Fei Miao

SPONSOR

MITSUBISHI ELECTRIC RESEARCH LABORATORIES

Path Planning with Deep Neural Nets



The modern world relies on road vehicles for almost every aspect of life. However, the speed at which these vehicles operate can make them deadly in human hands. Improvements in computing hardware, sensors, and machine learning algorithms have the potential to reduce the deaths, injuries, and damage to property caused by automotive accidents as well as increasing the economic efficiency of road vehicles. Moving into the future, new methods must be developed to minimize the number of accidents on the road. New control systems may be able to outperform human drivers in safety and could replace them entirely.

Mitsubishi Electric Research Laboratories has contacted the University of Connecticut Senior Design program and has asked them to design a vehicle testbed and implement a deep neural network for self-driving vehicles. CSE Senior Design Team 36 focused on the development of these methods in collaboration with a team of Electrical Engineering students who assembled the vehicle testbed that would evaluate the validity of the path planning algorithm. The neural network is designed to plan the path of the vehicle and appropriately adjust its course to avoid collisions and stay within the lane. The specific neural network structure that was used by the senior design team was inspired by a proposal from Dr. Karl Berntorp, published as US Patent 9989964B2. The vehicle testbed includes a sensor suite that will allow the vehicle to make real-time measurements of its surroundings and make decisions accordingly to maintain safe operation.

COMPUTER SCIENCE AND ENGINEERING

TEAM 37

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Yeshi Soleti
Aleksa Fiedorowicz

ADVISORS

Dong Shin

SPONSOR

CTSRC

Path Planning with Deep Neural Nets

Our project is to create a new and revamped website for the Connecticut Crash Data Repository. The Connecticut Crash Data Repository is a website that compiles all the available data for vehicle crashes in the state of Connecticut. For this project we will be working with Director Dr. Eric Jackson and his team at the Connecticut Transportation Safety Research Center. The main goal of the website is to provide users with analytics on motor vehicle accidents and the factors that contribute to those accidents. These factors include but are not limited to drug use, road condition, distracted driving, and weather conditions. We have been tasked with updating the graphics and layout of their current existing site, as well as creating new and exciting data visualizations that are easier for viewers to understand. Furthermore, we have been tasked with performing analysis on toxicology data of drivers involved in accidents, as well as performing analysis of the effects of the COVID-19 pandemics on vehicle accidents in the state. Finally, due to complications with the foundation that the original site was built on, we have been tasked with increasing performance on the website, as well as decreasing the load time across the site. These are the tasks outlined to us by Dr. Jackson that our team will be focusing on with our website. To handle the data set displayed by the website, we will be using a MSSQL Database and an Apache server. For the data visualizations and website formatting we will be using Plotly Dash and Python.

COMPUTER SCIENCE AND ENGINEERING

TEAM 39

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Zachary Zambuto

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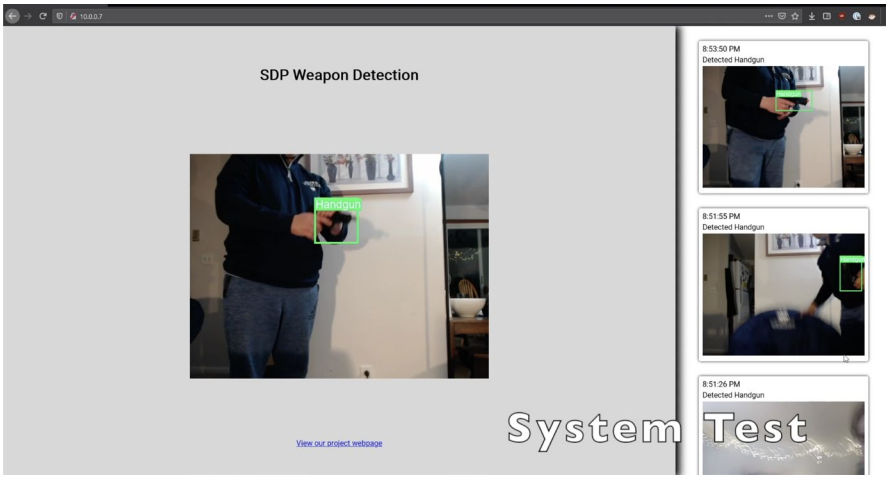
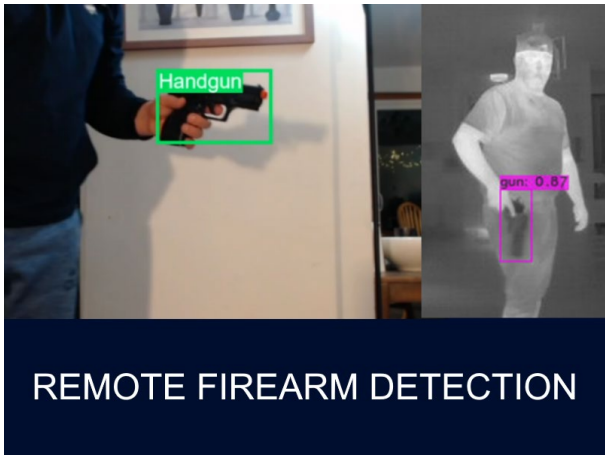
SPONSOR

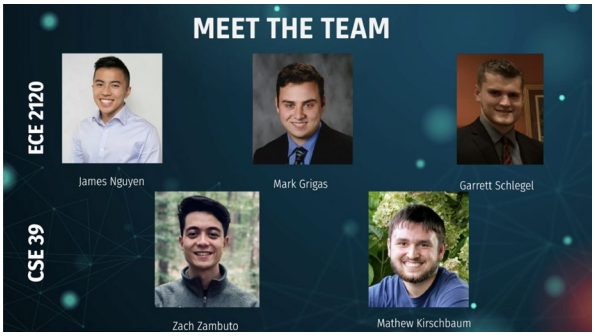
PRESCO ENGINEERING

Remote Firearm Detection



In recent years, the US has experienced many tragic shooting events. Businesses and public places need a security system design that can identify, deter, and eliminate threats with concealed firearms before tragedies occur. Our project uses modern AI and object detection to identify both concealed and openly visible firearms. The system has the flexibility to forward the detection results to a web-app interface or log the detections for future reference. We designed our project to find a good balance between size, speed, and cost – all aspects of the system are self-contained on a single small form factor computer – NVIDIA's Jetson Nano – along with either a standard or infrared camera (for detecting concealed weapons). The end result is a model that can detect open carry rifles and pistols at ~84 % MaP and concealed at ~70% MaP.





COMPUTER SCIENCE AND ENGINEERING

TEAM 40

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Mike Cote

ADVISORS

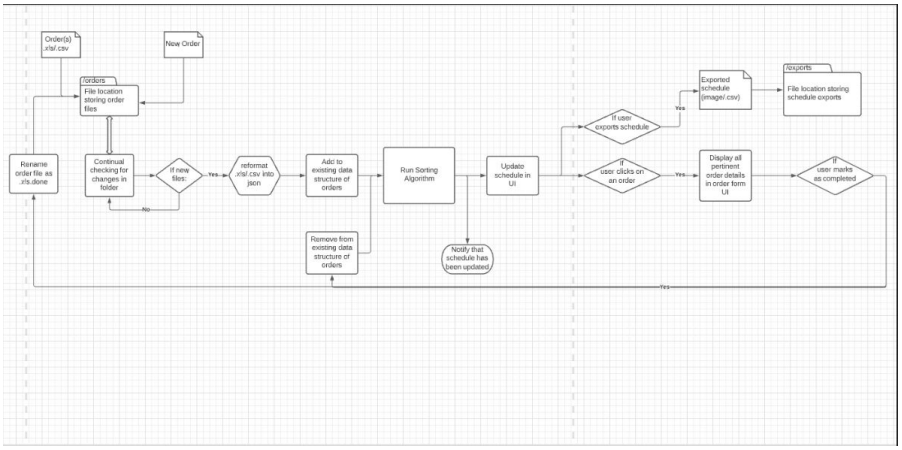
Ion Mandoiu

SPONSOR

Interface Technologies

Cut Room Scheduling

In the sewn goods industry, a cutting room is the industrial environment in which materials (usually fabrics) are spread and cut for apparel manufacturing. The processes of spreading and cutting are often complex and challenging to manage. Cutting rooms contain multiple tables on which the material is spread, often in multiple layers (called plys). Often, a manual spreader system is used in conjunction with an automatic cutter. Unfortunately, the automatic cutter systems are usually quite cost prohibitive and as a result a cutting room will often only have one that must be shared. Currently, cutting room managers must manually decide how to schedule the spreading and cutting of different orders in order to utilize these minimal machines and tables. This manual scheduling is suboptimal as it is simply not feasible for a manager to accurately determine the most efficient schedule that satisfies all of the various parameters. To solve this issue, our project team designed and developed an algorithm that, when given a list of cut orders and the needed information about them, will automatically determine what the best scheduling order is based on optimizing a series of factors (order due dates, order priorities, maximum cutter usage, and fastest schedule).



COMPUTER SCIENCE AND ENGINEERING

TEAM 41

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Samuel Anderson (ECE)
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ADVISORS

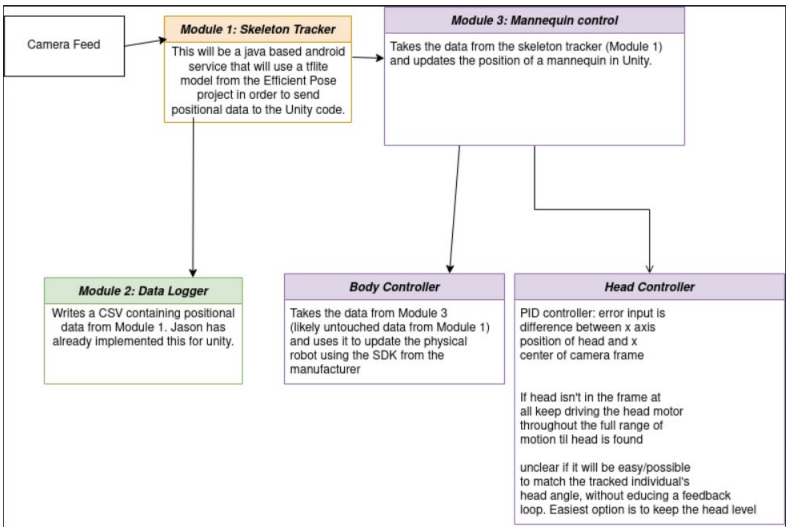
Phillip Bradford

SPONSOR

MOVIA

Human Position and Posture Detection System for Human Robotic Interaction Control

The main goal of this project was to design a posture detecting and replicating system that could be incorporated into a Kebbi robot. The system extracts body position, posture, and gestures using the Kebbi robot's built-in camera, then those features are processed using computer vision. After processing the robot's motors are driven to replicate the user's gestures and posture and the data frames are logged. The end goal was so users can educate and assist children using the Kebbi robot.



COMPUTER SCIENCE AND ENGINEERING

TEAM 42

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Kenny Payes Galeano

ADVISORS

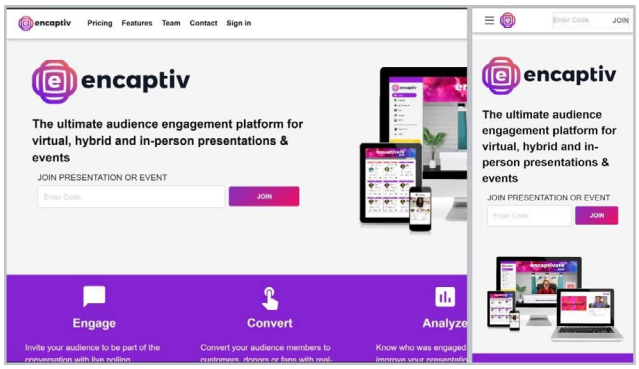
Phillip Bradford

SPONSOR

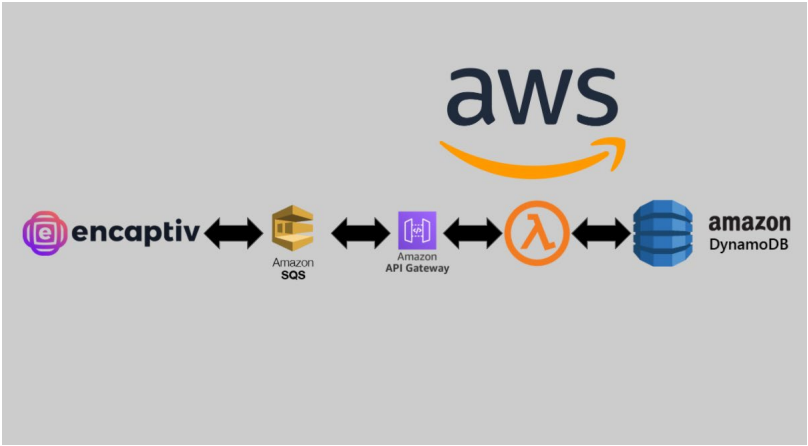
encaptiv

Encaptiv Marketing Website and Serverless API

The company encaptiv strives for perfection in online presentation, webinar, and event hosting. In order to provide useful functionality and a great user experience, encaptiv sought to improve their public marketing website and build an ARM (audience relationship management) product. To put it simply, encaptiv's goal is to maximize user value, and our team was thrilled at the opportunity to assist in this goal.



For the website portion of our project (Figure 1), our approach was to use industry standard Javascript framework (Vue) with an industry standard language (Typescript). The benefits of using a modern Framework include improved source code readability/ maintainability, dynamically generated content, and support for adaptive designs. The result is a website that was designed to be adaptive inside and out, giving its users and it's developers a seamless experience.



The umbrella project of an ARM (audience relationship management) product contains several complex components. An important component is an API (Application Programming Interface). An API is typically any software that allows for software-to-software interaction and data sharing. The API we created (Figure 2) allows for recording and retrieving audience data while providing an abstraction layer between the application and it's data, enabling simple, reusable access to data. With serverless technologies (AWS Lambda), it's possible to create small functional pieces of code accessible to an API without needing a traditional server set up, which can be costly and difficult to maintain.

We employed the Agile development method throughout to improve organization, get continuous feedback, and ensure sponsor requested changes were completed before strict deadlines. Writing user stories helped our team prepare demonstrations of the user value gained on a week-by-week basis. This constant communication and continuous feedback helped our team produce finished projects that were to our sponsors exact specifications.

COMPUTER SCIENCE AND ENGINEERING

TEAM 43

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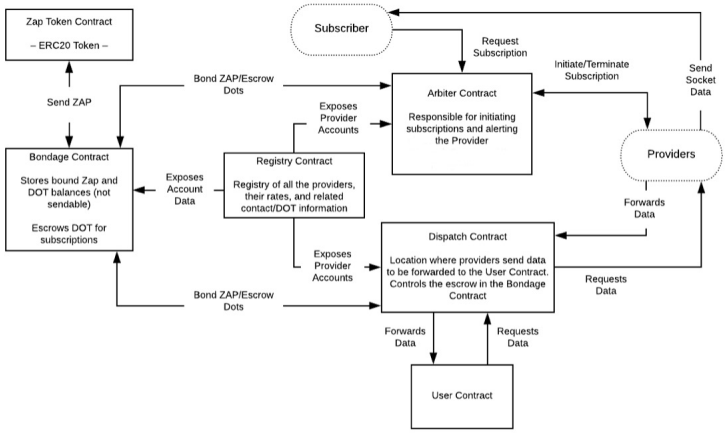
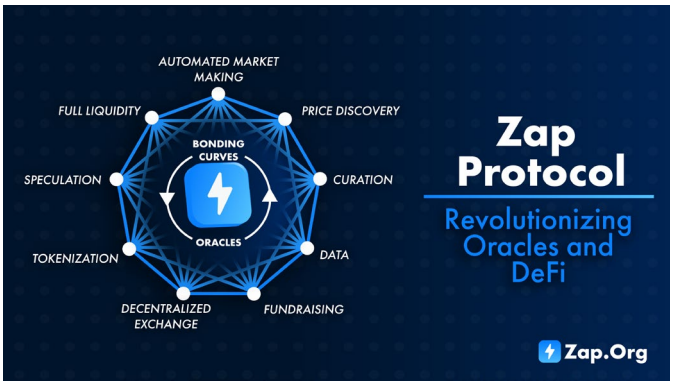
SPONSOR

Zap.org

Oracle Creation with the Zap Protocol

In the context of blockchains, the oracle problem is loosely defined as the security, authenticity, and trust conflict between third-party oracles and the trustless execution of smart contracts. The Zap Protocol, a project sponsored by the New York Blockchain Center and the Synapse Foundation, aims to solve this by democratizing the oracle creation process. This encourages a robust marketplace, wherein data providers and other decentralized services compete with each other. Our project was split into multiple phases. The first was a learning phase, where we learned the terminology of the blockchain space and became familiar with some of the technologies used by developers. The second phase entailed academic research on the oracle problem. Through our research, we helped develop novel ideas for possible solutions to the oracle problem. This in turn informed the Zap team of potential design changes to their protocol. The third phase consisted of helping to drive open-source development in several programming languages. By expanding their codebase from JavaScript to other popular languages such as Python and Java, more developers from a wider range of disciplines could participate in the Zap ecosystem. The final phase involved implementing our own oracle that serves to end users the latest basketball scores and relevant statistics from all major American basketball leagues, both at the college and professional level. We also built an accompanying web application, and thoroughly documented the process to serve as a model for future users of the Zap platform.





ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2101

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ADVISORS

Ashwin Dani

SPONSOR

SIKORSKY
A LOCKHEED MARTIN COMPANY

Modern Helicopter Flight Control System

A helicopter is a highly complex system. As helicopter technologies advance, these systems become even more complex. To reduce the workload on the pilot, helicopters have various flight modes that allow the pilot to delegate some tasks over to a flight controller. Drones are good approximations of helicopters. The drones considered in this project are multicopters (MC). They observe the same physical laws as helicopters only with different output methods. In this project, a new flight mode will be designed for the PX4 Autopilot system. This flight mode is known as Attitude-Command Velocity Hold (ACVH). The outputs of the controller are abstracted to Euler angles (roll, pitch, and yaw). The goal of this flight mode is to trim the drone at a certain constant velocity, both in forward flight and banking.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2102

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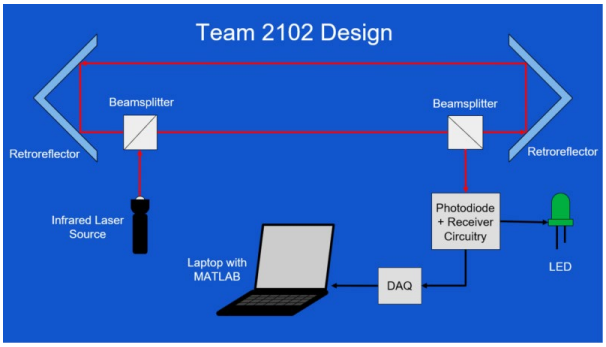
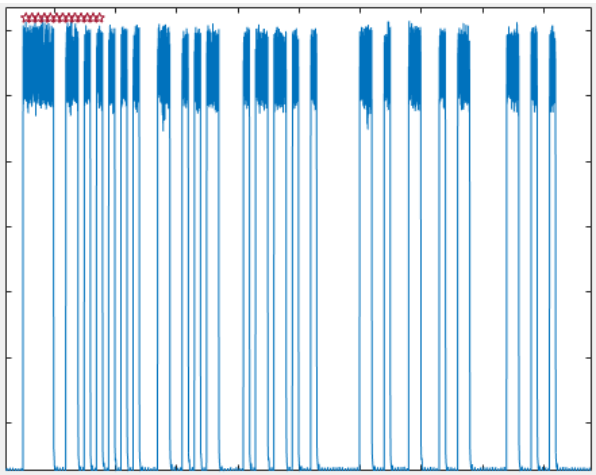
SPONSOR

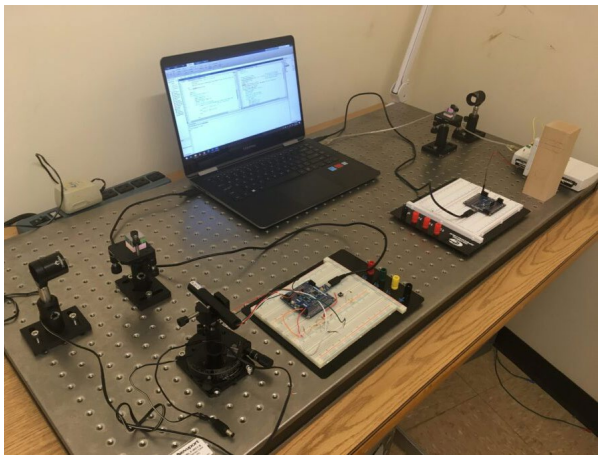
UCONN SCHOOL OF ENGINEERING
ELECTRICAL & COMPUTER ENGINEERING

Resonant-Beam Based Optical Wireless Power Charging and Data Communication

As an ever-increasing number and variety of smart devices (phones, TVs, video doorbells, appliances, etc.) communicate with each other over the Internet of Things, the demand for completely wireless power delivery and data transmission is greater than ever. Startups such as Wi-Charge have created prototypes for establishing wireless links to charge devices via resonating, extended-cavity infrared laser beams, which can send power over longer distances and with fewer energy losses than other competing alternatives. In theory, resonant beams should be self-aligning, even as the positions of transmitters and receivers change, and should shut off automatically if an object enters their path, making them inherently safe. The UConn ECE Department is investigating this cutting-edge technology, and our team has taken some of the first steps by designing and constructing an optical testbed (Figure 1). Our testbed consists of a one-meter long, free-space, infrared optical loop capable of transmitting power and data. A 10-mW infrared (invisible) laser sends light energy to a photodiode, which converts the light into electrical energy and powers an LED. Using a microcontroller, we are also able to send data pulses with the laser, and we can record the received data waveform (Figure 2) and decode its stored message using a data-acquisition unit in conjunction with a laptop running MATLAB. Future work can build on our testbed to produce a higher-power, extended-cavity resonant beam with the addition of a laser gain medium within the optical loop.







ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2103

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SPONSOR

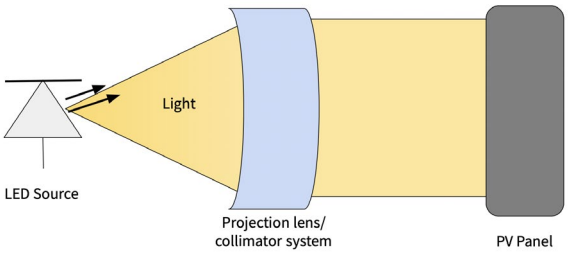
UCONN SCHOOL OF ENGINEERING
ELECTRICAL & COMPUTER ENGINEERING

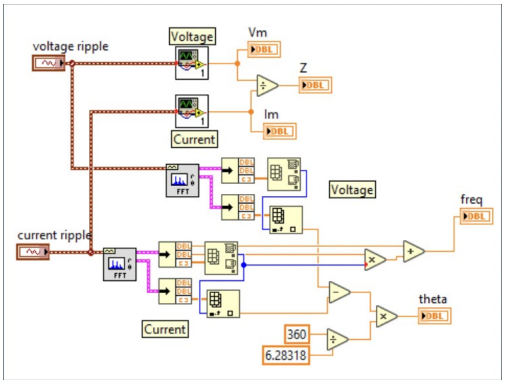
Light Intensity Modulator for Photovoltaic Panel Impedance Spectroscopy

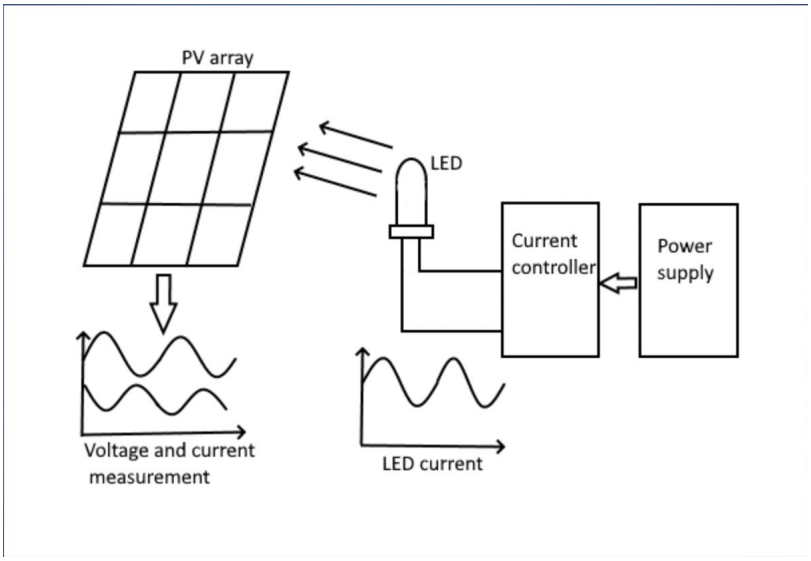
The purpose of this project is to design and test a LED driver circuit that controls the current of an LED array in order to modulate the light incident on a photovoltaic (PV) panel. This is done in order to perform impedance spectroscopy on the panel and determine equivalent circuit parameters. Impedance spectroscopy is a testing technique where a small AC excitation signal is applied to a material to determine resistances and capacitances. This can be done using specialized equipment such as a frequency response analyzer. The LED driver circuit will be able to modulate incident light and thus the voltage output of the PV panel in order to attain impedance data over a range of frequencies that we use to derive equivalent circuit parameters. The LED driver circuit is implemented using a synchronous buck converter. This project requires the design and fabrication of an interface board to detect voltages and currents from the panel and the LED Driver. These voltages are minimized, clipped, and amplified; the final signals are then sent to a data acquisition module. The signals are then used to determine equivalent circuit parameters. Factors that need to be taken into account when designing the apparatus include the alignment of the LED array in relation to the PV panel in order to maximize array efficiency, as well as isolation of the module from outside light sources.

This project is a continuation of research done at the University of Connecticut Center for Clean Energy Engineering.

Optical System Using a Collimating Lens







ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2104

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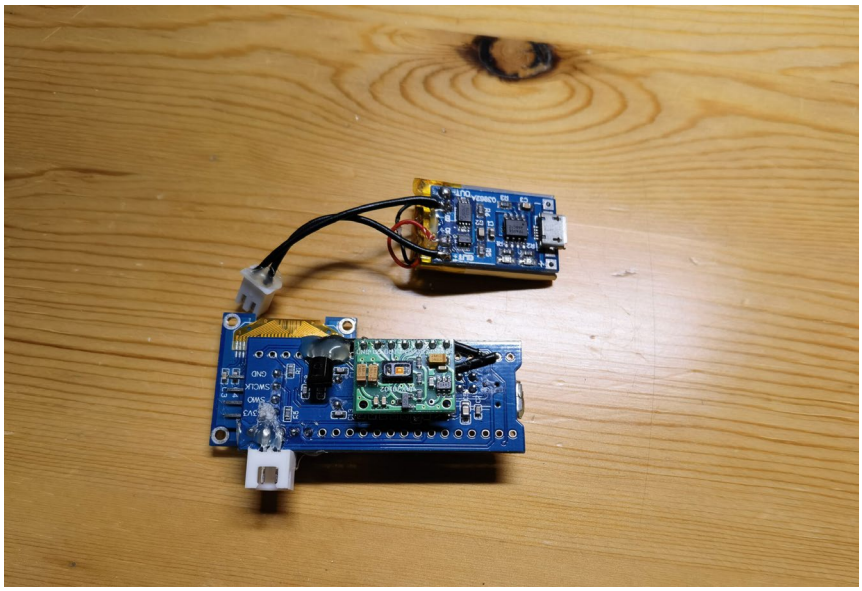
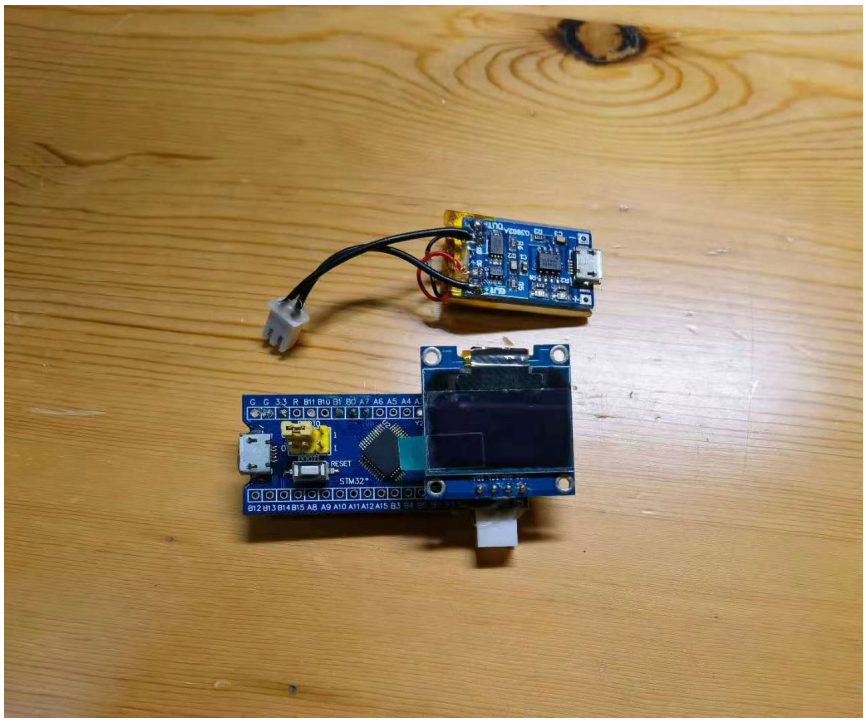
UCONN
SCHOOL OF ENGINEERING
ELECTRICAL & COMPUTER ENGINEERING

Wearable Biosensors

As fitness becomes a main melody in many people's life nowadays, being able to grasp the vital parameters of their body starts to show a more important role. This project focus on an emerging technology that appears in many modern wearable devices, like Apple Watch, Samsung Galaxy Watch, Fitbit, and Garmin. The goal is to build a portable device that can measure vital parameters of human body. We are required to get various types of detecting sensors to measure each parameter and then properly integrate and connect them all together with microcontroller where signal will be governed and sent to a computer. Programming with C should take place on the computer, and analyze and edit the signal from the detecting sensors. We are using two detecting sensors which are relatively easy to design and integrate for this project to measure three parameters: heart rate, blood oxygen rate, and body temperature.





ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2105

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Nihar Reddy

ADVISORS

Shengli Zhou

SPONSOR

MITSUBISHI ELECTRIC
Changes for the Better

WiFi-based Indoor Monitoring

In this project we are extending the application of commercial WiFi routers to enable sensing. Our project is a continuation of the works done from the sponsor side. We connected routers via AI mesh to build a WiFi testbed that is configured as transmitters. Then we used either another router or phone as the sniffer router to capture network packets. From the packets we can extract the Channel State Information(CSI) to understand how the wave propagates from the 5GHZ band. From there we gathered multiple datasets and processed this with different machine learning algorithms. This process was done iteratively as we explored different methods of data collection and variations to build a robust dataset. Then we applied preprocessing techniques from MERL along with different machine learning algorithms to increase accuracy throughout the course of our project.

Routers on the far left and far right are communicating with the center router while the phone acts as the sniffer router.

Our project allows us to predict the user's location and pose within our testbed. For example in one experiment we have identified five different locations in a room along with three unique poses the user performs while operating their smartphone. In another experiment, our testbed was able to determine the number of people in a room. This small concept can later be expanded to produce more data points within a larger testbed. Making this technology attractive to companies who need solutions to security, localization, pose recognition and more. To put it succinctly, our results allow us to determine the predefined location and movement of the user and/or users within the testbed with a certain degree of accuracy.

		Position 3			Position 4			Position 5		
		Pose 1	Pose 2	Pose 3	Pose 1	Pose 2	Pose 3	Pose 1	Pose 2	Pose 3
	Pose 1	784	156	20	28	200	8	16	108	180
Position 3	Pose 2	64	444	24	208	236	0	284	216	24
	Pose 3	0	0	1460	40	0	0	0	0	0
	Pose 1	28	28	28	592	28	16	460	308	12
Position 4	Pose 2	28	220	520	52	280	4	48	336	12
	Pose 3	4	0	124	52	8	760	0	552	0
	Pose 1	0	128	0	4	24	0	1280	60	4
Position 5	Pose 2	52	36	52	284	124	136	144	652	20
	Pose 3	0	0	0	0	0	0	0	0	1500

Back to back data collection		Accuracy for position and pose	
e.g	training data	0.574	
position 3 pose 1	testing		
	training data		

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2106

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Dakota Cook

ADVISORS

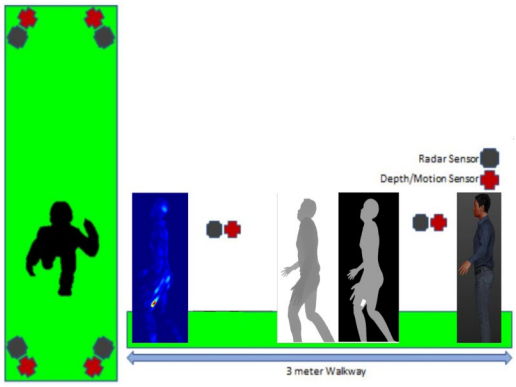
John Chandy

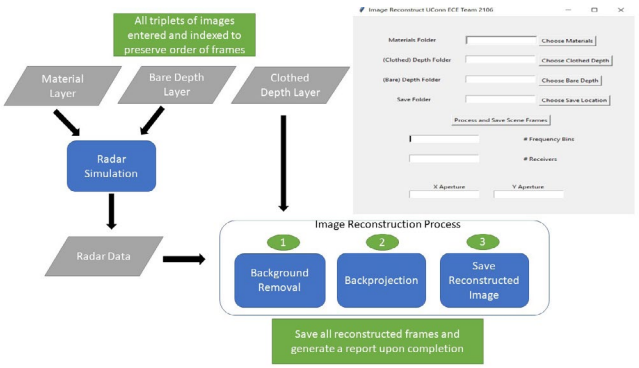
SPONSOR

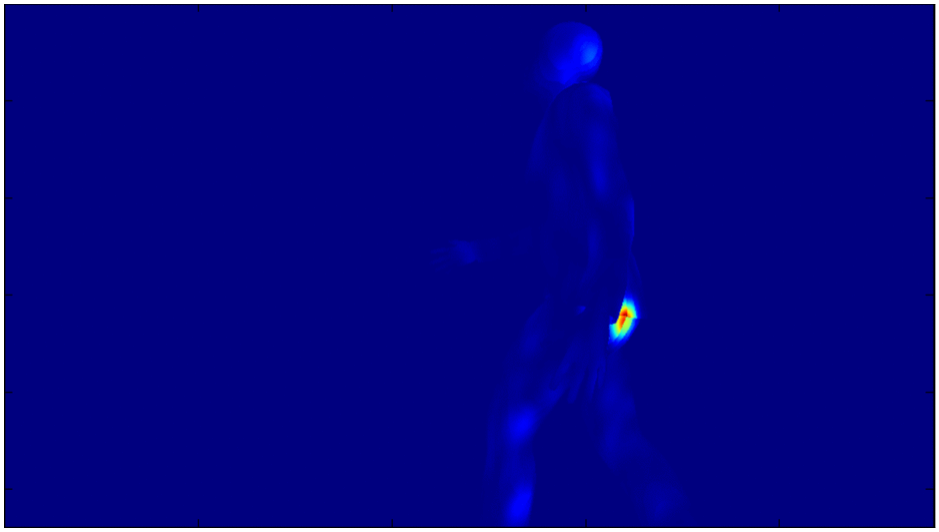
MITSUBISHI ELECTRIC
Changes for the Better

Seamless Security Checkpoint

The goal of this project is to develop a prototype for a passive security checkpoint that can replace millimeter wave scanners currently used in airports and other high traffic areas. Current checkpoints require individuals to stop and stand in a certain position while the device screens them, resulting in inconvenience. Our proposed solution uses a camera depth sensor and a radar to detect metals on a person as they walk through a short corridor. Thus, with the passive security checkpoint there is no need for people to stop moving during the screening process. The passive security checkpoint is being prototyped using a combination of open source software solutions. Blender, Carnegie Mellon's Motion Capture files, and MakeHuman were used to develop the depth camera simulations and model body types. Using the simulated outputs, Python's NumPy and CuPy libraries were used to aid in the development of image processing algorithms and radar simulations. This software based approach serves to mimic a hardware based solution which images a person walking through a corridor.







ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2107

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ADVISORS

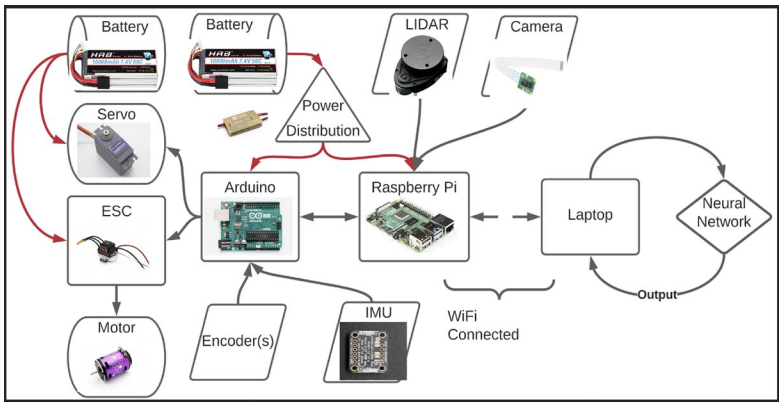
Shalabh Gupta

SPONSOR

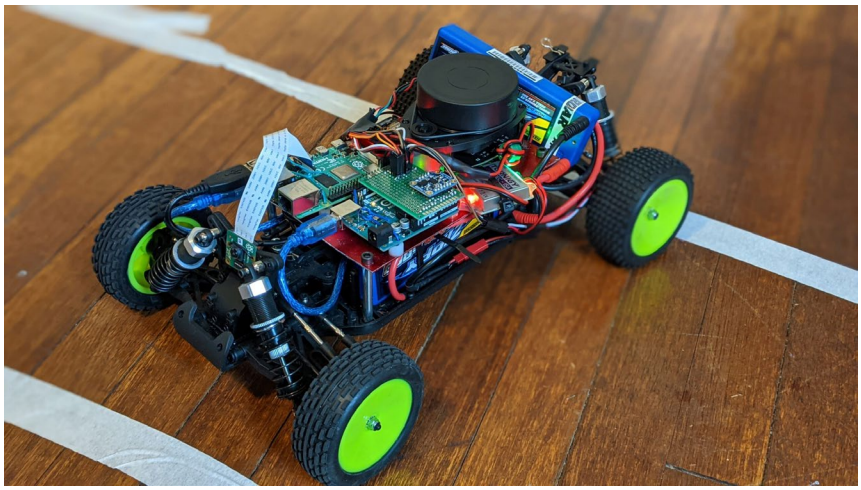
MITSUBISHI ELECTRIC
Changes for the Better

Path Planning with Deep Neural Nets

The goal of this project is to build a small-scale car setup employing a variety of different sensors like (depth/camera) to generate ground truth labels that will be used as training datasets for a vehicle maneuvering on a road. We will test and develop machine learning (specifically deep neural networks) that uses the sensor information to construct a vehicle motion in response to the sensor information.



To accomplish this goal, a testbed was built that uses Robot Operating System (ROS) to control a sensor-suite capable of self-driving. This suite includes a camera, LIDAR, inertial measurement unit (IMU), and encoders. These sensors are connected to an Arduino/Raspberry Pi that is wifi connected to an external laptop which processes the neural network. This allows for two modes of operating: the training teleoperation mode, and the neural networking mode. In the training mode the robot is controlled by a standard gamepad controller and the data recorded by the car is recorded on the laptop. In the neural network mode, the vehicle drives around the track autonomously.



ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2108

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ADVISORS

Abhishek Dutta

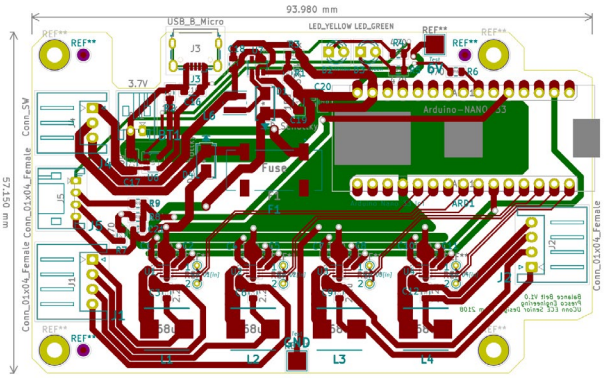
SPONSOR

PRESCO
Electronic Product Design and Manufacturing

Wearable Balance Belt

Presco Engineering is a design and development company located in Woodbridge, CT. They have partnered with Conrad Wall, creator of the original design of the Balance Belt. The aim of the original belt was for people in some type of balance rehabilitation, where the participants have lost their sense of balance either due to injury or to age. Presco Engineering has sponsored the development for a new design that is aimed towards fitness and health, where instead of it being solely a medical device, it is instead a training tool.

The original design, while functional, did have a variety of drawbacks. The belt used 6 total sensors and 4 tactile vibrators. The idea with this belt was to measure a person's orientation relative to the ground while they were standing. If the belt senses that the person has deviated too much from a vertical posture, the tactile vibrators would vibrate in the direction that they are leaning/falling towards in an attempt to have the user instinctively move to the opposite direction. The original design was very large, cumbersome to wear, and expensive to manufacture. The goal of our project is to update this outdated design and aim it towards a broader audience.



The fall correction system we implement must be small and draw little power, since not only will the battery size be constrained, but also for the sake of a longer battery life. This system also has to be very responsive, since it has to detect and correct a person from falling before they do fall. Discerning against a fall, and a controlled motion (i.e, bending down) will be difficult as they represent the same deviation from a person's center. This belt has to fit a wide variety of people, since this belt is meant for a general population and not just a specific size.

Our new design is much slimmer, as well as lighter. The old belt weighed approximately 2.2 lbs, and the new belt weights 1.o6 lbs. The new belt is also much more responsive, and features a progressive trigger system, where the transducers' vibration strength will increase as a person leans. It also contains an auto shut-off feature, where the belt will stop vibrating after a fall is detected and resume operation when the user stands up again. The belt also features the ability to pair with a cellphone via Bluetooth, and can track which side you are leaning towards.

Overall, this belt is a major improvement from the original as it is smaller, lighter, and has more features.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2110

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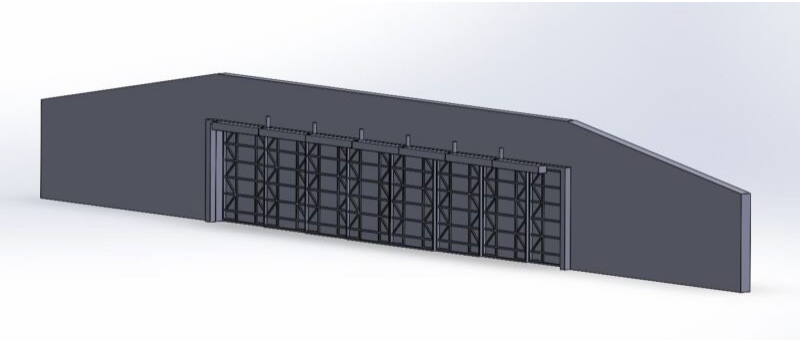
ARMY NATIONAL GUARD

Hangar Door Design for Heat Loss Reduction



The National Guard located in Groton, CT operates within a large hangar which requires them to open the north and south end hangar doors multiple times per day. Due to its location near the sea, the strong winds combined with the cold winter temperatures can make the working environment uncomfortable for the employees. On top of the discomfort caused, this issue has been putting stress on the heating system utilized to heat the hangar and it has been driving energy costs higher.

The reduction of heat loss in the National Guard's hangar is a large scale project. Our electrical and mechanical engineering teams from UCONN are focusing on finding and designing the best possible solution to this problem. The goal of this project is to ultimately increase the comfort of the working environment within the hangar as well as reduce the energy consumption wasted on heating the hangar. The design should not hinder any of the daily tasks completed in the hangar and should be an automated process. Our team is pursuing an air wall system composed of various air blowers, a suspension system to hold the machinery, and switches to automate the blowers. This design is the least obtrusive on the activities which take place in the hangar. Due to the large scale of this project our team is building and simulating the final design of this project and presenting the completed system design to the National Guard.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2111

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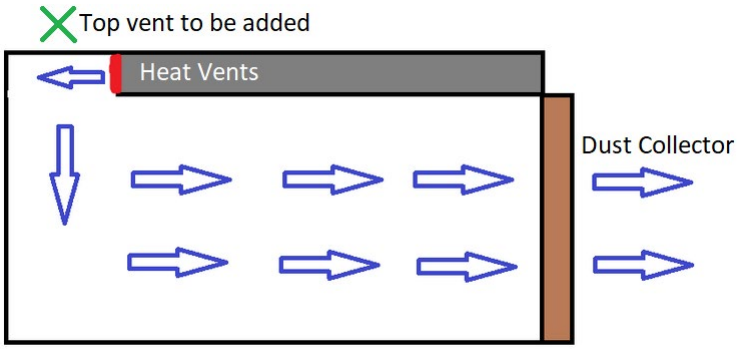
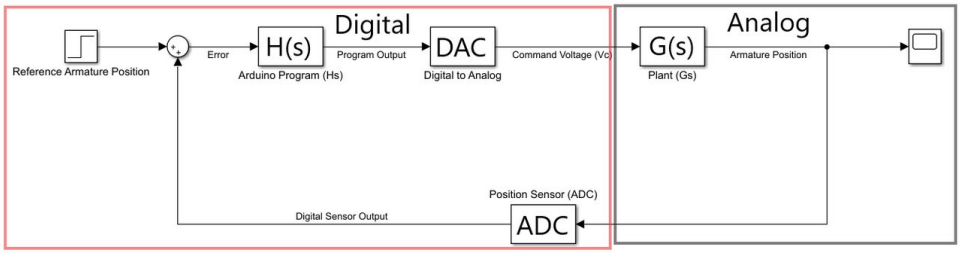
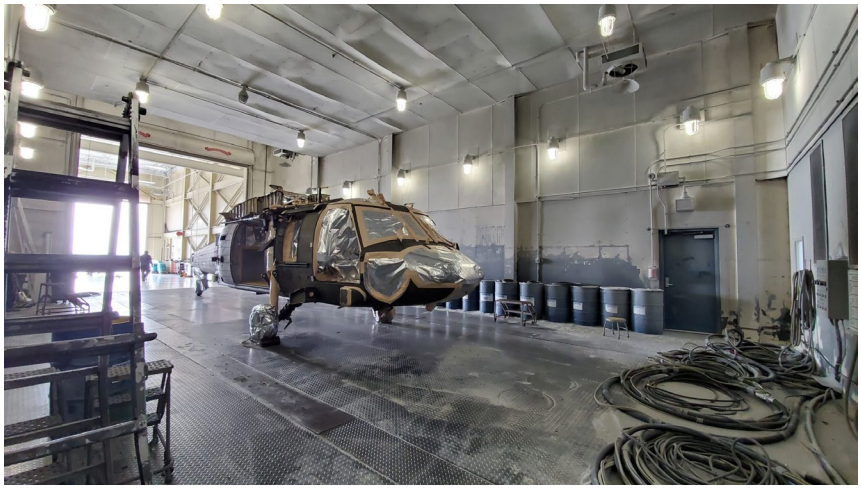
SPONSOR

Blast Media Booth Modernization

The National Guard TASMG in Groton has a large facility that does routine maintenance on helicopters ranging from from Black Hawks to Chinooks. Among these facilities is a blast media booth. This facility uses highly pressurized hoses which blast the parts and hull of a helicopter with “Type 8” Plastic Magic Media. When blasted the plastic media strips the helicopters of paint making them suitable for maintenance. This facility is now over twenty-five years old. The equipment and machinery in this facility have exceeded their useful service life and utilize obsolete technology. The system is prone to both mechanical and electrical failure and it is so old that any replacement parts must be custom fabricated with long lead times. The National Guard has tasked our group with designing a new modernized blast system. In our design we will be selecting new equipment and machinery for the blast booth. We will also be updating the other critical components of the blasting room. These other components include redoing the media floor collection system to be more effective than the current two trough design. The ventilation and airflow systems also need to be updated to ensure desirable airflow through the room and to maintain negative pressure in the room during blasting.







ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2112

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SPONSOR

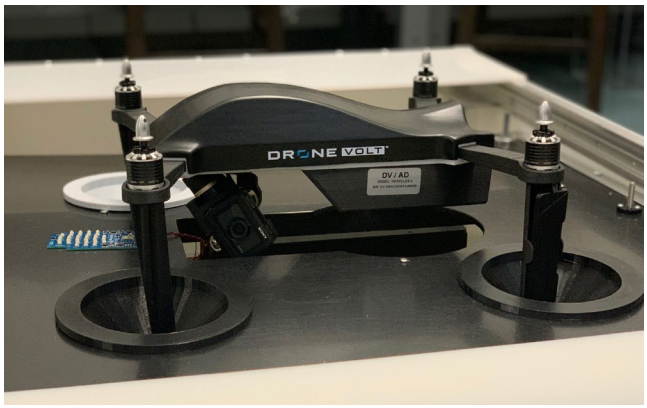
A.D Aquiline Drones

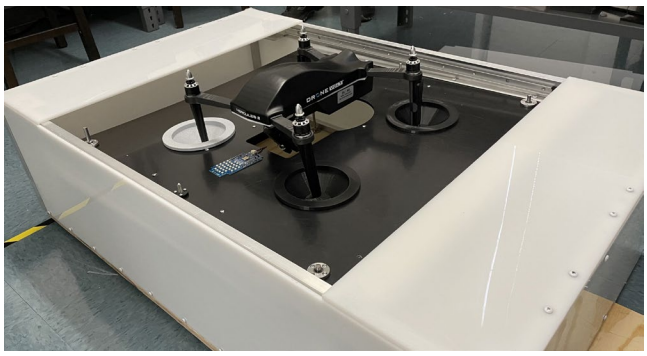
Static and Dynamic Drone Landing Platform

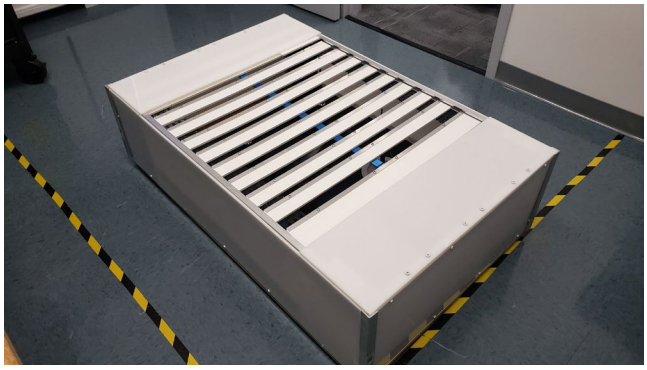
Aquiline Drones, located in the financial district of Hartford, CT, offers full-service UAV solutions with equipment, personnel, and cloud infrastructure for a multitude of use cases. A few examples of these UAV solutions include critical delivery, perimeter security, and asset protection. They have redefined the entire unmanned aerial vehicle (UAV) landscape by developing a unified, real-time cloud with autonomous flight capabilities, edge computing, and AI-enabled data insights.

Our senior design project focuses on designing and creating a functioning autonomous drone landing platform with wireless charging integration. The drone uses infrared landing technology to settle on the landing platform. When properly aligned, the charging coil on the platform should provide maximum power to the onboard drone battery once it is detected. The drone landing platform must also provide a safe enclosure for the drone, as shown in Figure 1. We will use a material for the top of the landing platform to protect the drone from various weather conditions and other external factors. The drone must be able to fit securely in place and must be able to be mounted on the roof of a vehicle. In Figure 2, you can see that the cones are fit for the drone's legs to maintain stability.

