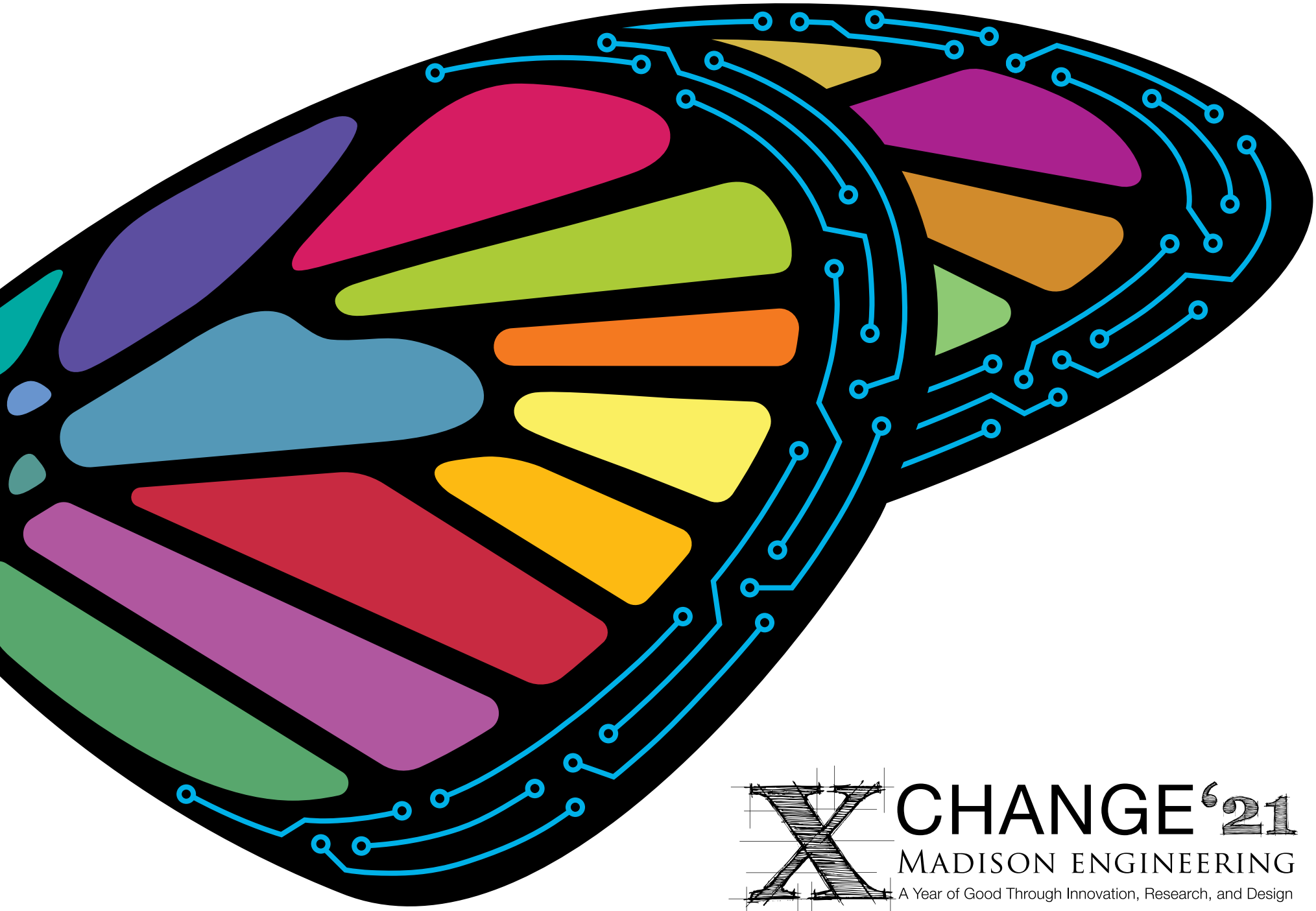


XCHANGE '21

MADISON ENGINEERING

A Year of Good Through Innovation, Research, and Design

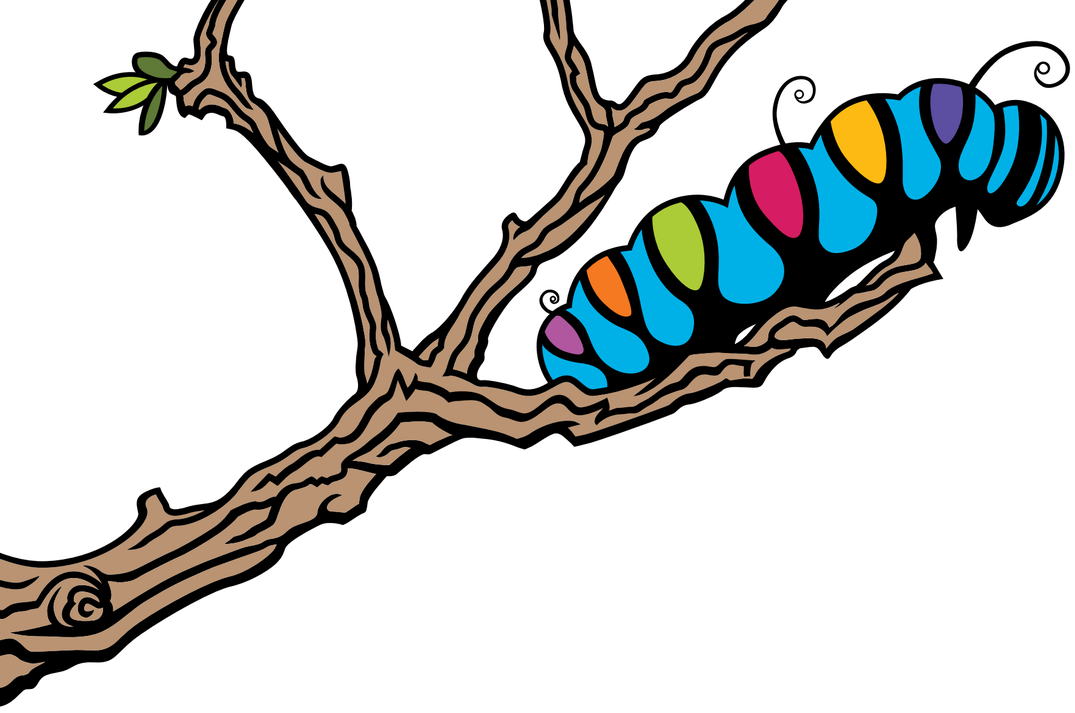
JMU

Department of Engineering

Mentoring and motivating Madison Engineering project teams during a global pandemic is no easy task, but we met that challenge and found innovative ways to connect, collaborate and create value. Thanks to all our students, faculty and staff that have forged ahead when it was easier to give up. Your efforts are noticed and have made a lasting contribution to the Madison Engineering community during this unprecedented time. And thanks to our families for supporting our important engineering work.

JACQUELYN K. NAGEL

Assistant Department Head
Department of Engineering



DISCOVER

What a year this has been! We have learnt so much about ourselves, our interactions and our communities. We dealt with anxieties about the fragility of our systems; natural and human-made. We held on tightly to the bonds that unite us, even as we changed and grew. And we continue to grow. Whether it be in the face of a raging global pandemic, the tensions of adversarial politics or the struggles for the ideals of social justice, this is humanity at its best; the ability to learn, adopt and adapt.

Even with all this hanging over us, the show did go on. Extending beyond solving problems, to seeing new possibilities, engineers joined other professionals to care, to reimagine and to do. As the world continues to contend with the balance between growth and survivability, the next generation of engineers will be at the forefront of fostering new visions of hope. What a remarkable profession this is.

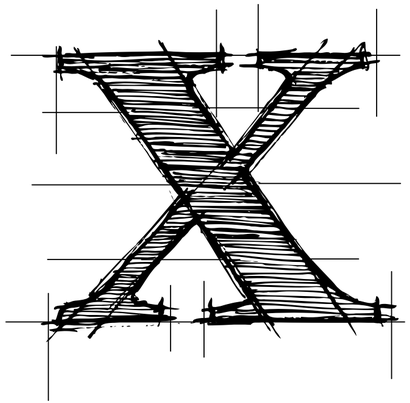
This is the theme of this year's celebration, a display of our strength, our resilience and our reemergence. Taking lessons learned and forging a better future with new possibilities and tools fashioned in tenacity. It was hard, but we did it.

Well done!

BAYO OGUNDIPE PH.D.

Interim Head
Department of Engineering
April 6, 2021

TABLE OF CONTENTS



DESIGN


HONORS

CASSIDY ANDERSON

This project explores creating a class where students of any discipline can learn about the field of engineering and the connections between engineering and the liberal arts. The class is centered around discussion of open-ended questions along with assignments and reflections to encourage curiosity, creativity, and critical thinking. Five main disciplines of liberal arts will be addressed: history, art, music, literature, and philosophy. Using Leonardo da Vinci and the concept of the "Renaissance Man," students will examine examples of interdisciplinary work and learn how to apply those concepts to their own field of interest. The course should leave students with an understanding that interdisciplinary problem solving allows for creative solutions.

JESSICA BESNIER

This thesis explores the relationship between poverty, water quality, education, community health, and quality of life in rural Tanzania and rural Guatemala. These metrics will allow for a throughout analysis of the relationships between the countries and will help determine their impact on the quality of life in places in these two countries. While Guatemala and Tanzania are drastically different countries, they share more things in common than not. By looking into these areas, conclusions were drawn about technologies and ways of life in these areas. Additionally, after analyzing data and comparing the similarities, differences, and unique aspects, the correlation between these five different factors inspired numerous ideas on ways to improve rural communities in these countries. One of the goals is that this project will help develop ways to translate lessons learned from one community to another by opening one's eyes to how two drastically different countries have so much that can be learned from one another.