The autonomous drone landing platform could further expand the applications of UAVs. The wireless charging capabilities of the landing platform allow for more usage. Since the platform will mount on the roof of a vehicle, it is beneficial to the military, general security, and delivery sectors. The drone platform will enable UAV solutions for work in remote areas and work in multiple locations. Aquiline Drones will be using this system in partnership with the Hartford Police department to strengthen public safety measures.







ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2113

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ADVISORS

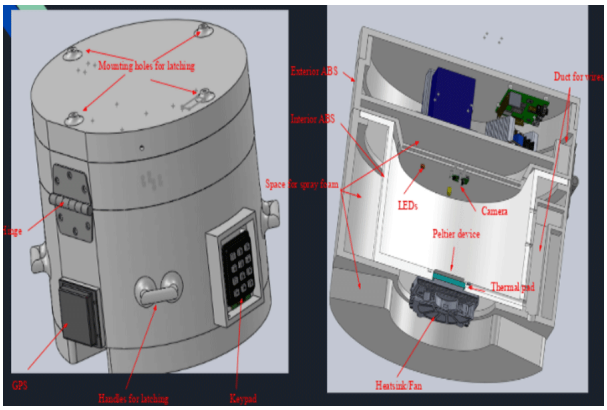
Shalabh Gupta

SPONSOR

Aquiline Drones

Smart Box for Transportation of Critical Articles

Our project is to make a container to carry medical articles such as medicines or organs for human transplantation. This container must be able to be carried by a drone. The container and its payload must be thoroughly monitored by an end-user or medical partner, and the payload must be cooled to an appropriate near-freezing temperature of 4o – 8oC. This is a joint project with UConn Mechanical Engineering, who is responsible for the design of the container, ensuring it is small and light enough to be suitable for a UAV carrier. The Electrical Engineering team is responsible for creating an internal sensor network and communications system to monitor the container's vitals, regulate internal temperatures, and sustain full activity and communication for at least one hour of flight time.



ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2114

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ADVISORS

Sung-Yeul Park

SPONSOR

Collins Aerospace

Densely-Packaged Electronics Circuits

Team 2114's project is a joint effort between the Electrical and Mechanical Engineering teams. Our main goal is to observe any differences gallium nitride (GaN) transistors exhibit in a DC/DC converter compared to a converter using a silicon (Si) transistor. Our research allowed us to predict that GaN-based devices will perform with higher efficiency and less power dissipation than Si-based devices. Our goal is to prove this in the laboratory using experimental results. These experimental results will provide our sponsor, Collins Aerospace, with information to aid them in their transition of using GaN transistors rather than Si transistors for aerospace applications, particularly those that require DC/DC converters. The challenges facing our Electrical team were designing a PCB board based on GaN System's GS61008P-EVBHF board and reporting all learnings gained from the design as well as the design files back to the sponsors. Then we were to send our design files to a PCB manufacturer to have our board fabricated and assembled. Another challenge we were assigned was testing the original GS61008P-EVBHF board with our custom PCB board and reporting any differences in performance or measurements that were discovered. One challenge facing our Mechanical team was taking pictures with a thermal imaging camera of the GS61008P-EVBHF and custom PCB board and reporting back all measurements and any notable differences. Another challenge our Mechanical team faced was creating a model of the PCB board in Ansys and running a thermal analysis on the PCB before it arrives and comparing it to the thermal imaging camera results obtained from pictures taken of the PCB.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2115

Talon Close
Tariq Ali

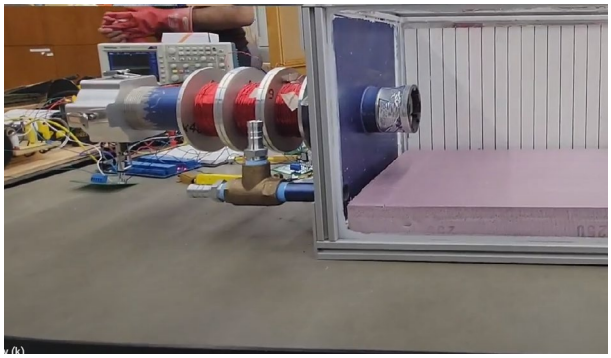
ADVISORS

Ali Bazzi

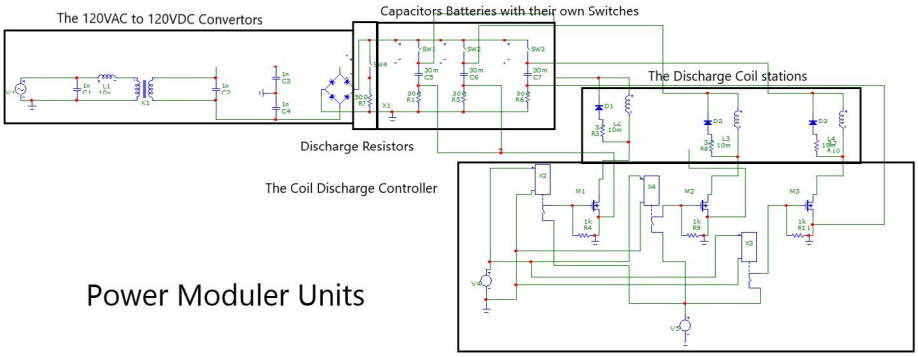
SPONSOR

NAVSEA WARFARE CENTERS NEWPORT

Underwater Electromagnetic Launch



The goal of our project is to successfully launch a projectile underwater using electromagnetic fields. This is accomplished by sending electrical currents through coils of wire in order to produce magnetic fields. When a magnetic field is created in a coil it will pull anything magnetic to the center of the coil. In our design, three coils are used to form a coil gun in order to propel the projectile out of the launch tube. The goal of each coil is to produce a magnetic field just long enough to bring the ferrous projectile into the center of the coil, then turn off so that the magnetic field does not stop the projectile from continuing forward. This is achieved by using a microcontroller to switch each stage of the coil gun on and off quickly. The main purpose of this launching technique is to be able to launch a payload, such as a U.U.V or Underwater Unmanned Vehicle, discreetly. This would be utilized primarily on submarines where reducing the potential noise of operations is of utmost importance.



Power Moduler Units

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2116

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Yang Cao (EE)
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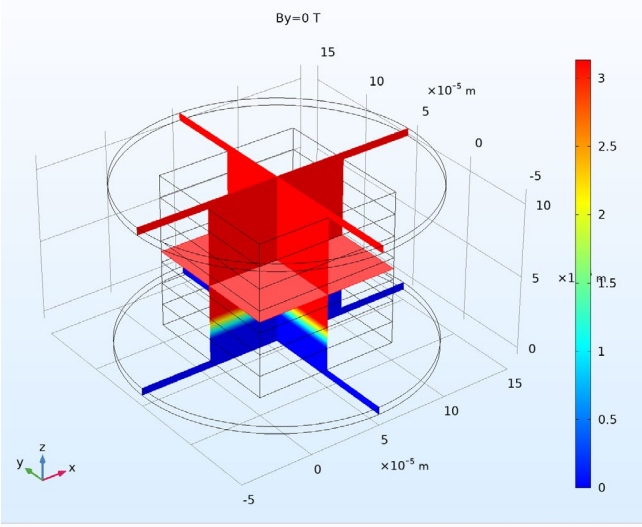
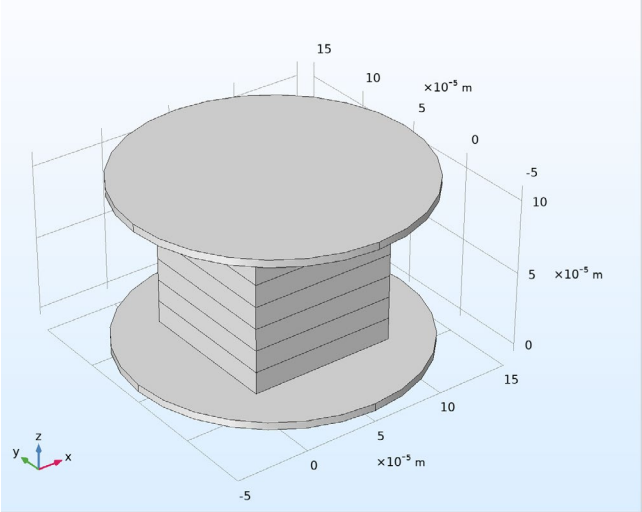
SPONSOR

GENERAL DYNAMICS
Electric Boat

MEMS Magnetometer

The main objective of this project is to design a precision MEMS (microelectromechanical) magnetometer for General Dynamics Electric Boat. By using MEMS, we can miniaturize the sensor, which will make it easier to deploy onto a PCB. This sensor could then be used on an autonomous vehicle to sense changes in the Earth's magnetic field. The Earth's magnetic field fluctuates around 36 microTesla, so Electric Boat gave us a target precision of 0.1 nanoTesla. There are many MEMS magnetometer types currently sold on the market, so we first had to determine the best solution for our project. After weighting all the potential options, we settled on designing a magnetoresistive magnetometer. This magnetometer works by changing resistance in the presence of a magnetic field. Running a current through the magnetometer generates a voltage, which changes due to the resistance change. To test a potential design, we simulated the performance and thermals of our design in COMSOL Multiphysics. We also designed a circuit diagram to interpret the outputs in voltage, from our magnetometer.





ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2117

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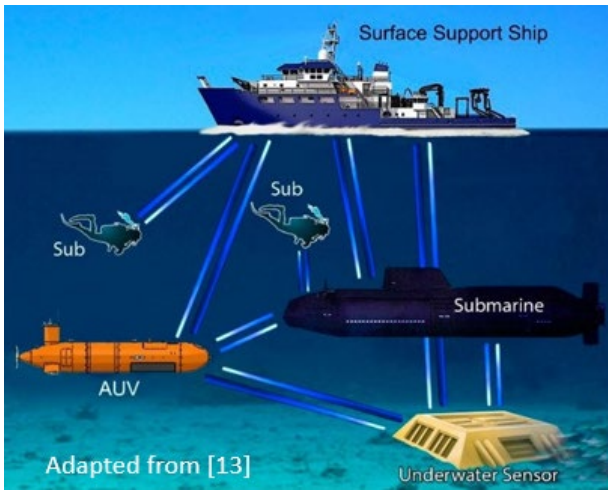
Necmi Biyikli

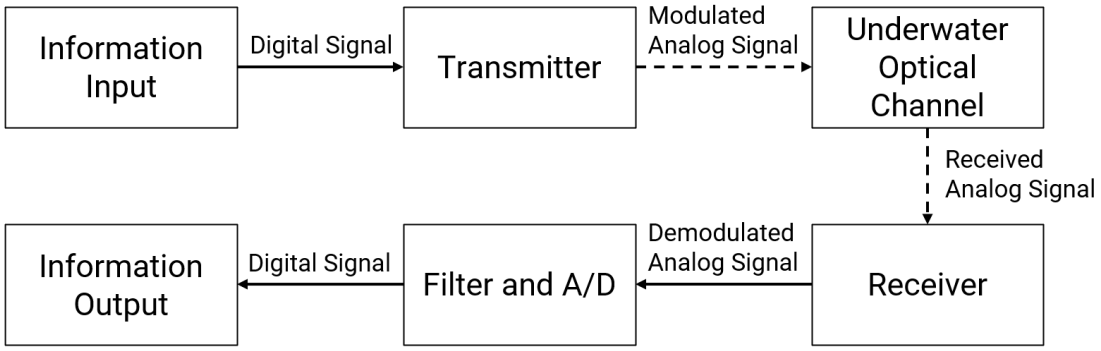
SPONSOR

GENERAL DYNAMICS
Electric Boat

Underwater Data Transfer



This project involves the identification and investigation of potential wireless technologies that can be used to transfer data between two or more moving underwater platforms within 30 feet of each other. These methods of data transfer would need to have a benign effect on aquatic life as well as improve the data transfer bandwidth and rate relative to the convention of Acoustic communication. Based on this engineering challenge, the work that has been done is centered around the alternatives to Acoustic Waves and the potential simulation and hardware implementation of systems of this nature. This has lead our focus towards Optical Communication as it has the potential for the highest data rate and bandwidth within the specified range. There are different restrictions that can occur in UWOC systems as well, so we have a responsibility to identify those if we are proposing this idea. We have also created an example hardware implementation of proof-of-concept data transfer system through a very small medium of water, to function as a hardware demonstration of what is possible with widely commercially available products & public online resources.



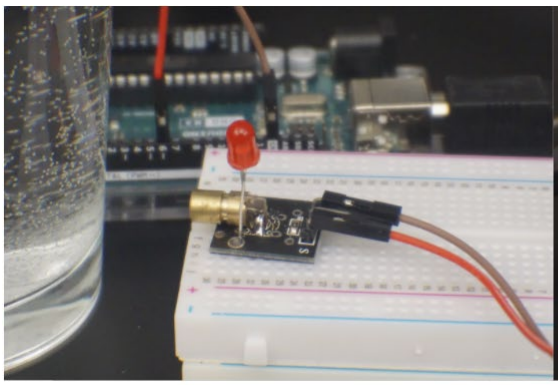


Figure 12: Picture of Transmitter Circuit

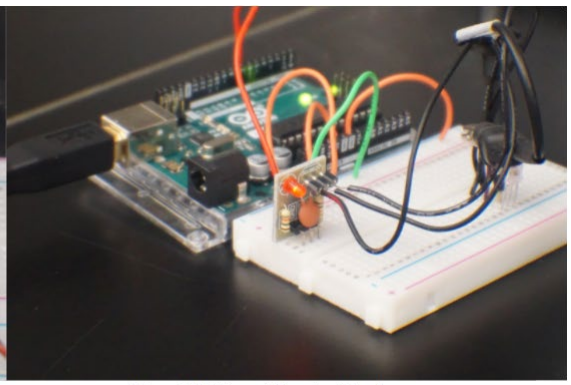


Figure 13: Picture of Receiver Circuit

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2118

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Nicholas Ottalagana

ADVISORS

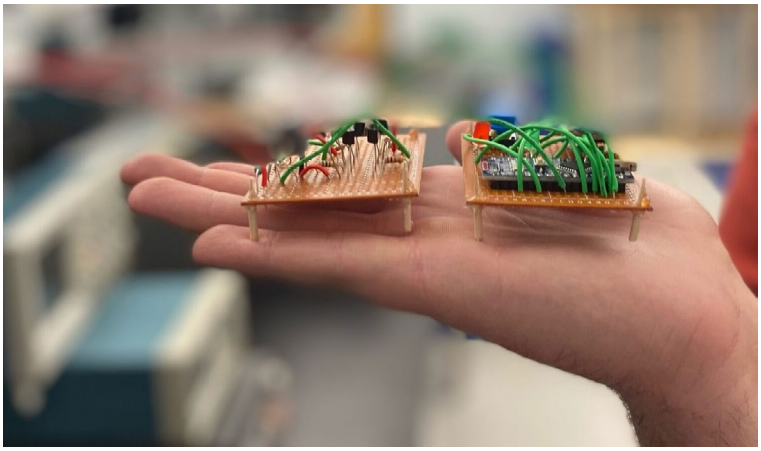
Liang Zhang

SPONSOR

Kolb CONSULTANTS

Dynamic Plantar Fasciitis Splint

The proposed Senior Design Project will have the team develop the concept of a Dynamic Plantar Fasciitis Splint into a fully functional prototype that will be worn by a subject for a proof-of-concept evaluation. The purpose of the device is to move up and down, stretching the user's foot to treat plantar fasciitis. The development process includes consideration of various mechanisms to drive the motion, CAD modeling, hardware design, and creation of physical models. In developing the concept the team must also consider issues relevant to future commercialization including component cost, ease of use, device safety, etc.



ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2119

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John Chandy

SPONSOR

EVERSOURCE

Statistical Analysis of Worker Efficiency

Worker behavior and crew efficiency are primary concerns for large organizations with employees working in skilled trades. These are work environments in which employees meet at a central location every morning, ride a truck to the job site, and return at the end of the shift.

The job may require loading material on the work truck prior to departure. A classic question in worker management is whether loading the trucks the night before a job, “pre-loading”, helps reduce time employees spend at the warehouse in the morning awaiting departure. This morning time, possibly involving truck loading as well as socializing, often constitutes a large portion of the work day. It is also desirable to know what other factors contribute to worker efficiency, such as weather, availability of manpower and equipment, etc.

The operations of large organizations yields a wealth of data, which modern data science can offer quantitative methods to analyze the performance of. The sponsor Eversource Energy desires the use of statistical methods to make data-driven decisions with the goal of determining whether and to what degree management policy decisions impact worker efficiency. Successful analysis has implications for costs of operations, hiring and purchasing, and productivity forecasting.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2120

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ADVISORS

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SPONSOR

PRESCO ENGINEERING

Remote Firearm Detection System

In recent years, the US has experienced many tragic shooting events. Businesses and public places need a security system design that can identify, deter, and eliminate threats with concealed firearms before tragedies occur. Our project uses modern AI and object detection to identify both concealed and openly visible firearms. The system has the flexibility to forward the detection results to a web-app interface or log the detections for future reference. We designed our project to find a good balance between size, speed, and cost – all aspects of the system are self-contained on a single small form factor computer – NVIDIA's Jetson Nano – along with either a standard or infrared camera (for detecting concealed weapons). The end result is a model that can detect open carry rifles and pistols at ~84 % MaP and concealed at ~70% MaP.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2123

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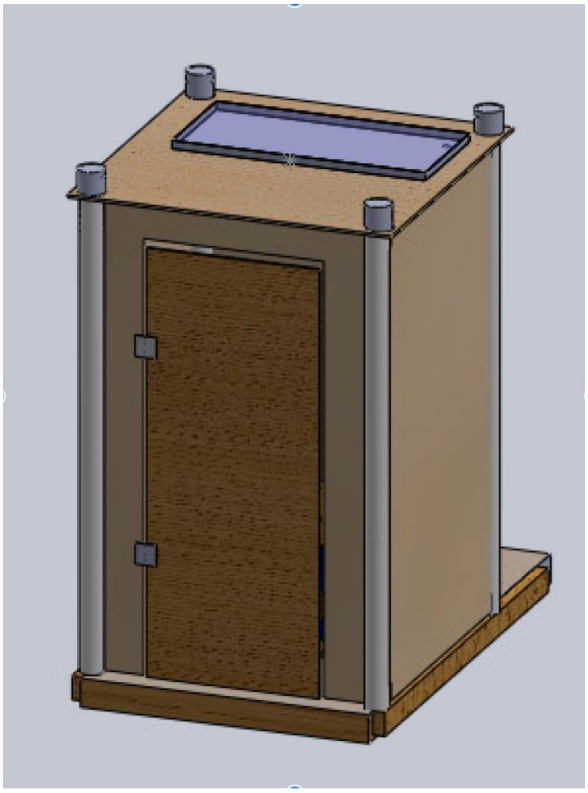
Liang Zhang

SPONSOR

LOOLOO

LooLoo - It's More Than Just a Porta Potty



The LooLoo is a portable toilet system designed to aid communities that have suffered from inadequate bathroom facilities which lack proper sanitation and structural stability. Many of these communities, including homeless encampments, natural disaster affected areas, and numerous international communities, are forced to and also prefer to practice open defecation, which creates biohazards and pollution problems within the areas.

The LooLoo offers a structurally sound, safe, and clean bathroom facility that has solar powered cell phone chargers, as well as waste separation to mitigate odors, ventilation, and proper sanitization measures.

For the purposes of this project, the electrical engineering team was tasked with designing and optimizing an electrical system that would provide both a charging station and adequate lighting. The electrical system consisted of reliable, replaceable parts, in the case of component defects and a simple design for accelerated assembly. While conducting research, our team decided upon using a monocrystalline solar panel over a polycrystalline panel due to the fact that its power efficiency is superior due to its limited number of silicon impurities. The other components were chosen so that the electrical system could provide 24 hours of lighting inside the facility as well as the ability to fully charge three smartphones. Even though construction of the facility has yet to be completed, conservative analyses from our team estimate that even in areas of the globe with lesser amounts of sunlight, our design should be more than able to do what we are tasked with. In addition, cost analysis of the components were performed in order to determine the most cost effective parts. The environmental sustainability of the electrical system was considered to provide a more 'green' experience. By simulating the operational conditions of the system through exploring various use case scenarios, we were able to employ a functional optimized solution.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2124

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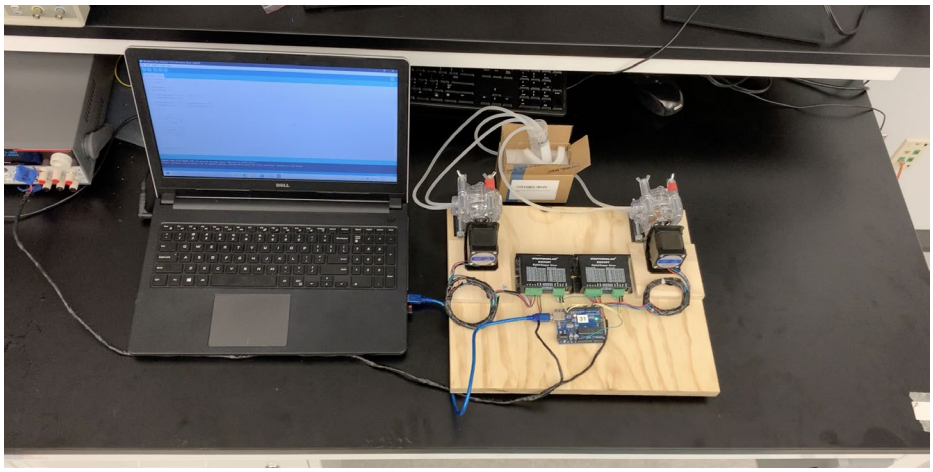
ADVISORS

Necmi Biyikli

SPONSOR

Biorasis
Needle-Implantable, Wireless-Enabled Biosensors

Biorasis Implantable Glucose Sensor Test Bench



Our project is a technical solution to a multitude of challenges Biorasis has encountered with their in lab testing with their implantable glucose sensor. We have redesigned and build a low noise programmable test bench that will produce little to no electrical noise while offering adjustable programming that allows for life like glucose fluctuation during testing. Our newly designed test bed is controlled by an Arduin0 Uno in which sends direction and pulse signals to two stepper motor drivers. These drivers control two stepper motors which are directly connected to two peristaltic pumps, each pumping a different glucose solution of different concentrations. This created an environment in which the Biorasis implantable sensor can read life like simulated glucose solutions while having no heavy RF noise interference during testing.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2125

Chris Nguyen
Kyle McShea
Tanzim Khan

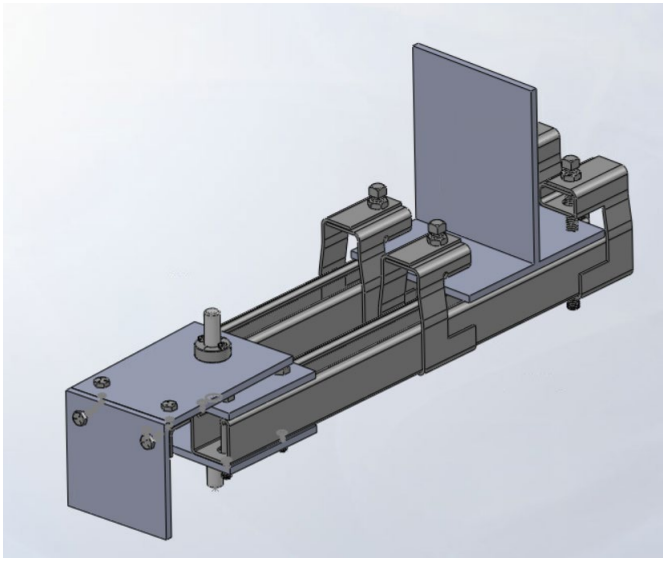
ADVISORS

Lei Wang

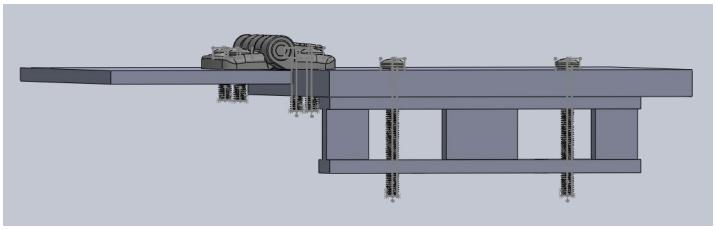
SPONSOR

Precision Point Systems
A Sports Specific Company

Development of an Absolute Position System for Rentschler Field



Team 2125 was tasked with creating a second iteration of a camera system initially prototyped by Precision Point Systems, LLC (PPS), for the purposes of recording and calculating the position of a football on a playing field. The system, composed of a set of cameras mounted around the playing field, is designed to capture images throughout a football game, compile them, and use them to pinpoint the ball's location via various image processing techniques. Team 2125 must develop and implement a new version of this system for use at Rentschler Field. The team's focus is on creating new, stable mountings for the cameras. Work on software development and networking of cameras is limited in scope, due to satisfactory performance by the existing system and the redefinition of goals by the sponsor and team as more information was gathered.



The main objective is to design mountings capable of being suspended from an I-beam, complete with a wide range of motion both horizontally (pan) and vertically (tilt). The overall system must be lightweight and portable for easy setup and removal after games. The system must be rigid enough to resist vibrations from wind and accidental contact, while still being easily adjustable. The pan & tilt mechanisms must be manually controlled (i.e. no external power source), and the camera casings, if modified, must have proper temperature and humidity control to prevent fogging of the camera lens during operation.

Design work and preparation were stymied until a site inspection was secured in late February, after which it was determined that the cameras would only be able to be mounted via suspension from an I-beam as opposed to mounting on a flat platform as previously thought. With this information, an array of 6 cameras was determined to be adequate for coverage. An automated control system for the casings was also developed using Arduino boards, with a fan and heater providing both temperature control & ventilation to prevent fogging.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2126

Robert Jacobson
Tommy De La Cruz

ADVISORS

Sung-Yeul Park

SPONSOR

KENEY PARK SUSTAINABILITY PROJECT

Designing of Solar Picnic Tables at the Historic Keney Park

The solar picnic table provides a space for park goers to relax while also providing solar energy for electrical devices. The design originated from a community survey conducted by the Keney Park Sustainability Project (KPSP). Hartford residents were asked what improvements they would like to see at Keney Park with charging stations being suggested by the residents. With the KPSP's focus on creating environmentally conscious citizens and urban farming, the combination of providing outdoor space and clean energy had led to the construction of a solar panel equipped picnic table. This table features an all year weatherproof design for electrical receptacles and speakers to enhance a park goers experience. A solar panel controller regulates the charging of the battery used to supply power to the receptacles and speakers.

ELECTRICAL AND COMPUTER ENGINEERING

TEAM 2127

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Paul Roach
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ADVISORS

Lei Wang

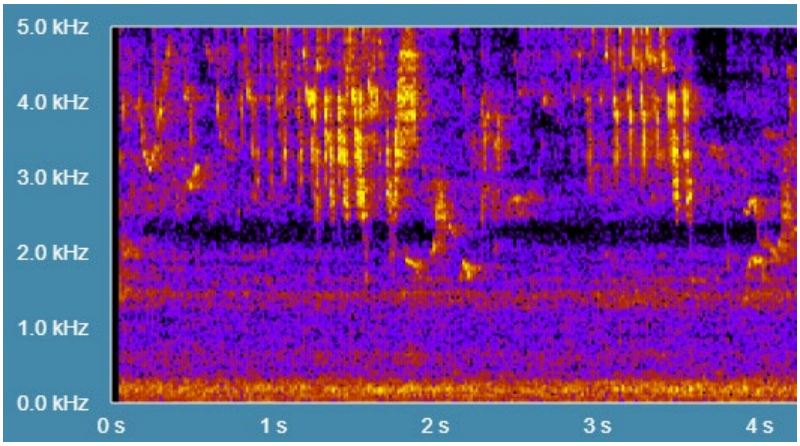
SPONSOR

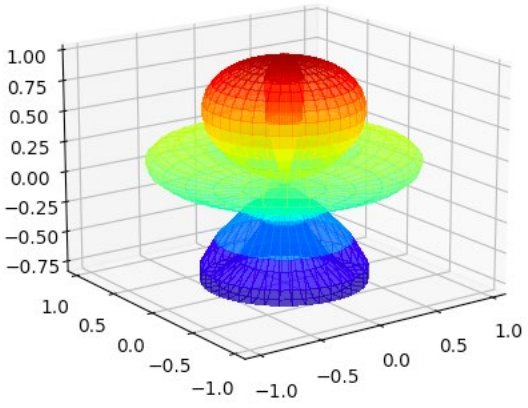
NAVAL UNDERSEA WARFARE CENTER DIVISION NEWPORT, RI — NUWC

Passive Acoustic Array Design for Environmental Monitoring

In underwater communications, passive acoustic hydrophone arrays are used for detecting objects and sounds in underwater environments. Analysis of these signals yields information about the source, such as its direction and identity. These arrays are often used on ships and submarines to detect other objects or animals present in the water. Current arrays, however, can be very costly to set-up, maintain, and calibrate. This project created robust sound classification and source localization algorithms that are able to run on an analogous in-air microphone array.

In particular, the project produced four distinct deliverables throughout its process: The first is a hardware microphone array device capable of recording multi-channel audio suitable for post-processing algorithms and applications. The second is a beamforming algorithm that determines the direction of arrival of a sound source relative to the microphone array. The third is a classification algorithm that detects the presence of and predict the type of source producing the sound (i.e., what type of bird made that specific call). Lastly, a sound dataset consisting of a 24 hour long continuous recording was captured. It was recorded by the microphone array designed.





ENVIRONMENTAL ENGINEERING

TEAM 1

Clifford Otis
Cydney Caterino
Todd Stueber

ADVISORS

Timothy Vadas

SPONSOR

Pfizer

Pfizer Water Efficiency and Recovery

Pfizer's facility in Groton, CT uses a significant amount of water to meet site demand for consumption and onsite utility demand for steam and chilled water generation: about 225 million gallons per year over the last five years. Pfizer requested a report determining water use by building, and wished to identify opportunities for water use reduction which can sustain demand while maintaining a safe and effective workplace that complies with regulatory requirements. This is an interdisciplinary project, and we worked with students from mechanical engineering and chemical and biomolecular engineering to address Pfizer's concerns, using our respective backgrounds to develop different approaches to solve the problem. In addition to assessing the water savings which may be realized through the installation of updated appliances, such as faucet aerators and newer toilets, the environmental engineering subgroup developed a proposal which investigates the functionality and feasibility of a reclamation system to treat and reuse water which is currently discharged into the Thames river. This required an understanding of the water pathways on Pfizer's campus, and the volume of water which would need to be treated. It was also necessary to know the chemistry of the water we proposed treating, and the required level of purity for reuse. If a coagulation/flocculation process followed by rapid sand filtration is used to reclaim the wastewater generated by the utilities systems, it may be possible to reduce Pfizer's water demand by as much as 61 million gallons of water per year: over a quarter of the annual water consumption.

ENVIRONMENTAL ENGINEERING

TEAM 2

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Florence Opoku
Lais Da Silva
Taryn Murasso

ADVISORS

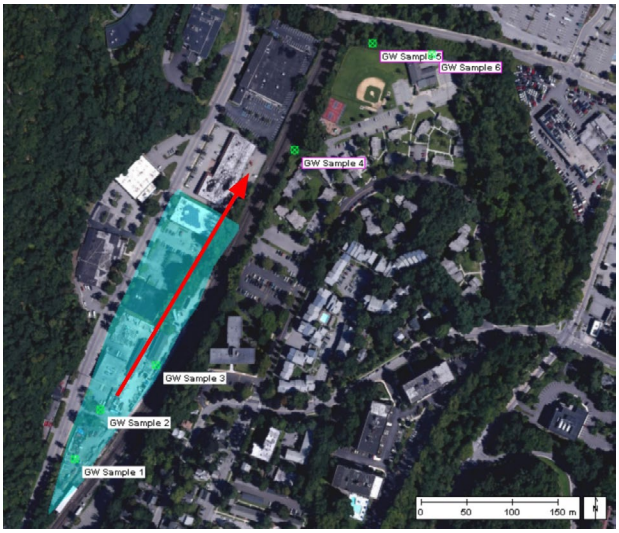
Timothy Vadas

SPONSOR

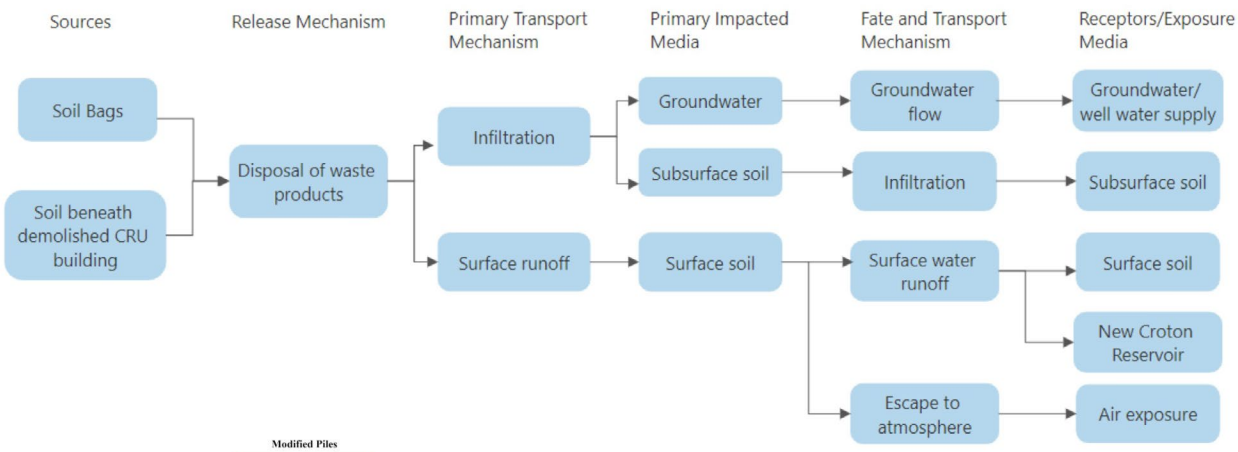
SESI CONSULTING ENGINEERS

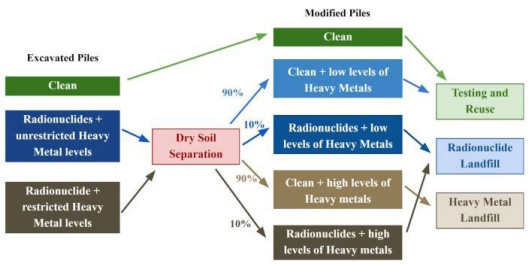
Canadian Radium and Uranium Legacy Site

The Canadian Radium and Uranium (CRU) site was historically contaminated with radioactive radionuclides and toxic heavy metals. Despite years of assessments and remediation, contamination still remains on site. For this project, a plan was developed to remove contamination from the site by excavating polluted soils and sending the soil through the process of dry soil separation. Dry soil separation helps separate out the radionuclide contaminated portions of the soil from the clean portions so that a greater volume of soil can be reused and less soil has to be sent to a landfill specializing in radionuclides. This solution is not only cost effective but helps reduce the need to bring in clean fill and topsoil to replace contaminated soil. In order to protect workers and the community, an air monitoring plan for during the remediation process and a groundwater sampling plan for after remediation were also created.



Conceptual Site Model (CSM)





ENVIRONMENTAL ENGINEERING

TEAM 3

Alexis Coley
Brianna Herman
Sarah Mazerolle
Ryan Tamayoshi

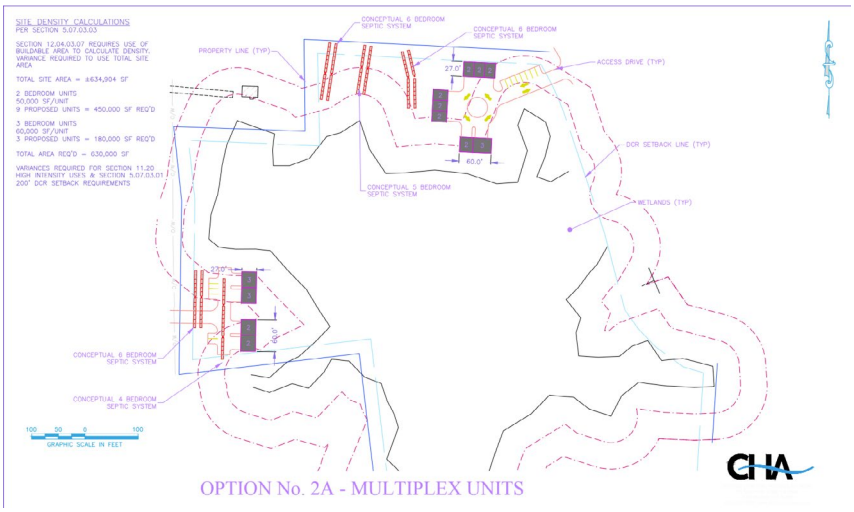
ADVISORS

Timothy Vadas

SPONSOR

CHA

Baxter Road Residential Water & Wastewater System



Willington Park LLC seeks to develop Multi-Family Housing on a ~16 acre plot of land between Route 32 and Baxter Road in Willington, CT. The developer is looking for 16 total housing units split amongst buildings of two to three units each. The site does not have access to municipal water and sewer systems, so sub-surface treatment systems and on-site wells will be needed.

Group 3 of the Environmental Engineering Program was given three tasks for this project. First, to design individual septic systems and leaching fields for each planned building under the regulatory compliance of the CT Public Health Code, accounting for effective leaching area, minimum system leaching spread, and regulatory separation distances. Second, to site possible well locations on the property given required minimum separation distances from site features and infrastructure. And third, to develop a site concept including the planned units along with all wastewater treatment infrastructure taking into consideration the pertinent zoning and wetland regulations, topography, and area requirements for the water and wastewater systems.

Given the site conditions, Group 3 developed a layout for 12 total units split amongst two arrangements of buildings to accommodate the central inland wetland and associated regulatory separation distances. The western arrangement consists of four total units over two buildings, with appropriately sized septic systems for each building's total number of bedrooms. An individual private well will be constructed for each building and tap directly into the plumbing system. The northeastern arrangement consists of eight total units over three buildings, and each building will be accommodated by its own septic system. In contrast to the other arrangement, these three buildings will be serviced by a single community well, likely with some form of atmospheric storage to meet peak flow demands.

ENVIRONMENTAL ENGINEERING

TEAM 4

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Mary Pizzuto
Caleb Wurster
Natalie Chmielewska

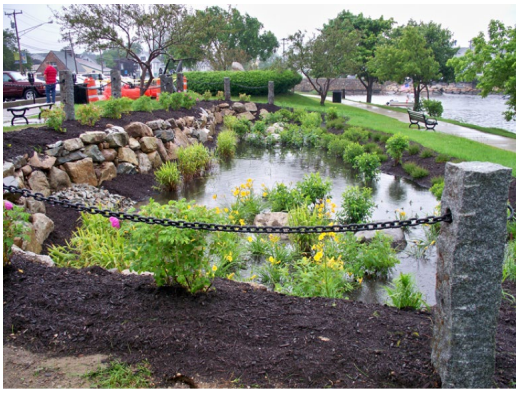
ADVISORS

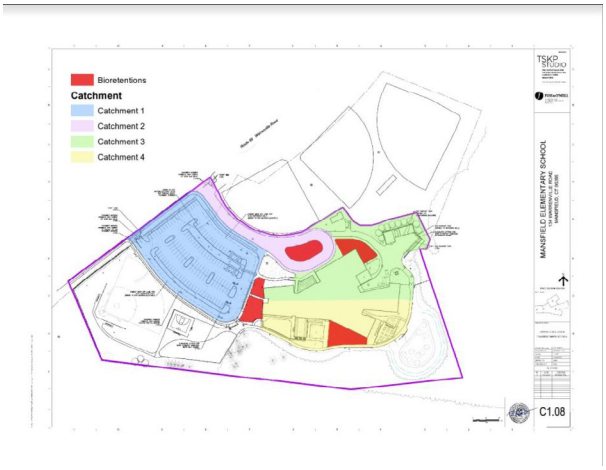
Timothy Vadas

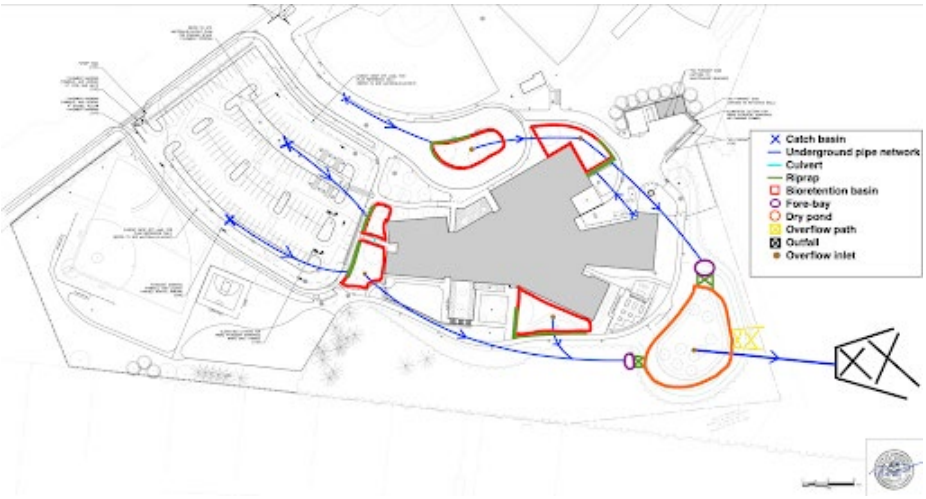
SPONSOR

Mansfield New Elementary School Stormwater Management Plan

The town of Mansfield, CT is currently under contract designing a new elementary school to be placed at the location of the existing Southeast Elementary School. Our group is tasked with designing a robust stormwater management system for the new elementary school, meeting Connecticut Stormwater Regulations for water treatment and peak flow control. Construction is expected to begin in April 2021, and the district is striving for the new school to become a Net-Zero Energy school, which is a building that returns as much energy to the power grid as it consumes. Ultimately, the stormwater system must be sustainable and fit the new green culture of the school, while altering as little as possible on the site. We designed a system of several stormwater Best Management Practices (BMPs), including bioretention basins, a dry detention pond, and an effective catch basin network. These will effectively treat pollution from the site and help control peak flow during large storm events. The system is designed to last for the lifetime of the school building. In addition to the design, we incorporated creative hands-on, outdoor, interactive components for the students at the school. A planned activity during the spring semester took place in coordination with some of the teachers at the school. This activity consisted of hands-on water treatment education appropriate for elementary students.







ENVIRONMENTAL ENGINEERING

TEAM 5

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Austin Frank
Brian Dinh
Ryan Morais

ADVISORS

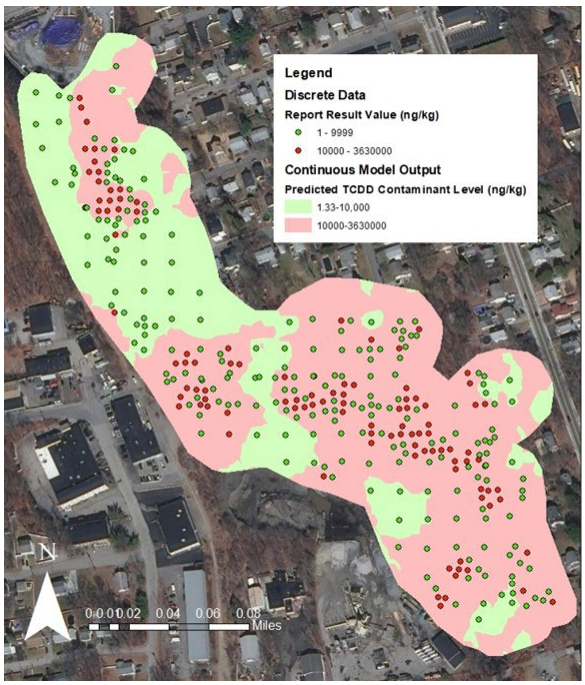
Timothy Vadas

SPONSOR

Loureiro

Centredale Manor Sediment Remediation

Loureiro Engineering Associates tasked the CMRP Senior Design team to develop a Physical Excavation Plan for the Allendale Pond area. This area also includes the nearby Allendale Reach and Allendale Floodplain that surrounds the pond. The design of the excavation plan will be dependent on the concentration of dioxin (2,3,78 TCDD) in the sediment located within the Pond, Reach, and floodplain. The excavation of the area will depend on the distribution of dioxin contamination in the context of the regulatory Land Disposal Restriction (LDR) of 10,000 ng/kg, which will be determined through the creation and analysis of a continuous contamination concentration model, based on previous sampling of the pond sediment. Due to the disturbance from excavation, Loureiro also tasked the Senior Design team to develop an Ecological Restoration Plan for the environmental redevelopment of the pond, reach and floodplain areas. This restoration plan included developing habitat for wildlife, erosion control, and vegetation considerations. An economics evaluation was also performed to estimate the cost of the excavation and restoration plans.



ENVIRONMENTAL ENGINEERING

TEAM 6

Gordon Gingras
Sydney Murner

ADVISORS

Timothy Vadas

SPONSOR

JK MUIR

Energy Efficiency of Water Treatment Plants and Pumping Stations

An energy audit was conducted on two sites in Connecticut, Powder Hollow Wellfield, and Stewart Water Treatment plant. The purpose of the audit was to optimize energy savings and increase the efficiency of the pumping systems. Pumping water is an extremely energy-intensive process that accounts for a major portion of the energy used for industrial processes in the United States. Maximizing the efficiency of these systems and cutting energy consumption come with both economic and environmental incentives. Thorough data analysis was conducted using information gathered from pump operators, testing at the site, and Eversource energy records. Using this analysis a series of operational and equipment changes are evaluated for their effectiveness at reducing energy consumption. Operational energy-saving measures do not involve the purchase of new equipment. Equipment energy-saving measures can also be taken, these involve the purchase of new equipment. Underperforming pumps can be replaced with new pumps. Variable Frequency Drives can be added to constant speed pumps in order to allow for speed change. A final recommendation was delivered with thorough energy and cost-saving report as well as a prediction of greenhouse gas emission reduction after implementation is reported.

ENVIRONMENTAL ENGINEERING

TEAM 7

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Ethan Patterson
Sita Nyame
Tony Lin

ADVISORS

Manish Roy

SPONSOR

Tighe&Bond

Water Treatment Residuals Handling at Aquarion Trap Falls Site

Aquarion Water Company is a water treatment company that operates several water treatment plants across Connecticut. Currently, Aquarion is looking to recycle a byproduct of the water treatment process known as water treatment residuals (WTRs) into reusable topsoil instead of sending these residuals to a landfill. We understand Aquarion Water Company is in need of assistance with the handling of its water treatment residuals and transforming its site. Our goals are to improve the drying of WTRs with wind aerators to limit levels of chloroform, to make the overall site more accessible and to construct a rain garden to capture stormwater runoff from the site. To achieve this goal, we conducted a field investigation, analyzed data taken at the site and researched design plans. After this, we developed sheds for the storing of aerators, a best management practice, and improved road conditions of the site. Our best management practices was a rain garden that was in accordance with the state and local regulations in regards to zoning, planning and wetlands and groundwater discharge. The road leading to the site and the areas surrounding it were covered with asphalt pavement to support the heavy weight of large trucks. During this process, our team applied our knowledge of water treatment processes, environmental chemistry, structural analysis and transportation design to offer an initial plan.

ENVIRONMENTAL ENGINEERING

TEAM 8

Jeanna Erickson
Rigel Watchmann
Joseph Forleo
Ryan Palzere

ADVISORS

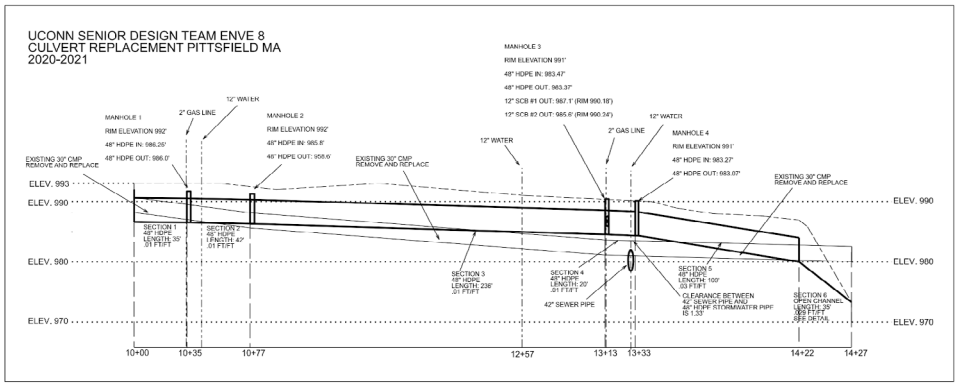
Manish Roy

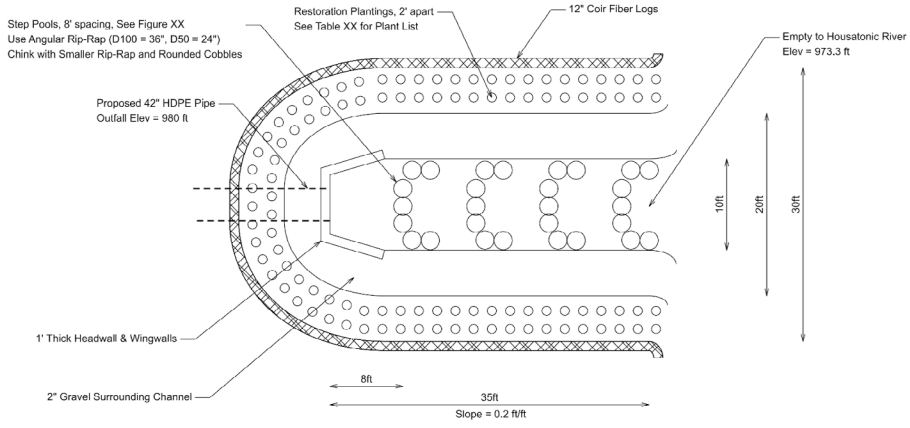
SPONSOR

KLEINFELDER
Bright People. Right Solutions.

Evaluation of Rehabilitation Options and Preliminary Design for a Culvert in Pittsfield

The town of Pittsfield, Massachusetts has requested assistance regarding a failing stormwater drainage culvert. The culvert pipe is located under Commercial Street in the east-central part of Pittsfield, just south of Massachusetts State Route 9, and runs under a section of the road to the edge of the Housatonic River. The client has requested for a determination of the best option to rehabilitate or replace the failing 30-inch corrugated metal pipe that drains into the river. Due to the broken and undersized nature of the pipe, sink-holes have formed in the nearby road surface, causing potential for damages to the vehicles and citizens using the street. In addition, the existing corrugated metal pipe conflicted with an intercepting sewer line. This conflict must be addressed and resolved in the design of the culvert rehabilitation or replacement. Additionally, it is known that there is a stormwater detention pond upstream that holds water coming from the contributing catchment area prior to entering the section of culvert to be replaced. This pond, located just north of the nearby railroad tracks and Route 9, played a significant role in determining an effective pipe diameter as it retains a considerable amount of water and thereby reduces the flow volume passing through the culvert. The team performed relevant calculations to determine the flow volume discharging into the Housatonic river through the culvert and concluded that the entire culvert was undersized. This led to their determination that the culvert should be replaced with a 42 inch diameter HDPE pipe based on a 5 year 24 hour storm model. Slopes of the 42 inch diameter HDPE pipe were set such that they would meet the minimum required slope of .05 ft/ft, while also maintaining sufficient clearance between the stormwater and the sewer system.