CHRISTOPHER JONES

This project aims to explore the different factors affecting the design of a sustainable latrine by focusing on a case study in Ifakara, Tanzania. In Ifakara, the community is currently struggling with wastewater contamination as a result of their current latrines. This stems from a lack of sealed latrines and a high ground water table. This project analyzes how the engineering design process was influenced by the socio-cultural factors of the community in order to develop a redesigned latrine. By utilizing my experiences within Tanzania as well as working on a capstone centered around my case study, I was able to analyze what factors influenced our design decisions. This project highlights my experience and the way in which engineering is influenced by socio-cultural factors.

BUILD


SENIOR

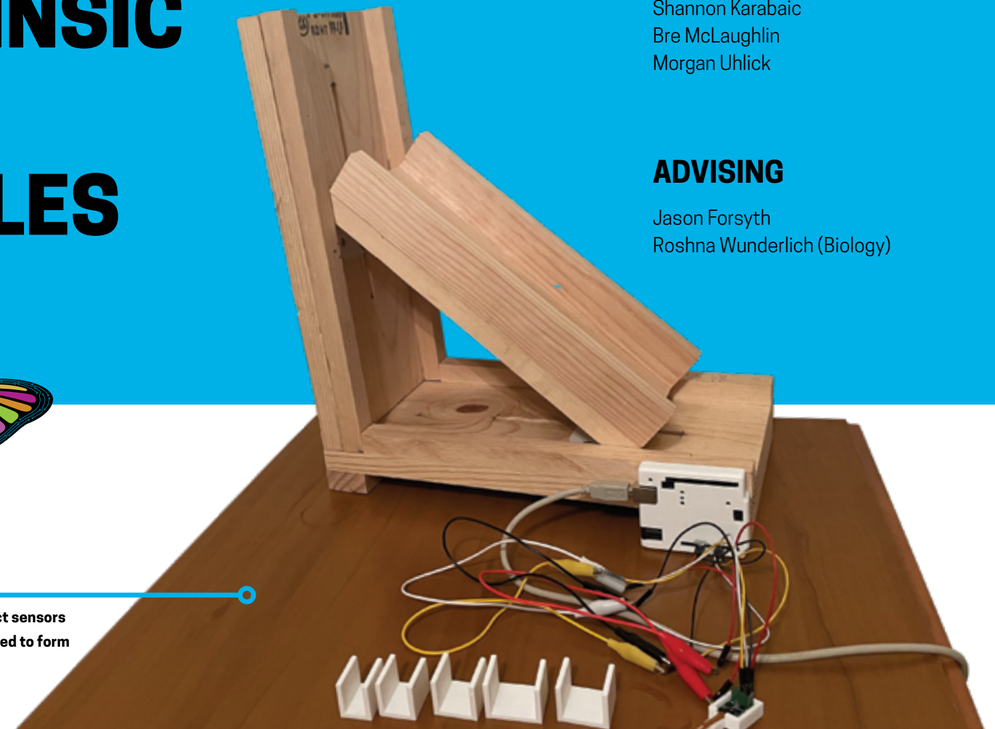
ASSESSING INSTRINSIC FOOT MUSCLES

TEAM

Nathan Carney
Niko Droukas
Shannon Karabaic
Bre McLaughlin
Morgan Uhlick

ADVISING

Jason Forsyth
Roshna Wunderlich (Biology)



A simple wood frame with SingleTact sensors and Arduino technology are combined to form our prototype.

Around the world, thousands of diabetics and elderly people suffer from weak intrinsic foot muscles causing them foot pain, poor balance, and loss of mobility. There is currently no favored method for professionals to test the intrinsic foot muscle strength of these patients. This project explores the ability to use force sensors and foot immobilization to create an accurate and efficient way to measure the intrinsic foot muscle strength. Using SingleTact brand sensors combined with an Arduino Uno, we were able to calculate different force outputs with given weights, as well as human toe forces. Our tentative conclusion is that two subsystems will be needed to achieve our goals: a sensing method (physical sensors and data collection) and a housing to immobilize the foot during testing.

The team tests its prototype.

BRIDGES OVER MOSSY CREEK TEAM A: CREEK BANK AND BED REHABILITATION

TEAM

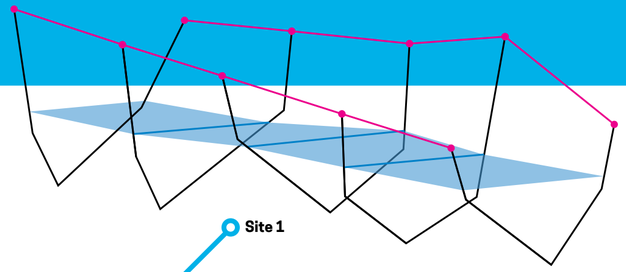
Huy Nguyen
Marcos Piggott
Devin Smith
Jack Williams

ADVISING

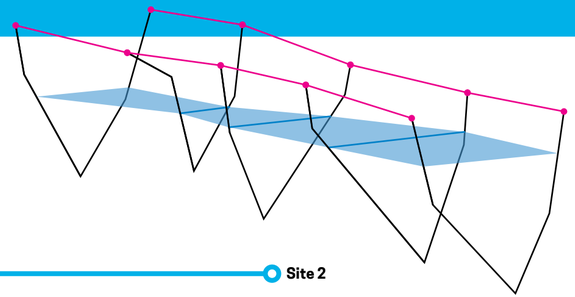
Bradley Striebig

SPONSORS

Brian Trow, Mossy Creek Fly Fishing and Trout Unlimited



Site 1



Site 2

HEC-RAS Models based on team's surveying measurements.

Nestled away inside of the Shenandoah Valley is one of Virginia's premier fly-fishing destinations, otherwise known as Mossy Creek. In May and September of 2018, the stream experienced a 500-year flood event which washed away previously built footbridges. Of the three sub-teams comprising the Bridges Over Mossy Creek capstone, Team A: Creek Bed and Bank Rehabilitation, seeks to topographically survey the current environmental conditions of a reach on the creek to supplement the exploration of potential methods of stream bank stabilization and restoration. The team hopes to hand off a topographical surveying report and the location of the focal reach to the other sub-teams. Through extensive background research in the field of water resources engineering, the team has compiled sufficient information necessary to compose and execute a surveying plan. Balzer and Associates provided a surveying workshop in which team members were trained on basic surveying equipment and procedure similar to that which will be implemented in the field. Using HEC-RAS, a river analysis software used by the United States Army Corps of Engineers, the morphological and hydrological data gathered from Mossy Creek can be analyzed and produce various models, including a steady flow water surface profile and a sediment transport model. Completion of this capstone will develop relevant experience and skills pertaining to water resources engineering and will bring the fly-fishing community of Mossy Creek one step closer to once again enjoying their passion.

It's not all glamorous. Measuring and surveying are accurately completed by getting a little wet.

BRIDGES OVER MOSSY CREEK TEAM B: FOUNDATIONS, ABUTMENTS AND SUPPORTS

TEAM

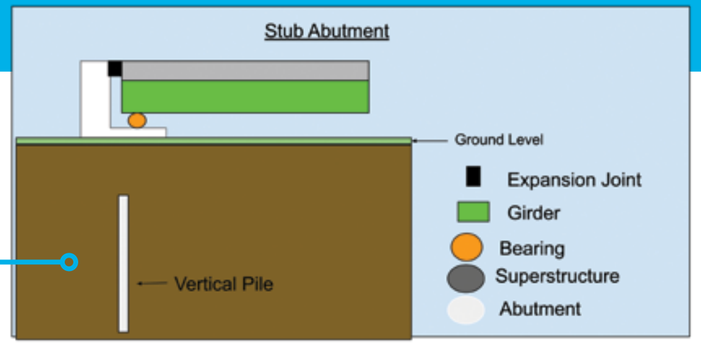
Anthony Bruno
Ryan Lesniak
Jack Lindberger
Conor McNicholl
Holden Tasillo

ADVISING

Daniel Castaneda

SPONSORS

Brian Trow, Mossy Creek Fly Fishing and Trout Unlimited



This diagram represents the concept of a common abutment system that the team may use to create more detailed designs.

Mossy Creek is Virginia's most famous fly-fishing destination, attracting vast amounts of tourists, visitors, and fisherman from across the country. Mossy Creek is a beautifully vegetated, limestone creek that meanders throughout the Shenandoah Valley, cutting in and out of Augusta County residents' properties. This project explores the complications that arise with pedestrian foot bridges when the creek is subject to flash flooding conditions. The goal of this capstone project is to design a sustainable pedestrian foot bridge that can withstand the forces from flooding, nature, and time. This sub-team is specifically responsible for designing the foundations of the bridge which serve to support the bridge deck and secure this structure to the surrounding grounds. Due to the recent reconstruction and rehabilitations of the creek's banks, we are limited in the equipment available for use to construct the bridge. These limitations have impacted the way locals design and construct their own pedestrian foot bridges seen alongside Mossy Creek. Our design utilizes lightweight, cost efficient equipment to construct pile foundations which require little to no excavation of the ground, making our impact on the environment minimal. This design will provide a lifelong lasting bridge that our client, his community members, and any other visitors can safely use and rely on.