ENVIRONMENTAL ENGINEERING

TEAM 9

Zachary Lepore
Victoria Masucci
Stephanie Burns
Alexa Wetmore

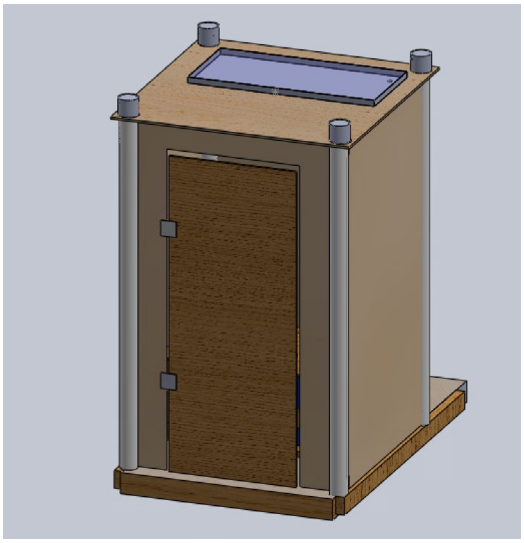
ADVISORS

Manish Roy

SPONSOR

LOOLOO

LooLoo - It's More Than Just a Porta Potty



The LooLoo is a portable toilet system designed to aid communities that have suffered from inadequate bathroom facilities which lack proper sanitation and structural stability. Many of these communities, including homeless encampments, natural disaster affected areas, and numerous international communities, are forced to practice open defecation, which creates biohazards and pollution problems within the areas.

The LooLoo offers a structurally sound, safe, and clean bathroom facility that has solar powered cell phone chargers, as well as waste separation to mitigate odors, ventilation, and proper sanitization measures.

One of the main responsibilities of the CEE team was to create a structural design that could withstand wind, snow, and rain forces on the exterior and high pressure loads on the interior toilet. Other objectives were to design a waste separation system that separates solids and liquids to mitigate odors and create a more hygienic bathroom environment. The strict diversion of urine also allows for the promotion of reuse as fertilizer. Other functions of the design include beginner-level building skills with a full build complete in under 2 hours, and the use of materials from an easily accessible store, such as Home Depot or Lowe's.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 1

Joshua Macchi
Julian Lebel
Michal Zyla

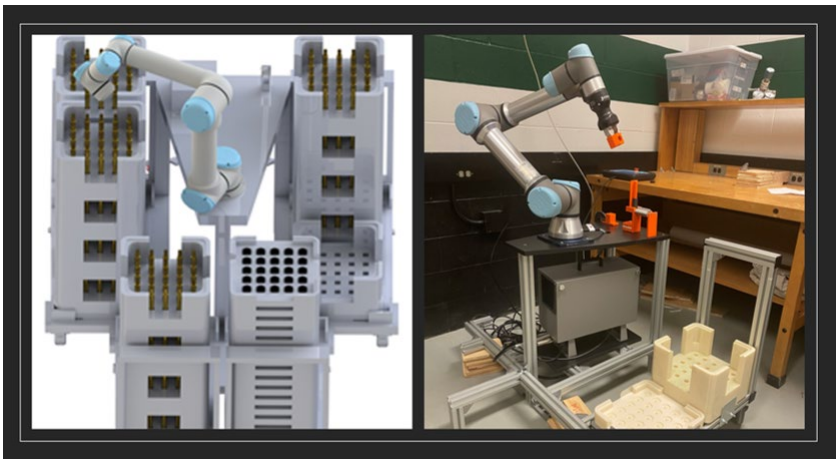
ADVISORS

Craig Calvert
Frank J. Cunha

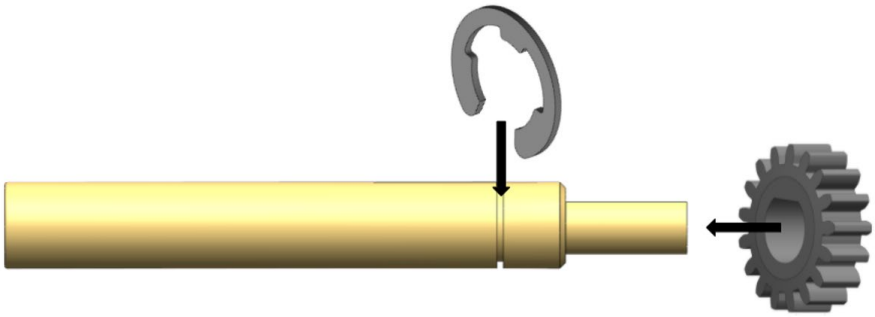
SPONSOR

BELIMO®

Robotic Process Automation



Belimo is the global market leader in the development and production of valves, actuators, and sensors for controlling heating, ventilation, and air conditioning systems. To save money on assembly and increase the amount of product the company can produce, manufacturing automation is being explored for smaller assemblies at Belimo's North American headquarters located in Danbury, Connecticut. The goal of the project is to implement an automated assembly system for a gear and shaft sub-assembly utilizing a collaborative robot. The Universal Co-Bot UR5e was chosen to handle this gear and shaft assembly which would limit human involvement.



Our team has built a physical, fully integrated RPA solution that can have a positive impact on Belimo's bottom line upon delivery. While granting the agility, efficiency, and performance manufacturers are looking for today, our solution achieves a 46.52% ROI compared to a commercial competitor. With the assembly process being automated, Belimo will experience shorter lead times, decreased operating expenses, and increased available human capital. Working jointly with Mechanical Engineering team 09, our team was able to develop this automated application through the design of mechanical components needed for the unique assembly and through the efficient programming of the cobot that allowed for the assembly iteration over palletized components. Belimo will be provided with comprehensive standard work for the programming of the cobot which will allow them to expand automated capabilities in the future at the Danbury site. This project gives Belimo an even greater advantage to maintain their position as a global market leader in the HVAC industry.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 2

Camila Baez-Paez
Luis Garces
Nicholas Perry

ADVISORS

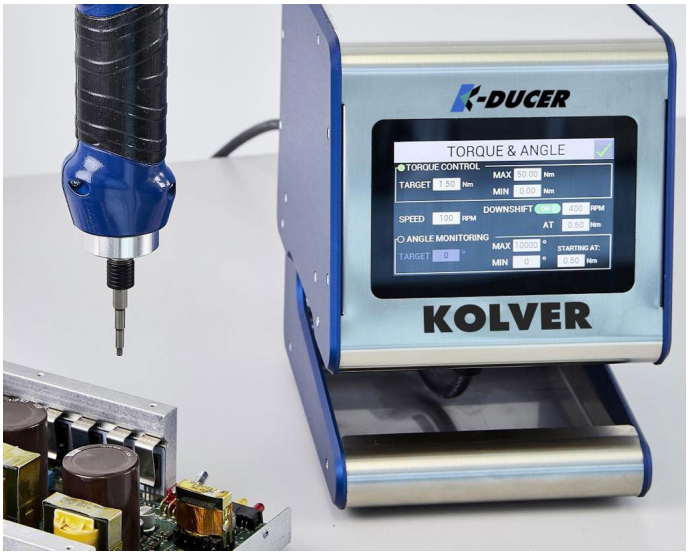
Craig Calvert
Frank J. Cunha

SPONSOR

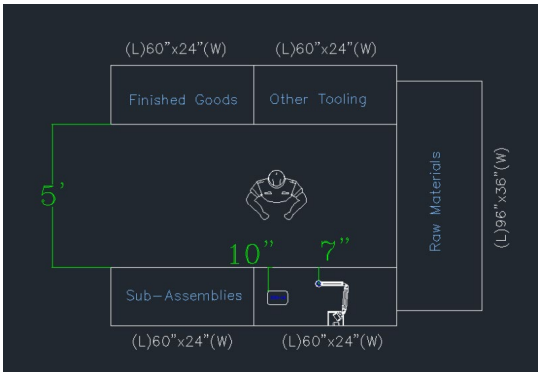
DYMAX
Adhesives and Light Curing Systems

Output Improvement of Screw Assembly Process

Dymax Corporation is a global leader in the manufacturing of adhesives and sealants located in Torrington, CT. Dymax manufactures innovative rapid light-curable materials, dispense equipment, and Ultraviolet/Light-emitting diode (UV/LED) curing systems. The company has recently been facing screw tensioning failures within some of its manufactured equipment, specifically the UV Curing Systems which has resulted in first-pass assembly internal failures. The objective of this project is to reduce internal failures and improve the output of the screw assembly process by analyzing the current screw assembly methods being used and researching other practices currently being conducted in similar industries. The metric of success defined for this project is that the implemented changes will significantly decrease the current internal failure.



A Pareto chart was created to identify and prioritize what defects to address first. After obtaining this information the team started researching possible solutions and arrived at the conclusion that implementing a transducerized/electronically controlled screwdriver would be the most effective way to meet the sponsor's requirements. The transducerized screwdriver was tested for reliability and experimental target torque values were obtained. The perceived benefits of implementing this tool were: decreased cycle time, labor hours, ergonomic risks, quality concerns, the risk priority number score in the process failure mode effects analysis (PFMEA), and increased availability of direct labor resources.



MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 3

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Arya Patel
Robert Digiacomo
Caroline Dhanager

ADVISORS

Craig Calvert

SPONSOR

Frito Lay

Frito Lay Sustainable Sanitation Initiative for Workforce Efficiency

Frito Lay's sanitation department had the opportunity to reduce labor costs and increase efficiency by utilizing new technologies and processes within their current sanitation practices. The project's goal was to present senior leadership with innovative upgrades to their current practices and prioritize them based on cost analysis and integration capabilities. After familiarizing the team with current sanitation processes through research and on-site visitation, the project team collectively began the determination of alternative processes. The goal was to find alternatives that do not require intensive manual labor and reduce costs in comparison to existing practices. The success of this project was reliant on discovering the right processes for our sponsor to then implement at the Frito-Lay Killingly plant. The decision of which process to implement will be made by the project owners at Frito-Lay.

As a result of Frito Lay's annual operating initiative, they aimed to reduce the amount of manual labor required for processes upheld by the Frito Lay Sanitation Department. The project team conducted research and evaluated industry best practices within sanitization. The team offered a deliverable which assessed the optimal strategies for implementing automated alternatives and proposed methods for implementation at the Killingly site. This project aided in the promotion of efficiency and removing inhibitors related to sanitation measures which were present at the Killingly site. Success of the project was achieved when feasible alternatives for automation were reached.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 4

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Nicole Morson
Sam Moran
Kiwon-Paul Dijonjee

ADVISORS

Craig Calvert
Frank Cunha

SPONSOR

HOLO-KROME®

Improving Furnace Maintenance Procedures and Eliminating Risk of Fall-Related Injury

Holo-Krome is a manufacturer of high strength fasteners whose products are used in a vast variety of industries. A central component in their production process includes the use of four industrial-sized furnaces. Maintaining the operational status of these furnaces through efficient maintenance is a top priority as they are essential to the delivery of Holo-Krome's high quality products. However, current furnace maintenance procedures at their Wallingford facility are cumbersome to say the least; requiring groups of workers to assemble a complex system of harnesses, anchors, and tie-offs in order to abide by OSHA regulation. Setting up this proper safety equipment often takes more time than it does to complete the actual task at hand. As a result, simple assignments become time consuming and daunting for the maintenance staff. If left unaddressed, this situation could lead to a dangerous work environment and/or cost Holo-Krome both time and labor that they could be devoting to other areas in need.

Our proposed solution delivers a fall protection system for one furnace that is both compliant with OSHA regulations and provides more convenient access to its roof to perform maintenance procedures. This solution outlines the construction of a raised catwalk structure which spans just over half the length of the furnace and is held by 17 main support columns. The platform is constructed from a customly-cut steel angle iron frame with sections of steel grate laid atop to span its entire width. In addition, a catalog-selected staircase is bolted to the frame and this entire structure is placed an inch away from the furnace so as to not interfere with features affixed to its surface. Beyond the platform, square railings with attached toeboards will be installed along edges of both the furnace and catwalk. However, these railings will only be placed along edges that pose a falling risk.

This proposed solution is further outlined in the system plan which acts as our final deliverable for the project. This plan includes all relevant CAD models, drawings, bill of materials, simulations, manuals, and reports related to the construction and use of our end product. Implementation of this plan will not only reduce the need for unwieldy harness equipment, but also help provide a safer workplace environment for employees. This project will be successful if we assist in reducing their annual fall protection-related costs, the safety of the furnace-access system is visibly improved, and the workers agree that the system we produce actually provides them with beneficial utility.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 5

Sabrina Dibble
Alex Naoum
Kerry Wolff

ADVISORS

Craig Calvert
Frank Cunha

SPONSOR

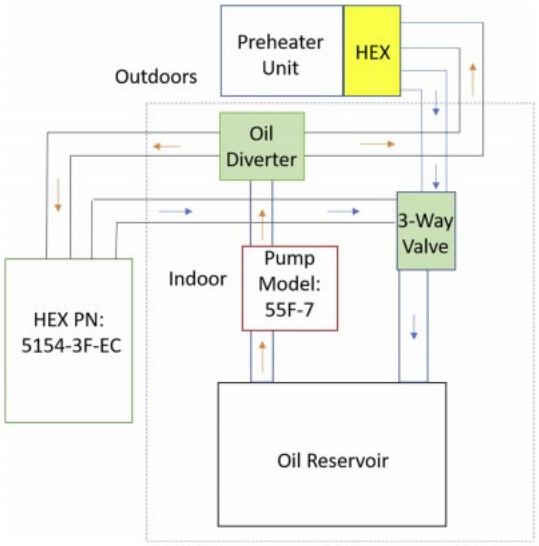
HOLO-KROME®

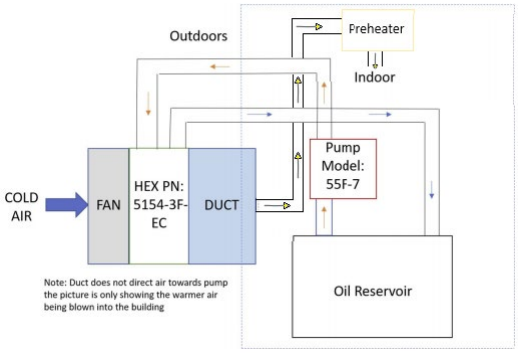
Holo-Krome Cost Savings through Eco-friendly Heat Transfer

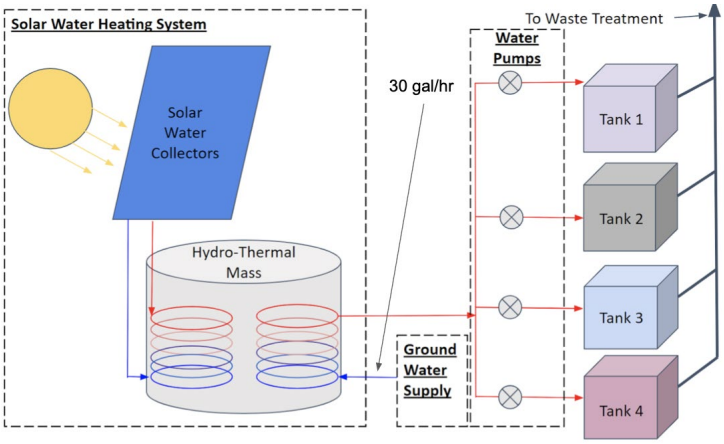
Holo-Krome, a Connecticut based company, specializes in high quality fasteners ranging from bolts to screws and studs. An important goal for company executives is to reduce spending on manufacturing processes, while also making the company more environmentally friendly.

Holo – Krome's production of high strength fasteners requires heat treatment via a continuous furnace line to get desired hardness and tensile strength. This process results in waste heat that is exhausted through a heat exchanger. The company decided that this waste heat may be an area in which they can save money while also working toward becoming a more green company. This was the basis of our project. The project focused on achieving a method of recovering the lost heat and utilizing it to preheat outside air during colder temperatures/winter months in order to provide comfort heating to the building. A key incentive was to reduce the levels of gas consumption used in preheating air for the building. Students created three designs. Upon calculating the achievable cost savings and efficiency for each design, it was determined that the three waste heat recovery designs did not provide a high enough cost savings or efficiency to justify implementation.

As a result, students proposed the company achieve its cost savings and sustainability goals via the use of solar water heaters. The solar water heaters will preheat the water used in the finishing process for the fasteners. If implemented, this will allow the company to use less electricity in the finishing line, thus contributing to both of the key goals.







MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 6

Kevin Perez
Anthony Abramov
Jinyoung Youn
Jared Annis
Wyatt Smith

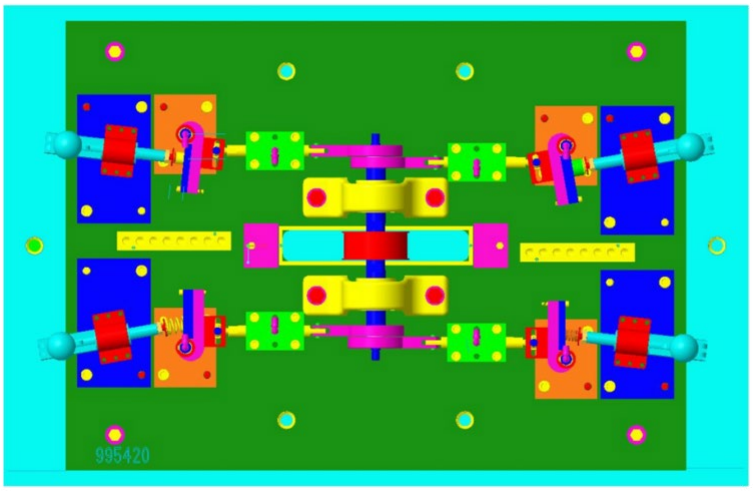
ADVISORS

Craig Calvert
Frank Cunha

SPONSOR

Jacobs Vehicle Systems®

Spring Fatigue Test Stand



Jacobs Vehicle Systems is a global leader in engine brake technology in the trucking industry. They specialize in the manufacturing of engine brakes and valve actuation technologies. Our group was assigned the task of updating Jacobs current spring fatigue test stand so that it can take into account both the linear and bending motion of their new rocker bias springs. We accomplished this task by designing a spring test stand that emulates the environment the rocker would be in if it was in the the engine to make sure the spring is compressed as how it would be in engine application. Our design has a rocker arm, a modular spring seat, and a modular spring pre-loader baseplate that can replicate how the spring would be compressed in engine application. Our design allows for springs to be tested under different rocker and engine applications. By having a spring fatigue test stand that accurately measures the spring life, the springs are less likely to fail while they are on customers's engines. If these springs break on the engine it will cause the engine brake to stop working properly and may even cause damage to engine components leading to engine failure. Creating a spring test stand that successfully measures fatigue life of spring will greatly benefit Jacobs by reducing the warranty costs associated with premature failure of springs in engine.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 7

Kelly Franklin
Kyra Cullerton
Neha Muktadir

ADVISORS

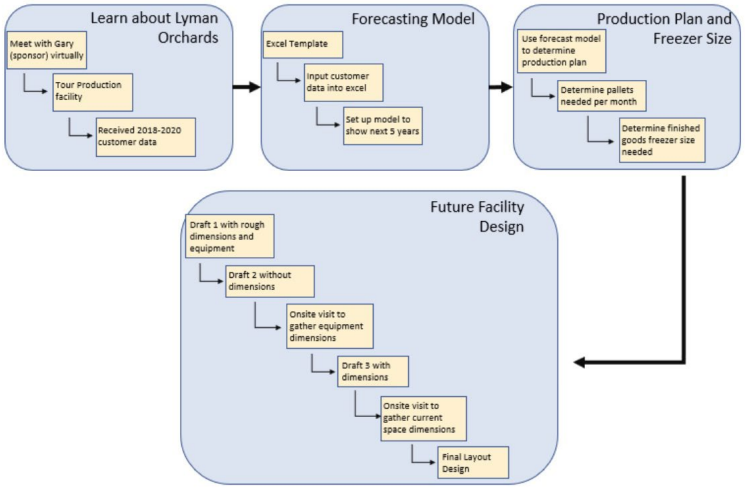
Craig Calvert
Frank Cunha

SPONSOR

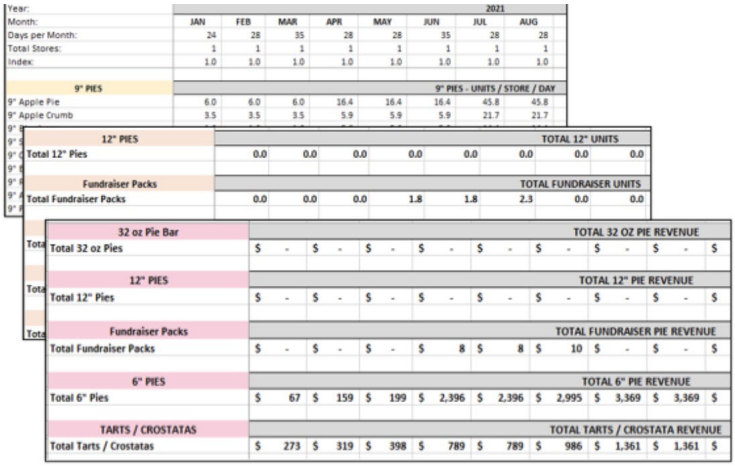
Since 1741 LYMAN ORCHARDS

Lyman Orchards Future Facility Design

With many growth opportunities approaching this family owned business, Lyman Orchards in Middlefield, CT, is seeking to expand into a new production facility. Lyman understands its market very well, and has a strong desire to meet certain revenues within the next few years. This new facility will be an addition to the brand to increase their capacity, optimize the production flow, and implement new technology and automation into their processes.



Throughout these last two semesters, the project team has been focused on analyzing Lyman's current information and data relating to their products, customers, and production flow to create the future facility layout. The goal was to see where modifications could be made to increase efficiency and reach a specific revenue goal over the next five years. Multiple deliverables were created and sent to the sponsor that showed where the company stands currently and what possible changes could be made.



Year:								2021
Month:	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
Days per Month:	24	28	35	28	28	35	28	28
Total Stores:	1	1	1	1	1	1	1	1
Index:	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9" PIES	9" PIES - UNITS / STORE / DAY							
9" Apple Pie	6.0	6.0	6.0	16.4	16.4	16.4	45.8	45.8
9" Apple Crumb	3.5	3.5	3.5	5.9	5.9	5.9	21.7	21.7

12" PIES	TOTAL 12" UNITS							
Total 12" Pies	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fundraiser Packs	TOTAL FUNDRAISER UNITS							
Total Fundraiser Packs	0.0	0.0	0.0	1.8	1.8	2.3	0.0	0.0

32 oz Pie Bar	TOTAL 32 OZ PIE REVENUE								
Total 32 oz Pies	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
12" PIES	TOTAL 12" PIE REVENUE								
Total 12" Pies	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$
Fundraiser Packs	TOTAL FUNDRAISER PIE REVENUE								
Total Fundraiser Packs	$ -	$ -	$ -	$ 8	$ 8	$ 10	$ -	$ -	$
6" PIES	TOTAL 6" PIE REVENUE								
Total 6" Pies	$ 67	$ 159	$ 199	$ 2,396	$ 2,396	$ 2,995	$ 3,369	$ 3,369	$
TARTS / CROSTATAS	TOTAL TARTS / CROSTATA REVENUE								
Total Tarts / Crostatas	$ 273	$ 319	$ 398	$ 789	$ 789	$ 986	$ 1,361	$ 1,361	$

A forecasting model was initially developed that laid out the various products and customers Lyman currently has and the extent to which these factors contribute to the profitability of the business. Subsequently, the team gathered information regarding the company's product pallets and current storage space. This was used to determine a suitable freezer and storage space for the new facility to support the amount of sales the company predicts to reach.

Finally, the team measured the current facility components and created a new layout for the sponsor to design the new facility around. This new production facility aims to increase capacity, efficiency, productivity, and material flow in creating their delicious treats that cater to their current and future customers.

Lyman has the passion to build and expand into new territories across the country. They have the potential to reach their revenues and goals with the resources provided by the team and their continuous effort to be competitive in this market!

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 8

Lindsey Fleck
Scott Gaffney
Blanche Gorham
Allison Pfahler

ADVISORS

Craig Calvert
Frank Cunha

SPONSOR

Since 1741 LYMAN ORCHARDS

Lyman Orchards Future Facility Design

After being in the pie business for 20 years, Lyman Orchards sought to optimize their wholesale pie business. To help Lyman accomplish this goal, the team travelled to Lyman Orchards weekly to conduct time studies on their highest selling products. Using this data, the team developed a forecasting model to optimize production by varying employee allocations at each production step. The team presented recommendations to the sponsor based on the bottlenecks identified in the time studies. These recommendations included new floor plans, scoop sizes, and production methods. Excel VBA was utilized by the team to create a model of the freezing process to show the capacity in the freezer according to the dwell times of the products and the rate that the products are being added and removed from the freezer. In order to create more freezer space so the freezer does not become a bottleneck with production increases, Lyman Orchards is working on the possibility of utilizing another building on property. If the new building is put to use, Lyman Orchards would incorporate three freezer trucks into their transportation to freeze the pies overnight at the loading dock of the packing facility. This scenario would allow for higher production in the original production space once the packaging equipment is moved. By implementing the use of the second building and the process suggestions, the team predicts that Lyman Orchards can see an increase of 70 to 80 percent of production.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 9

Gleimy Rodriguez
Eric Loconto
Fletcher Suedmeier
Ryan Glenney

ADVISORS

Frank Cunha

SPONSOR

Expulsion of Small Diameter Devices from Torpedo Tube Cartridges

This is a collaborative, research and development project between MEM team 9 and ME team 77, with sponsor Doug Merrick from the Naval Undersea Warfare Center (NUWC). NUWC is a full-spectrum research, test, development, engineering, and support center for the U.S. Navy.

This project focused on delivering a device that will launch multiple three-inch projectiles from a U.S. Navy, forward-facing torpedo tube. We created a design for a capsule that will be stored alongside MK.48 torpedoes within a VIRGINIA Class submarine. This capsule will be utilizing the cradle, loading, and firing mechanism already on board. The end result was a proof-of-concept prototype that is independently validated and will support the Navy in delivering combat-ready forces.

Throughout the year, the MEM and ME teams worked cohesively toward the same final goals. The MEM team generally led the CAD of the modules while the ME team led the ANSYS fluid simulations. Then, a test rig was manufactured and put to trial consisting of the CAD packages and ANSYS predictions.

The final deliverables for this project include:

- a design to launch multiple 3" x 39" projectiles in a volley-fire style within the submarine's max performance envelope
- full CAD and CFD packages with a 1/7 scale model prototype and 1/3 scale, dual barrel test apparatus
- an ANSYS simulation package

NUWC did not provide any sensitive information to the team. We worked with our sponsor to establish a reasonable set of assumptions that would guide the project's specifications. As a result, this system will not be integrated into the submarine directly but will require some changes to the parameters to ensure it will work in actuality.

MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 10

Logan Miller
Randall Louie
Curtis Fetteroll
Ahmed El-Mouwfi

ADVISORS

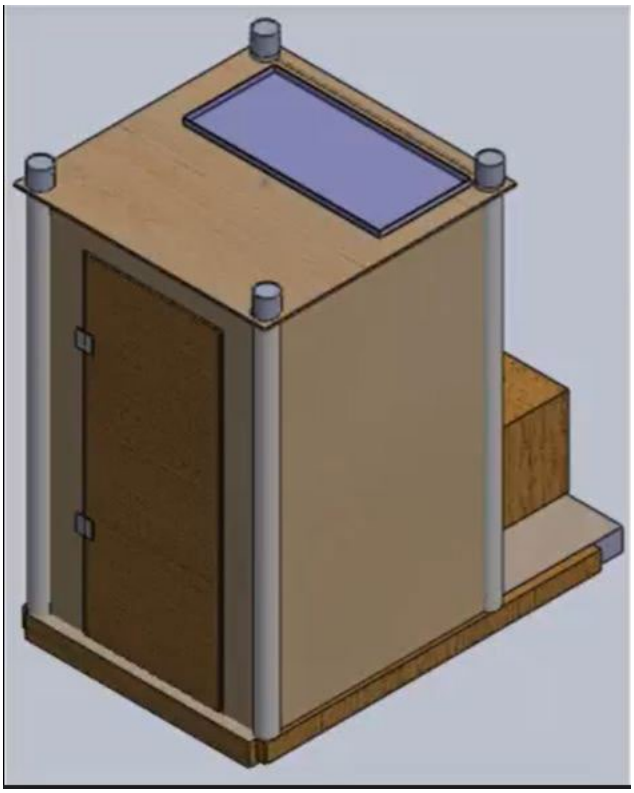
Craig Calvert

SPONSOR

LOOLOO

It's More Than Just a Porta Potty: Development of the Revolutionary Smart Portable Toilet

This interdisciplinary project aimed to develop a revolutionary portable toilet unlike anything already on the market. It has a modular design that is easy to assemble and includes features such as a waste management system and solar powered device charging capabilities. LooLoo will work with organizations already in the humanitarian aid sector to help those communities in need, specifically the homeless and disaster-affected or developing communities. These communities often struggle to accommodate their members' needs for a place to safely go to the bathroom, a privilege many people take for granted. This often causes health risks to develop due to open defecation in public facilities and water sources. The engineering design process in this project consisted of an iterative cycle of providing requirements, researching and presenting design solutions, reviewing those proposed designs, providing feedback, and repeating. Through this process the structural materials were narrowed down to those with the greatest balance of cost, weight, strength, and environmental resilience. The electrical components have been evaluated and modified multiple times to achieve an optimal design for power storage and output, while minimizing the cost. The waste management system minimizes bad odors while allowing for efficient storage, removal, and reuse. The business plan outlines the recommended marketing plan, distribution plan, and manufacturing plan for LooLoo to continue with in the future.



MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 11

Natiya Washer
Jacob Patterson
Maia Dufane

ADVISORS

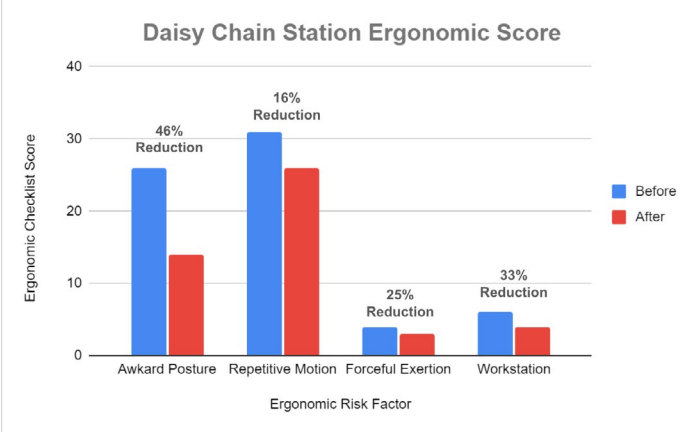
Frank Cunha
Craig Calvert

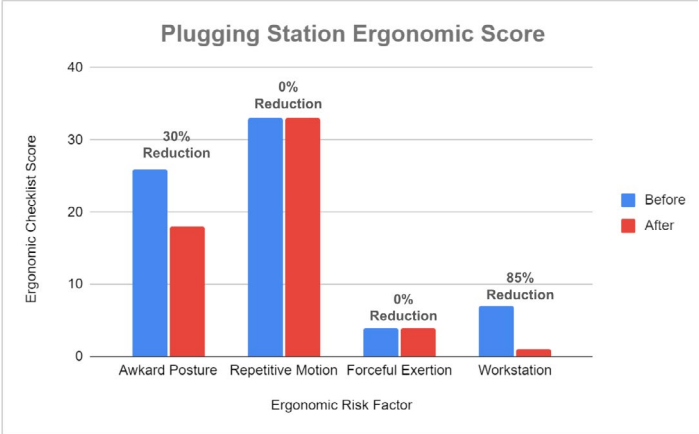
SPONSOR

Prysmian Group

Reduction in Ergonomic Risk Factors for Prysmian Group

Prysmian Group added a new assembly process about four years ago, since then the volume of that assembly has increased 300%. As the assembly line grew so did the concern for the health of the employees. The most pressing concern is ergonomic issues leading to soft tissue injuries. As a result, Prysmian reached out to Uconn to address their ergonomic concerns. The project consists of diagnosing the largest contributors to ergonomic risk factors and tailoring solutions to reduce them. Ergonomic checklists and surveys determined the two workstations containing the most ergonomic risks are the "Daisy Chaining" station and the "Plugging" station. Through root cause analysis at the stations, tailored and custom solutions were identified. To reduce the strain on the most ergonomically at risk parts of the body, new tooling and chairs were purchased. For the Plugging station, a new workstation was designed and built. This workstation is adjustable in both height and angle allowing workers to keep their bodies in more neutral positions than previously. Once the solutions were implemented, the ergonomic risk assessment was repeated to analyze the change in risk factors. There was a significant decrease in ergonomic risk factors for both stations. Finally, a business cost analysis estimates that the ergonomic solutions will lead to an annual savings of over $100,00 dollars and have a payback period of less than a year. Prysmian Group is pleased with the results of the project and is looking forward to keeping their partnership with UConn in the future.





MANAGEMENT AND ENGINEERING FOR MANUFACTURING

TEAM 12

Nishanth Sode
Xavier Amos
Oliver Bogan
David Bielawski

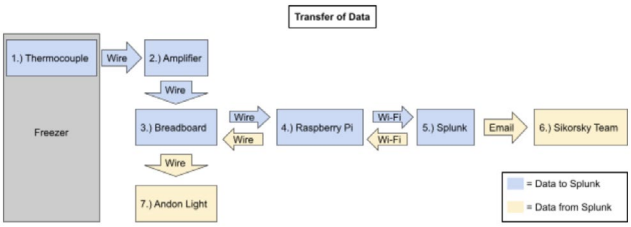
ADVISORS

Ryan O'Connor

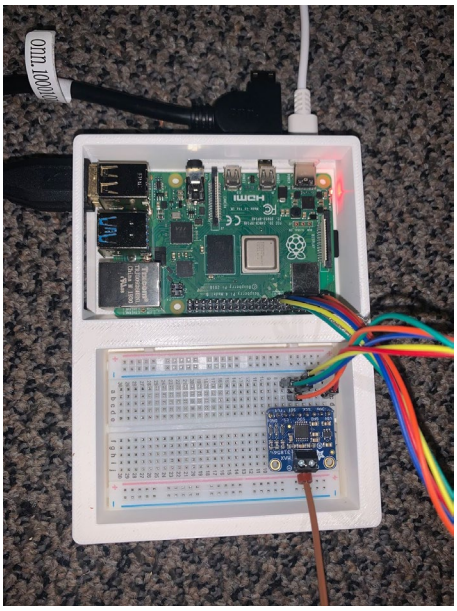
SPONSOR

SIKORSKY
A LOCKHEED MARTIN COMPANY

Analyzing Digital Outputs of an Ultra-low Freezer



Industrial Internet of Things (IIOT) is a new technology that allows machinery to transmit information such as real time status, diagnostics and operational data. The goal of this project is to monitor the temperature of an ultra low freezer, record the information in a database with real time data, look for trends within the data to predict variations, and alert the customer before the system is out of control. Deliverables for the project will include cost benefit analysis, architecture diagram, landscape document of sensors, selection of equipment, data analysis and development of the alert system. Given the amount of freedom in order to design our system, initial research was daunting due to the amount of information available.the completion of the aforementioned milestones guided us in the right direction in order to create an IIOT system that meets the requirements provided by Sikorsky.



Sikorsky Aircraft is an American aircraft manufacturer based in Stratford, Connecticut. Now under the ownership of Lockheed Martin, Sikorsky provides aircrafts to all five branches of the U.S. armed forces along with military services and commercial operators in 40 nations.

When manufacturing aircrafts a sealant is used to bind external components of an aircraft in order to provide structural support and protection from harsh environments. A new commercially available sealant is currently being used in the production process which is lighter than previously used sealants. This new sealant must be stored at -80F. Our goal for this project is to design a system to monitor deviation from calculated control limits, trigger an alarm when out of specification both electronically and via a physical device, and proactively look for trends in the current data that would alert relevant parties to a possible failure event.

MATERIALS SCIENCE AND ENGINEERING

TEAM 1

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Benjamin Ellery

ADVISORS

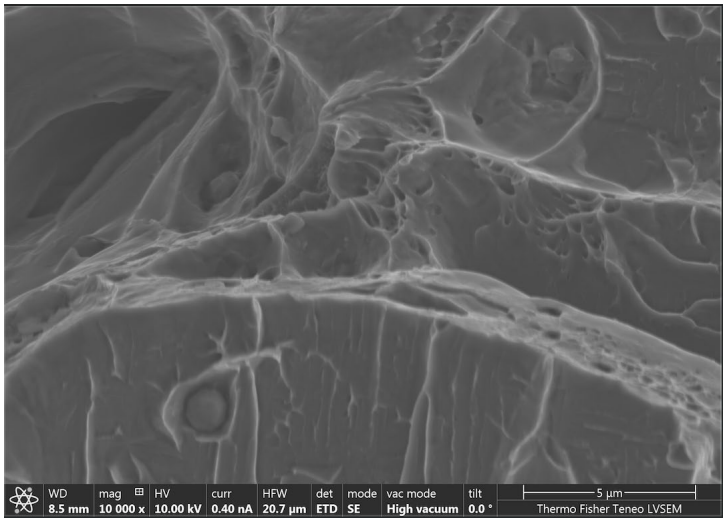
Harold Brody

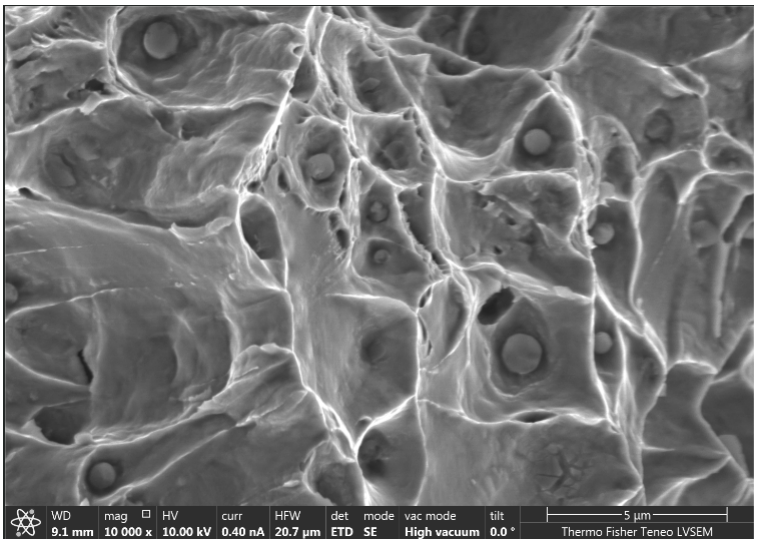
SPONSOR

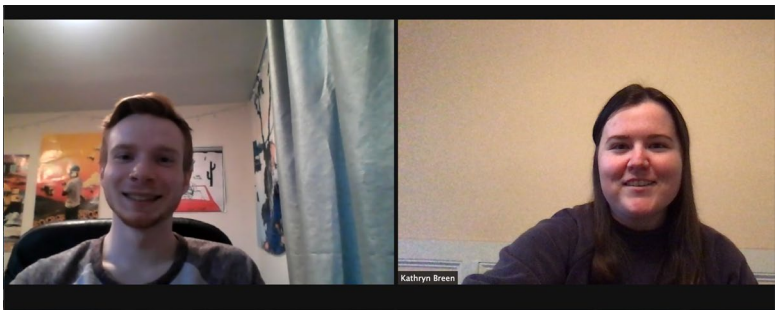
GENERAL DYNAMICS
Electric Boat

Flux Core Material Evaluation for Improved Welding of Duplex Stainless Steel

General Dynamic Electric Boat (EB) is investigating the use of the flux cored arc welding (FCAW) process for duplex stainless steel (DSS) applications. A flux core electrode is made up of metal sheath containing alloying elements, fluxing agents, deoxidizers and arc enhancers. Despite being manufactured to the same specifications flux core electrodes from different brands can operate differently, because each company has its own formula of the aforementioned constituents for creating these products. Currently, EB has identified two promising electrodes and has recognized that, at the micro-structural level inclusion content may have an effect over the mechanical properties observed. The goal of this project is to characterize the inclusions present in the flux-cored welds and build and an understanding of how their presence affects the mechanical properties and performance in application, with the intention of identifying a superior electrode. Characterization of inclusion content using scanning electron microscopy and energy dispersive x-ray spectroscopy was compared to tensile testing, ferrite count, and Charpy V-notch impact testing data of weld samples in order to affirm the impact of electrode composition and cooling rate on weld mechanical properties.







MATERIALS SCIENCE AND ENGINEERING

TEAM 2

Joshua Relucio
Joseph Tracey

ADVISORS

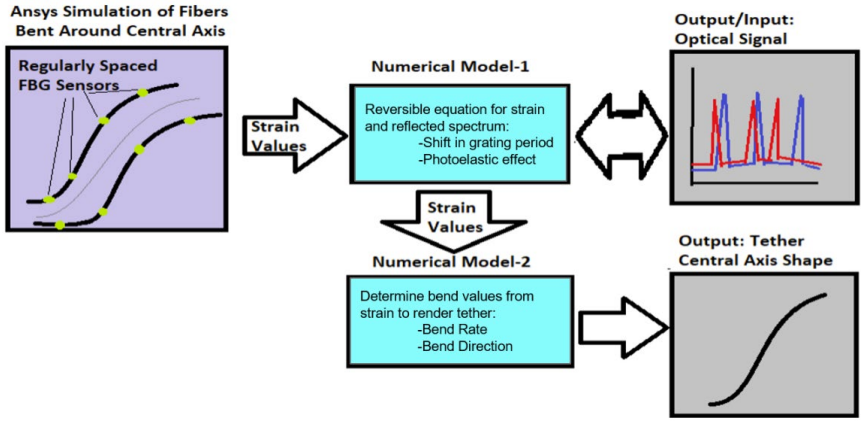
Serge Nakhmanson

SPONSOR

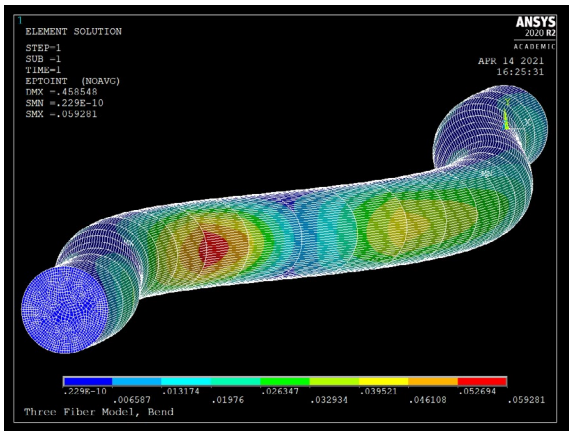
GENERAL DYNAMICS
Electric Boat

Tether Shape Monitoring

Tether management is of great importance with regards to unmanned undersea vehicles (UUVs). The role of the tether is to communicate data to and from the UUV and any extreme bending of the tether can damage the embedded optical fibers which in turn will produce a negative effect on its optical properties. This project concerns the creation and modeling of an optical fiber-based system where the fibers are the positioning sensors providing a lightweight and low-cost sensing solution to monitor the shape of the tether.



Our primary objective is to create an optimized fiber layout (cross-sectional) that allows for the overall shape of the tether to be solved for using strain values provided by ANSYS simulations. This is done through the concept of Fiber Bragg Gratings (FBG), where an applied strain to an FBG will result in a shift in Bragg wavelength. By leveraging the cross-sectional layout of the fibers and reading the Bragg wavelength at each “sensor”, one is able to decipher the shape of the tether.



MATERIALS SCIENCE AND ENGINEERING

TEAM 3

Nicolette Naya
Julia Opramolla
Zuyang Ma

ADVISORS

Montgomery Shaw

SPONSOR

FARREL POMINI
continuous compounding systems

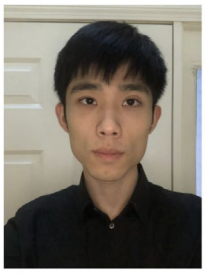
Analysis of Adhesion between Polymer Melts and Metallic, Ceramic, and Bimetallic Coatings for Continuous Mixing Applications

Farrel Pomini, the industry sponsor for this project, creates continuous compounding equipment for the mixing of polymer melts with pigments, fillers, and additives. The rotors of these mixers are coated to improve their longevity and wear resistance. The objective of this capstone project was to design a testing method for determining the adhesion of polymer melts to the coatings used on the continuous compounding mixer rotors as well as to characterize the adhesion between various polyethylene and polypropylene polymers and the hard chrome, C6000SD, and C9000 coatings. Farrel needs the rotor of a continuous compounding mixer to have a coating that minimizes adhesion to the polymer to ensure high productivity. The 2019-2020 UConn Capstone team determined that the adhesion of polymer melts to a coated metal surface can be quantified through the use of a rheometer and DMA (dynamic mechanical analyzer). This year the 2020-2021 capstone team designed a testing procedure for the AR-G2 rheometer. COVID-19 created obstacles for IMS lab use and in-person meetings. The temperature and force limitations of the instrument impacted the testing procedure.

To approach this project, a modified testing process utilizing the AR-G2 rheometer was used to analyze the adhesion between various polymer melts and coatings by determining the adhesive force. Temperature, sample area, compression duration, soak time, contact pressure, and the linear rate of removal are all important factors in the procedure. Experiments using the procedure determined a quantitative description of the coatings' adhesive properties. The final results discovered with the ideal factors aided the evaluation of the adhesion between the coatings and the polymers to ensure the productivity of the continuous compounding mixers.

Nicolette Naya

Julia Opramolla



Zuyang Ma

MATERIALS SCIENCE AND ENGINEERING

TEAM 4

Marin Bolko
Jeet Rosa
Samuel Schaefer

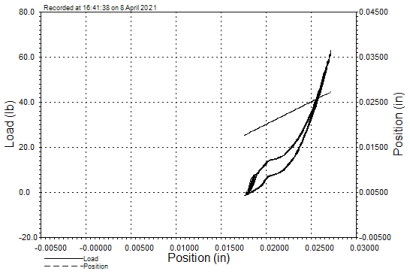
ADVISORS

Seok-Woo Lee

SPONSOR

Investigation of the Possible Effects of Ultra Sonic Cleaning on the Fatigue Life of Gas Turbine Components

Pratt and Whitney uses ultrasonic cleaning on gas turbine components to remove baked-on carbon and abrasive media accumulated during polishing. High frequency waves in the ultrasonic bath clean the surface of the part quickly and efficiently. Some turbine components reach their natural frequencies during standard use and fracture or reduce their fatigue life faster than expected. Pratt and Whitney worries that a similar phenomenon could occur during ultrasonic cleaning when the natural frequency of the part matches the frequency of the cleaner. This project aims to determine if ultrasonic cleaning has an effect on fatigue life.



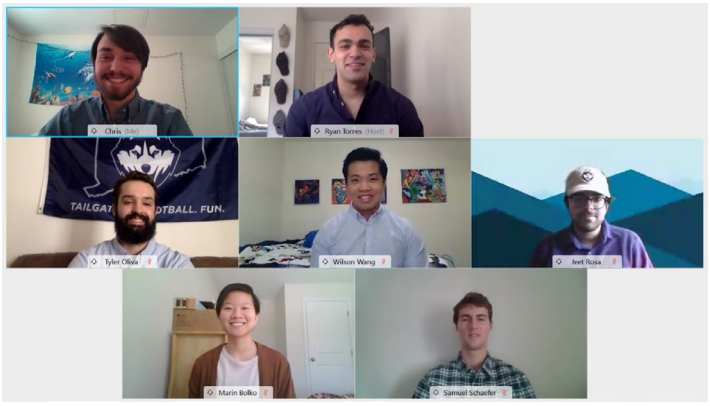
Specimen Identifier: 17-4PHSSC4

Geometry: Cylinder
Diameter: 0.0685 in
Length: 0.5000 in
Correction Factor: 1.0000
Area: 0.0027 sq in

Analysis Results

Extension at Load
Extension: 0.00400 in
Load: 10.00 lb
Extension: 0.02100 in
Load 2: 45.00 lb
Extension: N/A
Load 3: 100.00 lb

Testing was done with aluminum 6061-T6 rectangular beams and 17-4 PH stainless steel wire. The beam samples were put into the cleaner for 0 minutes,1 hour, and 5 hours and were imaged after each interval, but the images were inconclusive. The wire samples were ultrasonically cleaned for 1 hour and put into a wire fatigue testing machine where load-displacement curves were generated. The differences in the S-N curves were inconclusive.



MATERIALS SCIENCE AND ENGINEERING

TEAM 5

Brittany Nelson
Nicholas Simpson
Ryan Cormier

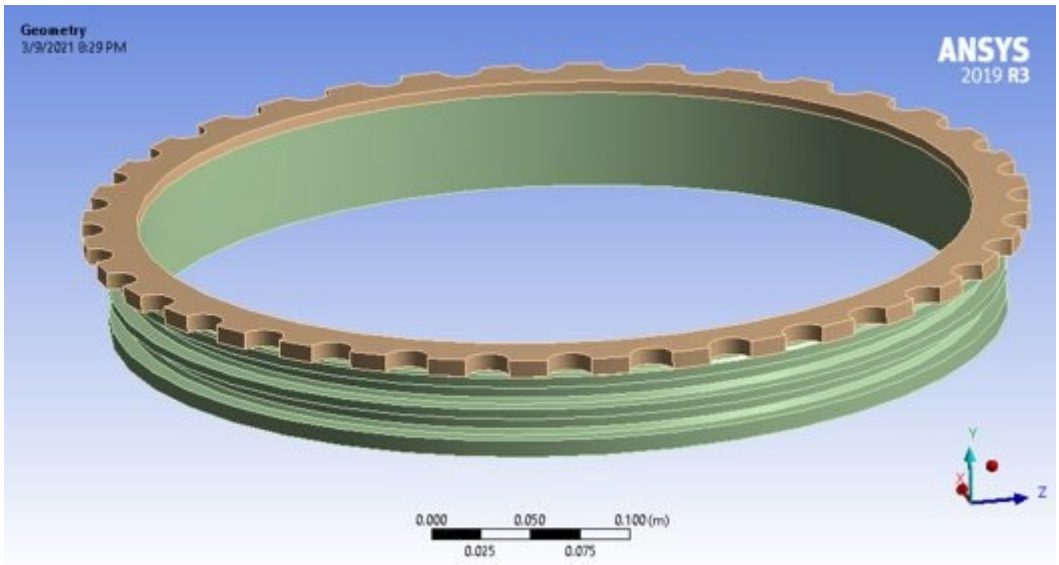
ADVISORS

Lesley Frame

SPONSOR

AERO GEAR
Insist on Excellence

Quench Plug for Ring Gear Manufacturing Process



Aero Gear is working on producing large scale ring gears for use in aerospace engine components. Their main problem in this production is distortion caused by quenching. To reduce the distortion present they have commissioned the development of a fixture to support the ring gear during heat treatment referred to as a quench plug. The quench plug is required to help maintain the tolerances of the ring gear during the heat treatment cycle and be reusable over a large amount of heat treatments. To accomplish this the quench plug must expand and contract at a greater rate than the ring gear to produce interference the gear during heating and be removed after cooling. Three materials were researched and tested to determine whether their thermophysical and material properties would fulfill the criteria. The material's creep behavior was one such property that was researched to determine if extended cycling of the quench plug would cause permanent deformation resulting in improper interference. The desired interference was based on the dimensions of the quench plug design and the thermal expansion coefficient measured experimentally. The dimensions of the quench plug were chosen based on a thermomechanical model produced by the mechanical engineering team. This model applied the material's properties to a simulation of the heat treatment process allowing for calculation of required thickness of the quench plug.