Mixing multiple concrete batches with varying compositions to analyze their material properties allows the team to understand what composition works best for their project.

BRIDGES OVER MOSSY CREEK TEAM C: BRIDGE DECK AND SUPERSTRUCTURE

TEAM

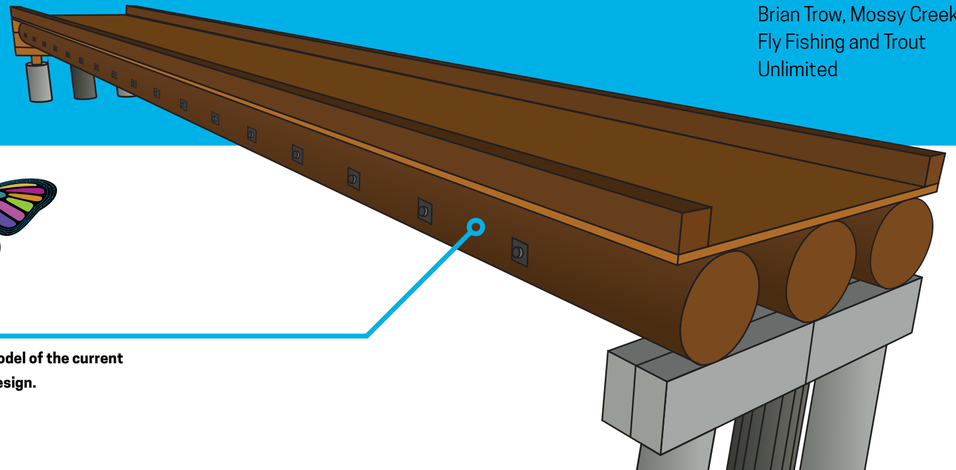
Jamie Clark
Colleen Cotter
Ian Howell
Jack Leary
Wyatt McCabe

ADVISING

Heather Kirkvold

SPONSORS

Brian Trow, Mossy Creek Fly Fishing and Trout Unlimited



Google Sketchup model of the current stationary bridge design.

Humans have been building bridges for thousands of years and some amazing examples stand as marvels of engineering and industry. These bridges aid in transportation across otherwise unnavigable paths; they scale from supporting freight trains to a single pedestrian on a hike. A local waterway in the Shenandoah Valley, Mossy Creek, has recently experienced extreme flooding events. These unexpected floods destroyed makeshift bridges which previously allowed local fly fishermen to access both sides of the creek. Team Bridging Connections (Mossy Creek Team C) was founded to address this problem by exploring topics within civil and structural engineering. They are responsible for contributing the bridge deck and superstructure to a bridge design in conjunction with teams A and B that will span across Mossy Creek and be able to safely withstand rapid flood waters. Team Bridging Connections has created a timber superstructure design from the ground up, generating detailed CAD models and technical engineering drawings that can be embodied by future teams. These models are supported by mathematical calculations and robust simulations that verify the superstructure will be able to withstand different loading conditions and stay intact in the event of a flood. Our final design is a stationary bridge with an accessible ramp to allow pedestrians to safely cross Mossy Creek.

The team conducting a site visit to examine the existing footbridges and creek bed.

COLLEGIATE WIND COMPETITION 2021

TEAM

Nikolas Bajs
Raymond Benner
Tre Bright
George Funk
Brady Monroe
Nathaniel Ray
Leith Rayes
Jaclyn Riddiford

ADVISING

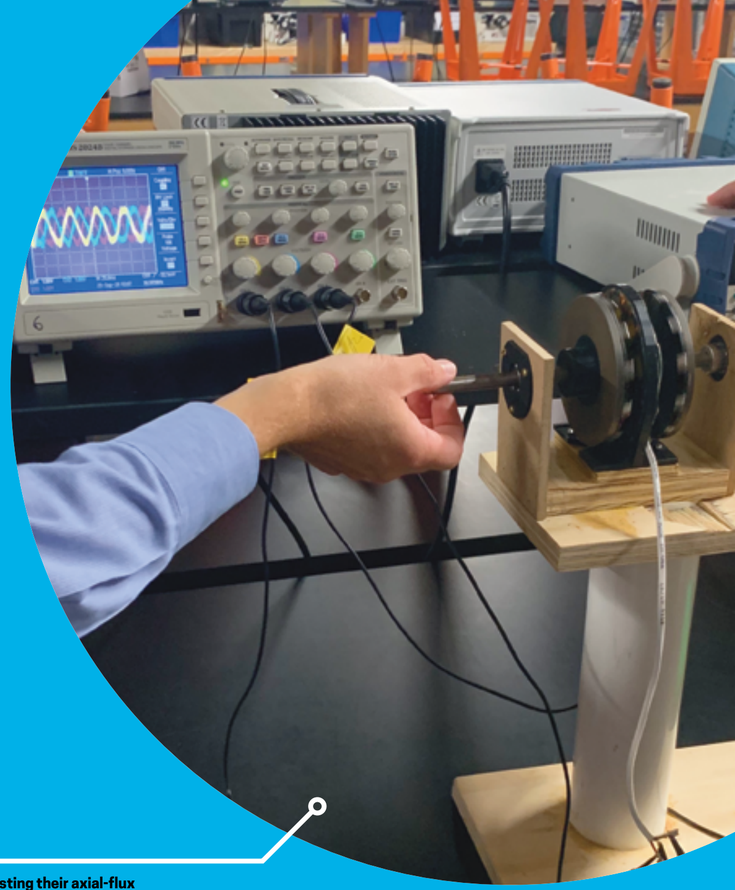
Keith Holland
Jonathan Miles (ISAT)
Edwin Clamp (Management)

SPONSORS

Department of Energy (DOE) and National Renewable Energy Laboratory (NREL)

The model of the mechanical design of the wind turbine for the Collegiate Wind Competition, including an active pitch system and the generator prototype model for reference.

Wind energy could supply 35% of the nation's electricity by 2035, according to the United States Department of Energy, creating a dramatic rise in the demand for educated personnel in the renewable energy field. Along with this, President Biden plans to make the United States a 100% clean-energy economy with net-zero missions by the year 2050, bringing more attention and demand from the renewable energy department. To address these urgencies, the Department of Energy hosts a competition each year in which they invite a select number of schools to design, build, and test a small-scale wind turbine that resembles a real-world solution for the growing energy demand. This competition provides experience and knowledge to students about wind energy for their soon-to-be possible careers. Using analytical and physical models, along with the help from the Junior Collegiate Wind Competition team, our team has developed an alpha prototype including the major subsystems of mechanical, rotor, generator, electrical, and programming. All these systems put together must fulfill the specifications and requirements set by the CWC in order to receive the most points. Along with developing, testing, and iterating our wind turbine in our new wind tunnel, we also learned and worked alongside ISAT and business majors to develop a project development plan for a 100 MW wind farm located in South Dakota. On top of this, the CWC added an extra part to the competition this year that allowed us to share and connect with others interested in or part of the wind industry, called the Connection Creation Contest. With the pandemic still ongoing, the competition will be held virtually, making our team test and present our results to the judges this June on JMU's campus.



The Collegiate Wind Competition senior team testing their axial-flux generator prototype to ensure its generation of three steady voltage waves.

DETECTING CHANGES IN ALGAE GROWTH USING MULTISPECTRAL IMAGING

TEAM

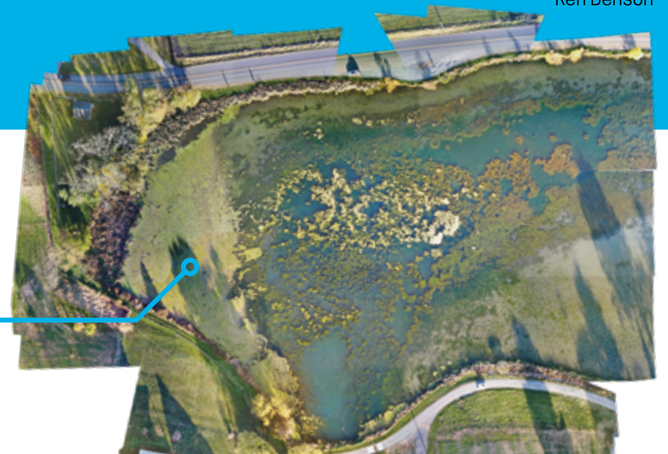
Jorge Barajas
Christian Detweiler
Cailyn Lager
Charlie Seaver
Mark Vakarchuk

ADVISING

Justin Henriques

SPONSORS

Ken Benson



The extent of algae bloom in a freshwater pond is clearly seen with the aid of a drone.

The impact of eutrophication kill wildlife and inflect billions of dollars worth of damage each year to our ponds, lakes, and other bodies of water. Ever since people started farming and growing food they have looked for ways to increase crop yield. Many modern farmers use fertilizer, primarily nitrogen-based fertilizers that plants soak up to repel bugs and increase crop yield. However, about 60-90% of the fertilizer is washed away in runoff polluting streams, rivers, lakes, and oceans. High nutrient-rich bodies of water from fertilizer runoff promote the rapid growth of algae, called algae blooms. As the algae die, bacteria in the water eat the algae and deoxygenate the water, leading to the death of animals within the bodies of water. This project showcases the development of an unmanned aerial vehicle (drone) that would be able to quantify the health of a body of water based on the amount of surface level algae, inspired by professor Henriques' humanitarian desire to approach environmental issues with new technologies to better understand the environment. The goal of this project is to automate analysis of multispectral imaging of bodies of water and determine the likelihood of eutrophication being present due to the change in algae growth.