MATERIALS SCIENCE AND ENGINEERING

TEAM 6

Louis Crisci
Kienan Tierney

ADVISORS

Volkan Ortalan

SPONSOR

3D Printed Materials and Processing for Seawater Applications

The Naval Undersea Warfare Center (NUWC) is interested in characterizing the degradation of 3D printed polymers for applications in unmanned underwater vehicles (UUVs). The ability to print parts on demand is advantageous for prototyping and reducing spare part inventory which results in increased flexibility and cost savings. Samples will be exposed to a simulated seawater environment for 2 weeks, during which the mass change is monitored. Following the exposure samples will be subjected to tensile testing. The materials investigated include Acrylonitrile Butadiene Styrene (ABS) and Formlabs' Grey Resin. ABS is a common thermoplastic used in fused deposition modeling (FDM). Grey Resin is a photopolymer that is cured by UV light during the stereolithography (SLA) printing process. The processing methods that will be investigated for ABS include acetone vapor polishing and coating the samples in hydrophobic Aerogel powder. SLA is being utilized due to the homogeneity of parts created with this process, therefore no further processing will be applied. The project seeks to find the material and processing method that will lead to minimal water ingression, while preserving the strength of the part.

MATERIALS SCIENCE AND ENGINEERING

TEAM 8

Karl Douglass Mueller
Evan Byers
Noah Kinard

ADVISORS

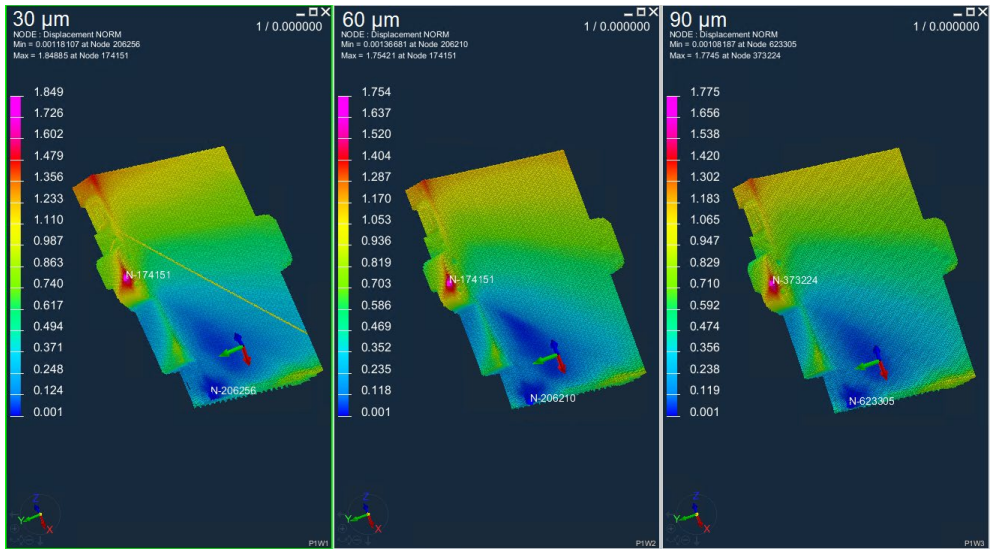
Rainer Hebert

SPONSOR

LOCKHEED MARTIN

Additive Laser Powder Bed Fusion 30µm/90µm Layer Height Comparison

The project involves the simulation and analysis of how various layer heights affects distortions induced in a part produced with a metal-based laser powder bed fusion (LPBF) additive manufacturing process. LPBF involves the deposition of a layer of powdered metal, applied in a controlled height, onto a base plate which is melted by laser at controlled power and scanning speed. While there are other parameters, such as part orientation and hatch spacing, this project is mainly concerned with the effects that layer height, laser power, and laser speed have on the deviations from the designed geometry. This project utilizes ESI's Additive Manufacturing software suite to calculate thermal gradients and distortions at key points during the process. The specific objective of this project is how layer heights between 30-90 microns will affect the final part geometry.



MATERIALS SCIENCE AND ENGINEERING

TEAM 9

Alex Distelman
Megan Hurley
Michael Geragotelis

ADVISORS

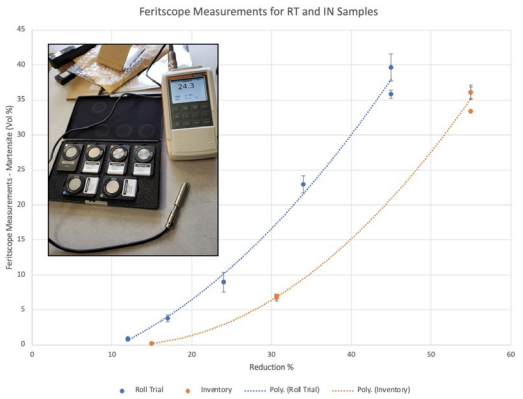
Yuanyuan Zhu

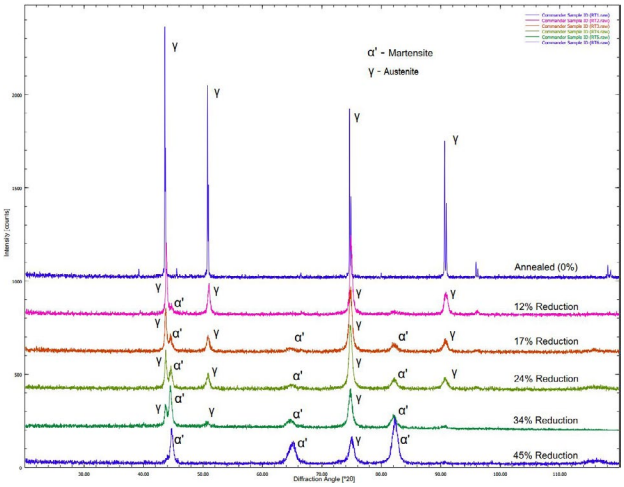
SPONSOR

Ulbrich
We Deliver Precision®

Rapid Martensitic Phase Detection for Improved Processing of 301 Stainless Steel

The focus of this project is to enable our sponsor, Ulbrich Stainless Steel and Special Metals, to measure the amount of martensite in their 301 stainless steel sheet products. The ability to monitor microstructural developments during processing ensures that the final product will exhibit the desired mechanical properties. Martensite forms from the austenite phase during cold rolling deformation. This diffusionless phase transformation from FCC γ-austenite to BCC α'-martensite corresponds directly with increases in the 301SS's strength and hardness. These microstructural changes to the austenitic stainless steel's structure enable martensite to be identified through advanced microscopy techniques. These techniques, such as SEM, XRD, and EBSD, can identify the crystal structure and morphology changes of the 301SS, and enable the quantification of the present phases of the steel. However, the previously mentioned techniques are expensive, require intensive training, and are time-consuming to run. Therefore, determining an inexpensive, easy, and fast method to determine the volume fraction of martensite in 301SS would be desirable for maintaining the production quality of rerollers.





MATERIALS SCIENCE AND ENGINEERING

TEAM 10

Joe LoDuca
Julia Roemer

ADVISORS

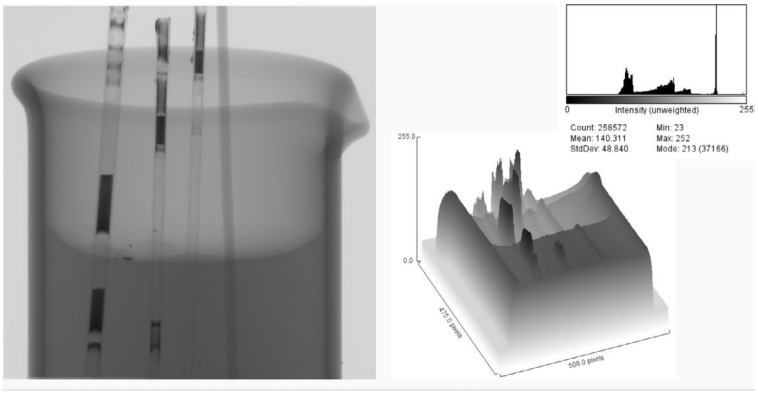
Jasna Jankovic

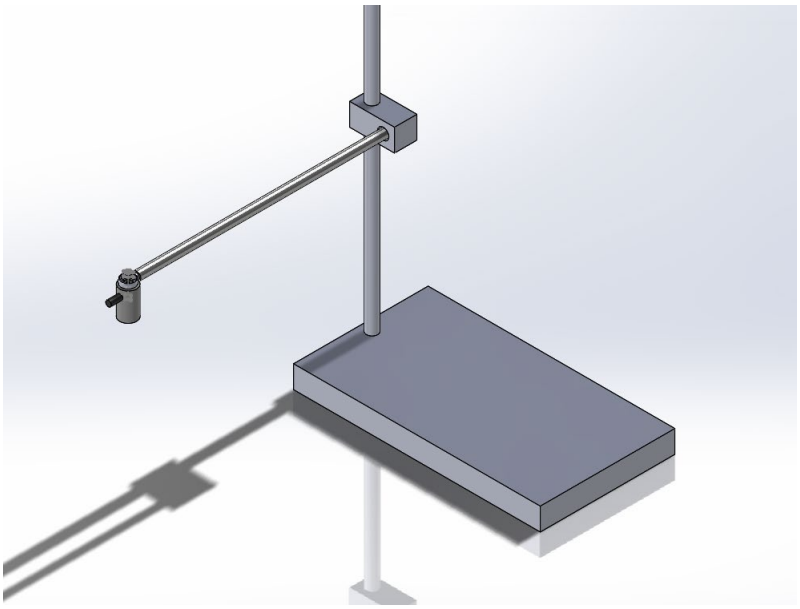
SPONSOR

Lawrence Livermore National Laboratory

In-situ X-ray Evaluation of Traumatic Brain Injury Dynamic Impacts

Currently the only methods to investigate traumatic brain injury (TBI) include post mortem analysis, high volume rat studies, and static CT, MRI, or brain visualization of a brain already experiencing TBI. LLNL is working to conduct the world's first study of the actual mechanism of TBI using dynamic radiography. In a first step, rudimentary brain structures and contrast agents have been examined that would be used for static radiography tests. The project includes the design of the brain phantom used for the dynamic CT test and the design of the elastic impactor. Phantom and impactor will be fabricated, tested, and then the X-ray radiographs will have to be analyzed. The setup must fit within the bounds of a flash X-ray system. A photo of the Army Research Lab's 3-ring flash X-ray system is shown below for reference.





MECHANICAL ENGINEERING

TEAM 1

Jacob Tran
Joseph Symochko
Mackenzie Lea

ADVISORS

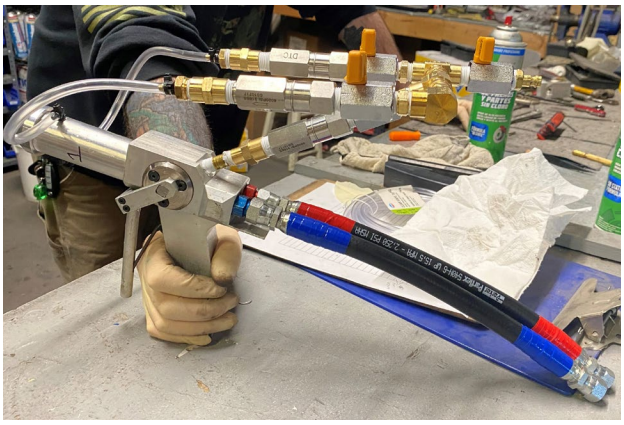
Francesco Carbone

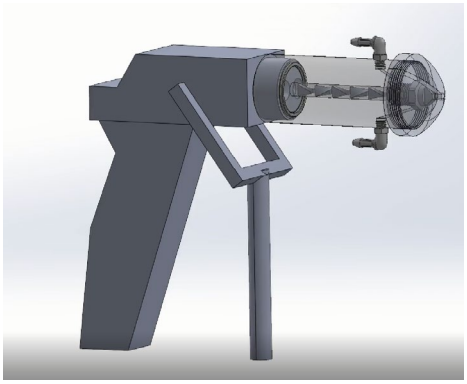
SPONSOR

ACME MACHINERY

Design of a Low Cost, Disposable Foam Spray Gun

The objective of the project was to research and design a low-cost, disposable foam spray gun continuing off ACME Machinery's initial prototype. If successful, it would be introduced into the future spray foam gun market. Spray foam guns have an input of two chemicals, isocyanate and resin. When mixed in a 50:50 ratio, the solution rapidly expands to form polyurethane foam, creating superior insulation for homes, commercial and industrial buildings. For ease of application, spray foam guns typically use compressed air to atomize and spray the foam, as well as incorporate a purge system to cleanse the gun of leftover chemicals and prevent clogging. Our spray foam gun had to operate at low-pressure and high-pressure between 120 psi and 1400 psi, respectively, for use for a homeowner and commercial environment, as well as have a comparable flow rate and spray pattern to current guns on the market. Current guns in the market can cost around $3,000 because of the multiple components involved and constant maintenance so our challenge was to reduce the amount of components to make a simplistic gun for a low price point of $100. Issues with ACME's initial prototype included improper mixing, no spray atomization, and lack of knowledge of the air purge system. The ME 01 team has come up with a design using Computer Aided Design and Computational Fluid Dynamics modeling to address these issues. After having our design machined, we planned and performed various spray tests to determine the effectiveness of our design with and without air assistance. With these tests we were able to come up with an iterative design to further meet our goals of simplicity and low cost.





MECHANICAL ENGINEERING

TEAM 3

Christopher Rowley
John Swanson

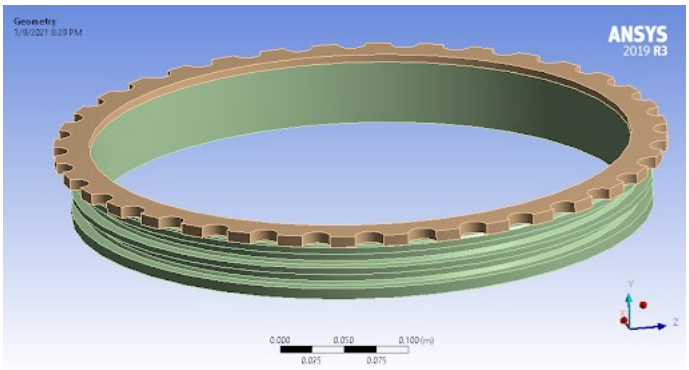
ADVISORS

Ryan C. Cooper

SPONSOR

AERO GEAR
Insist on Excellence

Quench Plug for Ring Gear Manufacturing Process



This project considers the geometric and material design of a quench plug that prevents distortion. Distortion happens during the hardening heat treatment processes. The heat treatment processes for the hardening of metal parts impose a variety of thermal and mechanical stresses that can result in geometric and microstructural weaknesses depending on the initial geometry and material of the part. For the investigation of this design, constraints provided by the aerospace manufacturer, Aero Gear, are considered. During the heat treatment process, as the quench plug and ring gear expand, they must experience interference that does not occur until the oven temperature reaches 1315°F. This interference must not exceed a limit of 0.008". After the ring gear undergoes heat treatment with the support of the quench plug, it must maintain a roundness measurement of its inner and outer diameters within 0.010". Finally, this design must be able to withstand 50 heat treatment cycles. In addition to these constraints, a design that maximizes the strength to weight ratio of the quench plug is desired. Minimizing the thickness of the plug is the factor considered to optimize this ratio.

We designed a thermomechanical analytical model to optimize thicknesses for each of the considered quench plug materials using the maximum shear stress theory in relation to the critical buckling of the plug. A thermomechanical analysis (TMA) experiment using a dilatometer was used to find variable coefficient of thermal expansion (CTE) values over a range of temperatures. Using a computer aided design (CAD) model of the quench plug, we performed thermal simulations in Ansys. Using the simulations, we were able to visualize the heat treatment processes and verify the results from the analytical model.

MECHANICAL ENGINEERING

TEAM 4

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Anthony D'Abramo
Candace Settle
James Greene

ADVISORS

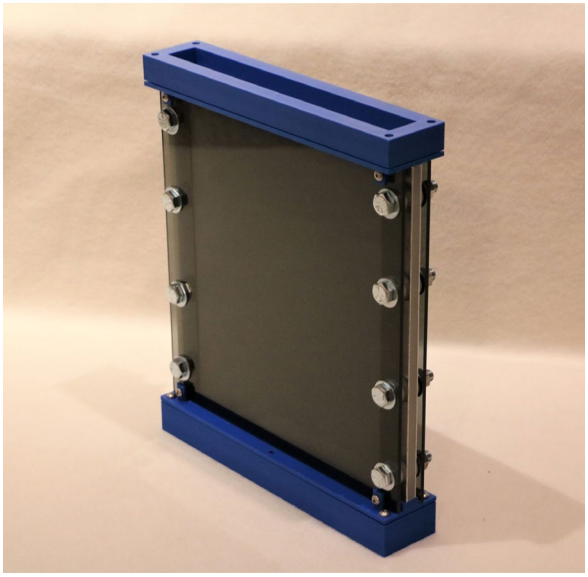
Chengyu Cao

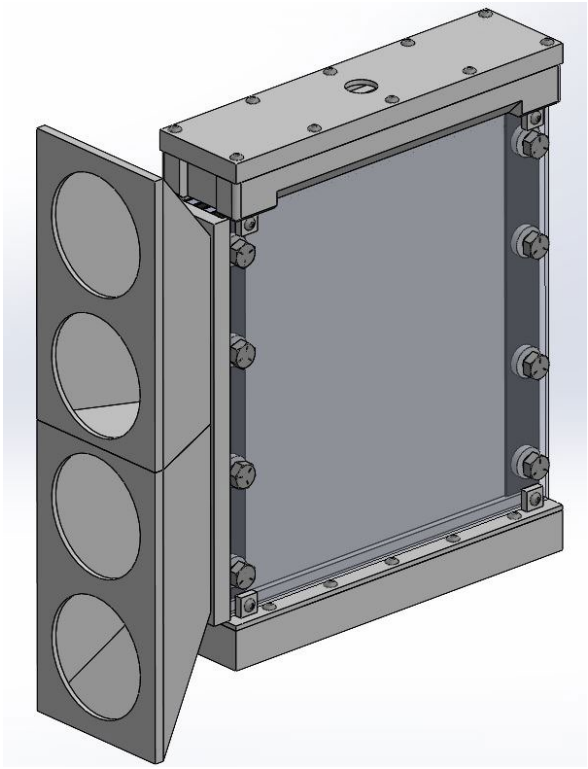
SPONSOR

agrivolution

Atmospheric Water Generator

Agrivolution LLC is a Connecticut-based company that develops technology to support sustainable farming practices. Among the most significant issues in agriculture today is droughts of increased severity and duration. This issue is predominant in California's Central Valley region, where more than 50% of all U.S. produce is grown annually. The repercussions of ongoing drought are three-fold: crop production is limited, natural aquifers are permanently dried by overpumping, and residential water shortages are common because urban water supplies must be shared with crop growers. However, a solution may already surround us: water contained in the atmosphere as humidity. The goal of this project was to design, manufacture, and test a device that converts ambient humidity to water for crop irrigation in California's drought-prone agricultural regions. This device absorbs water vapor from the air using a hygroscopic liquid desiccant—a dissolved salt that attracts water. Evaporating and condensing methods are then used to purify and collect the absorbed water for irrigation, respectively. This device is considered innovative because unlike traditional dehumidifiers, its operation is not limited to a range of environmental conditions. Rather, this device is designed to operate in any relative humidity and any temperature above freezing. In addition, a modular, scalable design permits the device to meet the irrigation requirements of variously sized crop growing operations. By providing California's crop growers with a sustainable source of irrigation water, this device could maintain or even increase crop production while restoring public trust in residential water supplies.





MECHANICAL ENGINEERING

TEAM 5

Emily Mitchell
Matt Boguszewski
Chris Payen
Yongkang Qiu

ADVISORS

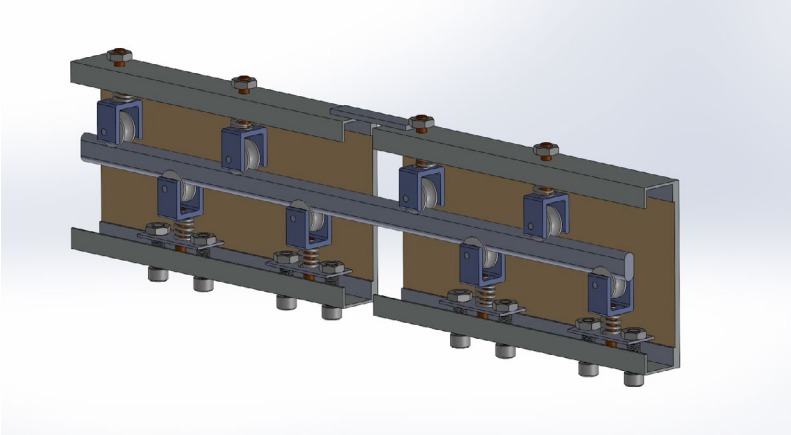
Nejat Olgac

SPONSOR

Airbornway

Redesign of Transconnector

Airbornway is an engineering and manufacturing company that is revolutionizing the transportation industry. The patent-pending Eagle Mobile Robotic Carrier (MRC) is a cabin system that will travel on a single cable system suspended in the air. The MRC will offer transportation solutions for many cities across the country. The ME05 group is redesigning a device called the transconnector, which is integral for the MRC and other cableway transportation systems. The transconnector device is able to provide mobile electricity through the use of the Gibson Cables, developed by Rodger Gibson of Airbornway. The first iteration of this device will be used for ski lifts and gondolas, which do not have access to electricity outside of the two terminals. With the electricity provided by the transconnector, the cabins will have lighting, air conditioning, and intercoms available. Our team is focusing on modifying the current design to allow the transconnector to turn corners, as the original prototype had colinear rigid mounted wheels. There were three major changes made to the original design, including implementing a spring loaded yoke wheel design, adding a locking mechanism for easy removal, and simplifying the electrical path.



MECHANICAL ENGINEERING

TEAM 6

Michael Fydenkevez
Asa Guest
Pranav Peddibholta
Joseph Plaisted

ADVISORS

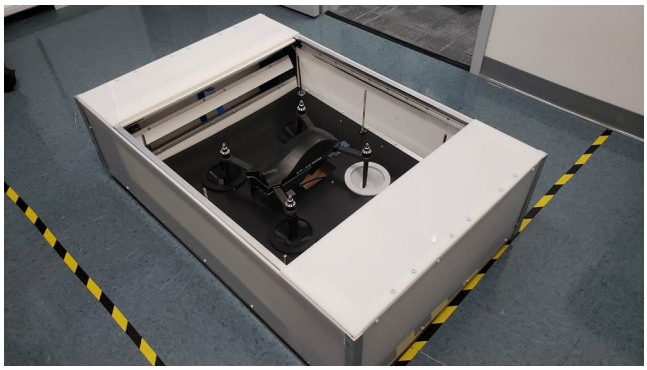
Chengyu Cao

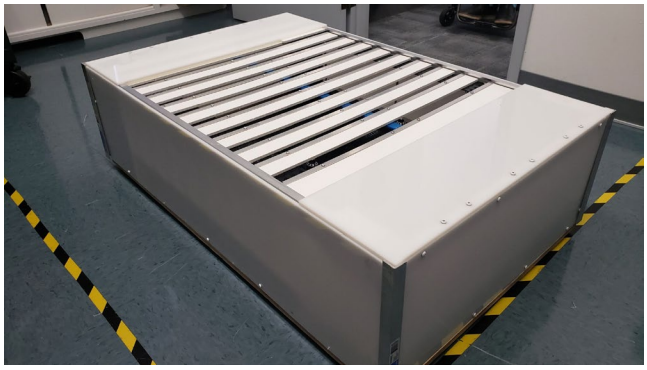
SPONSOR

A.D Aquiline Drones

Static and Dynamic Drone Landing Platform

The goal of this project is to develop a compact, drone landing system for Aquiline Drones. This is intended to be a proof of concept project designed around a specific drone model (Drone Volt's Hercules 2) that can be adapted for use with other drones. This landing system will enable drones to autonomously land on a platform once it comes into range, and then contain the drone until it is needed for its next mission. Drones outfitted with an IR Lock sensor will lock onto a beacon located on the landing platform, initiating the landing sequence. Upon landing, the platform will lower itself with the drone into the landing system where the drone will be magnetically secured to the platform to prevent additional movement. Wireless charging coils integrated into the drone allow the drone to begin wirelessly charging its onboard battery through the integrated charging system within the landing system. Once the drone has been completely lowered, an internally contained garage door style mechanism will close above, sealing the inside of the landing system from the outside environment.





MECHANICAL ENGINEERING

TEAM 7

Brian Frechette
Michael Pham
Veda Pandya

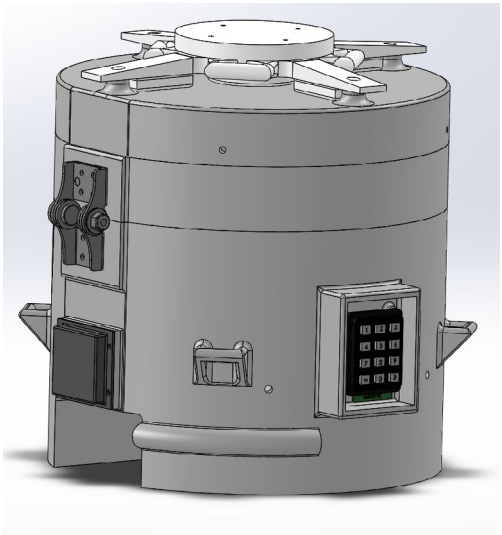
ADVISORS

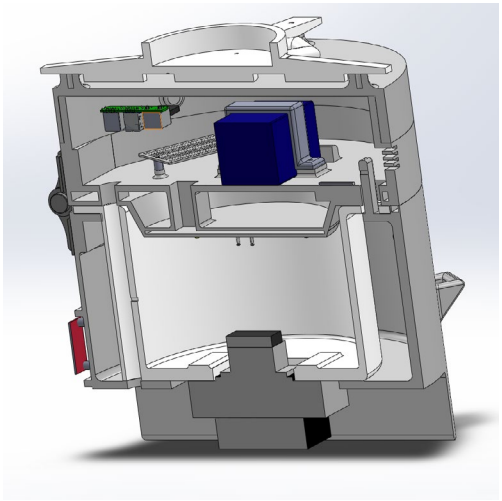
Chengyu Cao

SPONSOR

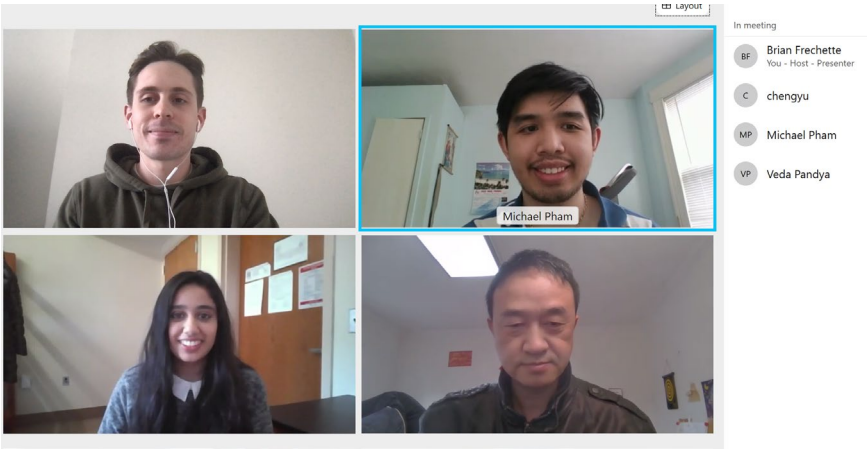
Aquiline Drones

Smart Box





Aquiline Drones provides Unmanned Aerial Vehicle (UAV) solutions for various applications across several industries. Several patients are unable to receive critical medication and/or vital organs needed for transplants in a timely manner due to issues surrounding logistics and unreliable delivery. The new Smart Box concept seeks to improve the likelihood that a patient receives such critical materials promptly by providing a UAV solution catered to the efficient transport of temperature sensitive materials. The objective of this project is to design, fabricate, and test a box concept that will optimize the delivery of temperature sensitive medicines and biological specimens, including human organs and tissue. This is a joint project between Mechanical Engineering (ME) and Electrical Engineering (EE). Major constraints with regards to the ME team include the aerodynamic form of the box, carrying capacity, impact resistance due to drops, box weight and dimensions, exterior UV rated material, internal insulating and biocompatible material, and an interior cooling system. It was desirable to 3D print our box, so we decided on using Acrylonitrile Styrene Acrylate (ASA) for our external shell and acrylonitrile butadiene styrene (ABS) for an internal box. Expanding Polyurethane was selected as the best insulating material due to its impressive 6.7 R-value. Thermoelectric cooling via a Peltier device was selected due to its compact structure, low weight, low cost, and effective cooling, as it proved capable of maintaining a target temperature of 8 degrees celsius during testing. The Peltier device operates in conjunction with a relay switch, enabling the system to be powered on or off depending on current system temperature requirements. The model was designed in Solidworks and iteratively tested in ANSYS using impact and vibration simulations. The box is set to be 3D printed and assembled throughout the month of April for a final demo at Aquiline Drones.



MECHANICAL ENGINEERING

TEAM 8

Jose Tanchiva
Joan Llerana
Yizhou Liu

ADVISORS

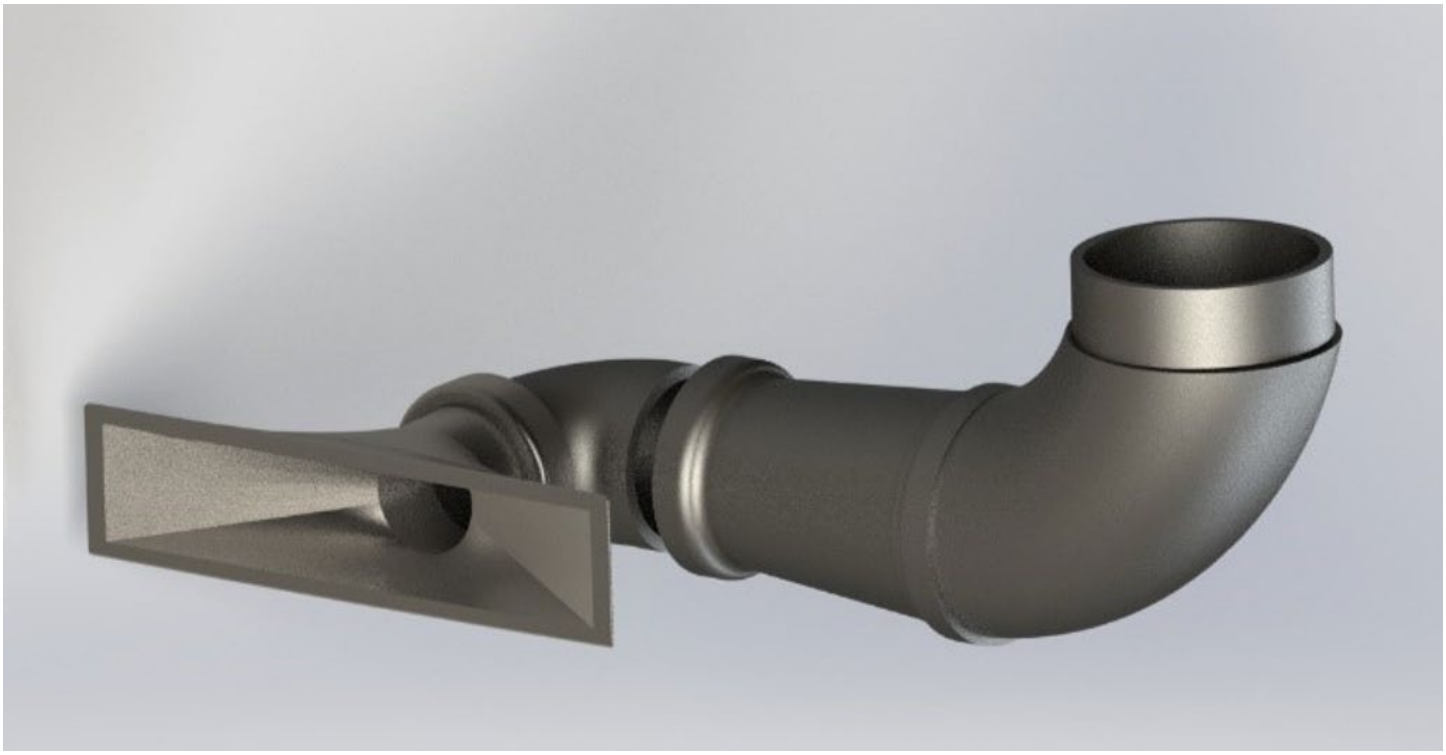
Bryan Weber

SPONSOR

ASML

Turret Temperature Conditioning System

The goal of ME 08 is to help the company to develop a more robust turret temperature conditioning system for cooling a reticle in a certain range, in a required time domain, and to balance the effect of fast cooling speed and unequal heat distribution. Team 08 has performed calculations, simulations, and designed 3D models to have a design of a cooling nozzle in the turret. The calculations were relevant to estimate the value of flow rate the nozzle had to distribute theoretically as well as the size of it. The 3D models were also important to show the design the nozzle must have according to the dimension constraints. ME 08 assumed the cooling process occurs in a closed system. By computer simulations, ME 08 analyzed the feasibility of different probability and obtain the influence of boundary conditions of the cooling effect inside the turret. In order to achieve the best results, the speed of cooling air, the nozzle shape, and the insulation material were considered to 3D print a prototype design of the turret temperature system and perform an experiment.



MECHANICAL ENGINEERING

TEAM 9

Alexander Kochanowicz
Zachary Melendez
Joshua Macchi
Julian Lebel
Michal Zyla

ADVISORS

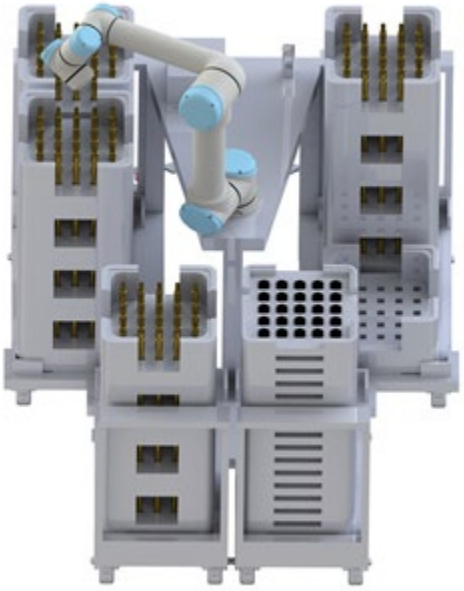
Jason Lee

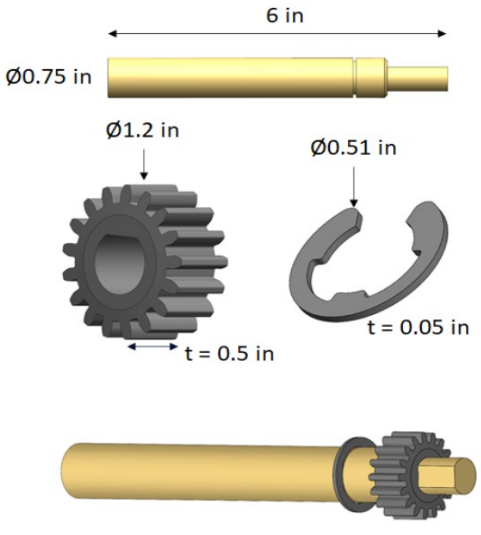
SPONSOR

BELIMO

Co-Bot Manufacturing Integration and Development

The manufacturing industry accounts for ~12% of GDP in the U.S., and is an integral part of the economy. In a competitive global market, companies in this industry must use some form of automation to keep up with increasing demand and labor costs. Belimo is a company based out of Danbury Connecticut, which manufactures and distributes HVAC systems and equipment, building automation devices, energy management systems, lighting controls, motors/drives, and air quality control products. Belimo is the global market leader for development and production of heating, ventilation, and air conditioning field device solution systems. The goal of the project was to implement a system of automation involving a manufacturing robot for sub-level automation by building upon the work done by the senior design team from 2019-2020. The implementation of this system frees up Belimo's employees to work on more impactful projects. This process involved analyzing previous research and design work done, as well as designing, iterating on, building, and testing the assembly workstation. Extensive design work was conducted to develop the tools needed for successful automation including a device that applied C-clips onto the gear shaft through a rack and pinion system as well as a fixture to slide over the co-bot gripper fingers in order to properly interface with all the components of the sub-assembly. These assembly accessories were designed in tandem with the workstation, in which a series of carts holding palletized parts surround a table holding the co-bot. The system was designed to process 400 parts in a cycle, limiting human involvement to palletizing the parts and moving the workstation carts, freeing up time for assemblers to work on more complex assemblies. Belimo would also like to use this system in the future to assemble other products. Using the carts and workstation we designed, they can create new pallets and program the robot using our template for these new assemblies.





Jason Lee

Alexander Kochanowicz

Zachary Melendez

MECHANICAL ENGINEERING

TEAM 10

Timothy Gamble
Daniel Islam
Christopher O'Connor

ADVISORS

Bryan Weber

SPONSOR

BIOMASS CONTROLS

Improved Design for Low Density Feedstock Conveyance

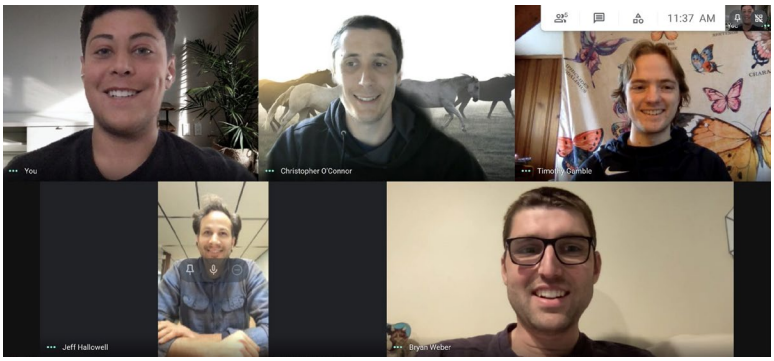
Low density fuels contribute to the inadequate sanitation that causes sickness in communities around the world. The BMC biogenic processor implements a continuous pyrolysis system that enables sanitation by treating pathogens and improving soil health while minimizing greenhouse gas emissions.

The goal of this project is to design and integrate a safe feedstock transportation system for a biogenic processor with a focus on bridging prevention, fire suppression, and fuel monitoring.

The transportation system entails a refined hopper design that maximizes volume and feedstock conveyance with a specified geometry. The modified hopper better prevents bridging and arches from jamming the bin outlet. The optimal angle for the auger as well as the angle of repose for the steel back wall were used to determine the ideal specifications for better feedstock conveyance. A subscale model was developed and connected to a motorized auger. The auger pulled wood pellets at 35% moisture out of the hopper as it was filled. This tested the performance of the design by observing how well it moved feedstock mass. Different angles and motor drive frequencies were tested to find the best parameters to move 1 lbm of feedstock per minute for ideal processing flow.

The refined system is also able to detect fires and autonomously suppress them to reduce damage and prevent burnback. The fire suppression system utilized a snap disc sensor indicating when temperatures breach a thermal threshold. This triggered a valve to release argon into the system, displacing the control volume of oxygen and extinguishing the fire. The system can then cool until it is ready to operate safely again. This minimizes the damage to delicate equipment and electronics used inside the system and protects the stored feedstock. The set up was tested at the Biomass facility by heating a detached pyrolysis pot with a coal fire. When the argon was dispersed into the flaming pot, the time and pressure needed to extinguish the fire was recorded.

Load cells placed under the hopper are able to monitor high or low fuel situations by tracking feedstock weight. They can be electronically integrated into the software that runs the processor. If the upper and lower limit of feedstock mass is breached, the load cells will send an electronic signal to the operating system.



MECHANICAL ENGINEERING

TEAM 11

Cristian Pabon
Nathaniel Skuba
Anna Toal

ADVISORS

Reza Sheikhi

SPONSOR

Charles Gray

Analysis and Design of a Black Powder Cannon

This project is sponsored by an independent University of Connecticut alumni, Charles Gray. The purpose of this project is to analyze a ceremonial cannon, made of 4140 low-carbon steel, and that uses Pyrodex as a black-powder substitute, in order to design and build a larger and louder cannon. To do so we performed a series of tests using the current cannon to measure the stress, sound level, and rollback data as well as the effect of varying the charge mass and packing pressure of the charge. This allowed us to estimate a factor of safety for the current cannon and to extrapolate a new design for the larger cannon. The new cannon was required to be made of the same material, have a 0.75" barrel bore, and be 50% louder than the previous cannon in terms of perceived loudness. To accomplish this we extended the barrel length which allows for the cannon to withstand greater pressures, and to be louder while also packing the powder as much as possible. After building the new cannon we ran additional tests to verify the loudness and factor of safety.

MECHANICAL ENGINEERING

TEAM 12

Samuel Collin
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ADVISORS

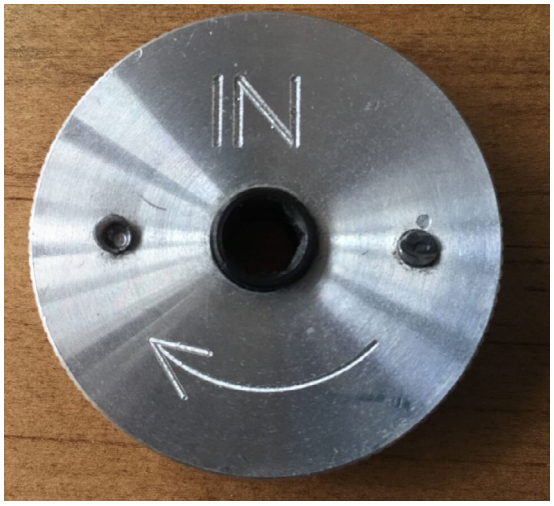
Thomas Mealy

SPONSOR

THE Chapman MFG. Co. Est. 1936 American Made Screwdriver Kits

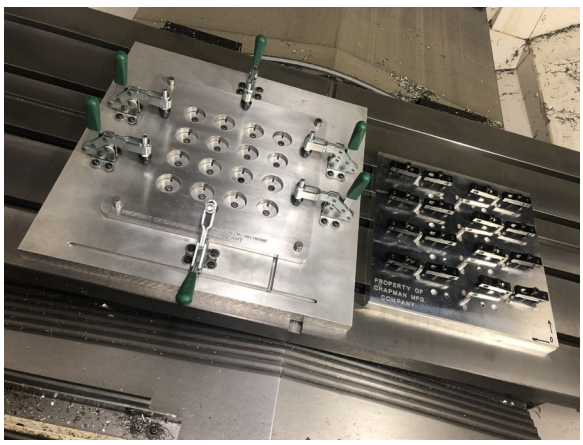
PR-13, Palm Ratchet - Processing/Introduction to Market

Our sponsor, Chapman MFG Co., is a family-owned company that makes high quality sets of tools that are proudly made in the USA. The project given to our team has the ultimate goal of bringing their new product, a tool called the palm ratchet, to market. A palm ratchet is a small tool, approximately 2 inches in diameter, that is meant to be an everyday carry tool that can comfortably loosen or tighten various fasteners. The steps required of our team to accomplish this goal include the prototyping and design, analysis, fixturing, quoting, and scheduling. For prototyping and design, we have created multiple SolidWorks models for the Palm Ratchet and Fixtures to determine the most effective ways to process these parts. We then manufactured prototypes of our final Ratchet design and fixtures for use in their manufacture. In trying to minimize the cost and maximize the capabilities of our fixtures for our sponsor, we generated fixtures that utilized lean manufacturing techniques, and in one case, were able to manufacture a multipurpose fixture that works for two of Chapman's part numbers.



To test the capabilities of the ratchet design, we ran torque tests on the completed prototypes, through both ANSYS simulations and live testing. To coordinate the manufacture of the production lots of the ratchets, we sent requests for quotes, or RFQs, to many shops in the local area to compare costs of production for the finished products. Determination of the required machine tolerances for proper fit, function, and lowest manufacturing costs were determined through prototyping, model comparisons and our responses for RFQs.

Our team is also working on a mini ratchet that is ~30% smaller than the original. Although following basically the same process as the normal palm ratchet, the mini ratchet is a smaller tool which required the process to accommodate for machining in tighter spaces. This required us to consider clearance for tooling requirements for the mini ratchet features much closer. We needed to make changes to our fixture concepts, part holding techniques and tooling diameters and machining orders to account for the smaller machining areas and radii on the mini ratchet. We were, however, able to test the capabilities of the mini ratchet in the same fashion as the original palm ratchet.



MECHANICAL ENGINEERING

TEAM 13

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Jared Nye

ADVISORS

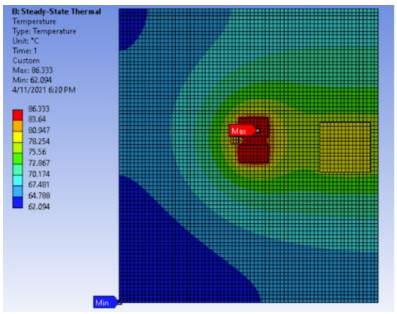
Wilson Chiu

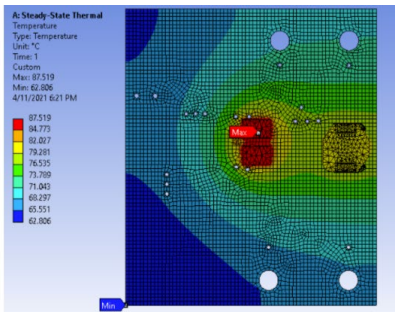
SPONSOR

Collins Aerospace

Densely-Packaged Electronics Circuits

Group 13's project is a joint effort between the Electrical and Mechanical Engineering teams. Our main goal is to observe any differences gallium nitride (GaN) transistors exhibit in a DC/DC converter compared to a converter using a silicon (Si) transistor. Our research allowed us to predict GaN-based devices will perform with higher efficiency and less power dissipation than Si-based devices. Our goal is to prove this in the laboratory using experimental results. These experimental results will provide our sponsor, Collins Aerospace, with information to aid them in their transition of using GaN transistors rather than Si transistors for aerospace applications, particularly those that require DC/DC converters. The challenges facing our Electrical team was designing a PCB board based on GaN System's GS61008P-EVBHF board and reporting all learnings gained from the design as well as the design files back to the sponsors. Then we were to send our design files to a PCB manufacturer to have our board fabricated and assembled. Another challenge we were assigned was testing the original GS61008P-EVBHF board with our custom PCB board and reporting any differences in performance or measurements that were discovered. One challenge facing our Mechanical team was taking pictures with a thermal imaging camera of the GS61008P-EVBHF and custom PCB board and reporting back all measurements and any notable differences. Another challenge our Mechanical team faced was creating a model of the PCB board in Ansys and running a thermal analysis on the PCB before it arrives and comparing it to the thermal imaging camera results obtained from pictures taken of the PCB.





MECHANICAL ENGINEERING

TEAM 14

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Jessica McCamish

ADVISORS

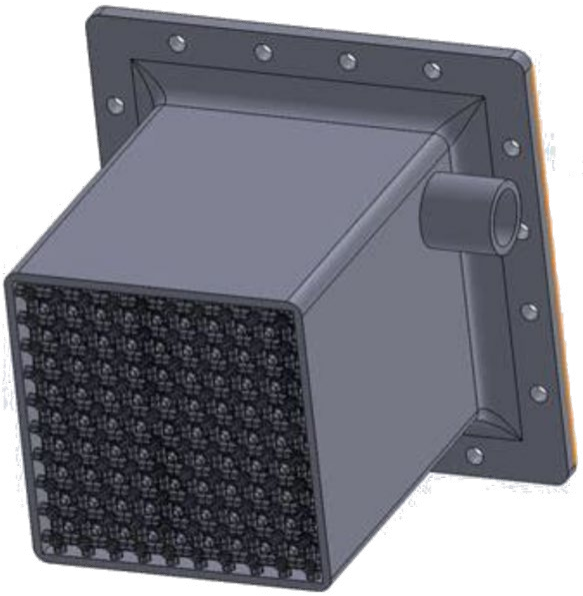
Ugur Pasaogullari

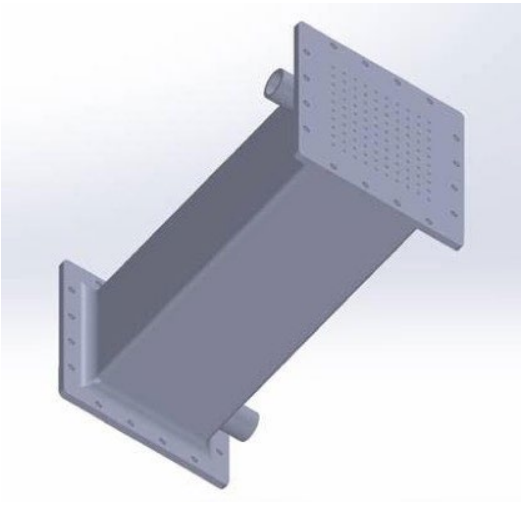
SPONSOR

Collins Aerospace

Additively Grown Phase Change Material Heat Exchanger with A Single PCM Chamber

Collins Aerospace, a subsidiary of Raytheon Technologies, is a key supplier of aerospace and defense components. This company specializes in aero structures, avionics, interiors, mechanical systems, mission systems, and power and control systems. As a top innovator across many sectors, Collins Aerospace wants to optimize their current methods of heat storage in space vehicles. Existing PCM heat exchanger configurations contain multiple PCM passages which make fabrication difficult, time-consuming, and expensive. Accordingly, the purpose of this project is to design, manufacture, and test an additively grown Phase Change Material (PCM) heat exchanger. The use of a PCM is desirable because it allows heat to be absorbed without any major changes in temperature as it changes from solid to liquid. It also benefits from the microgravity environment it must operate in. The new design is made up of a unique, monolithic, lattice structure which houses a single PCM volume. This configuration significantly simplifies manufacturing while still maintaining effective heat transfer and operating safely under designated conditions. The heat exchanger's scalability and resulting data suggests that a full-scale model could be used as a heat sink in a real spacecraft.





MECHANICAL ENGINEERING

TEAM 15

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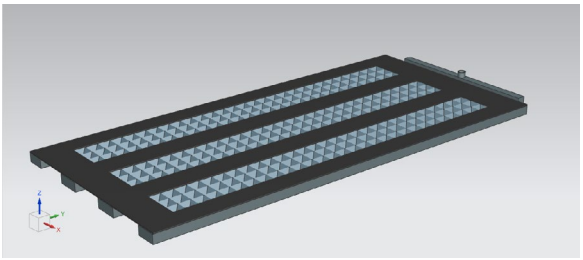
Oleg Nazarovets
Nathaniel Burgess
Tyrese Gaffney
Gabriel Zepeda (Fall)

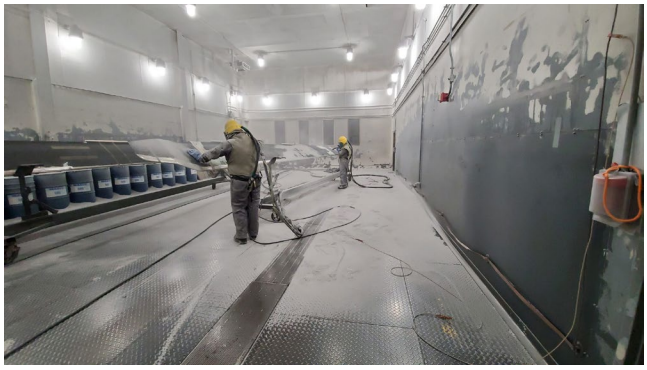
ADVISORS

Reza Sheikhi

SPONSOR

Blast Media Booth Modernization





The 1109th Theater Aviation Sustainment Maintenance Group is a division of the Connecticut National Guard located in Groton, CT. They are responsible for the refurbishment of helicopters used by the National Guard, which includes the task of blasting the paint off of the helicopter during the beginning stages so it can be painted to look brand new. The ME15 team, in collaboration with ECE 2111, was tasked with modernizing the 25 year old blast media system currently in use at the facility. As a result of its age, there are several problems that reduce its efficiency and inhibit the operators' abilities to do their jobs: the floor recollection system clogs easily, the ventilation system does not maintain the required negative air pressure, and 50% of the operators' working time is spent cleaning up. During the team's research and design process, the relevant safety codes, the available space, and the weight of the helicopters serviced in the booth were taken into consideration. The team was able to design and recommend a new floor recollection system as seen in Figure 2. This recommendation was based on the cost, efficiency, and needs of the facility. The team was also tasked with recommending new filtration equipment. In order to meet the needs of the site and adhere to the budget, the team consulted with an outside company. The final design and team's recommendations are currently being handed off to the National Guard to fully develop and implement the project.