A team member learns to manipulate the drone for accurate measuring of algae bloom.

LATRINES IN TANZANIA

TEAM

Catherine Beck
Jessica Besnier
Melaney Cutler
Megan Fedkoe
Mark Jockin
Chris Jones
Jordan Jones
Erik Idrizi
Cameron Miller

ADVISING

Adebayo Ogundipe, MSABI

The latrine prototype should help keep harmful bacteria from entering groundwater providing a safer alternative for residents.

Ifakara, Tanzania was known as “the place you go to die.” This was in reference to a historically high malaria infection rate in the area. Although Ifakara no longer suffers from extreme cases of malaria, the people are becoming sick from bacteria such as cholera and typhoid as a result of contaminated drinking water from bore holes. The source of this contamination comes from the current latrines used in the area. These latrines are not properly sealed and because of the high-water table in the region, bacteria from human waste is seeping into the community’s drinking water. Due to cultural and social practices, the community does not like to boil the water before drinking it. Similarly, the community is untrusting of filters as they do not believe a water filter can truly remove all the harmful bacteria. As a result, our capstone design team aims to prevent bacterial contamination by addressing the current failures in the existing latrine experience in Ifakara, Tanzania. We have spent the last two years working on this project and are in the final phase of testing and refining. We intend to send the community a report of our work with instructions and recommendations on how to implement our project into the community.

Zoom meetings enabled the team to continue their work through the challenge posed by COVID-19.

MADE: IN SPACE

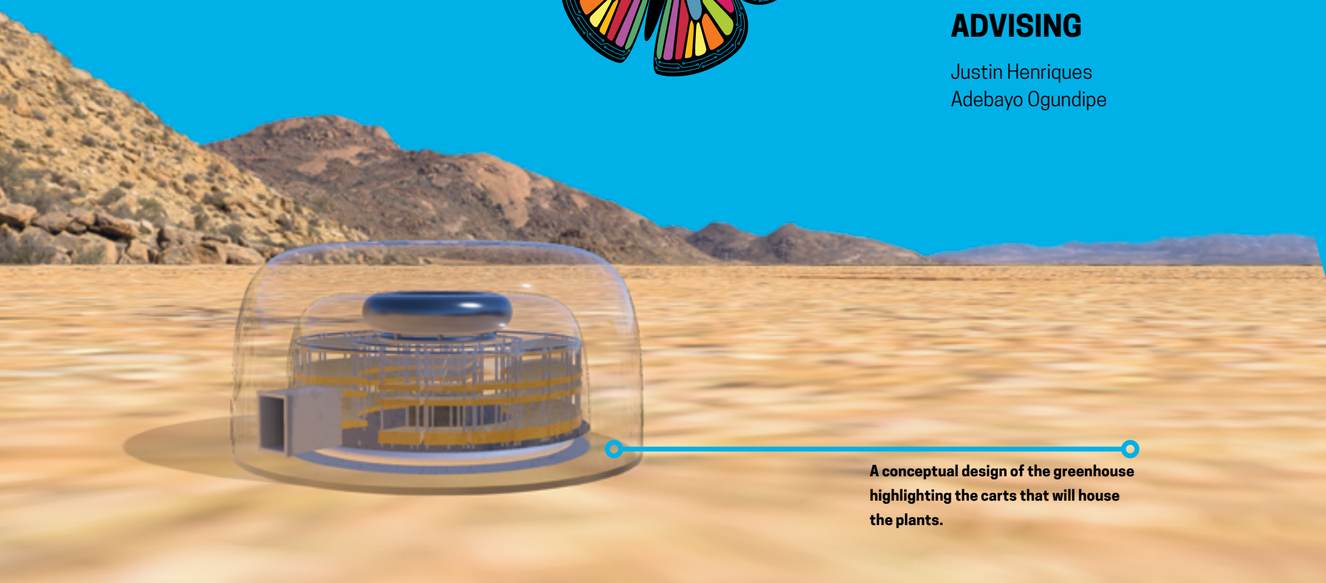
TEAM

Sophia Cronin
Lawrence Marfo
Javier Rodriguez
Zechariah Somers
Tanna Walters

ADVISING

Justin Henriques
Adebayo Ogundipe

With the current state of the world, there is more of a need to expand our inhabitable space. This being the case, we have turned our interest to the skies and beyond. Our focus has turned to the most likely candidate: Mars. On February 18, 2021, NASA successfully landed the new Perseverance rover on Mars, reinvigorating humanity's interest in space exploration, and by the early 2030's, NASA plans on capitalizing on this success by sending astronauts to explore the terrain and start the colonization of Mars. To maintain life on Mars, it is essential to sustain the health and well-being of these explorers. One of the major resources that is accessible on Earth, but not Mars, is food. Somehow, NASA needs to find a way to support a crew of four astronauts for at least 600 days on the desolate planet. The most sustainable solution is a greenhouse. Our project's goal is to design an Earth-like atmosphere in an enclosed and controlled environment on Mars, where crops can grow and thrive. The project's focus this past year was on creating a physical prototype of one of the plant housing carts equipped with a hydroponics system and sensors to monitor environmental changes. Join us as we show you what it takes to be MadE: in Space.



A conceptual design of the greenhouse highlighting the carts that will house the plants.

The team is going over a late stage iteration of a cart that will be physically prototyped.

RE-PURPOSING SILICON DIOXIDE MANUFACTURING WASTE

Amorphous silicon dioxide byproduct produced by the W.R. Grace K1 Plant in Curtis Bay, Baltimore, Maryland. Samples like this have been indirectly tested for pozzolanic activity when mixed with cement.

TEAM

Sarah-Margaret Andrews
Arthur Ashe
Sahm Azizi
Fitz Curran
Ronan Higgins
John Young

ADVISING

Kyle Gipson

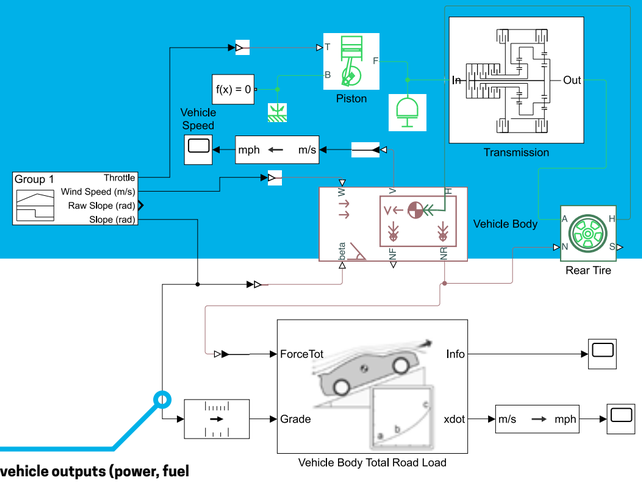
SPONSORS

W. R. Grace & Co.

Roughly 300,000 pounds of silicon dioxide byproduct are generated and discarded by a Maryland chemical manufacturer, W.R. Grace & Co., every month. This project explored the potential for this byproduct to be classified as a pozzolanic material. Pozzolans are described as any material rich in silica oxides, specifically in an amorphous phase, that react with water and lime to create a mixture with cementitious properties. Since 2008, the decline of the coal burning industry has led to a decrease in the supply of fly ash, a pozzolan used in concrete production. If this silicon dioxide byproduct can be classified as pozzolanic, it may have the ability to be used a replacement for pozzolans in cement. To determine the byproduct's potential pozzolanic activity the Strength Activity Index, an indirect testing method based on ASTM procedures, was performed. This involved testing for the compressive strength of several cement mortar specimens containing varying percentages of the silicon dioxide byproduct. Currently, the results from the Strength Activity Index tests are being analyzed to determine if the silicon dioxide byproduct shows signs of pozzolanic activity.

Team SiOsix conducting a Strength Activity Index test on cement samples containing the silicon dioxide byproduct from the K1 Plant at W.R. Grace.

SHELL ECO MARATHON STRATEGY TEAM



Analytical model that provides vehicle outputs (power, fuel efficiency, and fuel economy) for the fuel-efficient vehicle and a driving strategy around the track.

TEAM

Jonathan Amaya
Jordan Capelle
Francis Chval
Alejandro Mastrapa
Jordan Prax
Mark Rodriguez

ADVISING

Robert Nagel
Rob Prins

SPONSORS

Royal Dutch Shell

According to the Environmental Protection Agency (EPA), transportation accounts for 28% of greenhouse gas emissions in the United States. These air pollutants emitted from vehicles have played a role in increasing cardiovascular disease and cancer cases; furthermore, raising the concern in environmental topics such as smog and acid rain. The 2021 iteration of the Shell Eco-Marathon vehicle aims in giving a perspective of future car technology that includes minimal environmental impact with the utilization of an analytical model. The analytical model fosters the power of engineering with the help of Simulink to inform and validate design decisions involving the car in efforts to increase fuel-economy. This model also analyzes dimensions involving the driving strategy. Strategizing the course of the competition will help decrease the amount of fuel used by the vehicle, improving its fuel efficiency.

Shell Eco-marathon strategy team working on the fuel-efficient vehicle in the lab space.

SPENT GRAIN RECOVERY SYSTEM

TEAM

Peyton Dudley
Connor Feit
John Gardiner
Collin Kenney
Chris Smith

ADVISING

Samuel Morton III

SPONSORS

Pale Fire Ale

Dried brewers' spent grain.

Spent grain is the major by-product of the brewing industry. The high moisture content of the spent grain, over 80% water, causes it to have to be used within 24-hours. Here in Rockingham County and the surrounding areas, breweries give their spent grain away to farmers to be used as animal feed. Our project is focused on ensuring that spent grain is preserved before it spoils and is no longer consumable. This will be done by aggregating the spent grain from the area to then be dried, packaged and sold for a profit. The process will add value to the spent grain by increasing its shelf life. If the process is more costly to implement than the grain will be worth, a solution will be worked on to better coordinate pickup times for farmers and guarantee that none of this biowaste ends up in a landfill.

The team working on a presentation for their design review panel.

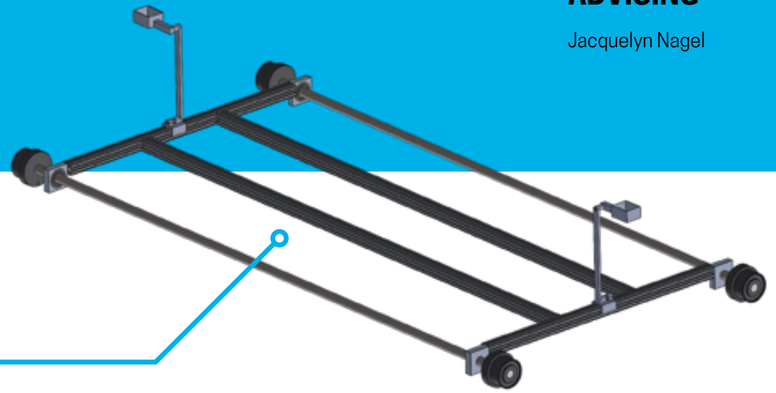
TRAIN OF THOUGHT

TEAM

Cassidy Anderson
William Hinkle
Lachlan Hudson
Ethan Keck
Trevor Kraeutler
Zach Wenzler
Adam Zahorchak

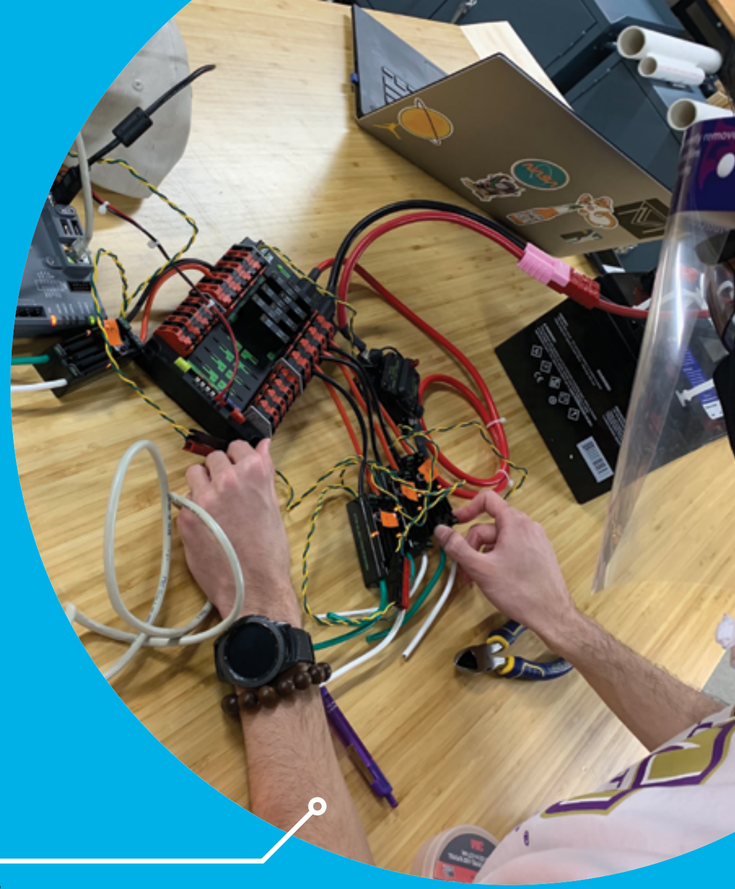
ADVISING

Jacquelyn Nagel



An autonomous rail cart with a video feed can be used to detect surface level defects, that can then be examined manually.

From January 2010 to November 2019, derailments have cost railroad companies over $350,000,000 in damages in addition to the costly environmental remediation cleanups and injuries. The Commonwealth of Virginia is home to many small scale railroads that have less than a total of 100 miles of track between destinations. Many of these small scale railroads do not have the resources to autonomously inspect their railroads and cannot afford the cost of large scale railroad inspection equipment along with the resources needed to run these inspection systems. The team has an ultimate goal of preventing or greatly decreasing the likelihood of train derailment by focusing on the detection of surface level defects on rails which will have an impact on all railroads while also helping the local short line railroads. By creating an inspection system that works for all railroad companies, they can more accurately and precisely find surface level defects than current manual inspections. The team has worked with industry experts to understand what the most common and dangerous surface level defects are and have explored different methods of detection. We are pursuing the creation of a small autonomous rail cart that takes images of the track from a video feed and sorts them into “good” or “bad” rail photos through machine learning. Locations with “bad” rail will then be re-inspected by manual inspectors to determine the severity of the problem and work towards fixing it. This system will identify and alert users to dangerous levels of rail damage while providing a cheaper inspection alternative for smaller railroads. It also acknowledges and takes advantage of the expertise and abilities of manual inspectors to make the final decision.



The team determines how to power their design.

USING VITAL SIGNS TO DETECT NOCTURNAL HYPOGLYCEMIA

TEAM

Brandon Duda
Josh Clements
Brady Finzel
MacKenzie Gring
Ashley Vayo

ADVISING

Jason Forsyth
Shraddha Joshi

A team member tests the prototype.

Over 34 million Americans, or 10.5% of the population, have diabetes and about 1.5 million Americans are diagnosed with diabetes every year. Hypoglycemia is often reported to be one of the most feared complications of diabetes, specifically when it occurs during sleep. Nocturnal hypoglycemia can be dangerous because an individual is unlikely to recognize symptoms or wake up during an episode. It may result in physical injury, poor quality of life, impairment in cognitive function, seizures, and even death. Our project identifies opportunities to improve the detection of the onset of nocturnal hypoglycemia by measuring the changes in vital signs associated with hypoglycemia. We have identified that changes in body temperature, heart rate, and perspiration rates are correlated to a hypoglycemic episode. We have developed a non-invasive device that is capable of continuously measuring these vital signs while the user is sleeping. The device detects any changes in the user's vital signs and then determines if these changes correlate to nocturnal hypoglycemia. If this correlation occurs, the device will awaken the user from sleep and alert them that they are experiencing the beginning of nocturnal hypoglycemia. The device will be an alternative way of detecting hypoglycemia without the use of measuring blood glucose levels. Our tentative conclusion is that this device will be more accurate and reliable in detecting the onset of nocturnal hypoglycemia.

Facing a new world of communication, the team persevered by meeting through Zoom.

REDESIGN


JUNIOR

AERIAL MULTISPECTRAL IMAGING

TEAM

Sofiya Gorban
Stephen Mitchell
Dylan Varghese
Tyler Webster

ADVISING

Jason Forsyth
Justin Henriques

The highlighted area shows changes in temperature, helpful for viticulturists and other types of agricultural producers.

Due to the inherent cost of precision agriculture systems, it is difficult for small scale farms to adopt cutting edge technologies. The Aerial Multispectral Imaging Capstone Project aims to bridge the connection between precision agriculture and smaller agricultural sectors. For the past two years, this capstone team has been working closely with Blenheim Vineyards to develop a web application that will process relevant agricultural data to create value for viticulturists at Blenheim. So far, the 2020-2022 capstone team has focused on expanding the scope of the project to include a ground-based sensor mesh network to detect the onset of frost. Ongoing work on the project includes prototyping and deploying a physical system to be deployed as well as updating the web app's user interface and database to incorporate the new data.

A team member checks the sensor on a chilly day.

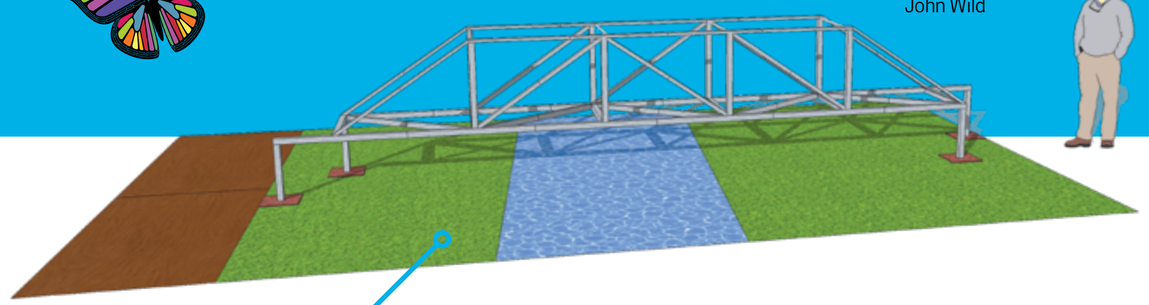
AISC STUDENT STEEL BRIDGE COMPETITION

TEAM

William Ahorsu
Michael Allsop
Jack Lochary
Andrew McHale
Jadon Rabon
Katie Smith

ADVISING

Daniel Castaneda
Heather Kirkvold
John Wild



Preliminary concept sketch of bridge design staged on the competition construction site layout.