MECHANICAL ENGINEERING

TEAM 16

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Austin Benzoni

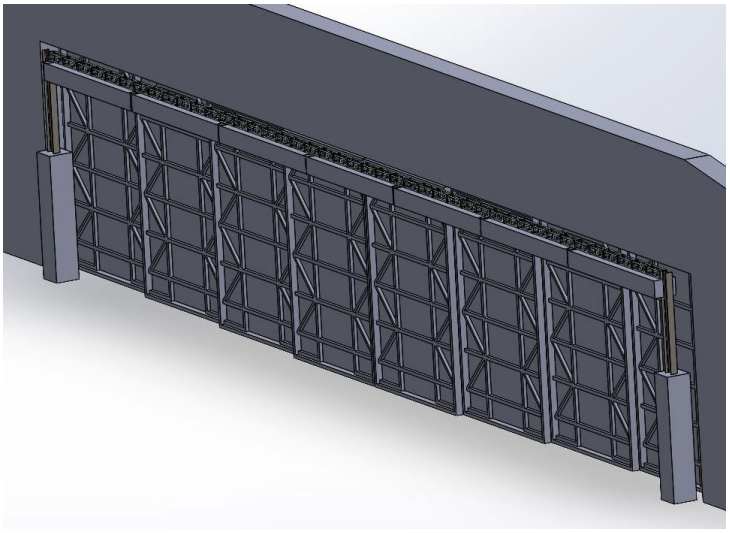
ADVISORS

Vito Moreno

SPONSOR

Main Hangar Door Winter Heat Loss Mitigation

The 1109th TASMG (Theater Aviation Sustainment Maintenance Group) is one of a few select groups in the U.S. Army that is qualified for full repair of the National Guard's inventory of active helicopters. Each winter, the hangar they operate out of loses massive amounts of heat each time the hangar doors open in order to bring helicopters in and out for repairs. The objective of this project was to mitigate the heat loss coming from the open hangar doors in order to not only reduce heating costs for the building but to also to help keep the soldiers working inside more comfortable and therefore more productive. The team designed an air curtain system which involved suspending heavy duty air blowers above the entrance of the hangar doors. This would create a large air curtain in front of the hangar doors stopping cold air from entering the facility and preventing hot air from exiting. One of the goals for this project was to create a system that would operate automatically, this meant that the only human input would be someone operating the hangar doors leaving the blowers to turn on and off on their own. The team conducted a heat transfer analysis on the hangar doors with the air curtain design to assure the heat mitigation was effective. Along with this analysis an electrical analysis was conducted to assure the amount of energy used by the air curtain was not greater than the energy previously used to heat the building during the winter. The team provided a full SolidWorks model of what the air curtain design would look like inside the building along with all of the dimensions of the design. Part of this model was the actual support structure that the blowers would be mounted on. Due to the weight of the blowers, they could not be mounted directly on the hangar itself. This led the team to research and develop a separate structure that would support the blowers on both ends of the hangar, while keeping the structural integrity of the hangar intact.



MECHANICAL ENGINEERING

TEAM 17

Leah Jackman
Jeffrey Albert
Gregory Haydon
Rachel Scott

ADVISORS

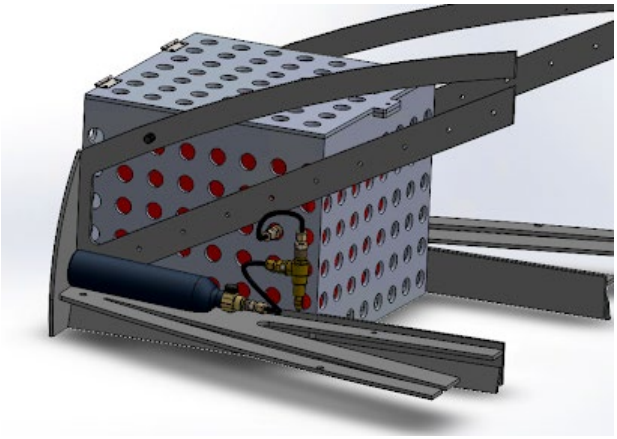
Jason Lee

SPONSOR

DIVE TECHNOLOGIES

Design and Prototype of an Emergency Ballast System for an Autonomous Underwater Vehicle

Dive Technologies is a designer of Autonomous Underwater Vehicles (AUVs) based out of Quincy, Massachusetts. This company is in the process of manufacturing deep diving underwater vehicles which will be subjected to all of the environmental stresses and factors that come with such depths. With such precision equipment, loss of hardware in the case of a systems failure would be detrimental to progress. Therefore, this project demonstrates proof of concept through research, reasoning, and the experimental prototyping of a system created to recover the AUV in the event of a system failure. The Emergency Ballast System is triggered in the event the AUV is unable to ascend under its own power. The goal of this system is to provide 100 lbs of buoyant force. In order to do this, increasing the volume or decreasing the mass of the AUV would create a buoyant force. The design outlined autonomously inflates a bladder, thus displacing 100 lbs of water and causing the AUV to become positively buoyant. This design inflates within 30 seconds of actuation, and is robust enough not to burst under the high pressure at ocean depth. This is accomplished by a compressed air tank that will inflate a bladder through a solenoid valve, which provides an on/off functionality via a signal which Dive Technology provides. This is all conducted inside of a cage to prevent the bladder from puncturing on other components within the AUV. The implementation of the Emergency Ballast System ensures Dive Technologies that the AUV is able to return to the surface during system failure.



MECHANICAL ENGINEERING

TEAM 18

Abbas Harris
Patrick Gough

ADVISORS

Frank Cunha

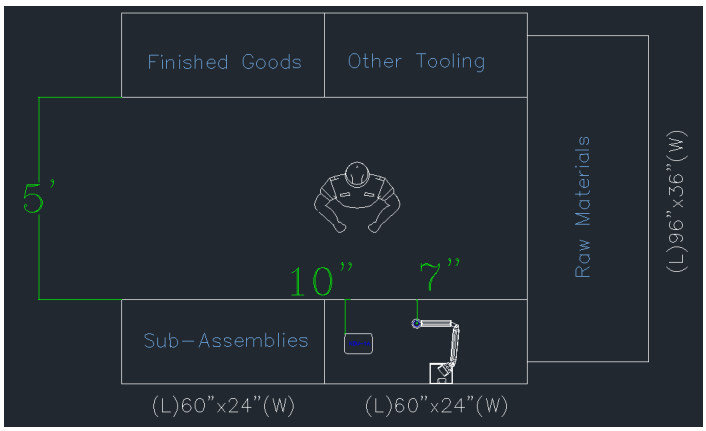
SPONSOR

DYMAX
Adhesives and Light Curing Systems

Output Improvement of Screw Assembly Process

Dymax Corporation is a global leader in the manufacturing of adhesives and sealants located in Torrington, CT. Dymax manufactures innovative rapid light-curable materials, dispense equipment, and Ultraviolet/Light-emitting diode (UV/LED) curing systems. The company has recently been facing screw tensioning failures within some of its manufactured equipment, specifically the UV Curing Systems which has resulted in first-pass assembly internal failures. The objective of this project is to reduce internal failures and improve the output of the screw assembly process by analyzing the current screw assembly methods being used and researching other practices currently being conducted in similar industries. The metric of success defined for this project is that the implemented changes will significantly decrease the current internal failure.

A pareto chart was created to identify and prioritize what defects to address first. After obtaining this information the team started researching possible solutions and arrived at the conclusion that implementing a transducerized/electronically controlled screwdriver would be the most effective way to meet the sponsor's requirements. The transducerized screwdriver was tested for reliability and experimental target torque values were obtained. The perceived benefits of implementing this tool were: decreased cycle time, labor hours, ergonomic risks, quality concerns, the risk priority number score in the process failure mode effects analysis (PFMEA), and increased availability of direct labor resources.



MECHANICAL ENGINEERING

TEAM 19

Jack DiFrancesco
John Dana
Romario Bowen
Vinny Fazio

ADVISORS

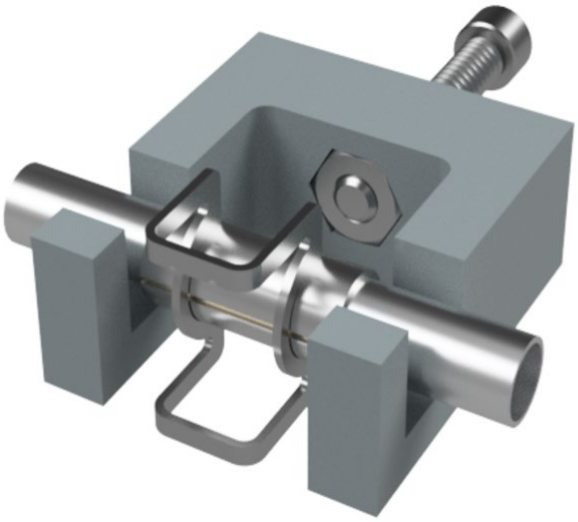
Vito Moreno

SPONSOR

EAP A CAM COMPANY

Alternate Wear Sleeve Installation Method

The purpose of this project was to find a significant time savings for the current process of affixing metal wear sleeves to tubes which are then sent out to be brazed together at 1950°F. Our sponsor company is EA Patten, located in Manchester, CT. We also received donated work and materials from Spartan Aerospace and Accurate Brazing, in Manchester, CT.



The current process is done in a layout that holds the tube in position using blocks referred to as C-channels which also show the mounting locations of the wear sleeves. The tube is marked where the wear sleeves are supposed to be mounted and then the tube is transferred to a separate workstation to have the wear sleeves attached to the tube using safety wire. We have sought major time savings by having the wear sleeves attached to the tube while in the initial layout, along with using a faster attachment method. To improve the attachment method, we have designed a special clip that simply snaps on to the wear sleeves and holds them in place. This is much quicker than using the safety wire, along with being more ergonomic for the end user. By redesigning the c-channels we have allowed the wear sleeves to be attached to the tube while still at the initial layout using our designed clip.

Throughout our project we have used a highly iterative design process. We would come up with multiple design ideas at once and evaluate each of them and then build upon what we learned to come up with a prototype to test. After testing we evaluated our results and came up with new designs based on what we learned. By using this process, we were able to come up with our final designs for the C-channel and clip, shown on the right. These changes have resulted in a time savings of approximately 85% with the overall process time being cut from 5 minutes to within the range of 30 to 45 seconds.

MECHANICAL ENGINEERING

TEAM 20

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Daniel Burke
Andrew Peterson
Zachary Adamson

ADVISORS

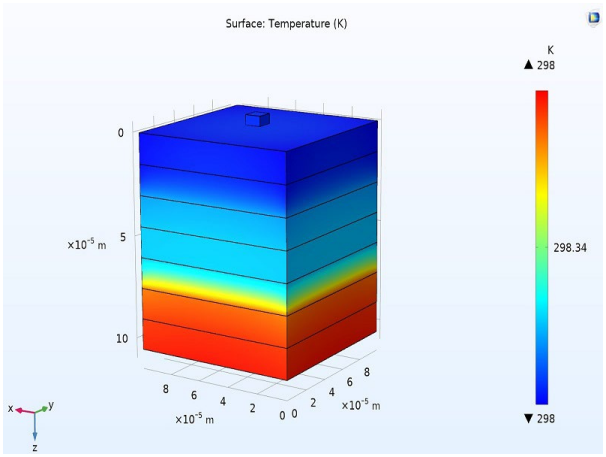
Georgios Matheou
Yang Cao

SPONSOR

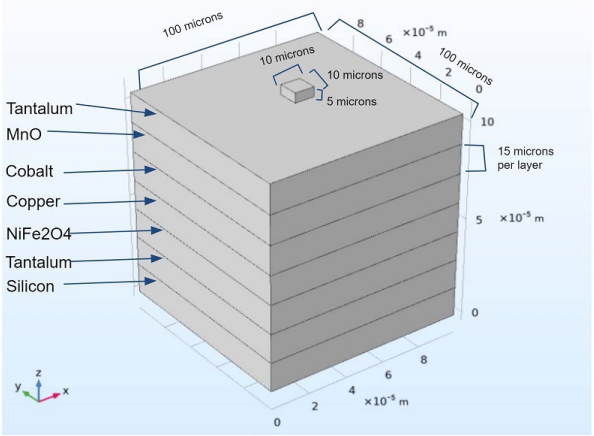
GENERAL DYNAMICS
Electric Boat

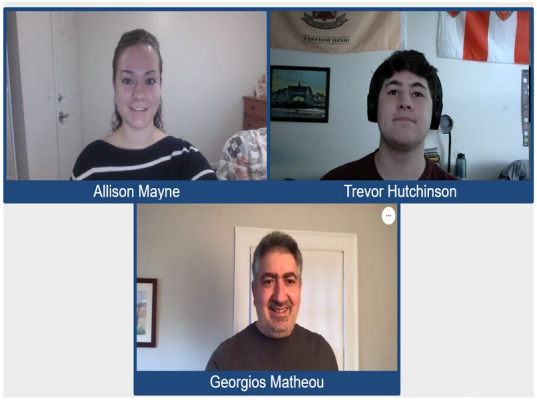
Micro-Electro-Mechanical System (MEMS) Magnetometer

Electric Boat has been working on designing, constructing, and advancing the technology that the U.S Navy uses since the late 19th Century. Electric Boat's aim was to fabricate a magnetometer using MEMS technology that is precise and can withstand conditions on an underwater vehicle. The objective of this project was to design and simulate a MEMS magnetometer that can be used for underwater vehicle detection utilizing slight changes in the Earth's magnetic field. The magnetometer design incorporates MEMS in such a way that is accurate and efficient while also reducing the size of the device in comparison to what is commercially available. Specifically, the MEMS magnetometer was designed under the requirement of measuring approximately 0.1 nanotesla (nT) changes in Earth's magnetic field.



To determine which magnetometer option would best satisfy the requirements of the project, a Pugh chart was created. The magnetometer we chose to design based on the Pugh chart down selection involves layers of ferromagnetic and antiferromagnetic materials to utilize the Giant Magnetoresistance effect. When these layers are exposed to a magnetic field, a voltage change is created across the length of the device. This voltage change can be measured and then the magnetic field can be determined. We modeled the geometry of the magnetometer prototype design in COMSOL and modeled the environment in ANSYS, including contact between the ocean, hull, and device housing. We were able to produce two thermal models which allowed the team to investigate what kind of thermal management might be needed for the device once packaged. In addition, mounting analysis was conducted as well as a prior art search. The analysis of this project as a whole provided information regarding the sensor robustness while in use onboard.





MECHANICAL ENGINEERING

TEAM 21

Jacob Boschert
Brendan Taylor

ADVISORS

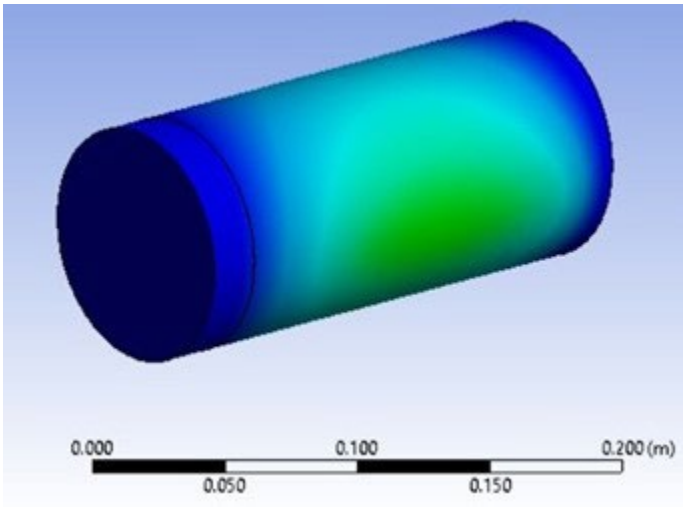
Chih-Jen Sung

SPONSOR

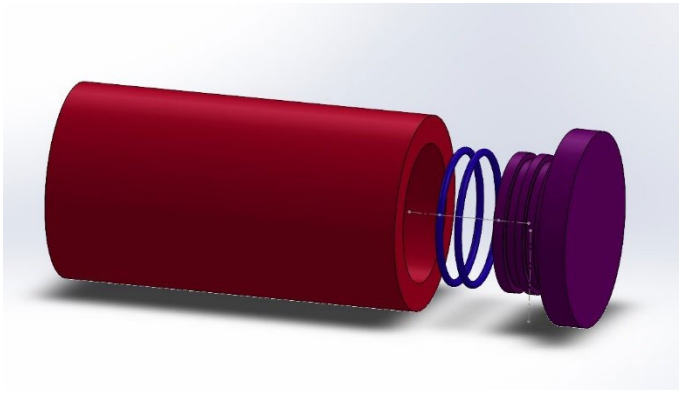
GENERAL DYNAMICS
Electric Boat

Underwater Data Transfer

The purpose of the collective project is to develop an underwater wireless communication transmitter to fit inside a UUV (unmanned underwater vehicle) for General Dynamics Electric Boat (GDEB). GDEB has established standards of excellence in the design, construction and lifecycle support of submarines for the U.S. Navy. The system will transfer data over a distance of at least 30 feet, with a rate of at least 100 kbps, with no packet loss during the transfer. The system must operate under a maximum current of 3 Amps and exposed terminal voltage of 30 VDC. The ambient temperature range is 0°C to 36.6°C and the system must operate at a temperature within 10°C of the ambient. This project documents the research and design of a waterproof housing unit for the communication system with heat transfer capabilities that keep the system within its operating temperature.



The housing unit for the transmitter inside the UUV is sealed with 2 O-rings to easily access the electronics while keeping it waterproof. With the communication system inside, the housing unit fits inside the “Riptide” UUV completely. The entire system withstands the same depths as the UUV, of 200 meters, while protecting the electronics in the event of cracks or leaks in the UUV. The initial thermal and stress simulations of the housing unit alone determined the material Acetal best suited the requirements of the housing unit design. Acetal kept the interior of the housing unit within 10°C of the ambient temperature and provided the strongest design against stress due to water pressure. Further analysis of the completed communications system, housing unit, and UUV determined the Acetal solution kept the communication system within 7°C of the ambient temperature and provided a 5 times safety factor at 200 meters. This design is 3D printed to showcase compatibility with the underwater data transfer communication system.



MECHANICAL ENGINEERING

TEAM 22

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Elena Ford
Benjamin Tuffy

ADVISORS

Ugur Pasaogullari

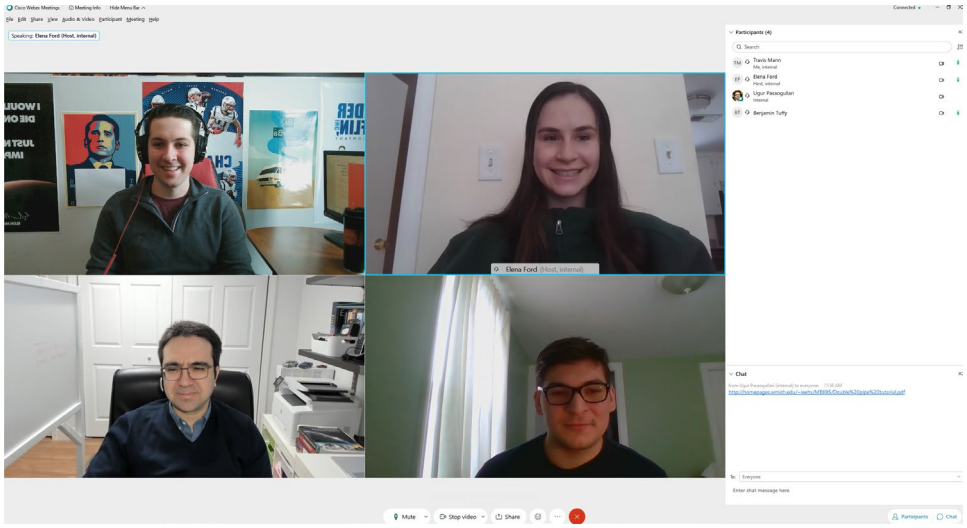
SPONSOR

FM Global

Thermal Runaway Uncertainty Analysis of Lithium-Ion Battery During External Heating

Thermal runaway is a positive temperature feedback effect of a system, caused by the electro-thermal mechanisms, with higher heat generation than effective cooling through the battery walls. This phenomenon presents a significant hazard for applications with many individual cells, due to the potential for runaway propagation. The analysis of thermal runaway in lithium-ion (Li-ion) batteries has been an ongoing study for several decades. Since the development of the first commercialized lithium ion battery in 1991 by Sony, the studies have become increasingly important. The commercialized applications of Li-Ion batteries are used for warehouse storage, electric-vehicle (EV) battery storage, data centers, and energy storage system (ESS) facilities. Li-ion batteries become a great hazard when exposed to abuses, such as mechanical, electrical, or thermal. These abuses will incite thermal runaway of the cell, leading to the release of flames and toxic, flammable gases.

Currently there is an unexplained uncertainty for when a cell will reach thermal runaway under a constant heat flux. FM global, an American mutual insurance company specializing in loss prevention, evaluates thermal runaway behavior in lithium-ion battery (LIB) cells using a fire propagation apparatus. However, causal and correlated explanations are still needed to explain the measured behavior. Causes for thermal runaway time uncertainties are determined through non destructive testing and detailed single cell modeling. Non-destructive testing is needed to identify relevant electrochemical or structural differences between batteries which affect thermal runaway time. For these tests, lithium ion battery cells with the same form factor, manufacturer, electrode material and state of charge are used. The main idea is to identify differences between cells which would otherwise be considered identical. Identifying differences between “identical” cells during non-destructive testing aids in the correlation of differences between thermal runaway times for “identical” cells during destructive testing. The final component is a detailed single cell model. The goal for this component is to calculate critical parameters such as material properties or internal temperatures in order to capture the measured surface temperature curves during thermal runaway.



MECHANICAL ENGINEERING

TEAM 23

Matthieu Bernier
Michael Savio
Alexander Nanai

ADVISORS

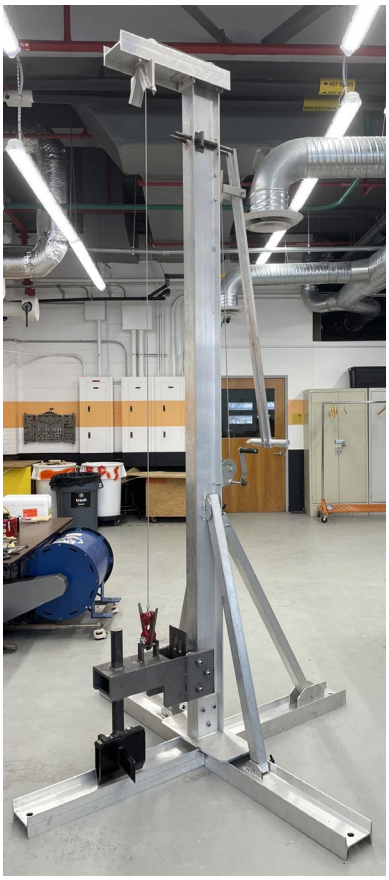
Thomas Mealy

SPONSOR

UCONN
SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

Guillotine Maul - A Mechanical Wood Splitter

This project is the upgrade and improvement of a manually operated guillotine maul wood splitter designed and fabricated by last year's senior design team. This maul splits logs into 4 pieces in one drop, creating firewood significantly faster than the hydraulic drive splitters in the marketplace. Upon receiving the project, we implemented a safety mechanism, a new two-handed winch system, additional weight to the head, and a new track-sliding system. Adjustable weight falls from sufficient height using impact force to split the wood. It operates within an entirely mechanical system, eliminates a great deal of manual work, and uses no motor, electricity or fuel. The splitting head and weight are cranked by reduction gears to maximum height, held at the top of the track by pins, and released by the push of the safety bar. The impact splits the wood with 4 cuts-in-one without the need for an engine. Thus reducing the bothersome noise and exhaust, refills and leaks of gas, oil, and hydraulic fluid, and the constant back-bending work to reseat half-logs on the splitter. As long as gravity remains in supply, the guillotine maul is ready to process firewood.



MECHANICAL ENGINEERING

TEAM 24

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Kiwon-Paul Dionne-Jee
Joseph Homan
Nicholas Curley
Danielle Gamelis

ADVISORS

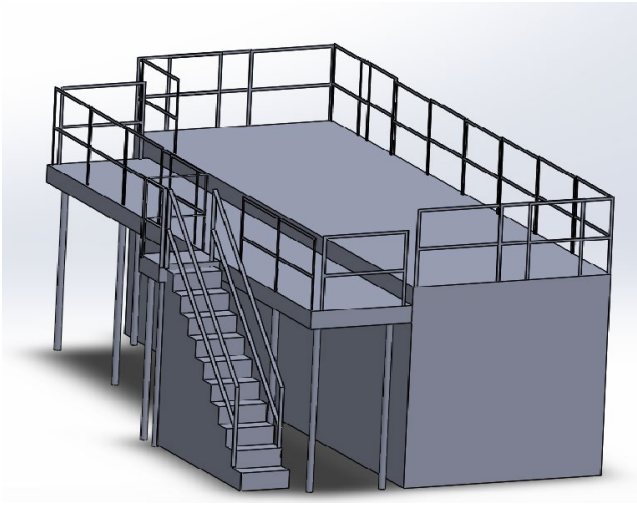
Frank Cunha

SPONSOR

HOLO-KROME®

Design and Implementation of Fall Protection System

This projects presents the planning, research, and design of a fall protection system. Holo Krome is a Connecticut based company that specializes in the design and manufacturing of fasteners. Currently, Holo Krome employs a harness system to protect employees from falling off of the top of the furnace. This harness system is cumbersome, uncomfortable, and time consuming to use, leading Holo Krome to seek a proposal for an alternative system. This project's solution to this problem is a catwalk and railing system that will be installed above and around the furnace to provide OSHA-compliant platforms to service the furnace. This catwalk will also remain small enough to not interfere with the surrounding factory work while still remaining OSHA-compliant. The platforms will be able to withstand 4 times the designated maximum weight, and the railings will be able to withstand at least 200 pounds of slide force loading. The implementation of this system will result in a less cumbersome maintenance routine, will require less training for future workers and will result in a more efficient workflow without the need to wear a harness.



MECHANICAL ENGINEERING

TEAM 25

Nathan Berardi
Michael Bladek
Austin Misorski

ADVISORS

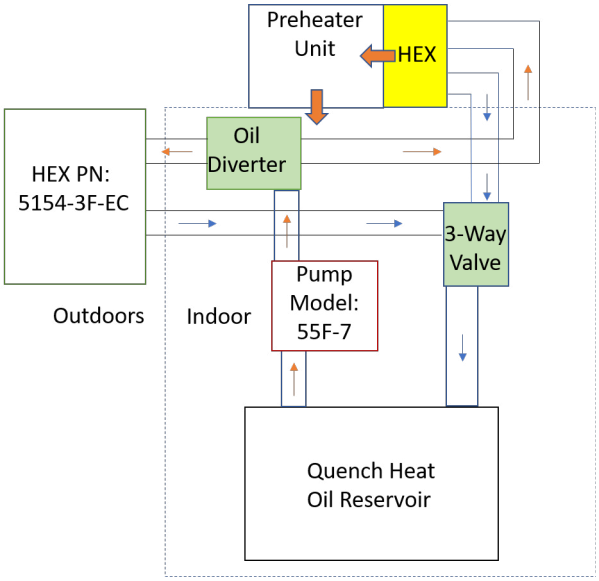
Reza Sheikhi

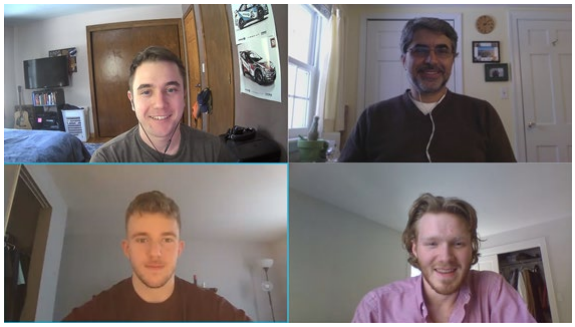
SPONSOR

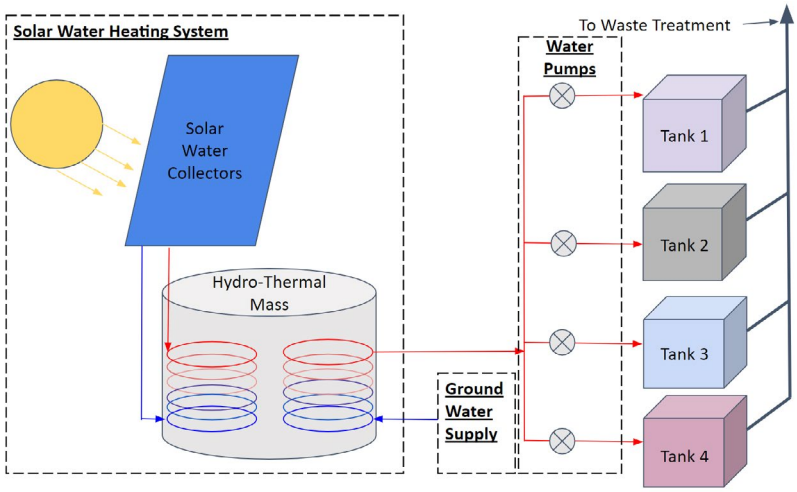
HOLO-KROME®

Recovery of Waste Heat to Preheat Incoming Air

Holo-Krome, located in Wallingford, CT, is a fastener manufacturer which prides itself in product quality and sustainability. They have been taking great strides to lower their carbon footprint, and find ways in which they may maximize their plant efficiency and lower overall fossil fuel and energy consumption. Our task is to research and develop plans for implementation of candidate heat generation systems to reduce or eliminate consumption of natural gas and electricity usage in applicable industrial processes at their plant. The first design involves utilizing the quench oil of a heat treat furnace redirected into the heat exchanger that would provide preheated air to a roof mounted natural gas heater. This preheated air will reduce natural gas usage in the pre-heater leading to lower annual heating costs. The second option involves utilizing solar heating to supplement electric heating for the fastener finishing process. Solar thermal collectors utilize a water tank as a thermal mass preheating fresh water supplied to finishing tanks maintained at 150°F to 180°F. Increasing temperature of fresh inlet water reduces electricity required by existing low wattage tube heaters. Each design has been modeled to determine system capability and return on investment.







MECHANICAL ENGINEERING

TEAM 26

Aimi Chiem
Kelly Crossman
Joshua Donahue

ADVISORS

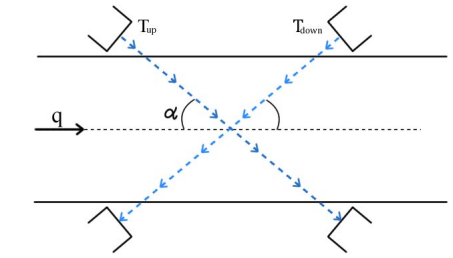
David Giblin

SPONSOR

HSB™
A Munich Re company

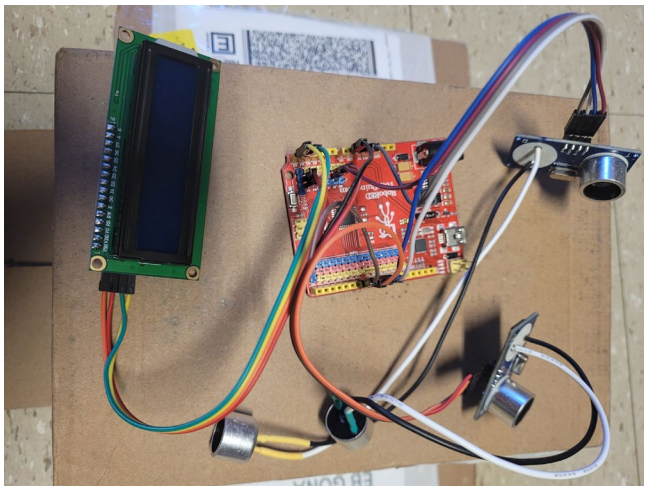
Ultrasonic Pipe Flow Sensor

The Hartford Steam Boiler Inspection and Insurance Company (HSB) deals in providing insurance to homeowners' boilers. They wish to use multiple Internet of Things (IoT) ultrasonic pipe flow meters to remotely monitor their clients' home systems. Data gathered with these meters will be used to help customers manage their risk profiles. Most existing commercial ultrasonic pipe flow meters are expensive and come with many features HSB does not wish to use. The objective of this project is to develop a low-cost IoT ultrasonic pipe flow meter to detect flows within household water pipes. Flow rate accuracy is not preferred; the meter only needs to detect if the flow rate is high, low, or in reverse. To prevent third party liabilities to third party installers, the meters must be non-intrusive and require no plumbing work. A prototype design was developed based on the transit time measurement principle of flow metering. With this principle, flow rate can be calculated using the upstream and downstream transit times, pipe diameter, and the inclination angle. The prototype was created using an Arduino RoboRed and two modified HC-SR04 ultrasonic sensors. One HC-SR04 is positioned to measure the upstream transit time while the other measures the downstream transit time. The transmitter is placed on the upper surface of the pipe while the receiver is directly facing it on the opposite side. The transmitted signals' paths are at an angle to the pipe's axis. The Arduino measures the time it takes for each transmitted signal to reach the receiver and calculates the flow rate based on the measured times. To test and validate our sensor, we modified an existing water loop system to mimic home water systems. The motor attached to the pump allows us to test our sensor for variable flow rates and pipes can be interchanged to test on different pipe sizes and materials.



$$q = \frac{\pi D^3}{4sin(2\alpha)} \cdot \frac{T_{up} - T_{down}}{T_{up} T_{down}}$$

T_{up} = upstream transit time
T_{down} = downstream transit time
D = diameter
α = inclination angle
q = fluid velocity



MECHANICAL ENGINEERING

TEAM 28

Richard Sarria
Nicholos Neil
Shuhan Huang

ADVISORS

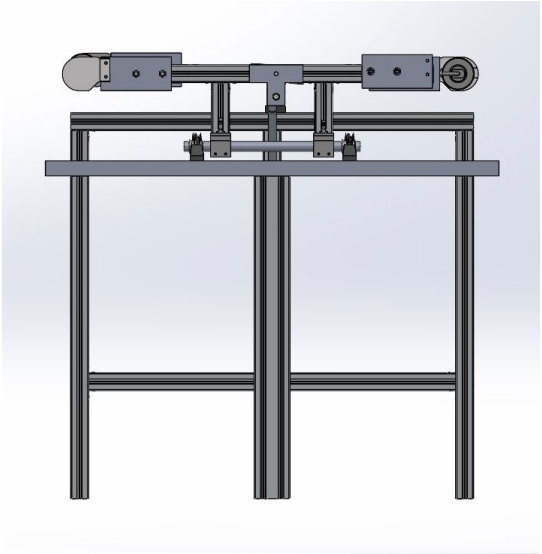
Nejat Olgac

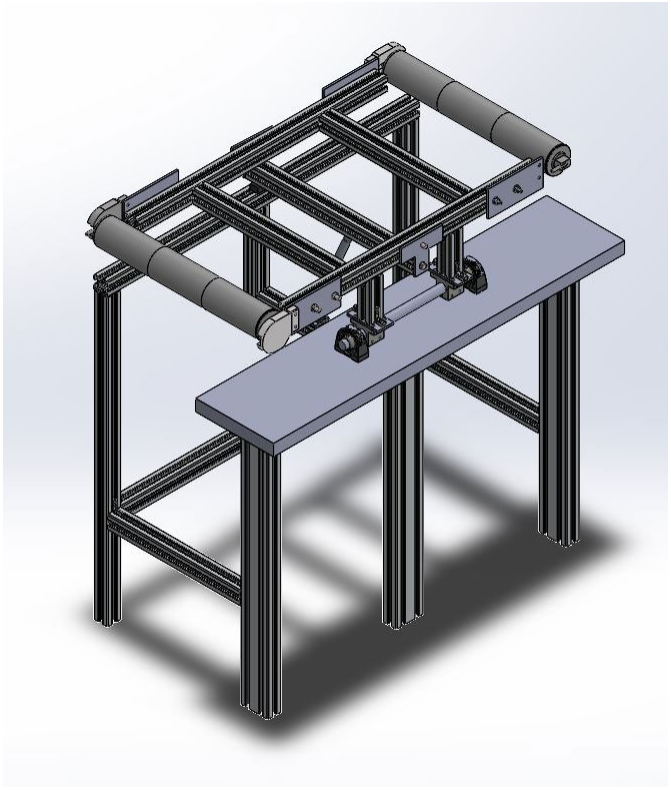
SPONSOR

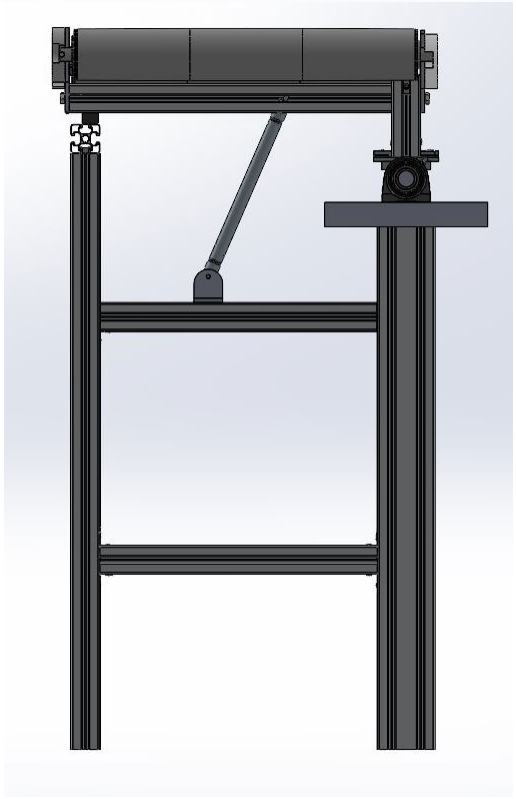
ID Mail Systems

Design A Low Cost Parcel Sorting Method

With the rapid development of global logistics, it's necessary for companies to increase the efficiency of their sorting systems. Therefore, the objective of this project is to design an efficient parcel sorting mechanism with lower cost, which is used for sorting medium packages weighing from 50 grams to 5 or 10 kg. The sorting system should be able to sort packages at the rate of 5000 to 30000 parcels per 8 hours. We use tilt tray sorters as the prototype of our design. The whole sorting system consists of two supplying tables, a bin which is connected to one table, a conveyor, a rotation shaft connecting the conveyor and the supplying table, and a piston under the conveyor. When a package is sent to the conveyor, the piston would push the conveyor to a certain angle, in order to let the package slide off the conveyor and fall into the bin. After the package leaves the conveyor, it returns to the initial state and redo the process when another package moves on it.







MECHANICAL ENGINEERING

TEAM 29

Dan Fitzgerald
Yana Misyuchenko
Mark Wezenski
Chao Tang

ADVISORS

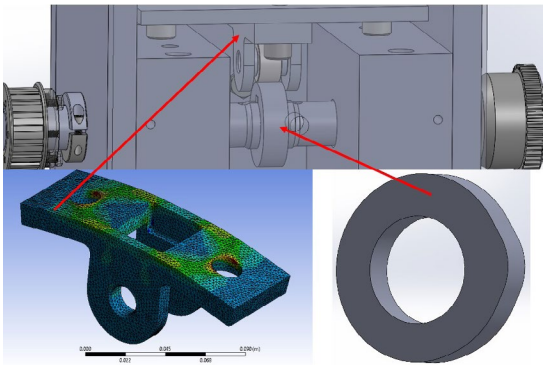
Vito Moreno

SPONSOR

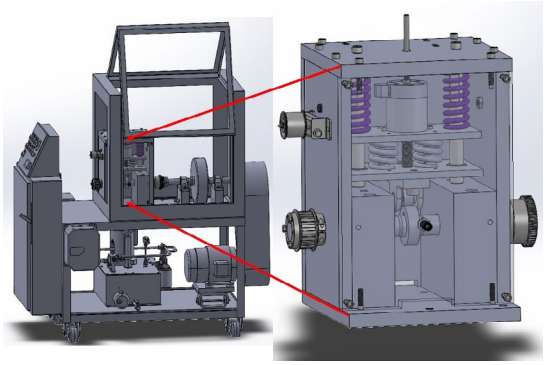
Jacobs Vehicle Systems®

Jacobs Vehicle Systems Cylinder Head Rig

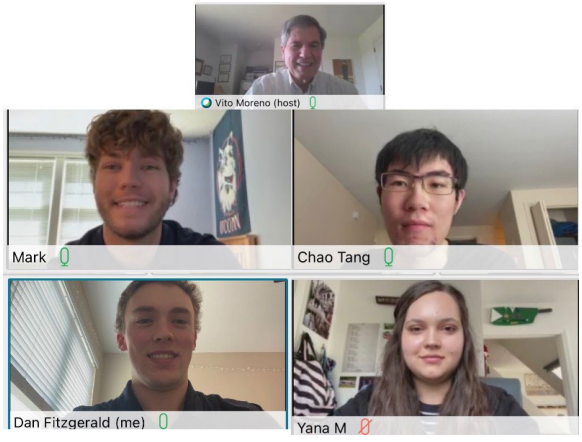
Jacobs Vehicle Systems develops engine braking and other valvetrain systems for the heavy-duty trucking industry. The goal for this project was to design a new test rig that would reciprocate the valvetrain like it would on an engine and allow the braking components to be exposed to full cylinder pressure loading similar to real-world conditions. The new test rig utilizes a spring pack system and two cams to apply the loading. The standard valvetrain cam actuates the rocker while the auxiliary cam, which was designed by the team and custom built for this project, compresses the springs to achieve the desired load.



The rig has been designed to fit onto an existing JVS test stand, which means that a new test stand will not have to be built. Throughout the design, safety was a big concern since these parts could experience up to 10kN of loading. To this end, the entire rig is surrounded by 1-inch-thick plating to prevent parts from being ejected during a system failure. In order to prevent failure in the operation of the rig, a safety factor of 4.0, which is the level recommended by JVS, was met or exceeded for all critical parts. This means that all critical parts can handle at least four times the load they are predicted to experience. Additionally, a design margin of 2.0 was met or exceeded for mean and alternating stress on all Goodman curves to ensure infinite life for all critical parts.



Lastly, this rig was designed such that it is compatible with any OEM valvetrain system. This gives JVS the ability to be flexible in their testing needs as they supply braking systems to multiple OEM's globally and no two systems are the same. This rig adds value to JVS by allowing them to test their engine brake rockers to full loading scenarios safely and effectively without the risk of damaging an expensive prototype or test engine. Jacobs Vehicle Systems will be able to use this rig to optimize their braking systems and continue to provide the best products to their customers.



MECHANICAL ENGINEERING

TEAM 30

Jared Annis
Wyatt Smith

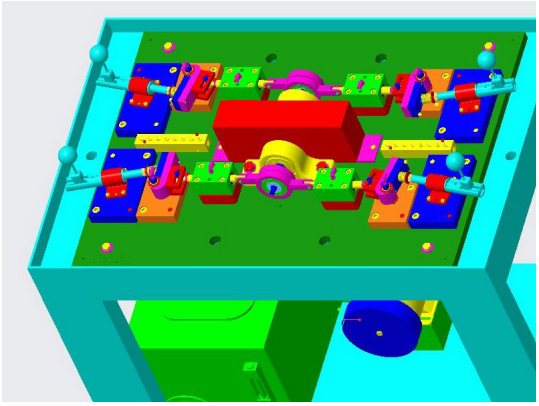
ADVISORS

Jason Lee

SPONSOR

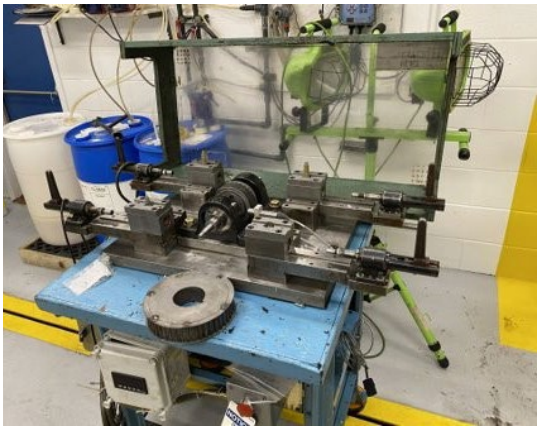
Jacobs Vehicle Systems®

Development of Coil Spring System Fatigue Test Stand

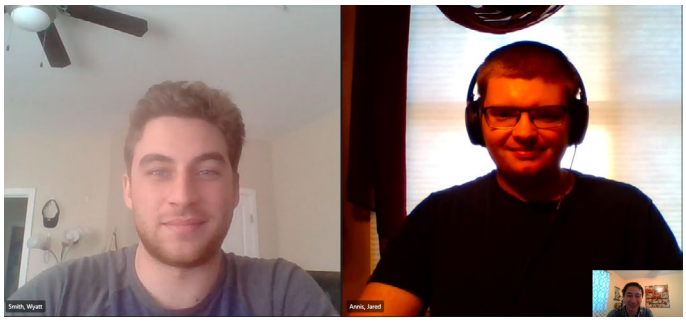


Jacobs Vehicle Systems is the world leader in engine braking technologies and heavy-duty diesel emissions-reducing solutions. Within Jacob's designs, various helical compression springs are used. Up until now, all of Jacob's designs compressed the springs in a linear fashion. However, Jacob's new prototype designs use a rocker bias spring that gets compressed in both a linear and a bending fashion.

The ME 30 senior design group was tasked with redesigning Jacobs's current linear motion spring fatigue test stand to be able to replicate both the linear and bending motions experienced by the rocker bias spring. This project was focused on updating Jacobs's current test stand so that it can properly and efficiently fatigue test the bias springs for these new applications.



To do this, we updated the design so that it has a common rocker arm, a modular spring seat, and a modular spring pre-loader plate that easily adapts the system to test bias springs from different engine designs and applications. The updated design also adds pressurized oil lubrication to the system, which allowed for a reduction in overall system wear and also increased the reliability of both the new and existing system components. An FEA analysis and a Goodman Diagram were completed on the pin in slot bracket to ensure that it will withstand the maximum inertial forces being applied to it during maximum system operating speed and also over the period of time that the test stand will be in operation. In addition, hand calculations were completed to ensure adequate drainage of oil to the oil tank during all conditions, including if the test stand is not on a perfectly level surface during operation.



The result is a system that is able to run reliably while accurately fatigue testing any of Jacobs's new rocker bias spring designs.

MECHANICAL ENGINEERING

TEAM 31

Laine Blummer
Kiera Burns
Elijah Jordan
Natalie Paliulis

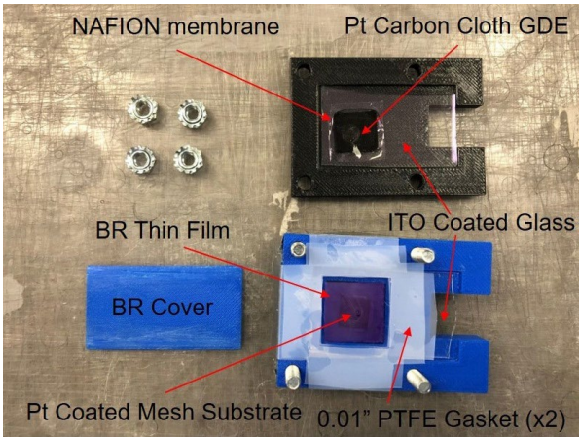
ADVISORS

Ugur Pasaogullari

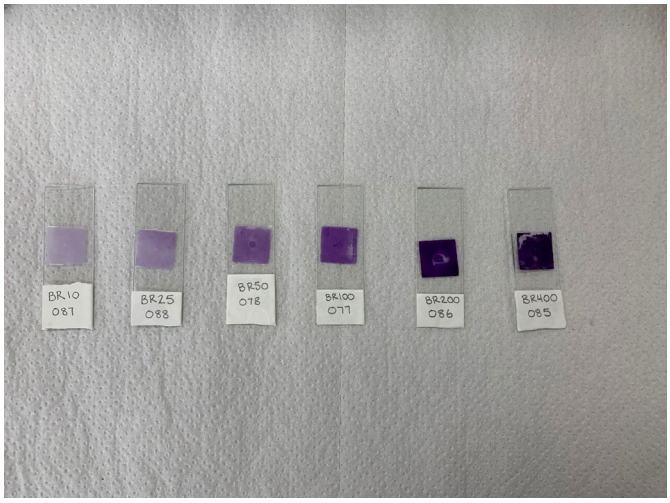
SPONSOR

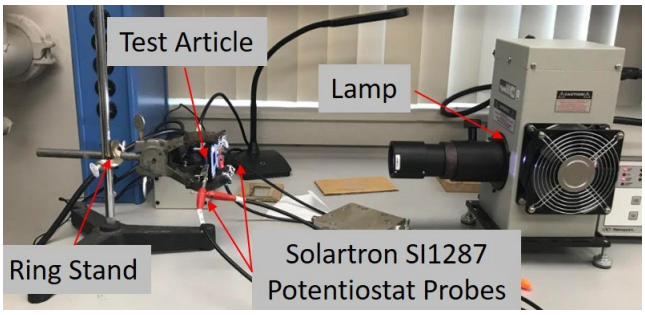
LambdaVision

Design of a Protein Based Photovoltaic Electrochemical Cell



LambdaVision is a company which develops technology utilizing the proton pumping capabilities of bacteriorhodopsin (BR), a protein present in the purple membrane of Halobacterium Salinarium. Their current work revolves around the use of BR thin films for the fabrication of artificial retina implants. The BR thin films are produced using layer-by-layer electrostatic deposition, such that the BR is unidirectionally oriented, allowing it to generate a pH gradient when exposed to light. Therefore, this technology is also promising in electrochemical cell applications for its dual function of generating a chemical gradient that can be converted into an electrical voltage, as well as directing protons to the hydrogen evolution site. The purpose of this project is to design and test a BR based photovoltaic electrochemical cell (PVEC) to determine the feasibility of BR as a means of improving the hydrogen production efficiency of a proton exchange membrane electrolysis cell via a reduction in ohmic and diffusion overpotentials. The photovoltaic and photocurrent response of varying cell design configurations and BR layer quantities were measured in order to quantify the BR's electrical contribution to the overall cell potential and finalize the cell design. The BR films themselves were optically characterized based on their absorbance and transmittance spectra, as well as microscopic imaging to observe the wear on the films at different points during testing. These tests justified the choice of a final cell design, which is evaluated by measuring the current density as a function of input voltage with and without the photoactivated BR. The feasibility of the cell is validated by a demonstrated improvement in hydrogen production efficiency of the cell with the addition of the selected BR thin film. Proving the feasibility of such a cell has exciting implications on the development of clean energy sources, as it would allow for more efficient hydrogen production, which has many applications as a clean and energy dense fuel.