The American Institute of Steel Construction's Student Steel Bridge Competition challenges student teams to design and develop a scale-model steel bridge. Over the past 25 years, over 175 schools compete each year across the country creating a hands-on steel structure that grows interpersonal and professional skills. An annual set of rules and regulations are set forth by the AISC for competition entries to abide by. This detailed set of rules requires the team to explore different design concepts and fabrication techniques to develop and build a steel bridge. On the day of the competition, the team will assemble and load test their fabricated design according to the competition requirements in front of a panel of judges. In order to maximize the strength of the bridge and simplify assembly, the team has decided to incorporate a truss structure into our design. With the use of AutoCAD and SAP2000 for the design and structural analysis of the bridge, the team was able to develop a concept that utilizes steel donations from local businesses.

The structural analysis sub-team discusses the forces on jointed connections while the materials sub-team inspects a steel member grade.

BEAVER CREEK RESTORATION

TEAM

Hunter Goodman
Jacob Messner
Lacey Monger
Jack Peot
Andrew Sklavounos
Tyrees Swift-Josey

ADVISING

Bradley Striebig

Aerial view of the Beaver Creek Case Study Site to be repaired using the Natural Channel Design Process.

The Chesapeake Bay Watershed has over 100,000 tributaries located throughout six states on the East Coast. One of its tributaries, Beaver Creek, is located right outside of Dayton, Virginia in the Shenandoah Valley and is the focus of this capstone. The objective of this project is to restore the riparian and instream habitat of a reach section of Beaver Creek to reduce the amount of stream bank erosion. Recent flooding events have damaged over 30 feet of riparian land through erosion and aggradation of the streambank. This has caused the creek to split into two different channels, forming an island in the middle, and leaving four streambanks susceptible to erosion. The excess erosion has harmed the local ecosystem through a loss of instream habitat through channel bed degradation, lower dissolved oxygen levels in the water and a lack of natural habitats for aquatic creatures. In addition, eroded sediments are the primary transport mechanism for moving nutrients like nitrogen and phosphorus into water. These excess nutrients then contribute to the harmful effects of eutrophication and pH imbalances that are present in the Chesapeake Bay Watershed. To approach these problems, the team is using a Natural Channel Design (NCD) process that consists of ten phases to restore the stream. After understanding the problem and gaining background knowledge on the NCD process, the team has completed Phase I of the process and is looking to complete Phases II-V during the 2021 Spring Semester. To help, the team is applying for a grant worth about $10,000 from the Embrace a Stream Program offered by the non-profit organization Trout Unlimited (TU). The grant, along with the assistance of the local Massanutten Chapter 171 of TU, will allow the team to formulate a design to restore the creek back to its natural state.

Team members at Beaver Creek learning about important macroinvertebrates and key characteristics of a healthy stream.

BIOMIMICRY GLOBAL DESIGN CHALLENGE

TEAM

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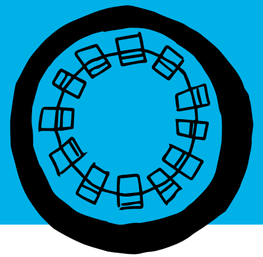
Zach Mountjoy
Wesley Quill
Kelly Riggan
Andrew Smith
Gage Waltner

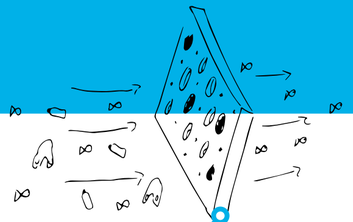
ADVISING

Jacquelyn Nagel

SPONSORS

Biomimcry Institute





Sketches of potential designs inspired by living organisms.

An estimated 14 billion pounds of trash, most of it plastic, makes its way into the oceans every year. With inspiration from the United Nations Sustainable Development Goal 14, this project aims to prevent increasing amounts of litter from entering the oceans by focusing on major watersheds that contribute to the ocean's litter pollution. The challenge, hosted by the Biomimicry Institute, emphasizes the use of Biomimicry, or Bio-Inspired Design, to create new innovations to solve current world problems. To address this problem, the team is working on identifying biological systems that are associated with the proposed problem and could provide inspiration for a solution. The solutions generated from the biological inspiration will be adaptable to different settings to ensure the greatest global impact. We intend to test our solution in local waterways before applying it to larger, more polluted areas before the submission deadline of June 31, 2021. A shared passion of cleaning the oceans drives us to create a sustainable, eco-friendly design concept.

The team goes over the challenge and brainstorms possible solutions.

COLLEGIATE WIND COMPETITION 2022

TEAM

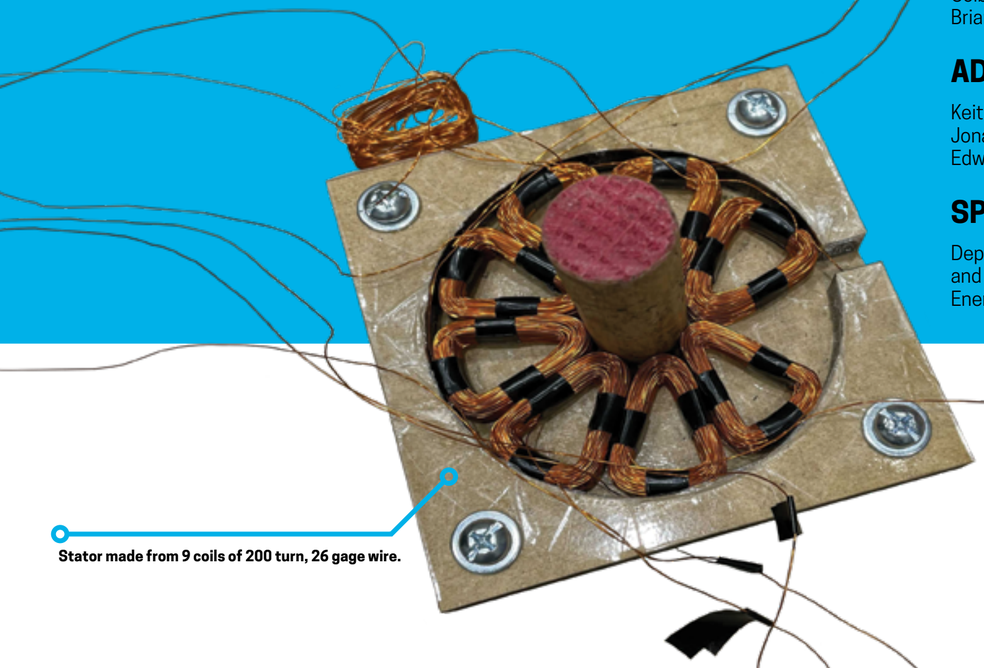
Joshua Bautch
Alexandra Davis
Garrett Downs
Ban Mansoor
Nicole Peterson
Matthew Porchetta
Colby Schneider
Brian Sweet

ADVISING

Keith Holland
Jonathan Miles (ISAT)
Edwin Clamp (Management)

SPONSORS

Department of Energy (DOE) and National Renewable Energy Laboratory (NREL)



Stator made from 9 coils of 200 turn, 26 gage wire.

According to the United States Department of Energy's Wind Energy Vision report, wind energy could provide 35% of the nation's electricity by 2035, creating a need for individuals with professionally relevant engineering experiences in the multi-faceted wind and renewable energy sector. The primary objective of this project is to develop a small-scale prototype wind turbine for the 2022 Collegiate Wind Competition, sponsored by the U.S. Department of Energy, and the National Renewable Energy Laboratory. In accordance with the published competition Rules and Requirements, the functional prototype will be subjected to wind tunnel testing to demonstrate power production, control, and safety capabilities similar to those of industry scale wind turbines. The team has begun creating concepts for multiple subsystems of the turbine using analytical modeling software and physical modeling.

CWC Team 2022 stands ready for the challenge.

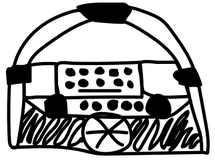
CONNECTED RELATIONSHIPS USING IOT

TEAM

Katelyn Anderson
Cassie Bedard
Garrett Hutson
Evelyn Munsterman

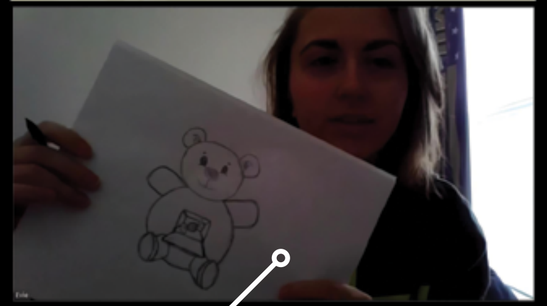
ADVISING

Shraddha Joshi



Sensors and software enable an interchange of ideas through the internet using physical objects.

Today's world has brought digital connection and physical distance to a new light. Due to obstacles such as lack of time or long distance, more and more people are using the virtual environment to stay connected to friends and family in everyday life. Our project's goal is to aid the older generation to utilize this environment to stay connected with their beloved grandchildren. We aim to do this by using the internet of things to create an easy-to-use product that helps mitigate the disconnection that comes with being separated from loved ones. Over the past semesters, we have done countless hours of research in order to get our project up and running. This research helped us decide on our stakeholder group (grandparents and grandchildren) which we then conducted interviews with to discover the main disconnects they face. We are currently using the most common disconnects to develop potential concepts with the hope to decide on a concept that we believe to be most beneficial to our stakeholders. After a concept is chosen, our team can progress in the design process to testing and fabrication. We are currently limited to the theoretical aspect of our project as we have yet to look at the technical requirements and what we as a group are capable of. Our team has high hopes to create an impactful device in the following two semesters to come.