MECHANICAL ENGINEERING

TEAM 32

Julia Pitruzzello
Zach Saville
Sean Stennett
Jose Vasquez

ADVISORS

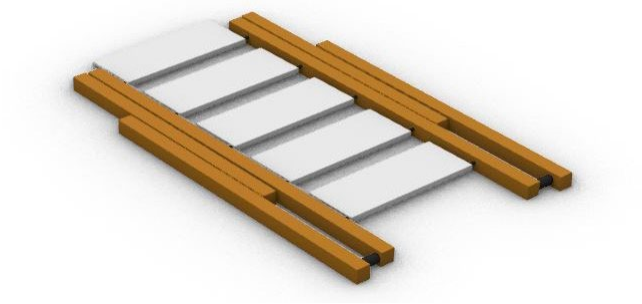
Vito Moreno

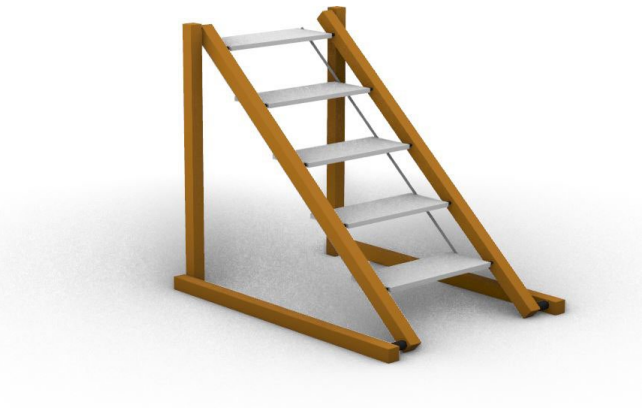
SPONSOR

LEFTY EQ
SWEET · SMART · DIVINE

Compact, Foldable Pet Stairs

Lefty Eq is a small, woman owned startup company focused on making improvements in various aspects of society. Owner Gabrielle Shoshan conceived the idea for compact, foldable pet stairs while living in a cramped city apartment with her small dogs. Dogs are often prone to back and leg injuries from maneuvering their way up and down large heights, be it from a couch or a bed. Our group was tasked with bringing Gabrille's pet stairs to life in order to alleviate the risk of injury in pets while creating steps that can fit into any living space. To appeal to all pets and pet owners, the stairs must be capable of supporting up to 200 lbs, weigh no more than 5 lbs, fold to a thickness of no larger than 3 inches, and be easy to handle. These steps should cost no more than $200 retail price while still being aesthetically pleasing to the customer. This project is a continuation from the Senior Design class of 2020 and because of this our group has been able to analyze the design from last year as part of our research and development process. This has allowed ME 32 to work directly on aspects of the previous design that fell short while making other improvements to better meet the requirements of the sponsor. The design constructed by ME 32 uses a folding mechanism devised to provide the pet owner with the greatest ease of transition from storage to full use. The material used to build the pet stairs was heavily researched and carefully selected by comparing each option's strength, weight, and durability. The dimensions of both the frame and steps were determined while taking into consideration the variation in furniture height as well as the wide range of sizes dogs can be. Combining all of these changes should allow our current design to make heavy improvements over the previous design in order to meet our requirements.





MECHANICAL ENGINEERING

TEAM 33

Paul Blum
Peter Crowley

ADVISORS

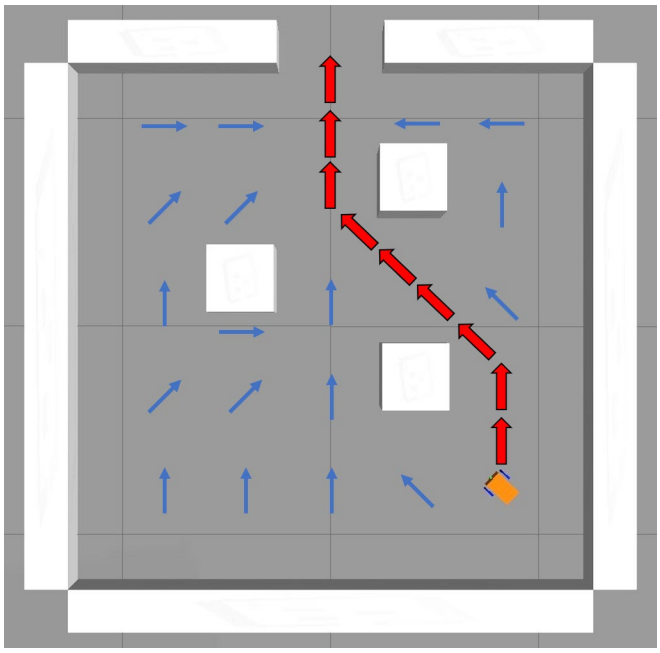
George Lykotrafitis

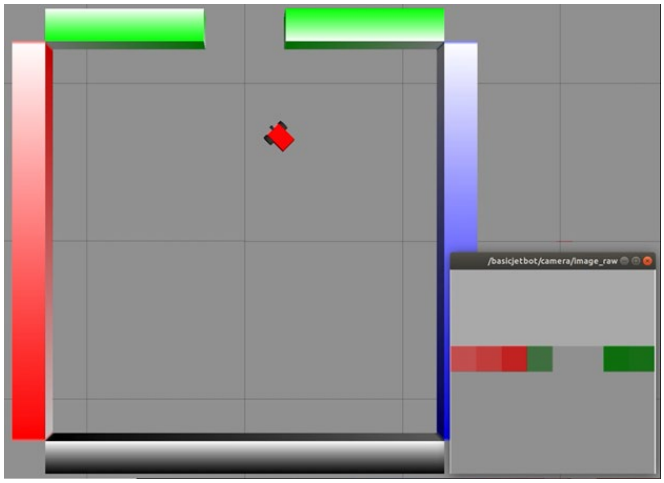
SPONSOR

UCONN
SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

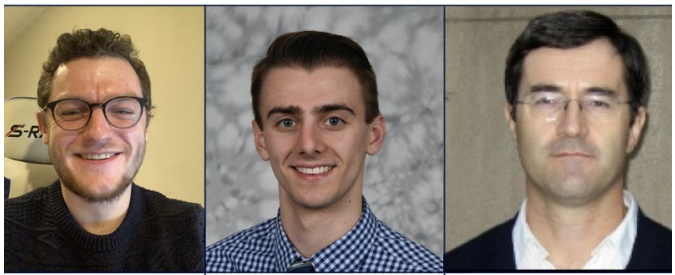
Deep Reinforcement Learning for Robot Self-Navigation and Room Evacuation

Since 2015, Deep Reinforcement Learning algorithms have had great success in mastering game-theoretic Markov Decision Processes (MDPs), such as Atari games, where an environment can be fully observable to a decision-making agent. Now, researchers are exploring how these algorithms can be used to train robotic agents for partially observable MDPs. In this project, we use Deep Dyna-Q Learning to achieve autonomous robot navigation based on raw image data from an onboard camera. Through trial and error, the robot learns that it should evacuate an enclosed space in the shortest possible time. This behavioral policy arises over the course of training in response to the environment's reward function: a small numerical penalty for each time-step before exiting. A neural network that takes RGB images as inputs is trained, based on the robot's experiences, to approximate the optimal action-value function. This can be used to achieve time-efficient evacuation by selecting actions with high value from a given state. We built a custom robotics simulation platform using ROS and Gazebo to support virtual training of the robotic agent in an advanced physics simulator with photorealistic graphics capabilities. Our platform is designed for use with a high-performance computing system– with sufficient hardware, training can progress thousands of times faster than possible in real life. We have had great success using the Dyna-Q algorithm with this platform to solve various iterations of the room evacuation problem, including versions with static obstacles and with varying environmental color schemes.





Deep Reinforcement Learning for Robot Self-Navigation and Room Evacuation



Paul Blum | *Peter Crowley* | *Dr. George Lykotrafitis*

UCONN SCHOOL OF ENGINEERING MECHANICAL ENGINEERING | *Senior Design Project Team ME33*

MECHANICAL ENGINEERING

TEAM 34

Stephanie DeVita
Abigail Rockefeller
Prashant Swami

ADVISORS

David M. Pierce

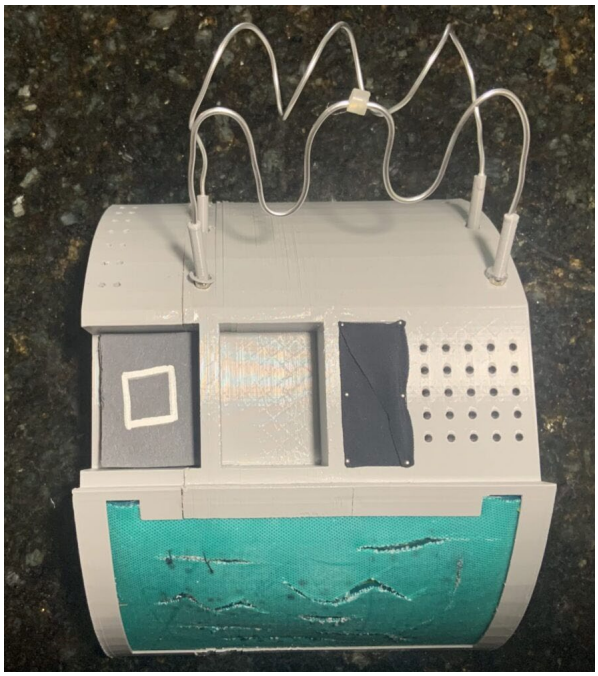
SPONSOR

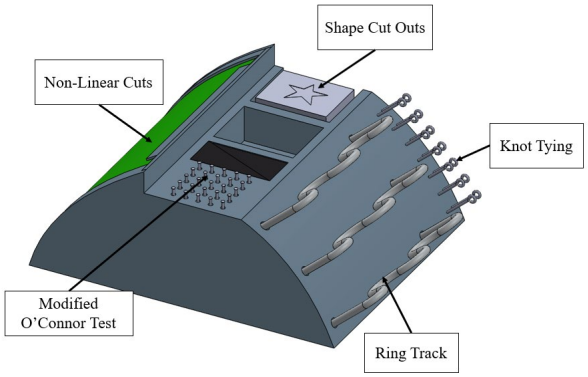
Medtronic

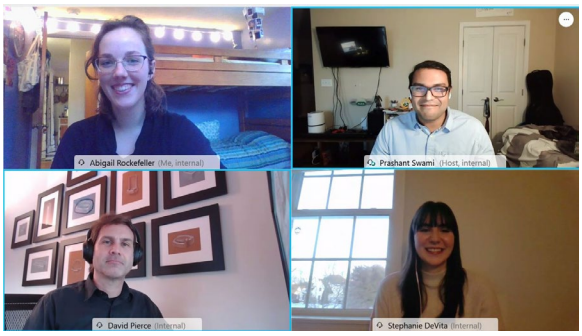
Design of Robotic Assisted Surgery Simulated Use Device

The objective of this project is to design and implement exercises into a new 3D simulated-use device to evaluate Medtronic's Robotic Assisted Surgery (RAS) system. Medtronic is a global leader in medical technology, service, and solutions to aid in surgery and patient recovery. They will use this device internally, in a non-clinical setting, to collect feedback on the functionality of their RAS system. An RAS system has four arms, one of which is equipped with a camera and the remaining three which can be equipped with surgical tools. The exercises test essential RAS skills. These include proficiency in fourth arm control, camera movement and dexterity. Fourth arm control refers to the use of all tool-bearing arms. Camera movement is the ability to navigate with an endoscope, and dexterity refers to fine motor skills. Exercises also simulate specific surgical procedures and are designed to be repeatable for efficient testing and reusable to promote longevity of the device.

The device consists of five exercises: Non-Linear Cuts, Knot Tying, Ring Track, Modified O'Connor Test, and Shape Cut-Outs. Non-Linear Cuts and Knot Tying simulate surgical procedures. Non-Linear Cuts simulates suturing by having the user stitch lacerations in synthetic skin. Knot Tying allows the user to practice surgical knots on eye-pins. In the Ring Track exercise, the user guides a ring along 3D tracks of varying difficulties. Fourth arm control is also tested in this exercise by having the user remove blockages along the route. The Modified O'Connor Test is a variant of a commonly administered surgical dexterity test. The user draws pins from a veiled chamber and places them into a grid of holes. In the Shape Cut-Out exercise, users cut out pre-defined shapes from card stock. We modeled the five exercises in CAD and integrated them into a 3D printed base that fits within Medtronic's abdominal trainer. Our final design was submitted by Medtronic to be patented within the year.







MECHANICAL ENGINEERING

TEAM 35

Kyler Vensel
Jake Schwartzmann
Joshua Lunn

ADVISORS

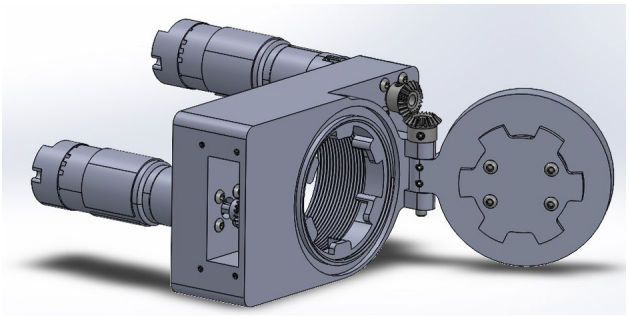
Alexei Poludnenko

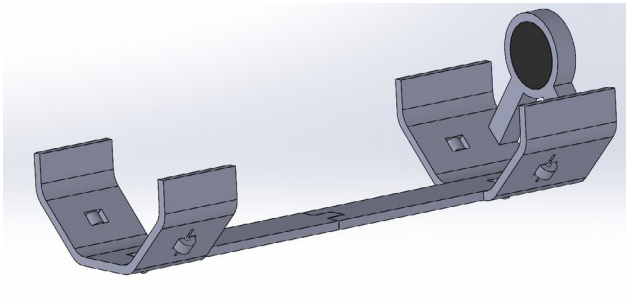
SPONSOR

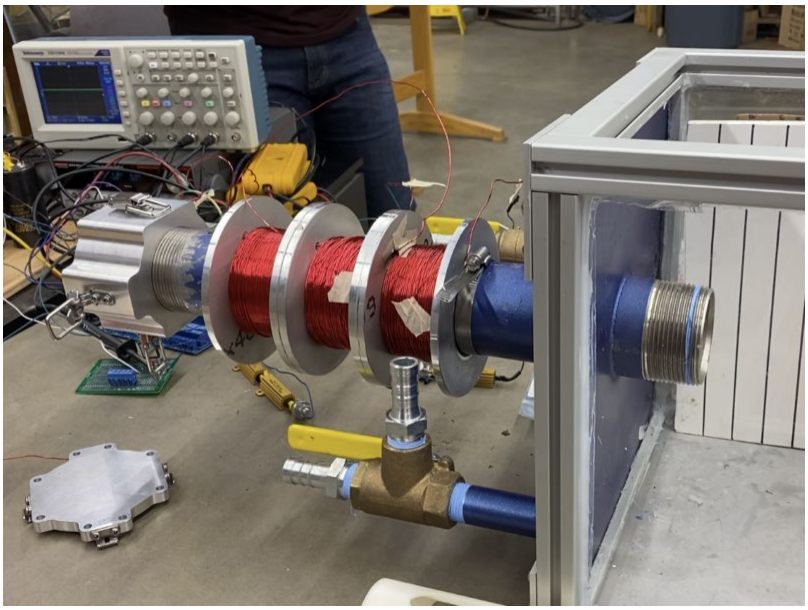
NAVSEA
NAVAL SEA SYSTEMS COMMAND

Electromagnetic Expulsion of a Cylindrical Body from an Outer Tube

The need for submerged launches and deliveries is paramount in the naval community. The issue with current submerged launch methods is that they are often inefficient and time consuming. Additionally, most of these launch methods are reliant on combustible materials which are dangerous and easily detectable. For this reason, the push for more fully electric systems has generated interest in the use of electromagnetic technology as a more efficient alternative to current submerged launch methods. The objective of this project is to successfully launch a cylindrical projectile from a submerged outer tube utilizing electromagnetism as the driving force. This projectile represents an unmanned underwater vehicle (UUV) which will be deployed using a ferromagnetic sled propelled by an electromagnetic coil gun acting as a solenoid. NUWC is also interested in a hatch system that can be remotely operated by a single user, which would simplify the launch process significantly compared to previous designs. Our design consists of a three stage coil gun, machined and fitted with 18 gauge copper wire. The hatches can be controlled remotely and are fitted with motors that can effectively create a watertight seal on the launch tube.







MECHANICAL ENGINEERING

TEAM 36

Aidan Esposito
Guy Shaffer

ADVISORS

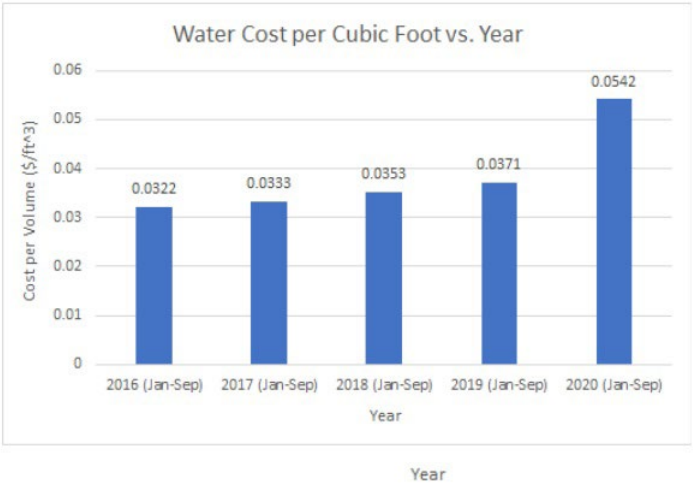
David Giblin

SPONSOR

Pfizer

Water Consumption Analysis

Our joint engineering team completed a water consumption analysis on selected buildings of the Pfizer Groton campus. This site currently has the highest consumption for all locations worldwide. Pfizer seeks to make significant reductions in water consumption while also reducing discharge cost to the sewer and Thames River. In order to do so, they will need a comprehensive report with which they can apply to various buildings and systems throughout their campus to determine water currently being consumed and calculate consumption and discharge savings through a variety of alterations to building systems and local and state compliance guidelines. This process provides Pfizer with a methodology to calculate water savings by analyzing building systems that consume and discharge the largest amounts of water. Thus including analysis of blowdown, make-up water, evaporative losses from their cooling towers, as well as a detailed examination of their steam condensate feed and return lines. This is done through the use of ANSYS Fluent in order to optimize these lines to ensure a higher efficiency from their boilers, resulting in less steam consumed and more returned. The components and devices within the chillers/cooling towers to continue minimizing all physical losses and thus discharge rate.



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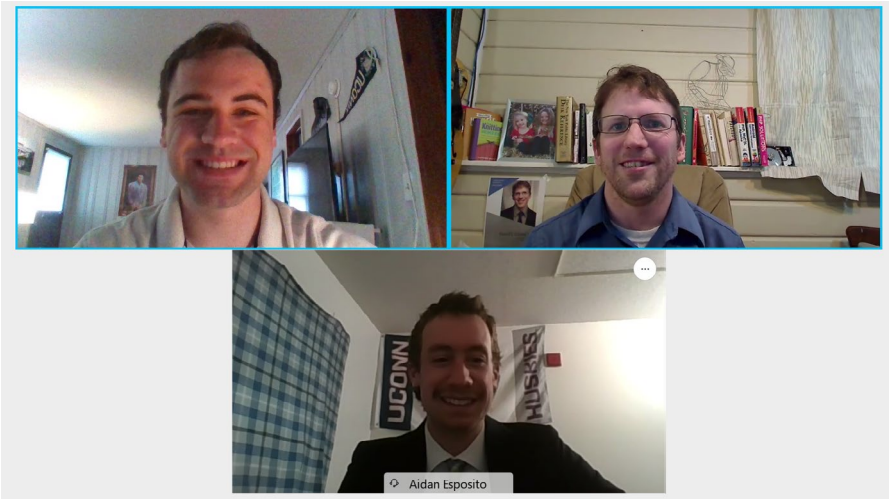


MECHANICAL ENGINEERING

TEAM 37

Austin Gray
Roger Lin
Matthew Tyler

ADVISORS

Alexei Poludnenko

SPONSOR

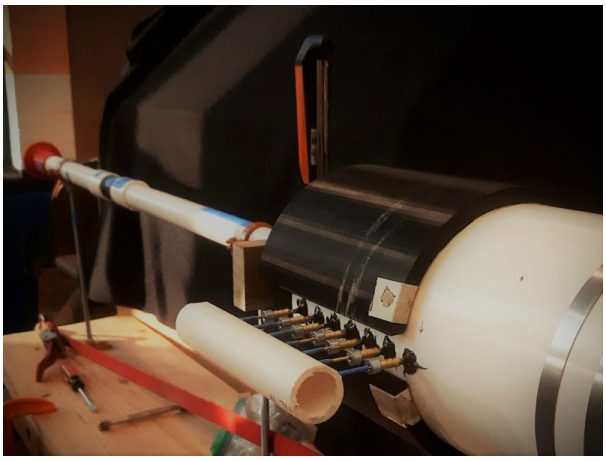
PCI Precision Combustion, Inc.

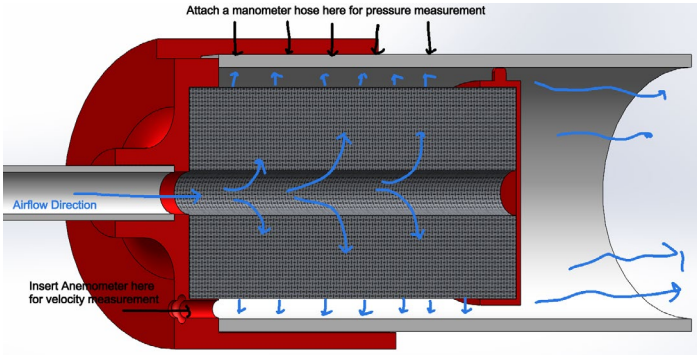
Flow Characteristics of a Catalytic Layered Screen

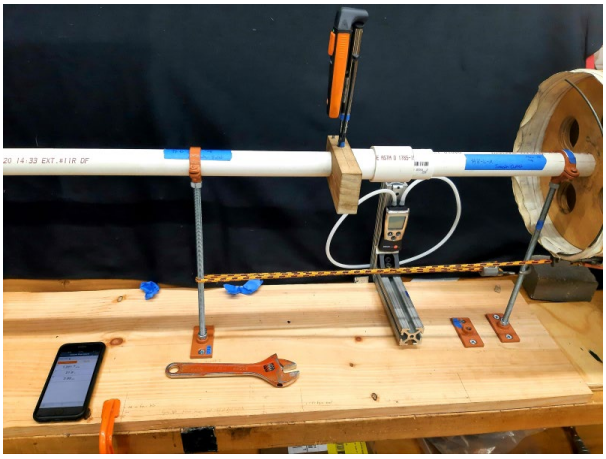
Precision Combustion Inc.'s (PCI) Microlith@ catalytic reactor design is compact, lightweight and highly efficient. It offers major performance and cost advantages when compared to conventional state of the art catalytic reactors. These catalytic reactors consist of multiple layers of expanded metal mesh. They have two primary configurations of this mesh: planar flow through a linear stack of circular screens; and radial flow through a roll of mesh plugged at the downstream end. PCI has obtained some simulation and experimental data on their planar flow configuration, but they have no performance data on the radial flow configuration. To provide this critical data, we have developed an experimental test rig and an ANSYS flow simulation. The relevant performance metrics are pressure drop and outlet velocity across the mesh assembly for each configuration.

The experimental rig was designed to facilitate precise and efficient testing of the two mesh configurations. Sections containing each mesh configuration as well as rig sections housing the flow instrumentation are able to be exchanged easily to resume testing. Two sensors were used for testing in the experimental rig: a hot-wire anemometer for velocity measurements, and a manometer for pressure differential measurements.

The results from testing confirmed PCIs results for the planar flow configuration. As predicted by our theoretical model, pressure drop across the mesh stack increased parabolically with increasing inlet velocities. Due to damage to the mesh roll, we were unable to obtain conclusive data for the radial flow configuration. Finally, we were able to provide recommendations for PCI's future product assembly and experimentation procedures for both configurations.







MECHANICAL ENGINEERING

TEAM 38

Brian Santivanez
Andrew Shortridge

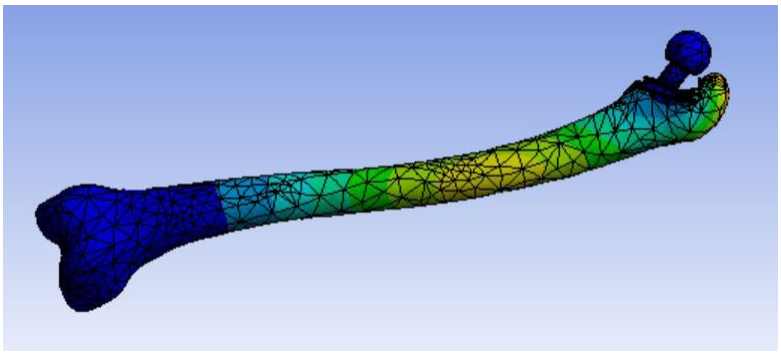
ADVISORS

Thanh Nguyen

SPONSOR

WINDHAM DENTAL GROUP

Predict the Occurrence of Late Prosthetic Orthopedic Distal Bone Fractures



As the number of prosthetic orthopedic procedures increases every year, it is important to assess the complications that may result following these surgeries. The orthopedic procedure of interest in this project was a total hip arthroplasty(THA), also known as a hip replacement. Following a hip replacement, there is a classification of fractures known as the Vancouver classification of postoperative periprosthetic fractures. Under this classification there are five different types of fractures that can occur postoperatively. The Type B1 fracture was the one we chose to analyze due to its location being below the femoral stem implant.

We modeled a femoral stem in SolidWorks to be inserted into a femur derived from a CT scan. Following the Vancouver classification, the Type B1 femoral fracture was simulated in ANSYS finite element software. The simulation results in the region of bone just below the implant were analyzed to see where fracture is likely. Thus, we were able to return a distribution of stresses for a given patient's loading scenario. The stresses in this particular region were then surveyed using statistics to assess significance. Corresponding p-values after each simulation allowed us to indicate with what confidence we predicted the induced failure in the region.

MECHANICAL ENGINEERING

TEAM 39

Calvin Colby
Andrew Dolan
Sami Yonjan

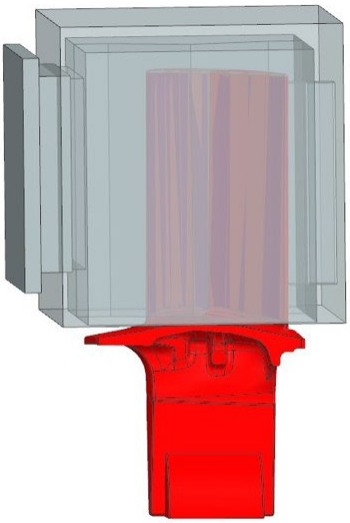
ADVISORS

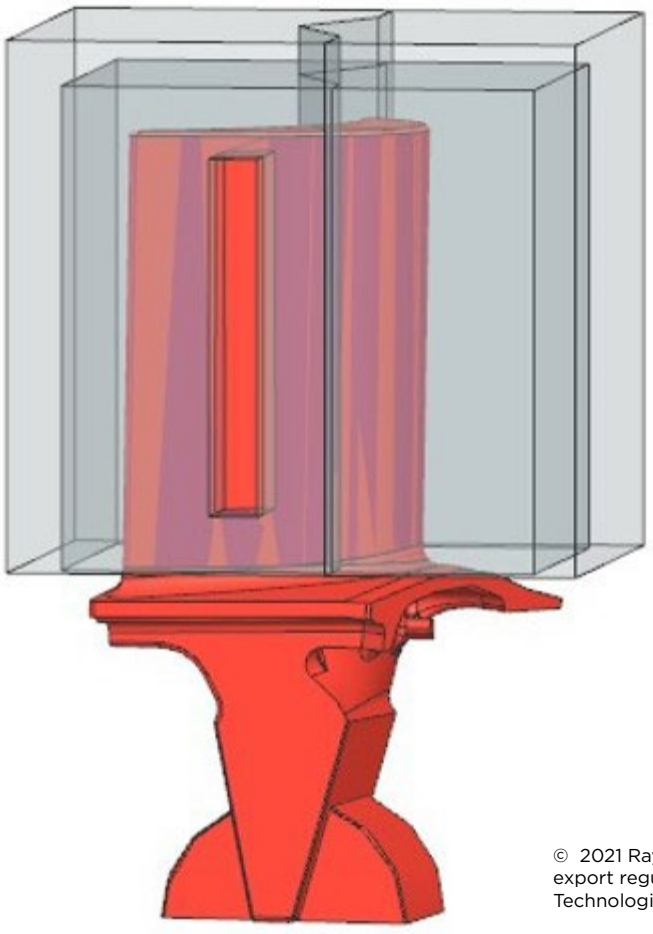
Tianfeng Lu

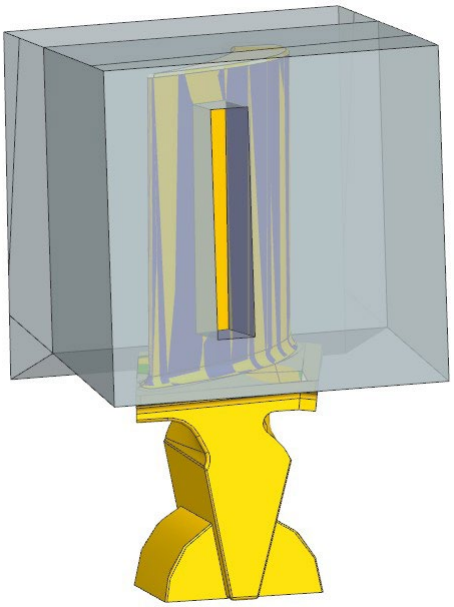
SPONSOR

Masking Method for Airfoil Cooling Air Measurement

The objective of this project is to improve upon the process of temporarily blocking cooling holes in turbine blades and vanes during testing. During one stage of testing, Pratt & Whitney must cover the cooling holes on their turbine blades and vanes in order to test that the airflow design distribution is met. The holes must be unblocked after testing is completed. Pratt & Whitney currently uses a wax-and-tape method that takes almost 2 hours on average to apply, test, and remove. Pratt & Whitney is looking to decrease that time by 90 minutes and create a process where the materials blocking the holes are reusable. Our team was provided with a turbine blade and told which holes should be blocked. For our design, a rubber mold was 3D-printed to fit around the blade to block airflow, with different iterations consisting of variable shells, materials, and shapes. The blocking method we have developed for this blade can be adapted and applied to all Pratt & Whitney turbine blades.







MECHANICAL ENGINEERING

TEAM 40

Matthew Jablonka
Mohamed Kane
Peter Westphal

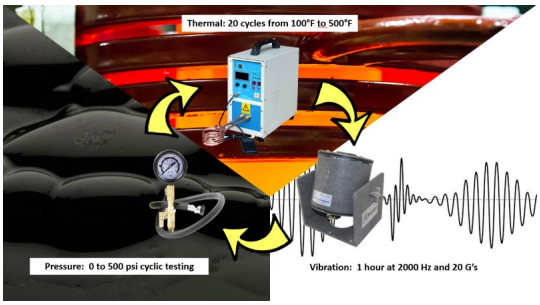
ADVISORS

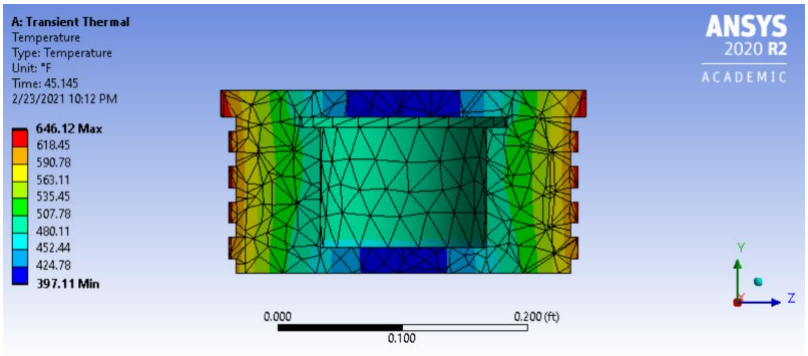
Ryan Cooper

SPONSOR

Thermal and Vibration Testing of Static Carbon Flange Seals

The objective is to simulate internal engine conditions on a carbon flange seal by conducting thermal, vibration, and pressure tests. The thermal test is comprised of 3000 thermal cycles heating from 100°F to 500°F. The vibration test is conducted at 2000 Hz and at an acceleration of 20 G's and for a duration of 150 hours. The pressure test is a cyclic test from 0 to 1000 psi. During the tests, the seal is compressed into a test rig that prevents oil from leaking and then subjected to the various tests. The seal has the potential to fail from thermal fatigue, vibrational strain, and pressure strain. The seal will need to be able to complete these tests without leaking in order for it to be a successful replacement to the current seals and reduce engine weight. The seal will be subjected to a combined test of the different elements, including a vibration and pressure test and a thermal and pressure test. The combined conditions resemble the engine more closely. The combined test will demonstrate the combined effects of strain and fatigue to determine if the seal is a suitable replacement.





MECHANICAL ENGINEERING

TEAM 41

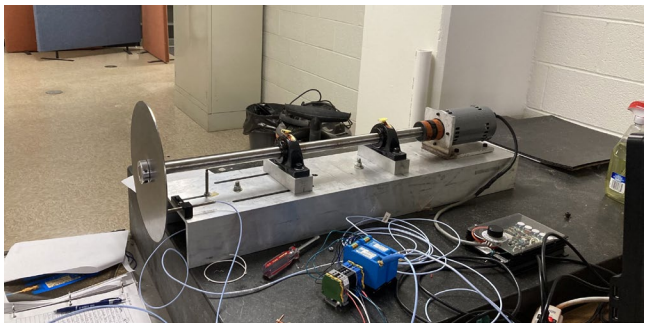
Elizabeth Deloia
Ryan Deoliveira
Kelsey McCormack
Trevor Smith

ADVISORS

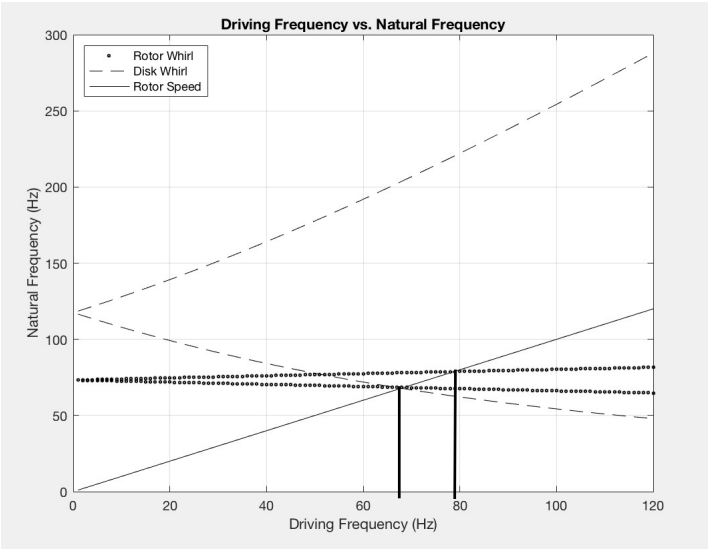
Jiong Tang

SPONSOR

Experimental and Analytical Demonstration of Coupled Disk-Shaft Vibration



When the spin speed of a rotor is equal to its natural frequency, imbalance can occur which in turn causes resonance within the system. This resonance greatly reduces the lifetime of the system. Therefore, when designing rotating systems such as jet engines, it is pivotal to avoid operating at or near the speeds that cause resonance. These are known as the critical speeds of the system. Understanding where these critical speeds occur is crucial to avoid the damage they can inflict. Traditionally, critical speeds are predicted assuming an uncoupled system in which the rotor dynamics assume a rigid disk and likewise, the disk dynamics assume a rigid shaft. As engines progress towards being lighter, there is a concern that the modes of the disk may affect the shaft and vice versa. Should this be true, the previous assumption of an uncoupled system will no longer be valid. The purpose of this project is to experimentally demonstrate coupling, and its effect on the overall critical speeds of the system. It is hypothesized that the critical speeds of the system will change once the system is analyzed as coupled instead of uncoupled. By experimentally determining critical speeds with different bearing stiffness values, the patterns of coupled rotor-disk vibration can be tracked against analytical results. The discrepancies in the data are understood from the fact that Matlab does not account for coupled disk-rotor vibration.



MECHANICAL ENGINEERING

TEAM 42

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Michael Masayda Jr.
Remi Goddu

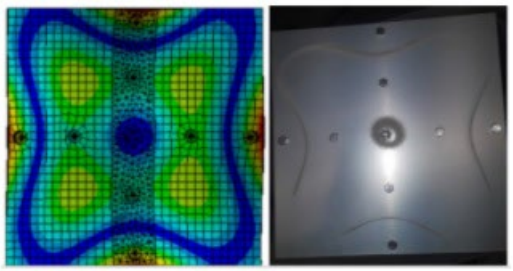
ADVISORS

David J. Giblin

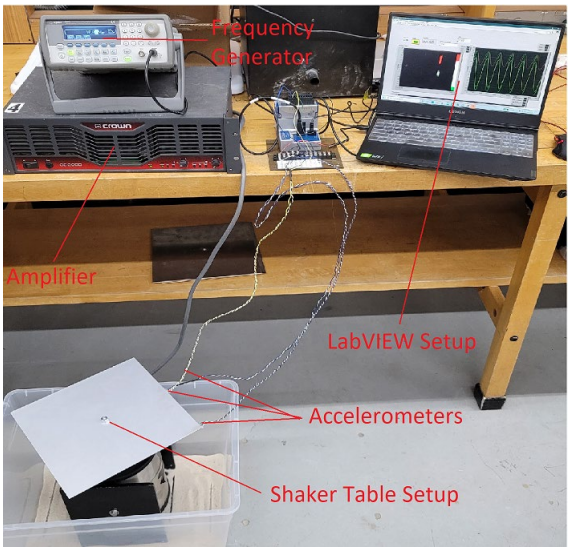
SPONSOR

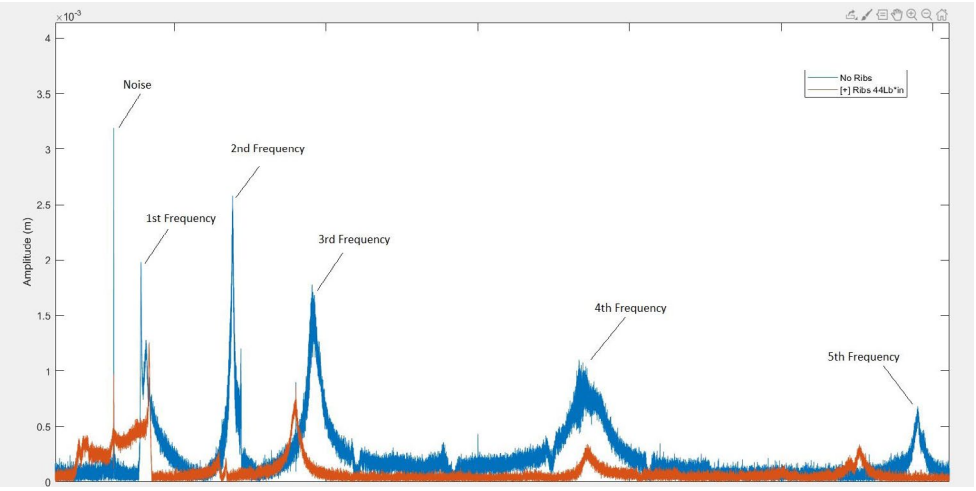
Determine Friction Dampening in Plate with Bolted Connections

Pratt and Whitney is an industry leader in civil and military aviation. It is apparent that reducing fatigue and extending the lives of engines and fuselage would be advantageous to their global customer base. The objective of this project is to design an experiment to quantify the effects of torque applied to bolts to dampen vibrating metal systems to build on research done in previous years.



In order to study the effects of torque applied to dampen vibrations, our team developed a Chladni Plate with stiffening rib configurations bolted to the underside. By creating a matrix of experimental damping coefficients with different bolt pretensions, we are able to determine the torque for optimal damping in each rib configuration. By utilizing ANSYS, our team is able to compare experimental results with data gathered from LabVIEW to the modal analysis results computed with ANSYS.





MECHANICAL ENGINEERING

TEAM 43

Benjamin Florian
Jordan Weber
Michael Kennedy

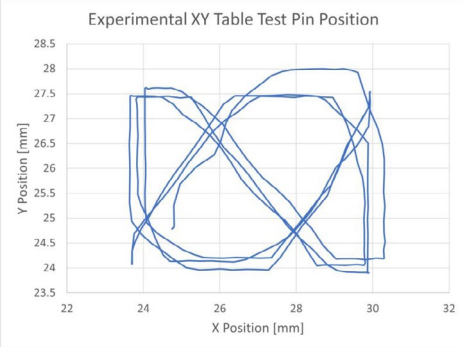
ADVISORS

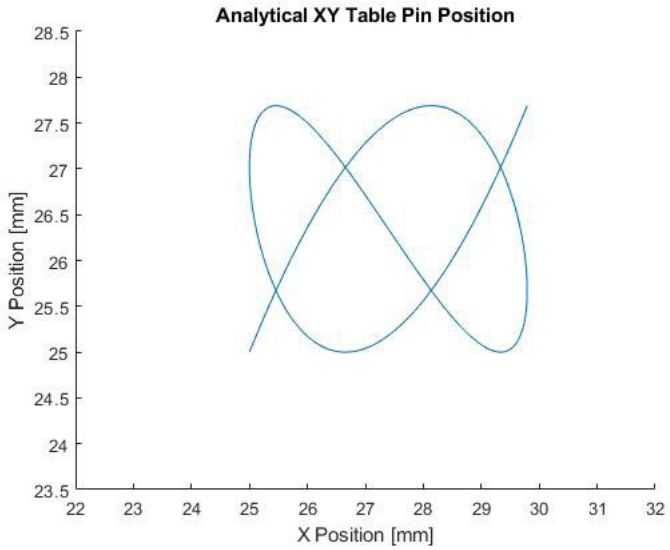
Nejat Olgac

SPONSOR

Tribology Test Rig

The goal of this project was to construct a prototype tribology test rig that can conduct tests with two degrees of motion, and determine the feasibility of a full-scale rig. As a continuation project, a portion of the physical rig had been completed by a team from last year, but the entirety of the control logic remained to be completed. The team started by determining the modifications they wished to make to improve functionality. This included the addition of a mechanical slide, a linear potentiometer to measure displacement in the z-direction, and an alteration of the method of attaching actuators to the x-y stage. After these modifications were completed, control logic and data acquisition code was created in LabVIEW. The control logic for the two actuators was done using feedforward and PI agains, which allows for closed-loop control that can accurately replicate the desired test plans. Once the code was completed, test plans were developed and run on the prototype rig, including a friction coefficient test, a wear rate validation test, and a test for the comparison of theoretical and experimental test patterns. To determine full-scale feasibility, research was done on larger components that could handle higher frequencies and larger loads, and structural analysis was conducted on the rig in ANSYS. The findings were reported to the sponsor for future reference during the creation of a full-scale rig.





MECHANICAL ENGINEERING

TEAM 44

Jeff Giusto
Joe Maloney

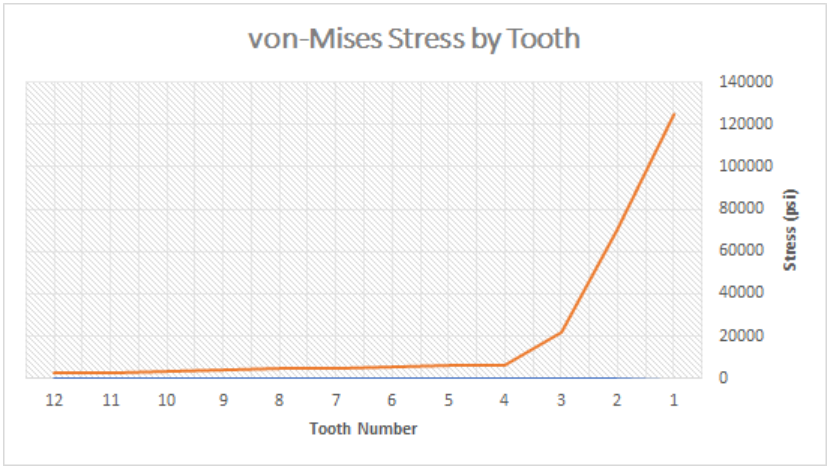
ADVISORS

Vito Moreno

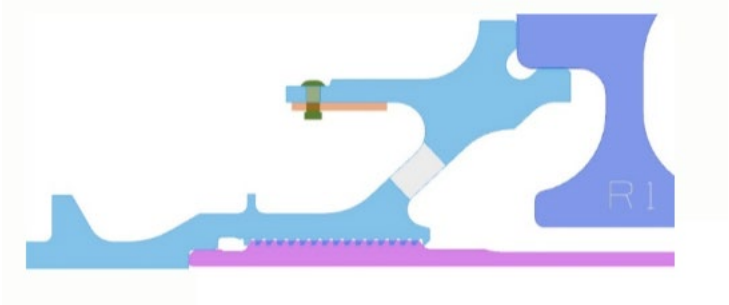
SPONSOR

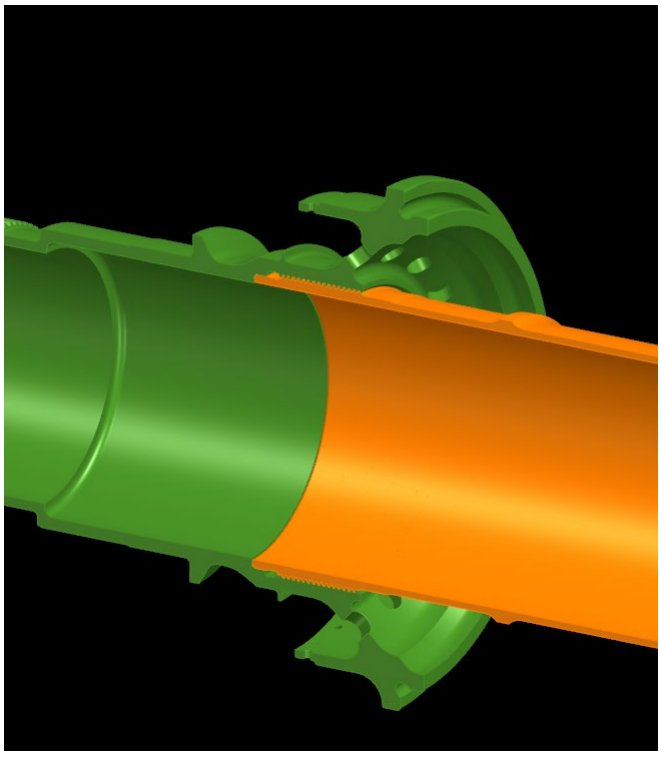
Optimization of Power Thread Form Geometry

Team ME44's project effort is to optimize a power thread in a Pratt and Whitney engine, which connects the tie-shaft to the front hub. The purpose of the tie-shaft is to transmit loading, both preloads and in-flight loads, and to reduce vibration in the assembly. Prior to beginning the project, P&W saw upwards of 90% of applied loading distributed on the first 3 teeth of the thread. Regardless if the entire thread has anywhere between 10-15 teeth, for example, this extreme stress concentration is seen at the first three teeth.



High stress concentrations can lead to reduced assembly life, permanent damage due to fretting and galling on the thread surfaces, and unsafe operating conditions if failure were to occur. Several parameters can be changed in such a thread; fillet radius, tooth width, flank, pitch, and even varying each of these by tooth along the thread form. However, through analytical testing, ME44 narrowed the focus to solely focus on pitch and flank angle as the only variable items in the geometry. Maximum and minimum values for flank and pitch angle, changed at predetermined intervals, served as guidance for thread geometry options. To ensure manufacturability, ME44 must stay within the aforementioned intervals. There are over 44,000 thread design options under this guidance. ME44 explored how changing both pitch and flank throughout the allowed interval affected the overall load distribution along the axial thread and made a design proposal to the sponsor (P&W).





MECHANICAL ENGINEERING

TEAM 45

Malcolm Honeyford
Michael Schaake
Maham Tanveer
Raymond Sanderson

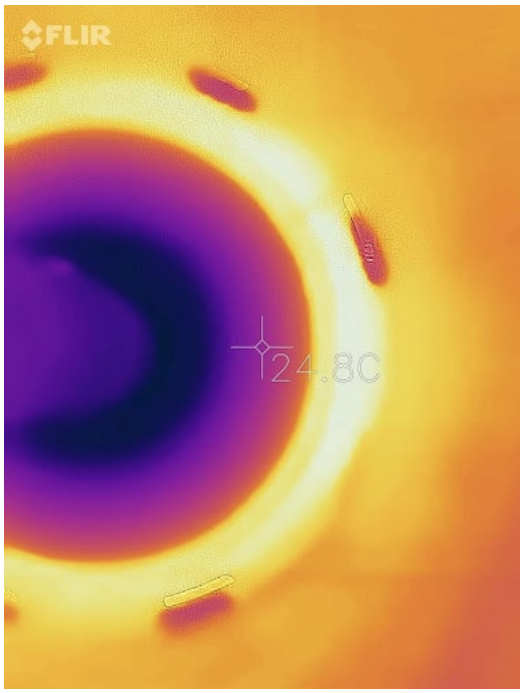
ADVISORS

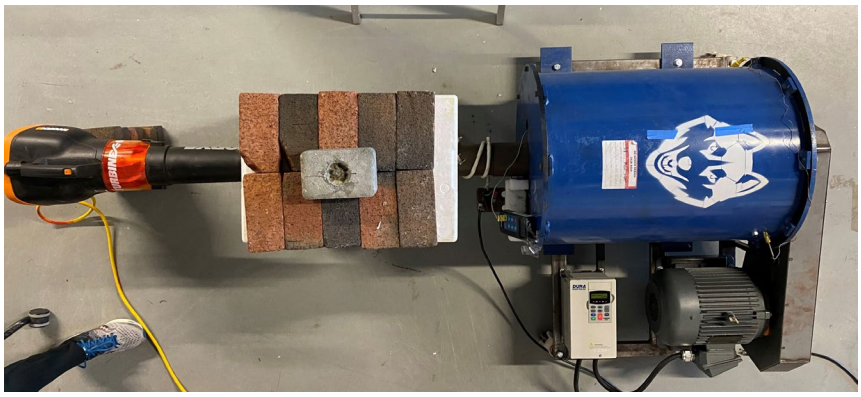
Xinyu Zhao

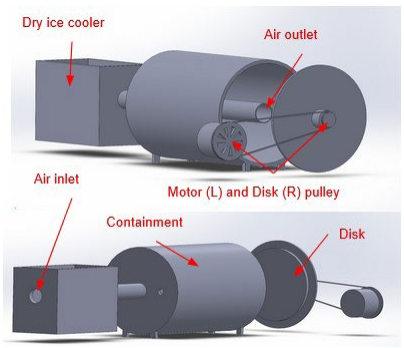
SPONSOR

Rotating Disk Heat Transfer Coefficient

This project aims to determine the film heat transfer coefficient on a rotating disk. A convection coefficient is not a measurable quantity and therefore it must be determined through analysis and experiment. In the spirit of this, the film HTC is calculated via experimental temperature data, a governing heat transfer equation, and a curve-fit tool. One of the project's primary deliverables is to ensure the rig can induce Reynolds numbers between 4.5×10^6 to 2.5×10^7. Reynolds numbers in this range reflect the operating conditions of the turbine and compressor sections of modern aero engines. Previous ME teams were able to spin a disk at 7500RPM resulting in a Reynolds number of 2.2×10^6. Our strategy to achieve the desired Reynolds number is to increase the disk's angular velocity with a more powerful motor and to decrease the kinematic viscosity of air with a dry ice cooling system. In the most recent experiment, the team ran the updated rig at 10260 RPM with an inlet air temperature of -1°C. This resulted in a Reynolds number of 3.31×10^6. To achieve the desired Reynold's number, the disk will need to spin at 14000 RPM with an inlet temperature of 0°C. This required upgrading to a larger pulley ratio and v-belt to ensure the motor is not over-worked. After completing the required speed modifications, the rig is now capable of reaching the lower bound of Reynolds numbers requested by the sponsor. Another primary deliverable is a CFD simulation of the experiment. This is a crucial step which will be used with empirical correlations to validate experimental data. Completion of this project will allow Pratt & Whitney engineers to better understand the thermal stresses that exist in compressor or turbine disks. This, in turn, will allow existing disk designs to be improved or foster the creation of new designs altogether.







MECHANICAL ENGINEERING

TEAM 48

Stephanie Rodrigue
Joshua Sproule
Chazz Alphonso

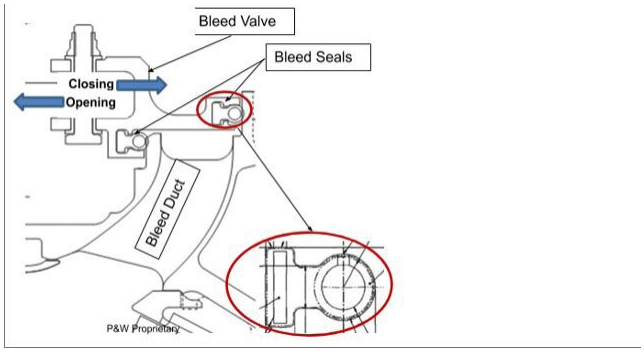
ADVISORS

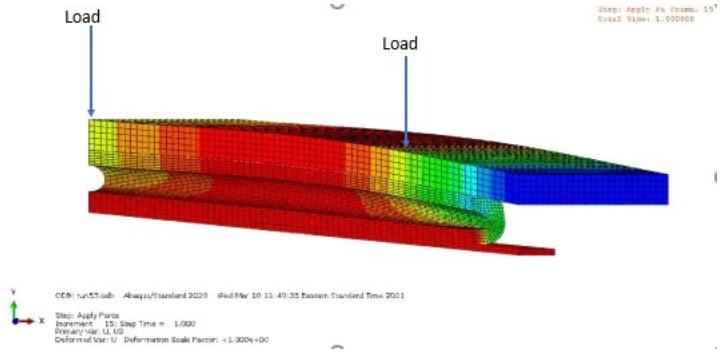
Vito Moreno

SPONSOR

Flexible Seal Performance

The objective of the project is to analyze the compressor bleed valve and seal used in Pratt & Whitney aircraft engines to define regions of non-uniform compression and develop ways to maximize uniformity, thus minimizing leakage. The compressor bleed valve consists of a bell crank lever connected to a rigid support that has multiple bar linkages that distribute the force to multiple points around an annular valve. The forces applied by the input lever move to the links and together the system compresses the valve against the bulb seal. Because the loads are point loads, there will be flexure in the valve, which translates to non-uniform compression against the leaking air. This results in leakage at regions where the beam deforms and is not restrained adequately by a link. With this project, the location and number of links, as well as the material and geometry selection of the valve, will be optimized to increase the compression uniformity. Conducting the project required researching the design criteria and any applicable analytical models, including linear and hyperelastic models of the rubber seal. Finite element analysis (FEA) simulations were run as a means of comparing with test data. A physical representation of the bleed valve and seal was designed and built for testing purposes. The physical representation consisted of a beam, analogous to the bleed valve, resting on a piece of silicon rubber, the bulb seal. Point loads were applied, as if they were those from the linkage assembly, and the deflections along the length of the beam were measured. To get a full understanding of the behavior of the beam and rubber, variations in the beam material, force applied on each point load, location of each load, and the number of loads were varied. Through analysis of the deflection curves in each of the varying scenarios, an optimal configuration of the beam and rubber was determined.





MECHANICAL ENGINEERING

TEAM 49

Ryan Torres
Tyler Oliva
Wilson Wang
Chris Mangini

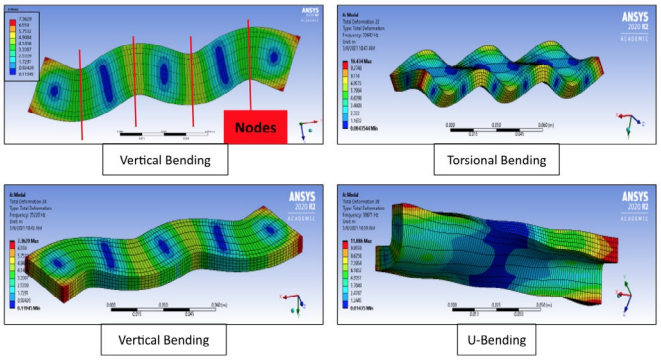
ADVISORS

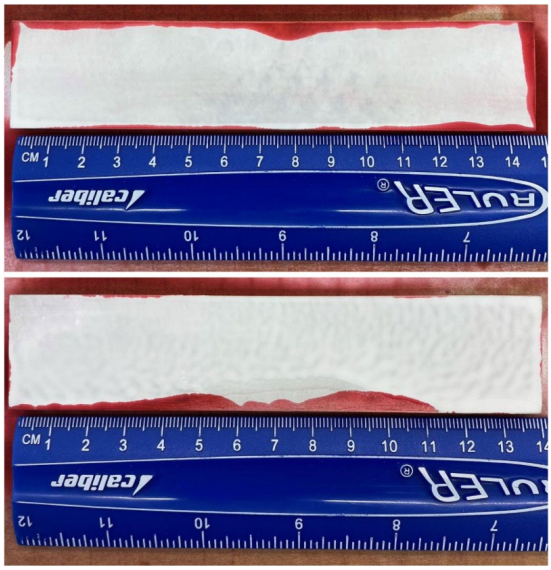
Jason Lee

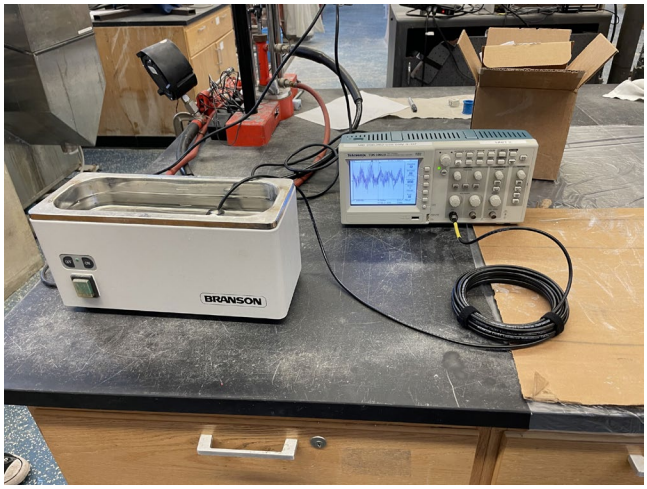
SPONSOR

Investigation of the Possible Effects of Ultrasonic Cleaning on the Fatigue Life of Gas Turbine Components

The objective of this project is to determine whether or not ultrasonic cleaning has a significant effect on the fatigue life of gas turbine components. Ultrasonic cleaning is commonly used to clean parts after they have undergone other industrial processes in order to rinse away residue and loosened particulate matter. Ultrasonic cleaning uses ultrasonic waves to excite water or another solution in a bath. This causes cavitation bubbles to form on the surface of a part within the bath, and when those bubbles collapse, a small jet of water hits the surface of the part, removing dirt or grime from it. The concern is, if the object in the bath has a similar natural frequency to the operating frequency of the cleaner, the part could be excited and damaged. In our approach we designed multiple parts of different geometries that had the same natural frequency of the ultrasonic cleaner, which oscillated between 34,000-37,000 Hz, with an average frequency of 35,200 Hz. We then exposed the parts to the cleaner for over 10 hours to simulate repeated cleaning sessions of turbine parts over their lifetimes. Since parts are normally cleaned for 5 minutes at a time in the industry, running them in the bath for over 10 hours simulated about 120 individual cleanings. We then analyzed the parts using a dye penetrant kit to help detect any stress/fatigue cracks. The dye penetrant test did not indicate any damage. We believe this is because the first mode of natural frequency of an object is where it experiences the highest loads. Since the natural frequency of the bath excited the 6th mode of the parts, it did not cause a high stress or strain. In addition, since the frequency of the bath oscillates, it is not always the same as the natural frequency of beams while it is running, so the part is not always being excited. From our tests, we have determined that ultrasonic cleaning will not affect the fatigue life of turbine components that are cleaned without being in contact with other parts and are cleaned in a bath that has an oscillating frequency.







MECHANICAL ENGINEERING

TEAM 50

Zoë Coleman
Andrew Bugryn
Steven Quinn

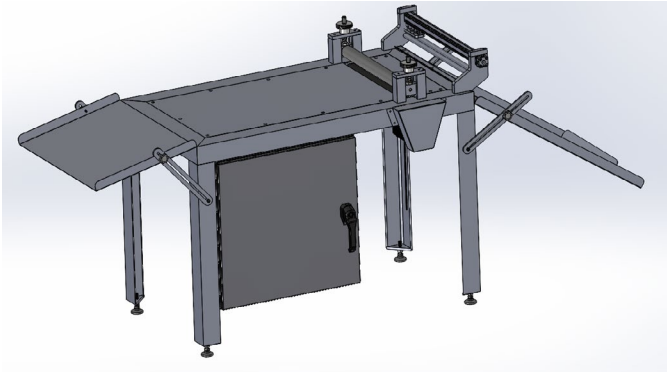
ADVISORS

Vito Moreno

SPONSOR

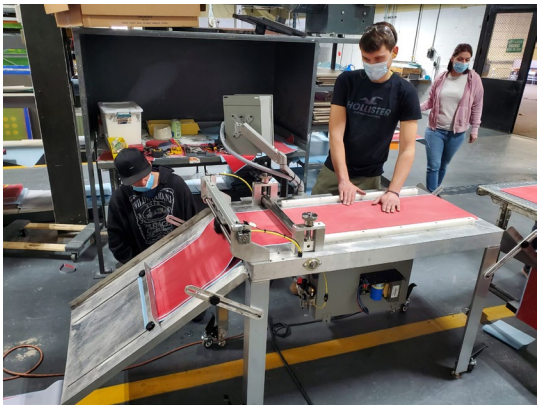
RUBBER LABELS USA
TRUSTED SINCE 1916

Rubber Calendering Process Automation & Improvement: Feed-Cut-Stack



Rubber Labels USA is a local family run business in Milford, CT who manufactures vulcanized silk screened rubber labels used in applications such as PPE, footwear, tire sidewalls, and more. Their current process requires three operators to produce calendered sheets of rubber. The first two operate the calender's feed and exit while the third performs post processing operations. In post processing, a layer of corn starch is applied as an anti-tack to prevent sticking. Then, rubber is measured and finally sheets are cut to length and stacked.

The objective of this project is to design, develop, and build an automated rubber post processing rig for Rubber Labels USA. This machine will replace the need for a third operator in order to make the manufacturing process more efficient, cost effective, and less labor intensive. In order to fulfill the role of the third operator, the machine will include a feed rolling system, cutting system, and stacking exit chute. The rig is controlled by a PLC and ladder logic program. Interaction with the machine and its parameters is done through an HMI touch screen and its control panel.



With our final design, the rubber sheet is pulled between two guides through a pair of spring loaded pinch rollers driven by a stepper motor. The sheets are fed to their desired length by counting the steps per revolution on the stepper motor. After the sheets have been fed to length they are cut using a shearing style cutter. The cutter, driven by a rodless pneumatic cylinder, rides against a hardened metal knife providing a consistent cut to the rubber. The cut sheets then exit the machine via a chute with an adjustable stop, allowing for neat stacking.

MECHANICAL ENGINEERING

TEAM 51

Osama Alarumi
Michael Sotzing
Yekai Wu
Stephen Rutkowski

ADVISORS

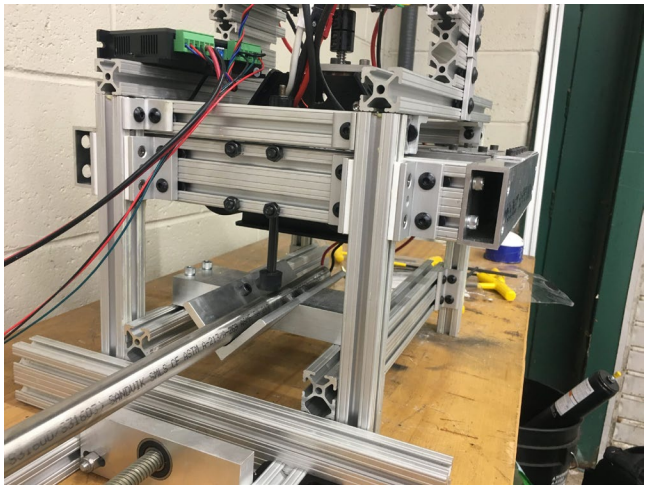
Thomas Mealy

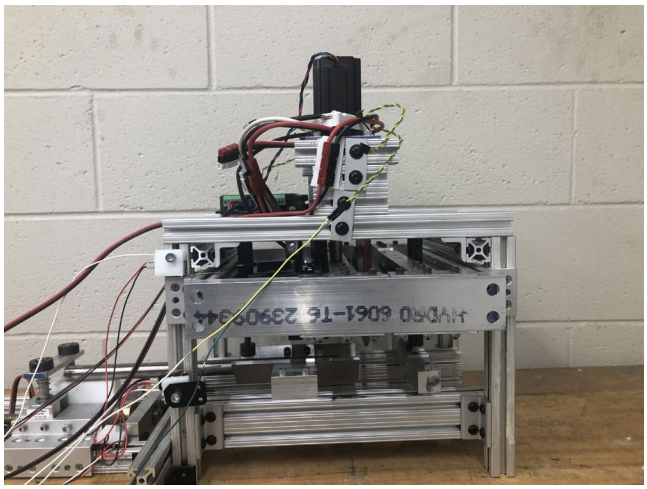
SPONSOR

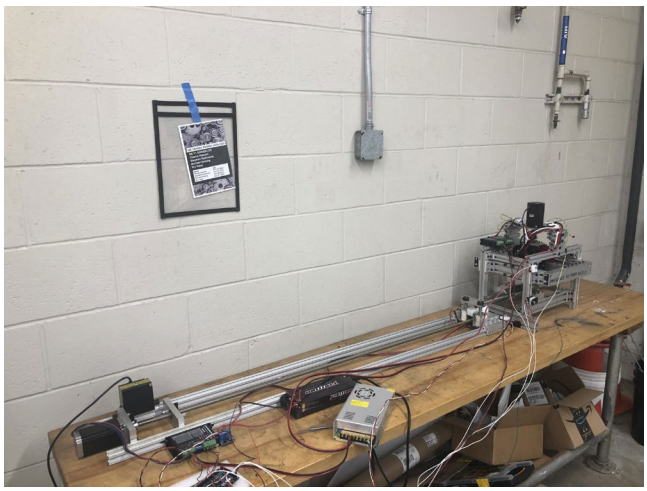
Swagelok

Automated Tube Cutter

Swagelok is a private international company that specializes in tube manufacturing for gas and fluid system components. They provide components that are made to order and prepare to meet any of the various parameters that customers may request. The objective of this project is to design and build a fully automated tube cutter that can handle and be preset to make differently sized cuts from 20 feet, 316 stainless steel tubes, and must comply with several requirements. This tube cutting machine would be a critical integration to Swagelok's efficiency for future endeavors. A specified criterion is the size range of the tubes it will be fed; this machine must allow cuts up to 4 feet, and for tubes with an outside diameter range of ¼" to ¾", and a wall thickness range of 0.035" – 0.095" cuts. It must also support holding and being fed ten of these tubes at once, and must withstand over 100 cuts consecutively without the need for maintenance. The most critical parameter is that this machine must be able to perform cuts that require minimal post processing and no discoloration of the tubes, as that will cause the product unusable. The machine is designed to take these sticks of tubing, feed them into the conveyor which then puts the tube under the saw blade at the preset desired length, and performs the cut.







MECHANICAL ENGINEERING

TEAM 52

Julia Machaj
Michael Deluca

ADVISORS

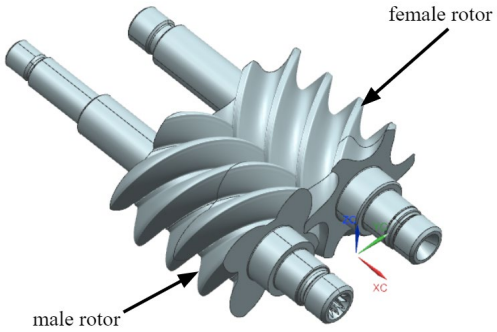
Bryan Weber

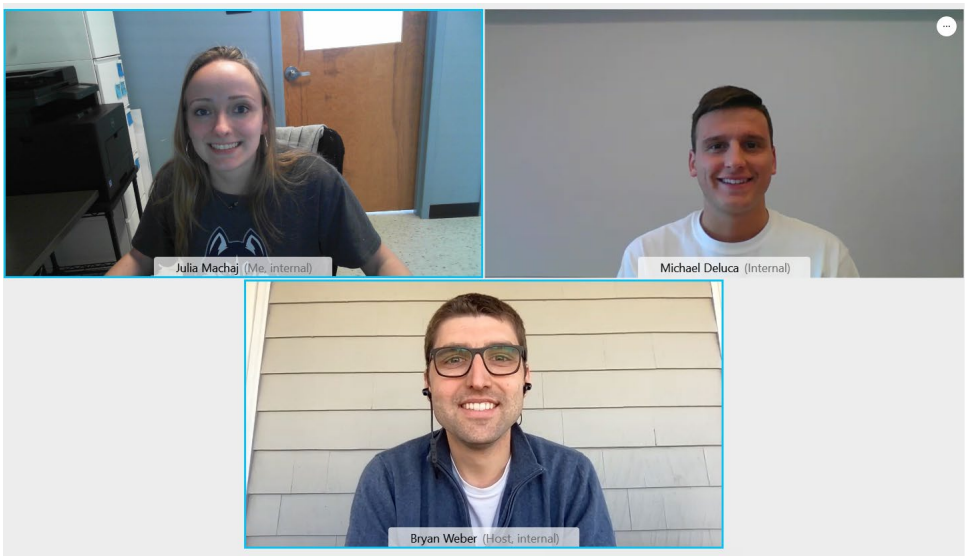
SPONSOR

Triumph Group, Inc.

ME52 Large Compressor Loading Study

Twin screw compressors are used in applications of refrigerant compression as well as fuel cell and turbo charging. The compressor is used for its simple arrangement, compact design, high rotational speeds, and high efficiency. This study analyses the pressure loading throughout the compressor and offers Triumph Group an analysis of this pressure gradient over various sizes of the compressor.





MECHANICAL ENGINEERING

TEAM 53

Kushal Thapa

ADVISORS

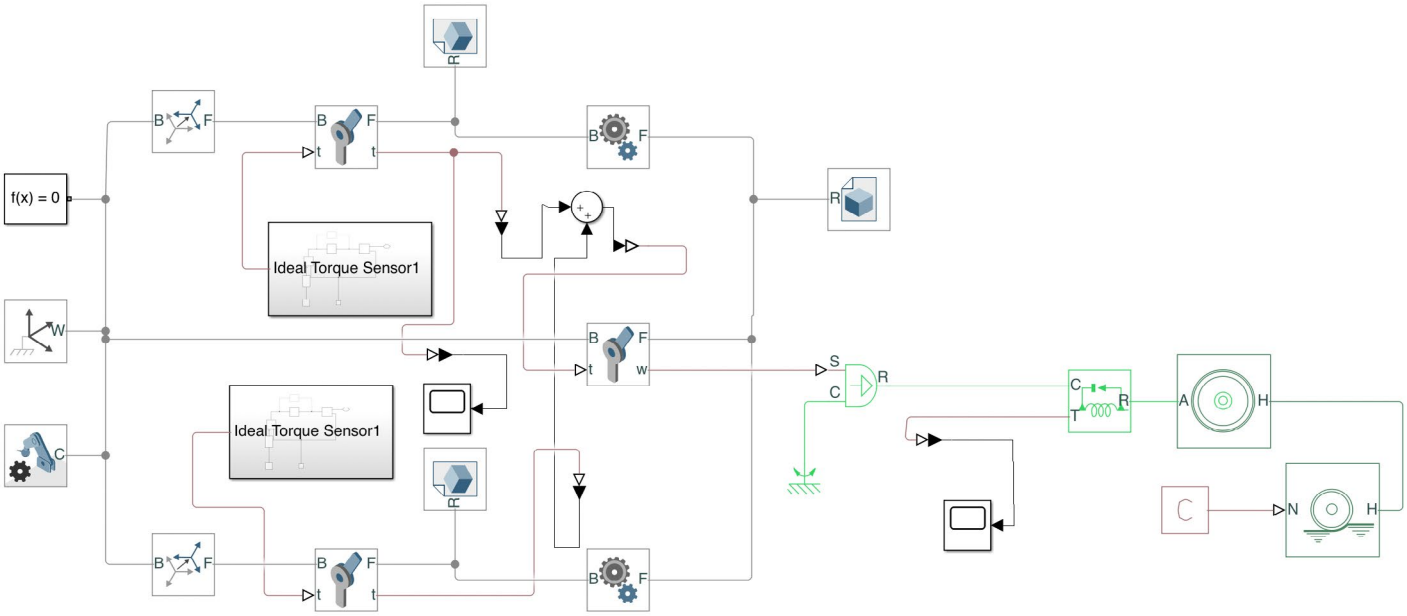
Chengyu Cao

SPONSOR

Triumph Group, Inc.

Modeling/Analysis of Airplane Rudder System

The objective of this project was to develop a Simulink model of a rudder actuation system and use it to optimize the performance of the system by exploring how different variables have an effect on the system. Triumph is one of the largest aerospace components suppliers for both commercial and military applications. They currently need a control solution for flight surfaces as well as a rudder system for small UAVs. The research and study for this project were conducted through the use of interaction analysis. Anything that negatively affected the system was expected to be found by determining key design parameters, design tolerances, design limits, and manufacturing variances. This model will also be used to optimize the system's performance by tuning damping valves. If successful, the effects of the project will be seen in use for flight surfaces on aircraft including a rudder system.



MECHANICAL ENGINEERING

TEAM 54

Eva Gurra
Oreoluwa Olowe
William Maciolek

ADVISORS

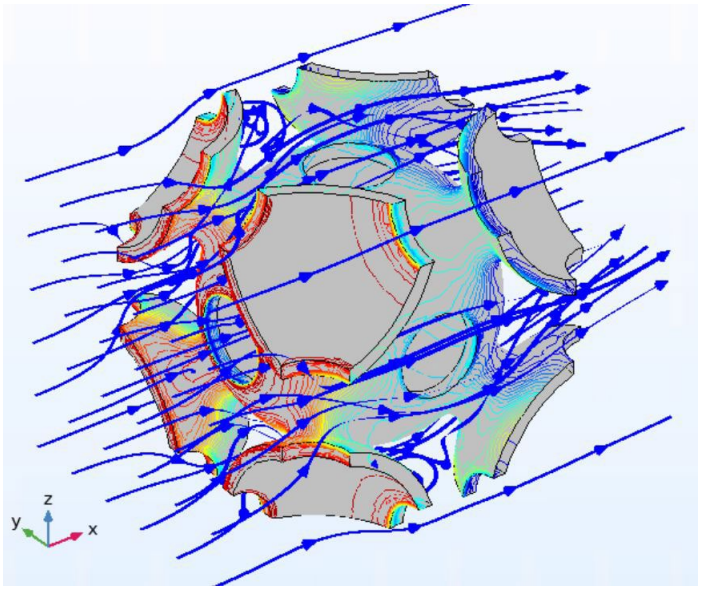
Wilson K.S. Chiu

SPONSOR

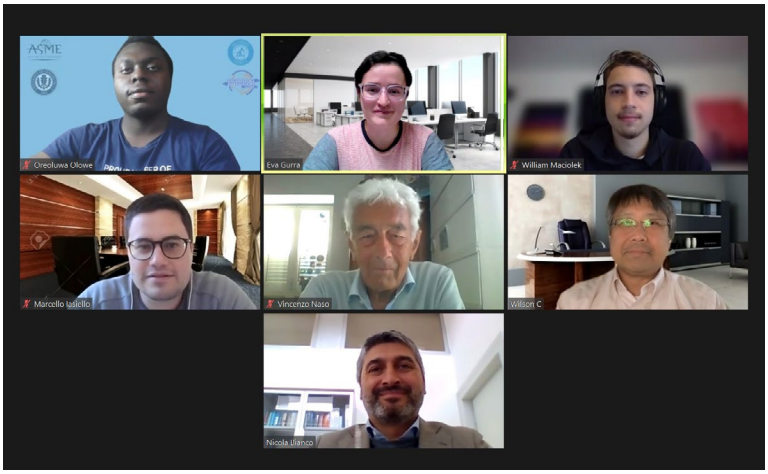
UCONN
SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

Conduction and Convection Heat Transfer Analysis in Architectured Open-Cell Foams

Conventional open-cell foams are porous, light-weight materials promising for heat transfer augmentation. They play an important role in the aerospace industry, thermal insulation, heat exchangers, and even in heat sinks for electronic power dissipation. Our advisor and collaborators have performed extensive simulations and research on various types of foam models including symmetrical models like Kelvin, Wearie-Phelan and tomography reconstructed foams and have developed correlations for these studies. In this project, we performed similar thermal-fluid analyses of a new custom architectured open-cell foam how foam properties such as porosity, cell size, and other geometrical parameters affect heat transfer.



Using COMSOL Multiphysics, we performed conduction and convection heat transfer simulations and varied several geometrical parameters in the foam to determine the configuration that would optimize heat transfer. We quantified heat transfer optimization with the calculation of the effective thermal conductivity (ETC), Reynolds number, Nusselt number and pressure drop. Finally, we developed the correlations for the effective thermal conductivity and Nusselt number as a function of several geometrical parameters in the foam including porosity, binder angle, and thickness. We have shown that architectured foams are promising for heat transfer and have developed new correlations on these geometries. We showed that we can modify the geometry to reach as low as a 15% deviation of the parallel model (an upper bound on ETC). We have also calculated a higher Nusselt number compared to the Kelvin foam model at equal porosity.



MECHANICAL ENGINEERING

TEAM 55

Christopher LeMay
Zachary Ohayan
Anthony Rivera

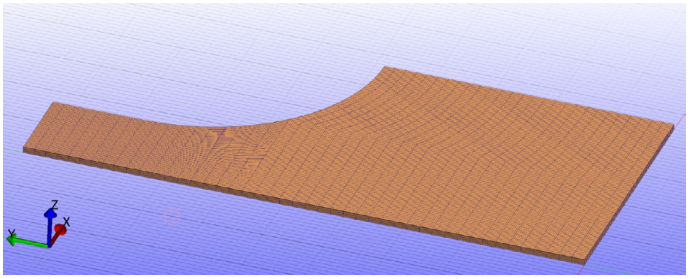
ADVISORS

David M. Pierce

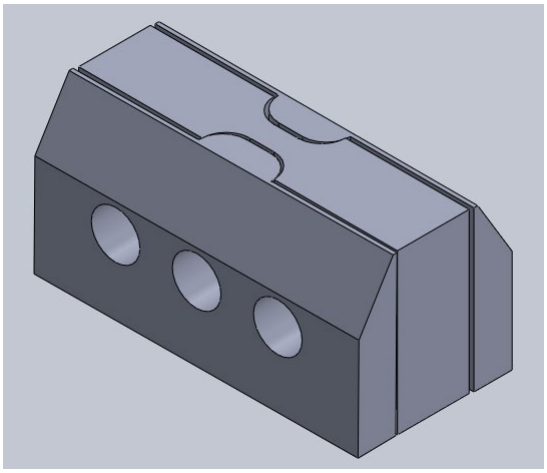
SPONSOR

LABORATORY

Design and Fabrication of Cartilage Specimen for Characterization



The Interdisciplinary Mechanics Laboratory (imLab) combines imaging, experimental testing, and computational modeling across disciplines to solve challenging, practical problems in biomechanics and engineering related to soft tissues, new engineered materials, and applications. The research group led by Associate Professor David M. Pierce is interested in understanding and predicting the mechanics of soft tissues and engineering materials. The first objective of this project was to find the optimum shape and size of a cartilage and collagen network to perform tensile tests. Our team used analysis through FEBio to determine the optimized specimen dimensions for testing. Additionally, we needed to improve the ability to produce sample sizes with these exact dimensions in a very accurate and efficient manner. To accomplish this, we were tasked with designing a tool that would speed up the specimen cutting process while also making the cuts more accurate. Using the identified dimensions from FEBio as a guide, we modeled multiple cutting tool prototypes. After preliminary testing, the approximate design we determined to be most efficient, precise, and accurate had a gauge length of 3.5mm, a radius of 3mm, a clamp width of 4.5mm, a clamp height of 6mm, a gauge width of 1.5mm and a thickness of 0.1mm.



MECHANICAL ENGINEERING

TEAM 56

Kyle Chester
Alec Van Slooten

ADVISORS

Xinyu Zhao
Patrick Meagher

SPONSOR

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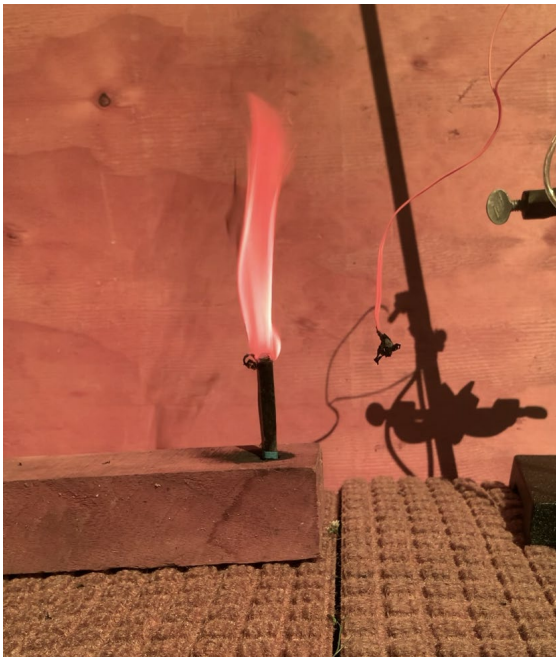
MECHANICAL ENGINEERING

Modeling of Solid Propellant Combustion

Solid propellants are solid-state mixtures of fuel and oxidizer that are ignited to propel rockets. The prediction of solid propellant burning rates is useful in rocket design, but it is also a challenge because of the complex physical and chemical processes that occur as the propellant burns. The project objective was to establish an understanding of the modeling of solid propellant combustion. A thorough literature review of the fundamental processes behind solid propellant combustion was first conducted, along with a review of current combustion models. An analytical model capturing the burning process of solid propellant was then created in MATLAB. This model takes in the formulation of the propellant and uses a tri-flame and a twophase approach to calculate the propellant burning rate. Small strands of ammonium perchlorate composite propellant were additionally burned and studied to validate this analytical model. Numerical simulations conducted in ANSYS Fluent were further used to support the analytical model and to establish the impact of different material properties on the propellant burning rate. The generated models will be used in the future to help identify which solid propellant formulations to use for specific applications.



MECHANICAL ENGINEERING

TEAM 57

Daniel Lapinski
Edouard Quiroga

ADVISORS

Julián Norato

SPONSOR

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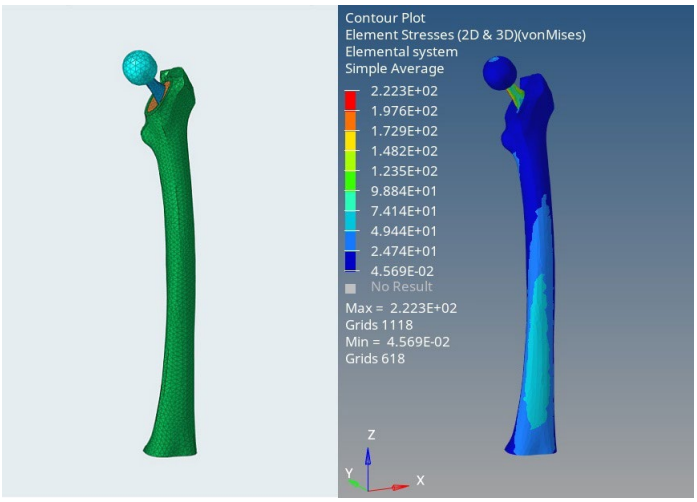
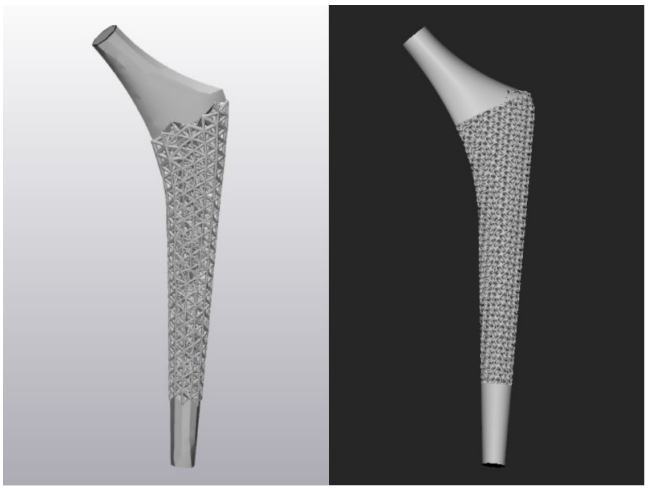
MECHANICAL ENGINEERING

Design of a Functionally Graded Solid-and-Lattice Hip Implant

The objective of this project was to design, optimize, and fabricate a functionally graded lattice infill hip implant that better imitates a hip bone than conventional hip implants on the market. Two separate designs were developed for this hip implant: an octet truss structure and a gyroid triply periodic minimal surface (TPMS) topology. Current solid infill designs may have satisfactory mechanical properties such as high compressive strength but can fail due to stress shielding. This phenomenon occurs when the stiffness of the implant is greater than the stiffness of the bone, resulting in reduced bone stress and density, causing bone loss. It was also required that the implant matches pre-existing constraints for conventional implants such as appropriate biocompatibility, fatigue life, and modulus of elasticity, in addition to additive manufacturability.



As part of the design process, a Design Failure Modes and Effects Analysis (DFMEA) was performed, which is a preventative measure to avoid failure routes. After, an intact femur model and a baseline model, where the solid hip implant was inserted into the femur, were created. Both a femur and a basic hip implant CAD part were obtained and meshed using HyperMesh, after which finite element analysis was performed to consider the von Mises stresses acting on the different parts of the implant and the strain energies to calculate stress shielding.



Using OptiStruct, the baseline model was optimized to model an octet truss lattice with beam elements. Size optimization was used to determine the size of the strut diameters in the octet truss. The strain energy calculations demonstrate that the octet truss lattice reduces stress shielding more than the baseline solid hip implant. Using nTopology, a proof-of-concept 3D model was created for the gyroid TPMS lattice infill hip implant. Finally, an octet truss prototype was fabricated using 3D printing with Ti6Al4V material.

MECHANICAL ENGINEERING

TEAM 58

James Hormann
Simone Stanton
Jack Baumgartel

ADVISORS

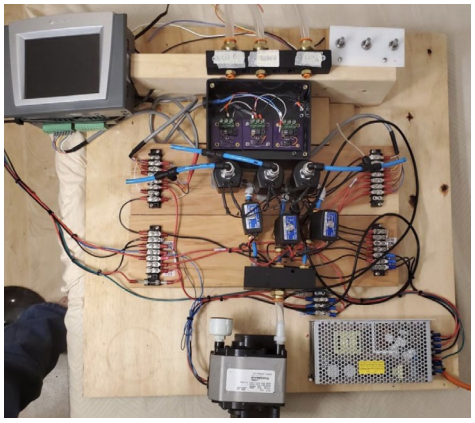
Ying Li

SPONSOR

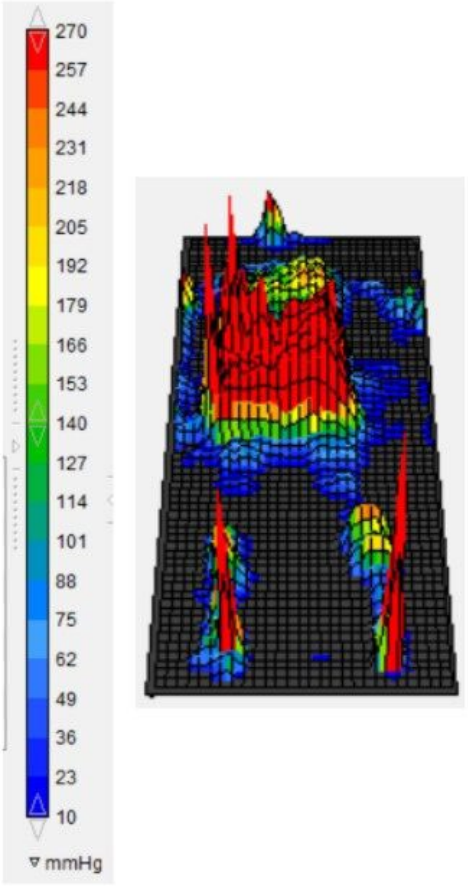
UNISOFT MEDICAL CORPORATION

Engineering of a Smart Pump for Single Patient Use Hospital Mattresses

Unisoft Medical Corporation is a medical device company that created Unisoft One, the first single patient use therapy mattress for hospitals. Unisoft recognized that while all other areas of medical technology were advancing, the hospital mattress has remained unchanged for years. The Unisoft One was designed in order to prevent pressure ulcers and the spread of infectious disease in a clinical setting by eliminating the risk of cross-contamination from reusable mattresses. Prevention of pressure sores was achieved by utilizing alternating low-pressure cells within the mattress to continually redistribute a patient's weight.



The primary objectives of the project were to complete the redesign of an existing smart pump prototype and optimize the control system through various tests. Research into upgrading the pump and valves was conducted, and new parts were implemented into the design. Tests were performed to determine the best pressure outputs for different weights and heights. Time-based and pressure-based alternation cycles were compared to validate the effectiveness of pressure-based cycles. In order for the smart pump to be integrated into a clinical environment, a production-like housing for the system was designed.



MECHANICAL ENGINEERING

TEAM 59

Luke Vancraeynest
Aiden Drzewiecki

ADVISORS

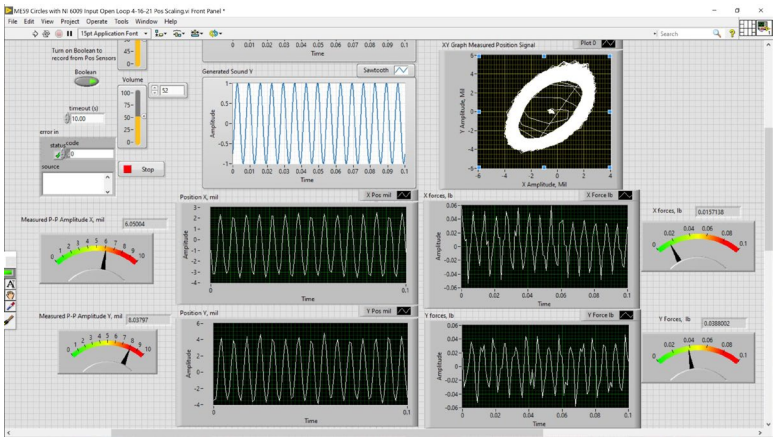
Nejat Olgac

SPONSOR

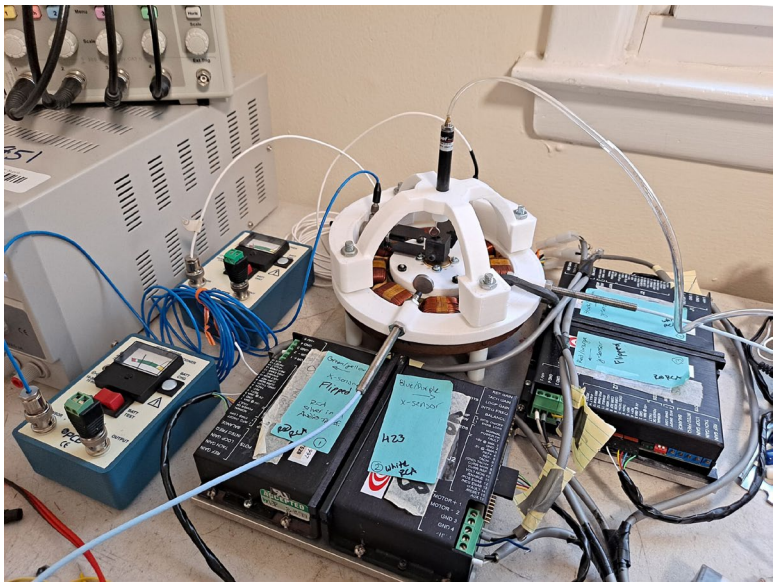
Raytheon Technologies

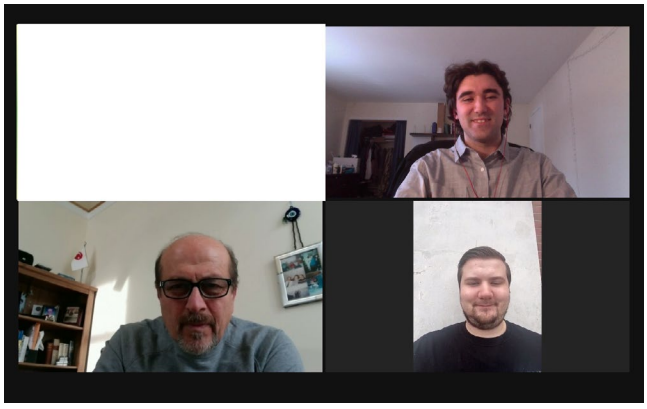
Method for High Frequency Wear Testing

The purpose of this project is to continue improving upon the existing test rig prototype from last year's team ME60. The requirements of the test rig are to represent low amplitude (10 mil), high frequency (up to 1000 Hz) controlled wear patterns such as a circle on a test specimen, while also applying a vertical load on the test specimen. The test rig consists of a magnetic bearing which creates a magnetic field to control the movement of a center core piece in user defined wear patterns. A LabVIEW VI sends signals to external soundcards, which further send the signals to amplifiers to control the power of the magnetic bearing's coils. This LabVIEW VI is capable of changing the frequency and amplitude of the desired signals, as well as the desired wear motion pattern of the core. The VI also measures the movement of the core and plots this as a comparison to the desired wear motion patterns.



A 3D printed platform is fastened into the core, upon which a material sample is mounted. The vertical load applicator frame includes a 3D printed test specimen holder. The test specimen holder is depressed by way of a pneumatic actuator, thereby pressing the specimen against the material sample it will wear against during testing. Load cells connected to the specimen holder measure the forces experienced by the test specimen when the core is in motion, while position sensors measure the motion of the core within the magnetic field.





MECHANICAL ENGINEERING

TEAM 60

Christopher Floto
Madison Mulqueen
Evan Duffy
Vinh Dau

ADVISORS

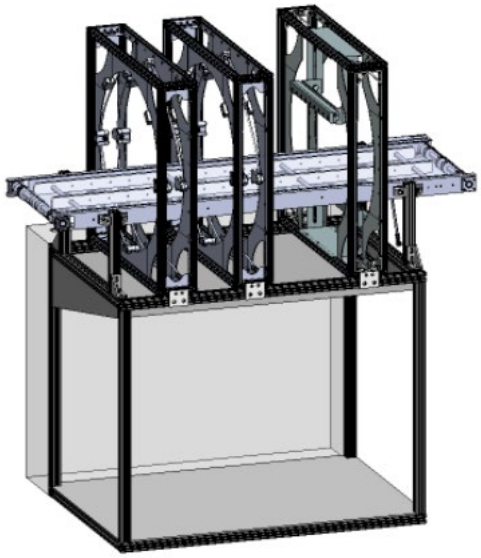
Vito Moreno

SPONSOR

Whitcraft EASTFORD

Design and Manufacture of an Automated Parts Washer

The objective of this project was to research, design, and fabricate an automated parts washer for our sponsor Whitcraft. Located in Eastford, Connecticut, Whitcraft is a global leader in formed, machined, and fabricated sheet metal aerospace components and assemblies. Lean manufacturing methodology such as continuous improvement or Kaizen is heavily implemented in their facilities in an effort to constantly develop processes and reduce waste. The influence of this methodology can be seen in our project as the parts processing revolves around single piece flow.



Parts coming off of Whitcraft's hydroform machine have a layer of viscous water soluble machining oil which must be washed off prior to the next machining operation. Their current process involves a machine that uses an agitation basket to wash parts in batches of 20 parts and a large corn tumbler for drying the wet parts. The newly implemented parts washer will transition this cleaning portion of the production line from batch washing to single piece flow. The machine is designed to be mobile, completely autonomous, and requiring minimal operator input, allowing smooth integration into the preexisting production flow. It operates by using a driven mesh conveyor belt to move the parts through modules to clean, rinse, and dry each part. The modules are complemented by a reclamation system which will filter out oil and soap to recycle water back into the system and reduce resource demand in the production line. A programmable logic controller will be used to control and automate the whole system. Our final machine design optimizes the footprint to 4'x8' (66% reduction), drastically reduces the part takt time to 3 minutes (94% reduction from batch washing), and maintains a sound production level of less than 80db to comply with OSHA regulations.

MECHANICAL ENGINEERING

TEAM 61

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Christopher Huynh
Tomi Alao

ADVISORS

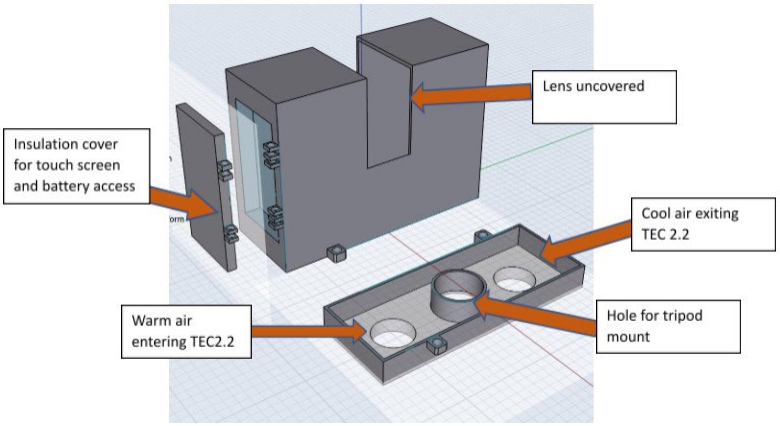
Wilson K. S. Chiu

SPONSOR

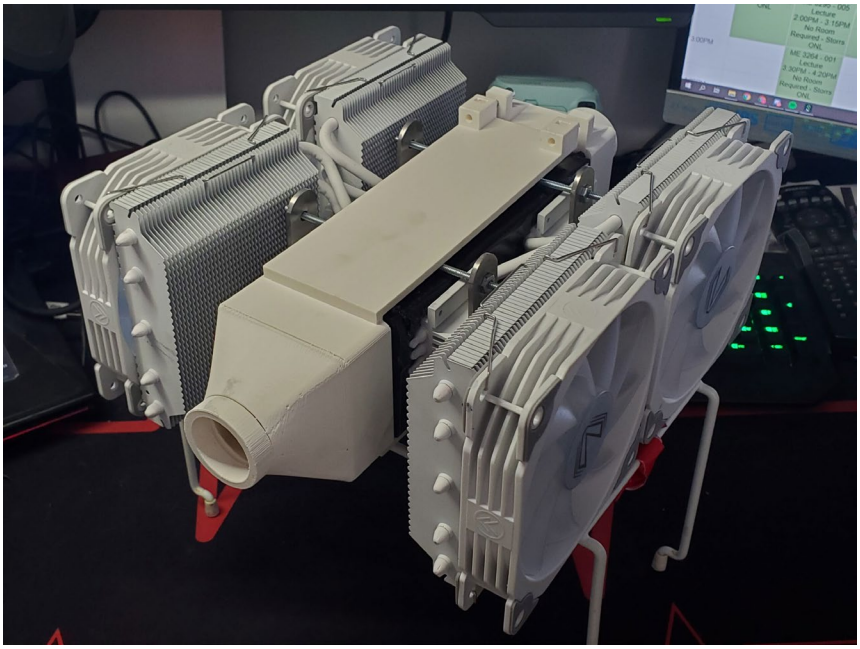
ZACHRY

Design, Development, and Fabrication of a 3D Laser Scanner Cooling System

This project involves the design, development, and fabrication of cooling system for the Faro Focus x330 3D laser scanner used by Zachary Nuclear Engineering. Zachary is an engineering company that uses the x330 scanner to take measurements and create CAD models of nuclear facilities which engineers use to develop analytical models and design plant modifications. The scanner has a maximum operating temperature of 104˚F which can be much lower than ambient temperatures in certain parts of a nuclear facility, this leads to the shutdown of the x330 which increases time and cost of a project.



Our solution involves insulating the x330, circulating air from the x330 to a cooling device that uses solid state heat pumps called Peltier devices, heatsinks with fans to dissipate heat from the hot side Peltier device, pipe heatsink to remove heat from the cooling air and a fan to move air through the pipe heatsink. The Peltier devices help keep the vibrations produced by the cooling device to a minimum which maintains the quality of the scans. Using this set up the TEC 2.3 is able to reach a max heat removal of 84W which correlates to a temperature drop from the inlet to the outlet of the cooling device of 31˚F (17˚C) at an air speed of 5.83 m/s.



MECHANICAL ENGINEERING

TEAM 62

Austin Eichelberg

ADVISORS

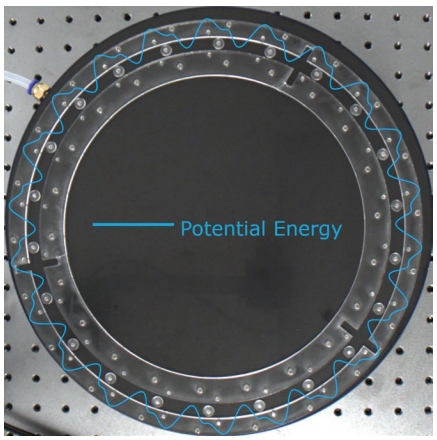
Osama Bilal

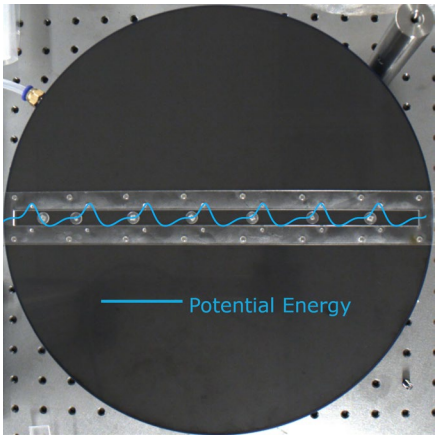
SPONSOR

UCONN SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

Controlling Reciprocity in Nonlinear Granular Media

A granular media is a collective system of discrete elements in which the combination of all local interactions governs the overall behavior of the material. Nonlinearity in such systems refers to the disproportionate relation between two changing variables. This could be, for example, separation distance and repulsive force between two individual elements. One particular interest in these materials is their ability to manipulate and filter waves. The objective of this project is to design and fabricate a material that can allow the passage of waves in one direction, but prevent them from traveling in the other. This material property, known as nonreciprocity, can be used in a number of applications such as wave filtering and wave steering. By combining nonlinear stiffness with the bistability allowed to each element in the material, an initial nonreciprocal wave filter is produced and studied in both numerical simulations and experimental tests. The design consists of a uniform 2D lattice of repelling magnetic dipoles, some of which are fixed to a rigid boundary, while others are free to move and transmit waves. Early results show that the nonreciprocal features are heavily dependent on the geometry of the boundary which can be modified to prevent waves of various amplitude and direction.