Sharing via the internet in the age of COVID-19 has emphasized the need for innovative ways of communication, especially for our stakeholders, grandparents and their grandchildren.

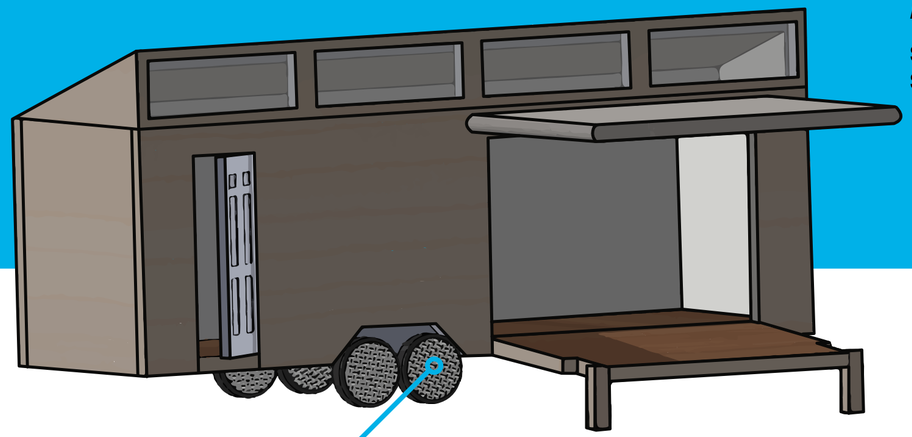
FOOD TRUCK FOR THE MIND

TEAM

Raphael Bianchi
Nick Ciccone
Erik McIntosh
Matt Paredes
Zach Weller

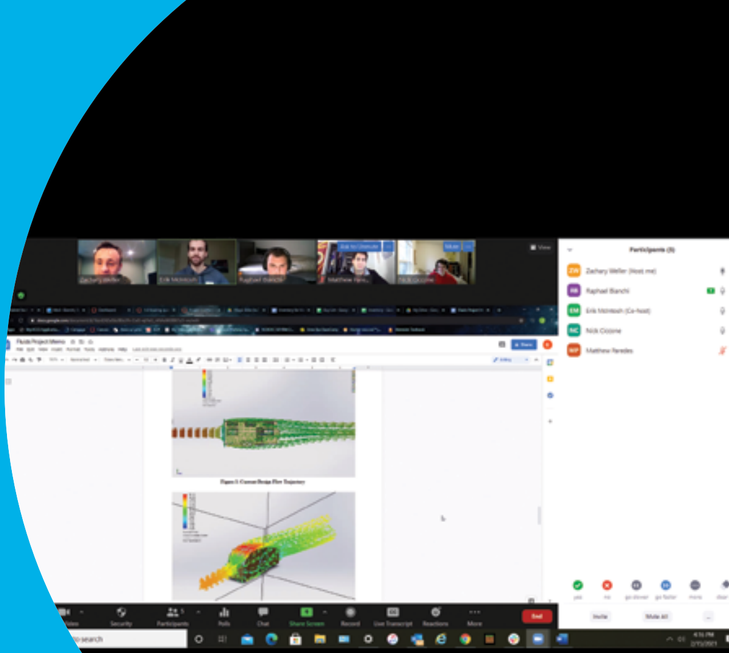
ADVISING

Samuel Morton III
Steven Harper



A prototype of the Food Truck for the Mind was developed using Solidworks CAD modeling.

In the United States, half of the high school graduates who have an interest in Science, Technology, Engineering, and Mathematics (STEM) are not proficient in skill sets necessary for these fields due to a lack of educational engagement. The Food Truck for the Mind project explores this deficiency and has been tasked with increasing interest in younger generations for STEM education in Rockingham County. The team has worked on designing, planning, and constructing a mobile trailer that will allow STEM educators to communicate technologies and subject matter to an outdoor audience. The end-product will be a modular space that accommodates for multiple methods of learning in a variety of topics. So far in our project development, the team created a project management plan, CAD models, a fluid drag analysis, and created plans for mocking up each sub-system of the trailer. The previous team has also completed construction of the trailer's frame, and purchased many of the required materials. Since this project is still in the concept generation phase, there has not been an observable impact on the surrounding community. The trailer is expected to be used as a tool to engage the Rockingham community in learning about STEM technologies, which will hopefully lead to a more active community in STEM learning.



The team used road modeling software to test wind forces.

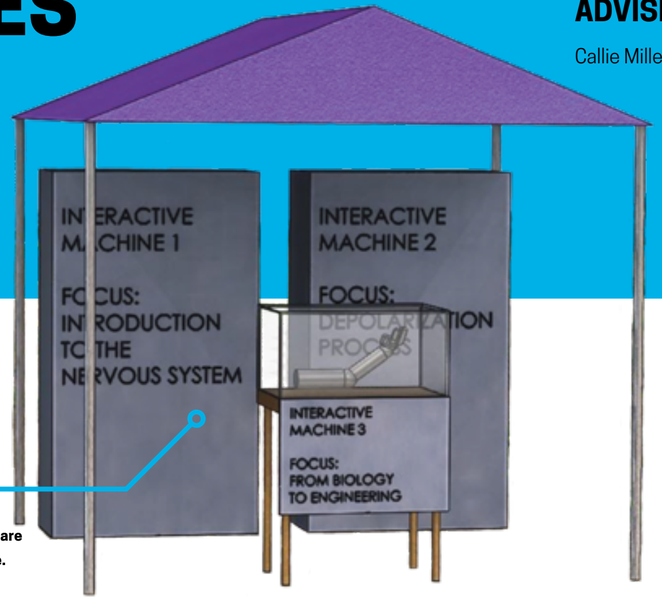
INTERACTIVE BIOPHYSICS MACHINES

TEAM

Lauren Dargan
Jenna Lindsey
Ryan Motta
William Sullivan

ADVISING

Callie Miller



Various requirements, stakeholder profiles, interview quotes, and rough concept sketches are all project elements represented in this collage.

Our team is working on the very first Interactive Biophysics Machines capstone project where we will be developing an engaging display comprised of biophysical components. Our goal is to introduce our product at the annual Rockingham County Fair as an attempt to help inspire young kids to generate an interest in science and technology. With this, our team's current problem statement is as follows: Rockingham County Public Schools appear to have an abundance of STEM-based resources made available for students of all grade levels. However, the students do not have an interest in utilizing them and do not take advantage of the opportunities provided, especially so with 4th to 6th grade students. Therefore, the goal of this project is to spark and empower the 4th-6th grade students' interest in STEM. We are currently working to develop various activities for the kids in attendance to use; one of which will be a bionic arm, in the form of a myoelectric prosthetic. This interactive machine allows the user to control an artificial limb through the use of electric impulses sent throughout the body, which are responsible for muscle contraction. We hope to have this, as well as a few other activities, ready to go for the 2021 fair and will be working to refine and improve our product as we enter the Fall 2021 - Spring 2022 semesters.

The team is meeting on Zoom to collaborate on coming up with concepts for an IoT device. Here is one rough concept the team sketched early in the concept generation process.

NASA STUDENT LAUNCH INITIATIVE COMPETITION

TEAM

Coleson Baughan
Brandon Carroll
Cameron Funk
Ben Hoare
Kris Krueger
Abby Maltese
Gray Roisch
Kelly Sadel
Trace Scordo

ADVISING

Keith Holland

The National Aeronautics and Space Administration (NASA) strives to advance the understanding of space and astronomy for the betterment of life on Earth. Each year, NASA hosts a Student Launch Initiative (SLI) competition, which offers students the opportunity to engage in a research-based, experiential project to develop and launch a high-powered rocket vehicle (HPR) and payload system. Students must design, fabricate, test, launch, recover and obtain data from a scientific payload at the competition launch site. Additionally, the student team will present detailed design, technical, and safety reports for the review and approval by NASA officials, maintain an online presence, and host STEM engagement events to reach over 200 people within their community. This inaugural JMU competition team has developed the foundation for entry and participation in the 2022 SLI competition by establishing relationships with local HPR experts, understanding competition requirements, learning about rocketry, and developing the 2022 competition proposal. Currently, the team is designing, simulating building and testing small-scale models and is obtaining guided HPR design and launch experiences to prepare for the 2022 competition.

Team members attending a rocket launch to get a better understanding of the launch process.

High power rocketry experts have helped with design and testing.