MECHANICAL ENGINEERING

TEAM 63

Nicholas Erskine

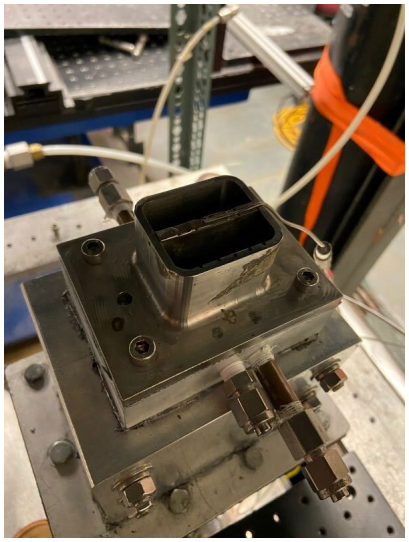
ADVISORS

Baki Cetegen

SPONSOR

Experimental Investigation of Turbulent Premixed Flames with Pre-Vaporized Liquid Fuels

The purpose of this Senior Design Project is to prepare a bluff-body combustion rig for liquid fuel that is to be pre-mixed with heated air. The fuel injection system is updated to reliably measure and control the fuel's flow rate using a variable area flow meter. Thermocouples, silicone rubber heating tapes, and a temperature controller are implemented to monitor and heat the walls of the combustion rig to prevent fuel droplet condensation. This is meant to completely vaporize the fuel droplets to maximize mixing between the fuel and air molecules before reaching the bluff-body-stabilized flame. The flames of interest in this research are stabilized on a piece that spans across the long-side of the rectangular cross-section where the premixed fuel-air flow exits. This is known as the bluff-body. It is of interest to analyze flames where the average fuel-air velocity is 5, 10 and 15 m/s at the bluff-body. Since the air that comes from a compressor is the bulk of the mass flow, Hot Wire Anemometry (HWA) is conducted to calibrate the compressor air pressure to the velocity at the bluff-body. The fuel droplet vaporization is tested using a Particle Image Velocimetry (PIV) laser and camera that detects scatter from larger particles, such as fuel droplets, in a flow of gas. Beyond the Senior Design timeline, the goal of this research is to investigate flame behavior as flames of jet fuel components (n-dodecane, toluene and ethanol) near blowoff. Flame characteristics such as temperature, velocity, flame shape, flame height, and species composition, can be measured using advanced laser diagnostic techniques. The measuring techniques used in this project include Filtered Rayleigh Scattering (FRS), PIV and High Speed Chemiluminescence Imaging. FRS and PIV are used to obtain temperature and velocity data of the flame and its surrounding area. This data can then be compared between flame stages as a flame nears blowoff to observe how a flame's behavior changes.



MECHANICAL ENGINEERING

TEAM 65

Kurt Jonke

ADVISORS

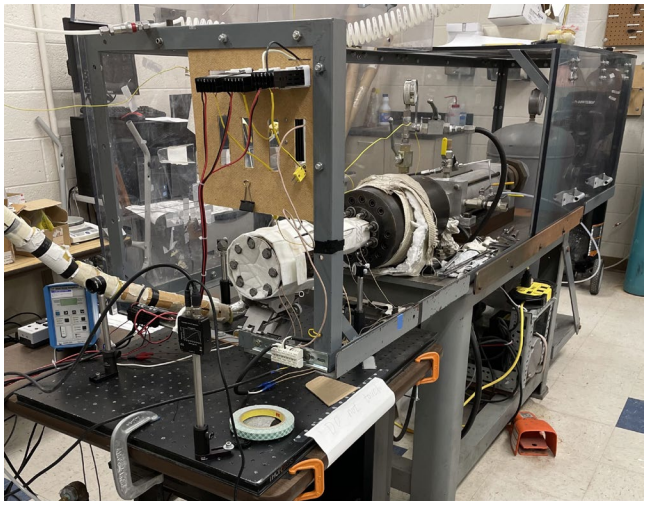
Chih-Jen Sung

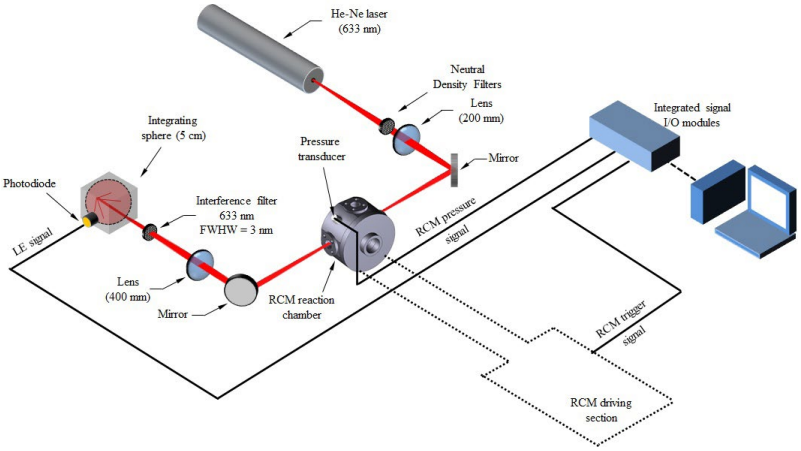
SPONSOR

UCONN SCHOOL OF ENGINEERING
MECHANICAL ENGINEERING

Soot Measurement of RD587 and its Surrogates Under Engine Relevant Conditions

The objective of this project is to examine the feasibility of high-pressure soot measurement of RD587 and its surrogates in a rapid compression machine (RCM) to meet the needs of the scientific community and aid in the development of chemical kinetic models. There is a strong need for the global reduction of particulate matter production by combustion processes in internal combustion engines. This is an issue that requires the formulation of renewable and carbon neutral fuels in conjunction with technological advancements in engine technology. Soot models are produced to predict the soot formation tendencies of gasoline fuels. This project will serve useful in the betterment and validation of such models with the production of experimental data sets under engine relevant conditions. The determination of the sooting tendencies of RD587 and its surrogates also allows them to be quantitively compared. The design and analysis of an experimental setup implementing laser diagnostics was required to accomplish the project's goals. This setup can later be reused to study other fuels. The light extinction method was used to measure the soot volume fraction as a function of compressed temperature, compressed pressure, and equivalence ratio of the chosen fuel and oxygen/diluent.





MECHANICAL ENGINEERING

TEAM 66

Nicolas Tricard

ADVISORS

Xinyu Zhao

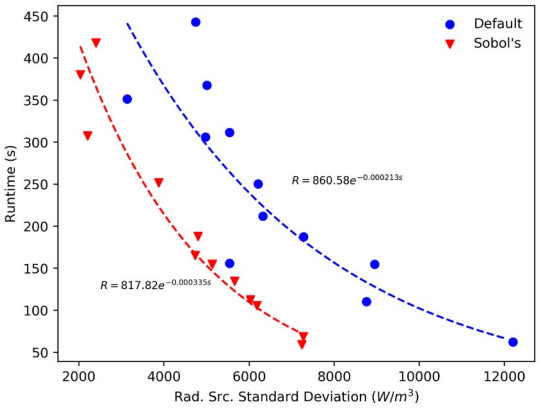
SPONSOR

Computational Thermal Fluids Laboratory (CTF)

University of Connecticut

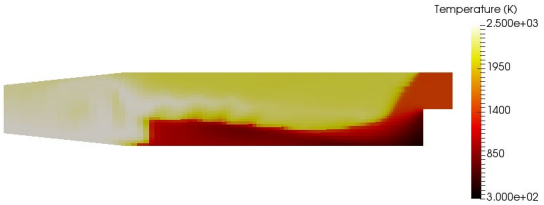
Advanced Computational Techniques for Radiation in Combustion Applications

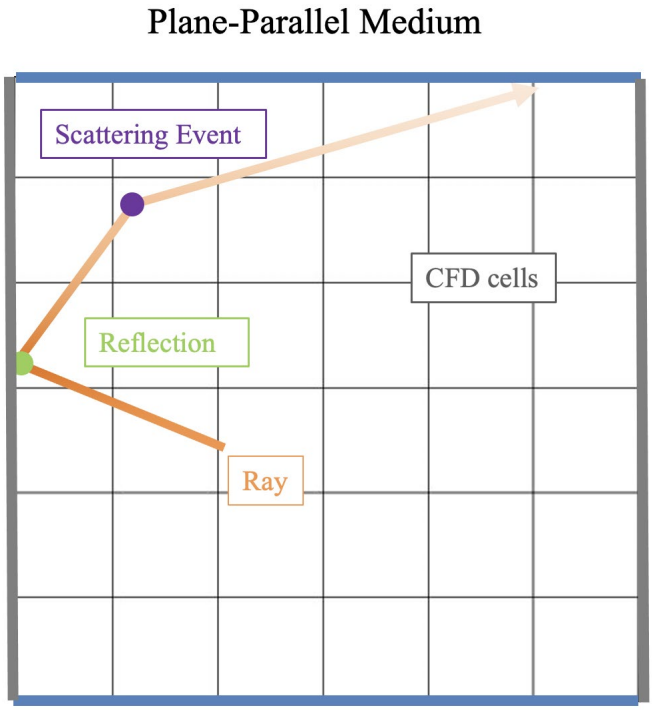
Modeling thermal radiation in combustion applications can be computationally challenging both in terms of runtime and accuracy. As a result, combustion researchers and engineers often do not have the ability to account for accurate radiative heat transfer in most practical combustion applications.



Currently, the Monte-Carlo method is the most accurate method of modeling thermal radiation. In this method, a large number of rays are generated and traced through the CFD domain, transferring energy between locations. Each ray uses random numbers to generate its direction, location of emission and wavelength. Provided these attributes, the ray can be appropriately traced until full absorption.

Two methods are introduced in this project to improve the ray tracing process. The first being a low-discrepancy sequence (LDS) random number generator, and the second being a new ray tracing algorithm. The LDS random number generator was proven to allow for faster convergence, hence reducing computational time. While the new ray tracing algorithm routine showed promising results by allowing for up to 66% faster computation and 10% less memory usage.





MECHANICAL ENGINEERING

TEAM 67

Kevin Snyder

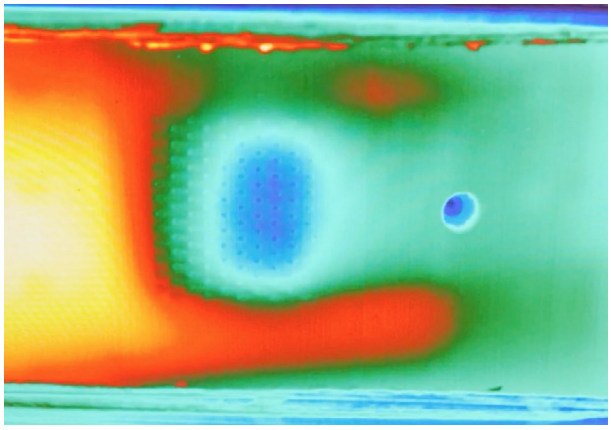
ADVISORS

Baki Cetegen

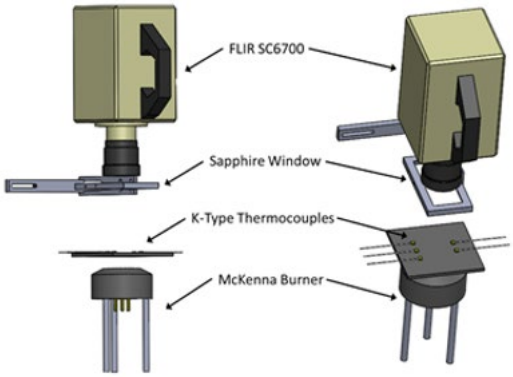
SPONSOR

Infrared Imaging Analysis of Effusion Cooling Effectiveness in High Temperature Vitiated Crossflow

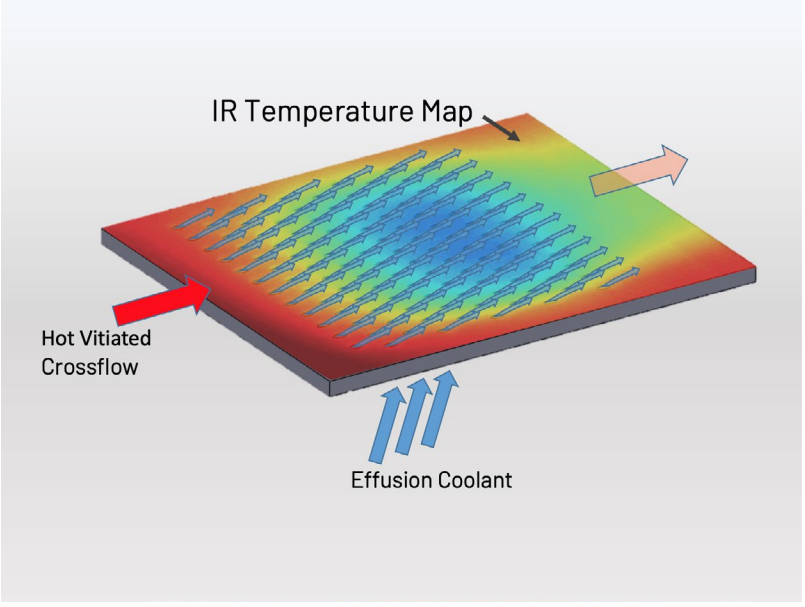
This research project investigates thermal characteristics of effusion cooling and presents methodologies for obtaining surface temperature, cooling effectiveness, heat flux, and heat transfer coefficients using infrared thermography. The objectives for this research were set in coordination with the Aero Thermal Fluids Combustion team at Pratt & Whitney. The analysis provided in this research provides experimental validation of effusion cooling numerical models. Effusion cooling effectively allows combustors to operate at higher temperatures by directing cool flow from the compressor through small angled holes to form a protective cooling film above the surface of the combustor liner.



The novel characteristic of this research is the ability to perform infrared imaging through a hot vitiated crossflow that reaches ~1400 K. This technique is used to analyze thermal characteristics of effusion cooling with various hole configurations over a range of blowing ratios between 1 and 10. A HITRAN analysis was completed for the emission from gaseous combustion products to identify desired wavelength range to image. It was found that between 3.75 μm and 4 μm emission from crossflow is minimal, allowing imaging of surface behind crossflow with minimal interference. An in-situ calibration was then performed using a bandpass filter centered at 3.91μm ± 0.178μm.



Multiple effusion plates were tested to compare effect of hole configuration on cooling effectiveness. Infrared measurements of front and back surface temperature were converted to temperature maps in MATLAB. Front side temperature images were used to calculate cooling effectiveness using known crossflow temperature and coolant temperature. An ANSYS model was developed to use front and backside temperature images to calculate heat flux. Preliminary heat transfer coefficients were calculated using gas temperature images generated by Rayleigh scattering thermometry and heat flux values from ANSYS.



MECHANICAL ENGINEERING

TEAM 68

Audrey Watkins

ADVISORS

Osama Bilal

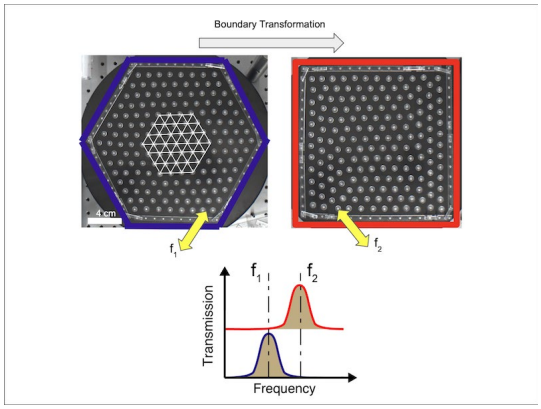
SPONSOR

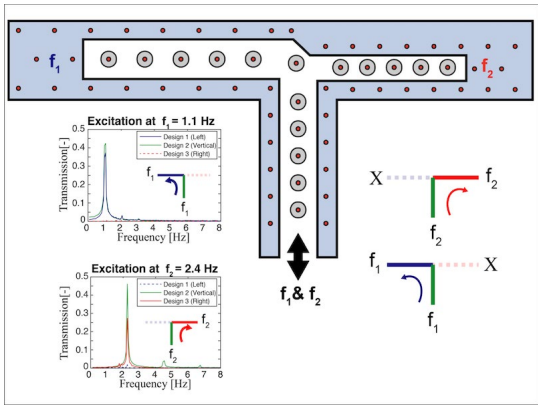
UCONN SCHOOL OF ENGINEERING

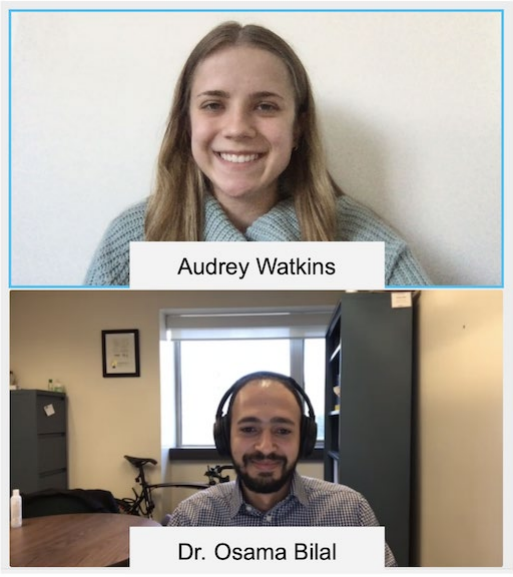
MECHANICAL ENGINEERING

Sensing and Demultiplexing Ultra-low Frequency Waves

Metamaterials are manmade materials that have wave propagation properties that are not naturally occurring. A singular unit cell repeated in space is the basic building block of these materials. The geometry of the unit cell determines the dynamical properties of the metamaterial when excited with mechanical waves. The determination of ranges of frequency attenuation versus propagation is of interest. Unit cells with specific shape, size, and stiffness, allow for the tuning of the propagation and attenuation frequency ranges through the metamaterial. Most metamaterials are capable of attenuating waves within the kilohertz range, however, by designing and creating self-assembled unit cells within magnetic potential wells, the infrasound wave range (below twenty Hertz) is attenuated. The objective of this project is to design self-assembled metamaterials capable of controlling infrasound waves in a tunable manner. The strength of the magnetic field and the lattice patterns, created by the self-assembled, uniquely shaped unit cells, both have an influence on the wave frequency ranges that can propagate through the metamaterial. The unit cell lattice patterns can differ by modifying the boundaries of the metamaterial, which affects the interactions between the self-assembled unit cells, therefore changing the properties of the metamaterial. The resulting unique lattice patterns and their wave propagation properties are modeled numerically and tested experimentally. The numerics assume an infinite material model, exploiting the fact that the metamaterial is constructed of identical unit cells repeated in space. In the experimental part of the work, the propagation and attenuation of the mechanical waves is measured as the oscillations of the unit cells as a result of the excited frequency ranges. The comparison of the numerics and experimental data shows that the propagation of ultra-low frequency waves can be controlled through a metamaterial.







MECHANICAL ENGINEERING

TEAM 70

Matthew Bonvicini
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Steven Riley

ADVISORS

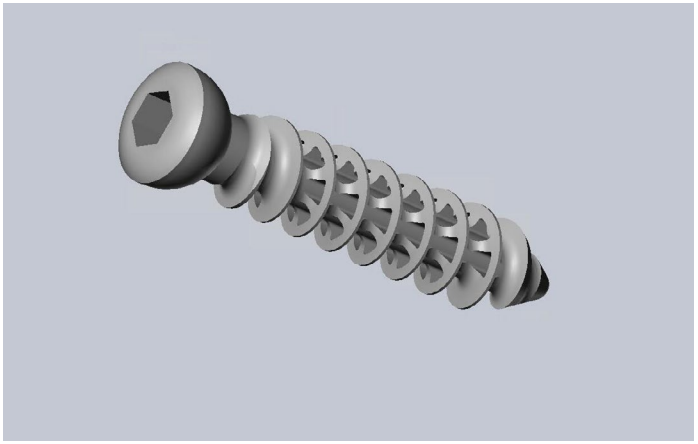
Julian Norato

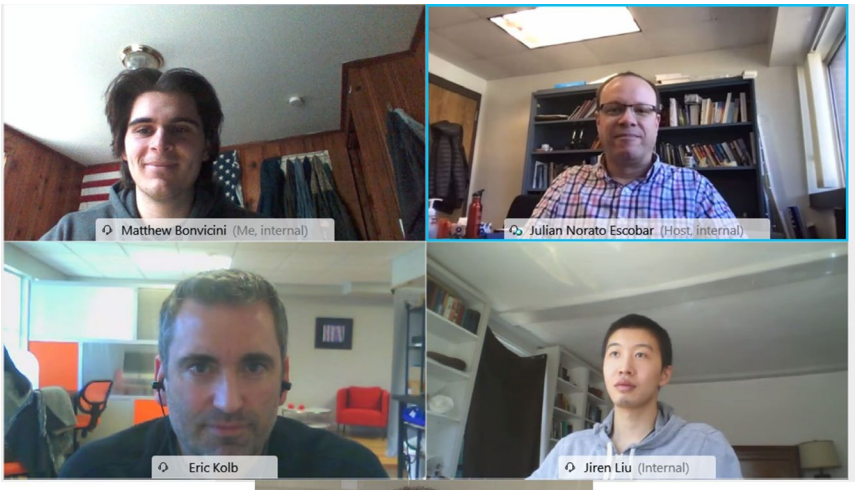
SPONSOR

Kolb CONSULTANTS

Optimization of an Orthopedic Bone Screw

In 2008, our sponsor, Eric Kolb, created a consulting company known as Kolb Consultants with a focus on improving several aspects of everyday life. These aspects were fitness, health care, and manufacturing. More specifically, one of the things he looks to improve and optimize are orthopedic bone screws. The scope of this project was to research the ASTM Standard for bone screws and to test Mr. Kolb's bone screw design with apertures in a SolidWorks model. This allowed us to see if the screw did or, with some design changes, could meet the requirements for certification. We also modeled and tested a traditional bone screw to validate and compare results. We researched existing orthopedic bone screw designs as well as the material they are made of. Once we had a foundational understanding of that, we began to research and understand the wide range of bone densities that are present in the human body. This was important in correctly applying the tensile and shear strengths that correspond to a particular bone. To determine if the screw could withstand the different forces within the body, we conducted a finite element analysis. This was key in determining if Mr. Kolb's aperture design was optimized. We concluded that Mr. Kolb's screw design is capable of withstanding the needed forces and a physical screw should be created and tested.





MECHANICAL ENGINEERING

TEAM 71

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Aryaman Misra

ADVISORS

George Lykotrafitis

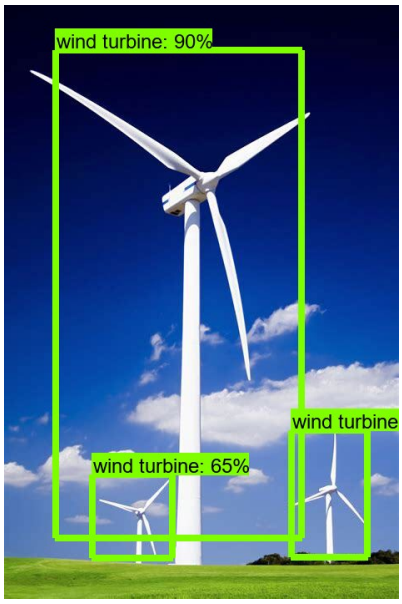
SPONSOR

NAVSEA WARFARE CENTERS
NEWPORT

Autonomous Aerial Inspection of Wind Turbines

The Naval Undersea Warfare Center (NUWC) is the United States Navy's full-spectrum research, development, test and evaluation, engineering and fleet support center for submarines, and autonomous systems. This project presents the research, design, and development of an autonomous aerial unit capable of utilizing computer vision methods for the inspection of wind turbines.

The objective of this project was to design and develop Computer Vision software that recognizes three bladed Horizontal Axis Wind Turbines (HAWTs) of any size and their major components through the use of Machine Learning and Artificial Neural Networks (ANN). The completed software is incorporated onto a microcomputer to run the detection algorithm in real time. The microcomputer is positioned onboard a drone that is outfitted with a camera to serve as the object detection system's input data stream. The user interface that displays the output of the algorithm was designed to be both comprehensive and intuitive for the drone pilot to use.



For the microcomputer, the team selected a Raspberry Pi 4B to run a tensorflow based object detection model. The selected model was the 'Efficient Det D0' model authored by Google which was retrained to specifications of the project. Data Augmentation techniques were implemented on hundreds of training images as part of the preparation process to retrain the model, while a subset of validation images were used to tune the parameters of the detection model.

The selected drone was the 'Holybro X500' custom drone which was selected for its payload capacity and compatibility with the Raspberry Pi. The drone was constructed and fitted with custom elements in order to increase flight time and secure the microcomputer on board the drone. A long distance telemetry system was integrated to allow communication between the drone and the pilot.

MECHANICAL ENGINEERING

TEAM 72

James Jordan
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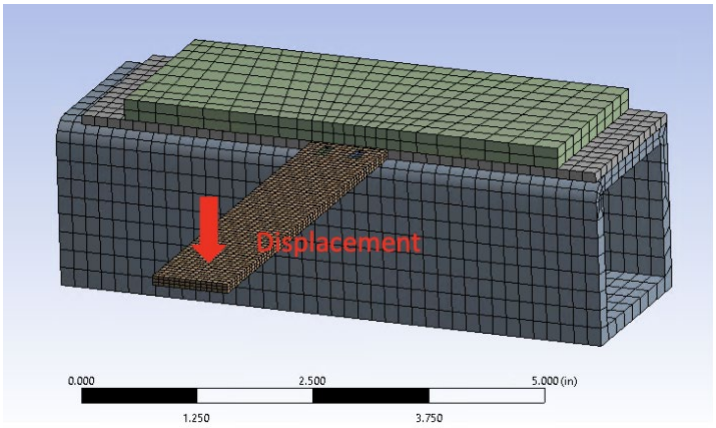
Deonarine Sumeersarnauth

ADVISORS

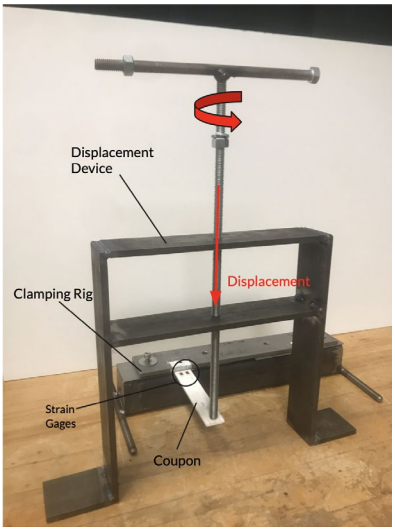
Ryan Cooper

SPONSOR

CMC Sensor Adhesive Strain Capacity Evaluation



Pratt & Whitney, a leader in aeroengine design and manufacturing, has consistently looked for ways to improve aircraft performances. Ceramic Matrix Composites (CMCs) are a class of materials that can improve weight reduction and engine performance compared to traditional materials used in the manufacturing of gas turbine engines. Greater performance is achieved due to the CMC's ability to withstand higher temperatures, 2900 °F compared to 2200 °F of typical alloys. The objective of this project is to quantify the debonding strain between an adhesive and two CMCs. Traditional adhesives used in attaching strain gages to ceramic matrix composites have poor bonding conditions and can not be used for extensive testing and validation. A test rig has been provided by Pratt and Whitney which clamps a rectangular CMC coupon in a standard cantilever beam configuration. A mathematical model based on Euler Bernoulli Beam Theory was created to predict the strain experienced by the CMC test coupon while under a displacement. The results from this model were validated by a numerical model created in ANSYS Static Structural that simulates the test conditions. Both these models explored the effects of torsion on the CMC coupon as well. Preliminary tests to quantify the level of strain at which debonding occurs have been conducted by a previous design team, however they encountered stability and torsional issues that affected their results. We have designed and created a displacement and clamping system to provide a known displacement to the coupon while eliminating issues experienced by the previous design team. Four strain gauges were attached to each coupon to measure the strain experienced under displacement. Each test was run until the CMC coupon failed or the adhesive debonded from the material. The level of strain that caused failure was quantified in order to determine if the adhesive was a suitable candidate for more extensive CMC testing.



MECHANICAL ENGINEERING

TEAM 73

Justin Guilfoyle

ADVISORS

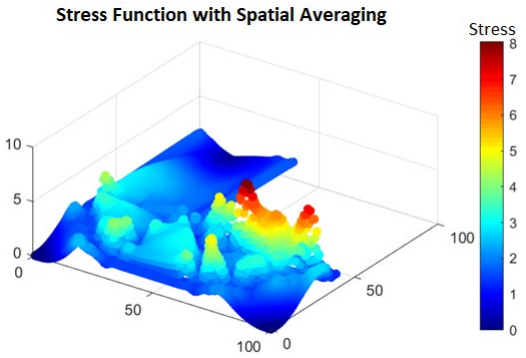
Julián Norato

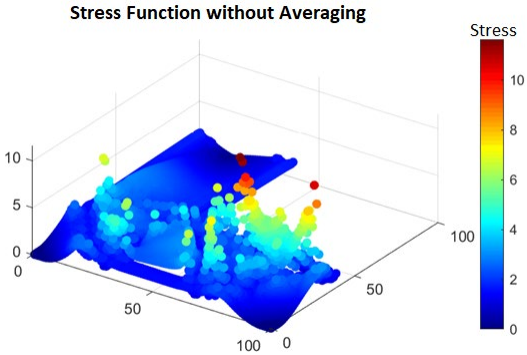
SPONSOR

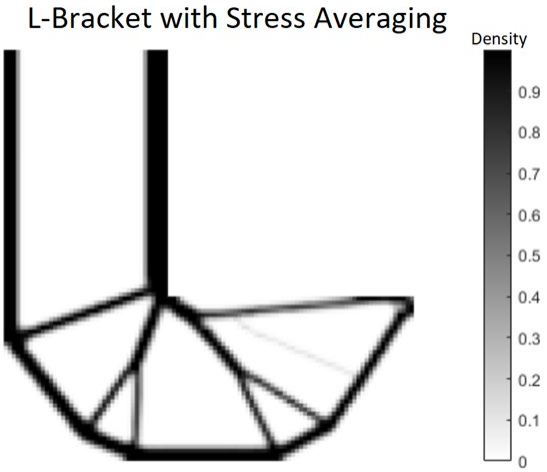
Structural Optimization Laboratory

Stress Averaging Techniques: To improve accuracy and convergence in Stress-based Topology Optimization

The objective of this research project is to investigate the effects of stress averaging techniques on the accuracy of designs and convergence in stress-based topology optimization (SBTOP). Topology optimization (TO) is a structural design methodology used to determine the optimum design for an engineering challenge. Compliance-based TO algorithms are typically used in commercial engineering due to the amenable mathematic properties of structural compliance. Compliance-based algorithms do not necessarily produce designs optimized to a material's failure criteria. These designs require post-processing to remove excess material and/or produce a feasible design. SBTOP algorithms evaluates the structural response of a design via the stress function which reduces post-processing requirements. The use of the stress function poses several challenges including the accuracy of stress values and the smoothness of the stress function over the design domain. Stress averaging techniques are a proven error recovery technique used in finite element analysis to improve the accuracy of stress values. Stress averaging has been implemented in a density-based SBTOP algorithm to determine its effect on performance and the optimality of designs.







MECHANICAL ENGINEERING

TEAM 74

Emma Finnerty
Ryan McAneany
Adam Velardi

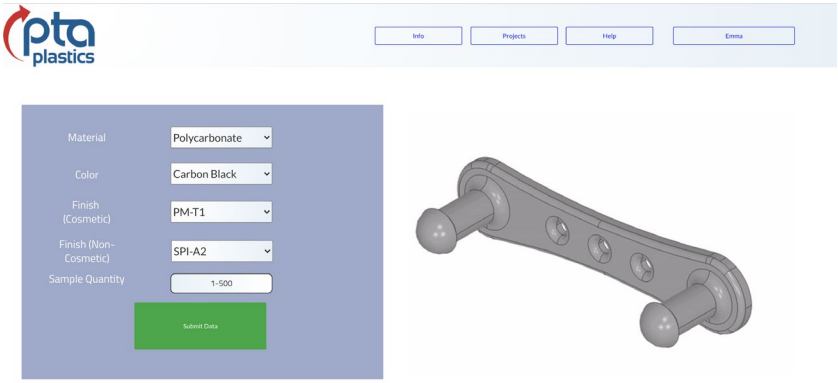
ADVISORS

Horea Ilies

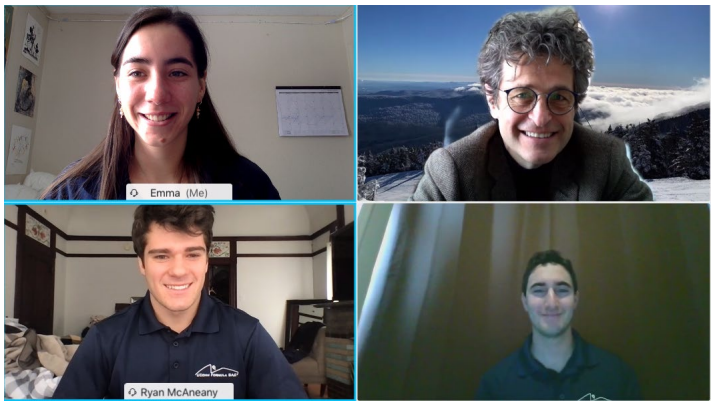
SPONSOR

ME 74 Automated DFM Analysis for Injection Molded Plastic Parts

PTA Plastics is an injection molding solutions provider that is interested in providing accurate quotes to its potential customers through a web interface. The potential customers that request quotes for molds from PTA rarely have adequate manufacturing experience. Consequently, PTA must perform a design for manufacturability (DFM) analysis for the submitted designs prior to providing an accurate quote.



The main objective of this project was to investigate the feasibility and options for automating the DFM analysis workflow required to provide these quotes through a web application. A second objective was to provide a proof of concept for development of the web application and supporting software. The team studied the injection molding process, as well as its manufacturability constraints imposed on the designs. The team's efforts extended into how an application development engineer manually analyzes and critiques a given CAD model. This information was used to design the workflow of the web application. Subsequently, the team performed a comparison of the capabilities provided by several leading DFM software systems.



The team proposed a proof of concept using API access of specific programs as one of the practical solutions that can address the needs of PTA Plastics. This option allows PTA Plastics to utilize existing, robust commercial software functionalities integrated with a web application. The team has also identified a second option involving the development and maintenance of a stand-alone DFM software, requiring in-house development. Finally, the team suggested the layout and functionality of the web application's interface as a prototype developed through a web interface design tool. This prototype lays out the structure of the final web based automated DFM analysis and provides some interface suggestions.

MECHANICAL ENGINEERING

TEAM 75

Niccolo Meniconi
Mike Bernard

ADVISORS

Hongyi Xu

SPONSOR

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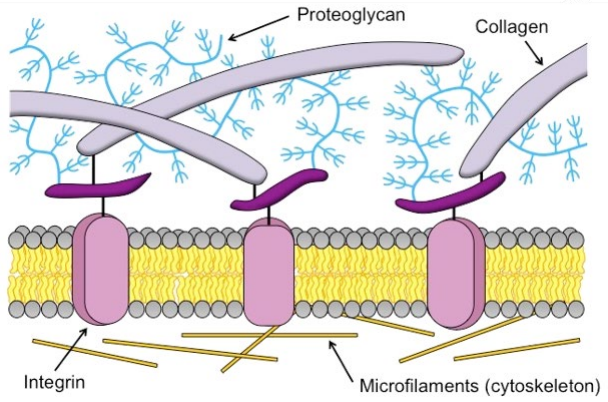
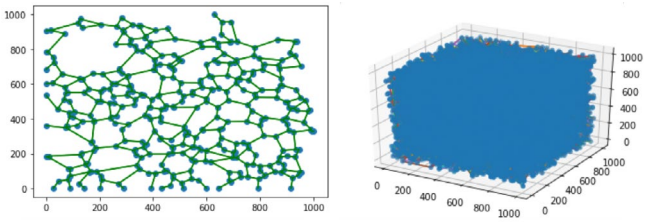
MECHANICAL ENGINEERING

Extracellular Matrix Mesh and Dynamics Modeling

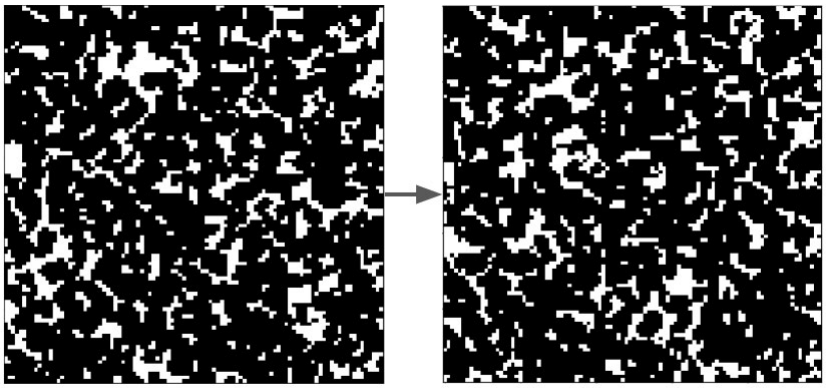
The extracellular matrix (ECM) is a tissue compartment constituted by proteins, glycoproteins, and glycosaminoglycans that assemble to form a complex 3D network. The ECM provides structural and biochemical support to surrounding cells. Despite the important role the ECM plays in forming biological tissues present in many living organisms, there is not a molecular dynamics model which accurately predicts structural behavior in experimental testing. A molecular dynamics model for ECM would provide researchers with a means of predicting ECM behavior with software, rather than with tissue samples. This could decrease the time spent studying diseases of the ECM before a treatment can be developed.



Our customers are Dr. Tarakanova and Dr. Xu, who are researchers in the UConn Mechanical Engineering department. We will be developing a computational model of ECM which will allow researchers to simulate ECM dynamics.



This project is split into two parts, which we are worked on in tandem. The first part is developing software which, given a 2D image of ECM, can generate a 3D node-edge graph representative of that sample. This node-edge graph will be the input to molecular dynamics software. The second part is developing a computational model of ECM, which, when applied to a 3D node-edge graph generated from an image of ECM, will allow researchers to study the macromechanical properties of that sample.



2D Exemplar Reconstruction

MECHANICAL ENGINEERING

TEAM 77

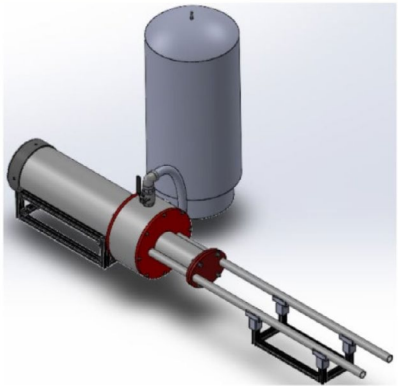
Ashley Gillette
Alton Jones
Ryan Radziewicz
Evan Sandgren

ADVISORS

Tianfeng Lu

SPONSOR

Expulsion of Small Diameter Devices from Torpedo Tube Cartridges



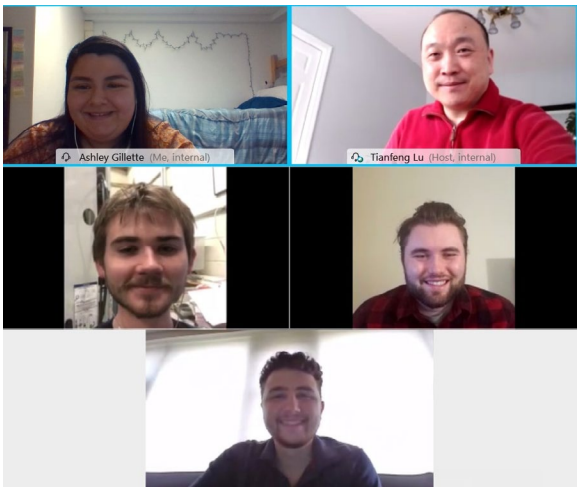
This is a collaborative, research and development project between MEM team 9 and ME team 77, with sponsor Doug Merrick from the Naval Undersea Warfare Center (NUWC). NUWC is a full spectrum research, test, development, engineering, and support center for the U.S. Navy.

This project focused on delivering a device that will launch multiple three-inch projectiles from a U.S. Navy, forward-facing torpedo tube. We created a design for a capsule that will be stored alongside MK.48 torpedoes within a VIRGINIA Class submarine. This capsule will be utilizing the cradle, loading, and firing mechanism already on board. The end result was a proof-of-concept prototype that is independently validated and will support the Navy in delivering combat-ready forces.

Throughout the year, the MEM and ME teams worked cohesively toward the same final goals. The MEM team generally led the CAD of the modules while the ME team led the ANSYS fluid simulations. Then, a test rig was manufactured and put to trial consisting of the CAD packages and ANSYS predictions.

The final deliverables for this project include:

- a design to launch multiple 3” x 39” projectiles in a volley-fire style within the submarine’s max performance envelope
- full CAD package with a 1/7 scale 3D printed model and 1/3 scale dual barrel test apparatus
- an ANSYS simulation package



NUWC did not provide any sensitive information to the team. We worked with our sponsor to establish a reasonable set of assumptions that would guide the project’s specifications. As a result, this system will not be integrated into the submarine directly but will require some changes to the parameters to ensure it will work in actuality.

SYSTEMS ENGINEERING

TEAM 1

Evan Cyganowski
Colin Fitzsimonds
Lydia Krahn
Rachel Martineau

ADVISORS

George Bollas

SPONSOR

nel

Computational Fluid Dynamics Analysis and Symbolic Regression of Multiphase Separation

NEL Hydrogen is a global company, delivering hydrogen production technologies such as water electrolysers. This process splits water molecules to produce hydrogen, which can then be used for energy production. Within NEL's hydrogen production process, a downstream, multi-phase separator tank separates oxygen from water and returns a high purity water stream to the production cycle. Our goal was to improve the efficiency of NEL's phase separator using computational fluid dynamics. We used ANSYS Fluent to simulate oxygenated water flow and study the effect of varying separator geometries on separation efficiency. Using the simulation results and Alamo's symbolic regression software, our group created an algebraic model to correlate the phase separator geometry with separation efficiency. The application of this model would provide NEL Hydrogen with a tool for designing efficient phase separation units for their water electrolysis processes.

SYSTEMS ENGINEERING

TEAM 2

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Ciara Dobrowolski
Danielle DelPiano
Emalie Belleza

ADVISORS

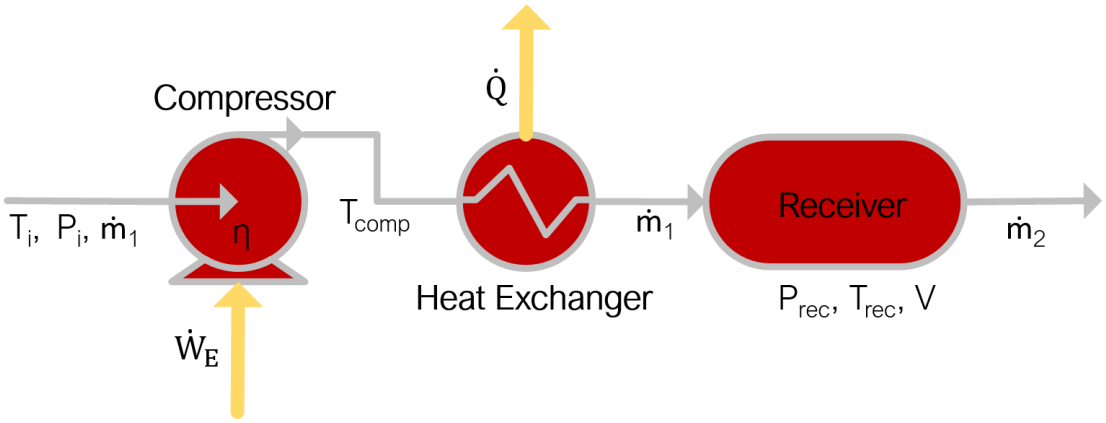
Matthew Stuber

SPONSOR

Collins Aerospace

Optimal Design of Compressed Air Systems

At the Collins Aerospace plant located in Windsor Locks, CT, the facility engineering team has collected a wealth of information on their compressed air system, which is their most expensive utility. This includes power consumption, flowrate, temperature, and pressure data at 5-second intervals in addition to P&IDs and equipment specifications. The goal of our project is to organize and analyze this information, develop a numerical-based model of their air system, compare the results to the data to identify inefficiencies, and make control and design recommendations to improve efficiency and reduce operating cost. We developed our model by creating a process flow diagram of the system and determining the appropriate model equations for each unit operation. Then, we adapted the system for solving in MATLAB. The independent variable in our model is system flowrate, and the dependent variable is system pressure, which is required to calculate other important metrics like compressor power consumption and outlet temperature. Our model is a tool for Collins to analyze various aspects of their compressed air system, including power consumption, inlet conditions, set pressures, and control strategies. It will be adapted as required by the facility engineering team at Collins and has the potential to result in significant performance improvements and energy savings



SYSTEMS ENGINEERING

TEAM 3

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Louis Duller
Seth Fortin
Brandon Mello
Qianlong Wu

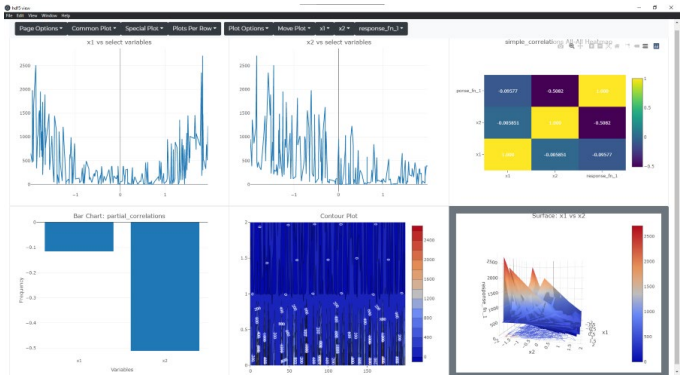
ADVISORS

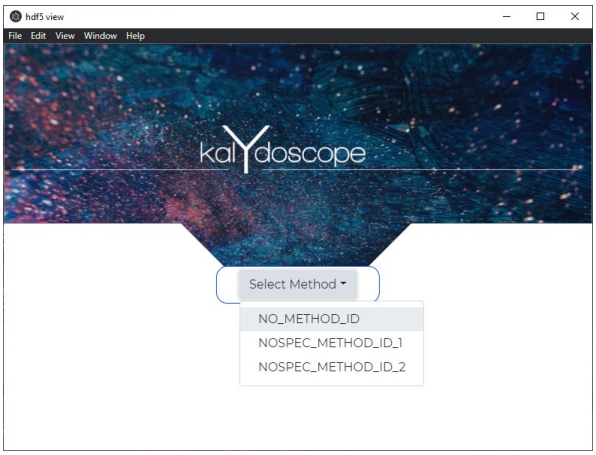
Yufeng Wu

SPONSOR

Carrier

HDF5 Interpretation and Visualization





The sponsor of this project, the Carrier Corporation, uses state-of-the-art technologies for model-based systems engineering (MBSE) of complex systems. One of the model-based design toolkits employed by Carrier is a software called Sandia Dakota. The Dakota software uses a file format known as HDF5 to contain the outputted information from the analysis results. Dakota's HDF5 output files have a difficult structure to follow, in turn producing results which are difficult to interpret. Carrier is looking to develop a method by which they can automatically process such HDF5 files and make more efficient use of the information contained within them. Leading into the project which the team has been presented by the company: develop an application which can seamlessly parse an HDF5 file produced via the Dakota application, and use the information contained within the file to provide the user with an interface in which they can better analyze and visualize the information contained within. The application is a desktop application which is capable of reading and processing HDF5 files and utilizes web-based technologies in order to create a pleasant and intuitive interface allowing users to extract significant information from HDF5 files through producing versatile plots and visualizations of the data contained in various ways. The application will allow the Carrier team to easily visualize the results of methods, compare and contrast variables, find optimal values, and more. The application grants users the ability to create a variety of custom visualizations from the datasets contained within a wide-array of user provided HDF5 files. This application was developed using the Electron software framework, React and Bootstrap components, as well as the H5PY and Plotly libraries for data processing and visualization generation.

SYSTEMS ENGINEERING

TEAM 4

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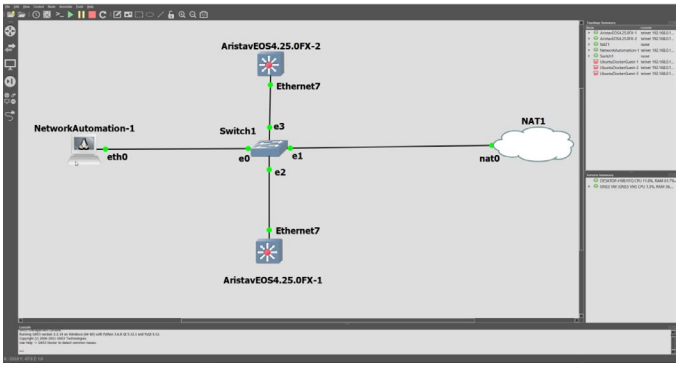
SONALYSTS

Model-Based Systems Engineering Switch Configuration



Sonalysts is a company based in Connecticut that has integrated advanced technology capabilities of a defense research, development, and engineering firm while also providing solutions to services involving graphics design, sound design and set construction or exhibitory business. Sonalysts' goal in sponsoring this system engineering project is to introduce the team upon the subject of model-based systems engineering of complex systems that are built from the synergy of computational and physical components, in this instance, an Arista switch is the main focal point. This exposure increases the awareness of systems engineering while also illustrating its concepts through projects. Another worthy note for the importance of this project is that major changes have been initiated by the Department of Defense which prioritizes the practice of Agile software development process as a means to improve the software quality and speed of delivery.

The goal of the project is to generate Arista switch configurations, which will then be loaded the new configuration onto the switches. Our was tasked with modeling the switch on a systems modeler called Cameo along with the necessary components and possible security features, if necessary, of a nominal target network. Additionally, the model exports all the essential configuration of the switch. The team also developed Python based code to convert the output of the model into configuration files that could be loaded onto the switch. The ultimate goal of this software development is to eliminate any manual updates that occur when configuration files are generated before being loaded onto the switch.

SYSTEMS ENGINEERING

TEAM 5

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SPONSOR

Collins Aerospace

Densely-Packaged Electronics Circuits

Team 2114's project is a joint effort between the Electrical and Mechanical Engineering teams. Our main goal is to observe any differences gallium nitride (GaN) transistors exhibit in a DC/DC converter compared to a converter using a silicon (Si) transistor. Our research allowed us to predict that GaN-based devices will perform with higher efficiency and less power dissipation than Si-based devices. Our goal is to prove this in the laboratory using experimental results. These experimental results will provide our sponsor, Collins Aerospace, with information to aid them in their transition of using GaN transistors rather than Si transistors for aerospace applications, particularly those that require DC/DC converters. The challenges facing our Electrical team were designing a PCB board based on GaN System's GS61008P-EVBHF board and reporting all learnings gained from the design as well as the design files back to the sponsors. Then we were to send our design files to a PCB manufacturer to have our board fabricated and assembled. Another challenge we were assigned was testing the original GS61008P-EVBHF board with our custom PCB board and reporting any differences in performance or measurements that were discovered. One challenge facing our Mechanical team was taking pictures with a thermal imaging camera of the GS61008P-EVBHF and custom PCB board and reporting back all measurements and any notable differences. Another challenge our Mechanical team faced was creating a model of the PCB board in Ansys and running a thermal analysis on the PCB before it arrives and comparing it to the thermal imaging camera results obtained from pictures taken of the PCB.

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