SHELL ECO-MARATHON PROPULSION AND DATA ACQUISITION

TEAM

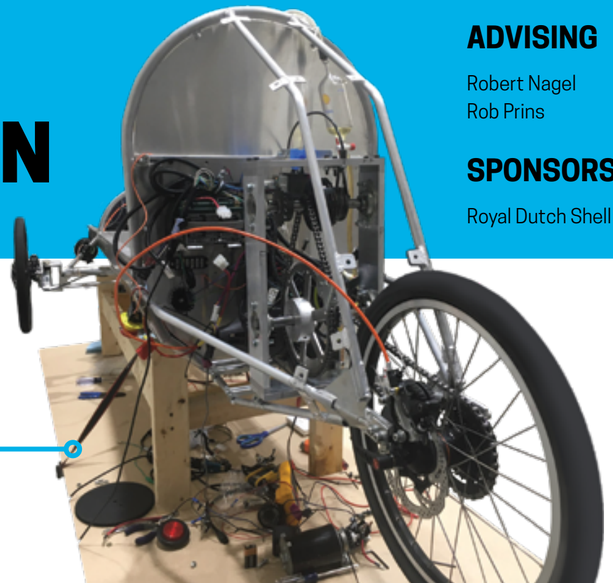
Adam Gremminger
Camden Hollowell
Kyle Lewis
Nicholas Pumpelly
Jake Schmank
Charlotte Solak
Jack Stephenson
Nick Tsoleas

ADVISING

Robert Nagel
Rob Prins

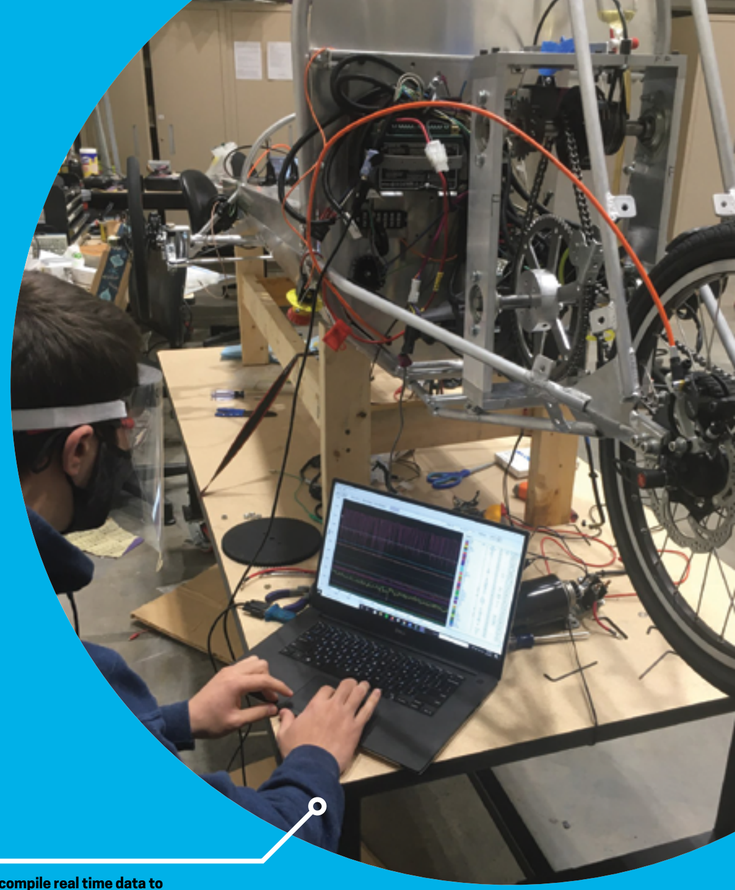
SPONSORS

Royal Dutch Shell



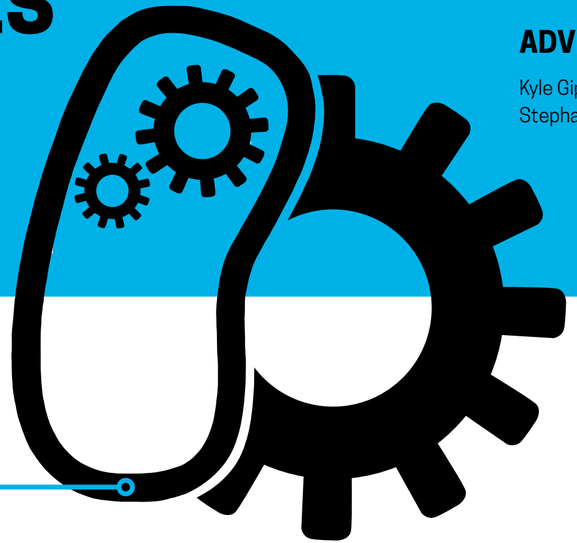
The current iteration of the Shell Eco-Marathon vehicle.

Every year, Shell Eco-Marathon brings students from across the world together to help make steps toward reducing fossil fuels by designing energy efficient vehicles to compete against one another. This legacy project has evolved over the last few years allowing James Madison engineering students to explore automotive design and cross collaborate with previous Shell Eco-Marathon Teams. This project is focusing on the data acquisition to compile real time data, to tune, and to maximize performance of the legacy vehicle that will be inherited from the current team. This year's efforts have been focused on designing and building system testing methods to assist in the collection of data. The main data acquisition method is utilizing EcoCAL software and sensors that are equipped on the drivetrain and vehicle. This data should directly translate to the vehicle allowing the team to fine tune the engine and make adjustments. In conclusion, the data collected will benefit the current and future teams in making meaningful design decisions. Those design decisions will be centered around making the competition vehicle more energy efficient.



The team uses EcoCAL software and sensors to compile real time data to analyze at a later time.

SYNTHETIC BIOLOGICAL MACHINES



Bioengineering technology has enhanced the quality of life for billions of people worldwide.

TEAM

Melanie Blatt
Corinne Brady
Lydia Chupp
Tommaso Piccorossi
Amy Veihdeffer
Johnna Verry

ADVISING

Kyle Gipson
Stephanie Stockwell (Biotechnology)

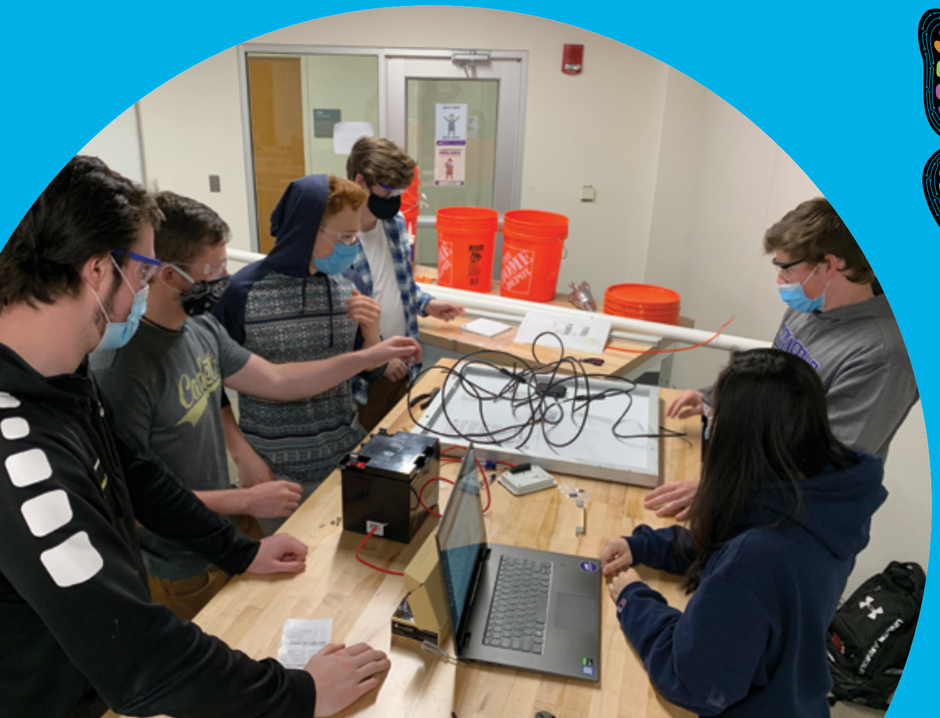
The UN 17 Sustainable Development Goals open the door for engineering to play a new role in biological research. Answers to some of these goals could be found through developments in synthetic biology as current and future multidisciplinary capstone teams are tasked with using engineering fundamentals and technology to redesign a biological system. The purpose of this redesigned system is to build solutions to local and global challenges. The progression of the project will be used as a foundation for future teams to compete in the International Genetically Engineered Machine (iGEM) competition which showcases projects that address synthetic biology within a global scope.

The team works to narrow their focus in developing an innovative product.

DELIGHT


SOPHOMORE

CHESAPEAKE BAY OYSTERS AND LEATHERBACK SEA TURTLES

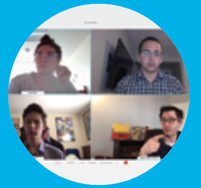


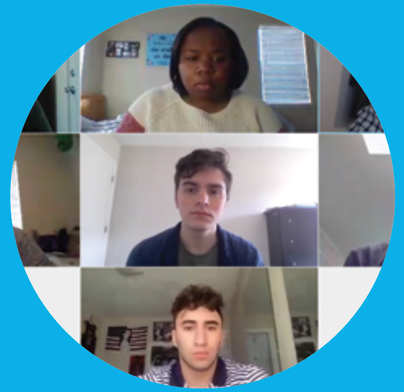
How might one design positively impact both conservation efforts for Chesapeake Bay oysters as well as leatherback sea turtles?

Ask any of our Madison Engineering sophomores and they might say: the answer lies in being able to deploy sensing equipment off-shore for remote monitoring, data collection, and transmission—a goal our students have been working steadily toward since August 2020 with Northrop Grumman Corporation and Madison Engineering alumnus, Joshua Kay.

Sophomores over this past academic year have focused on designing extensible buoy platforms with capabilities for energy harvesting, data collection, storage, and transmission usable by organizations focused on conservation efforts of oysters and oyster habitat in Chesapeake Bay as well as organizations in Melbourne, Florida focused on understanding leatherback sea turtle migrations. The overarching goal is to explore off-the-shelf components to create low-cost options accessible and applicable to a wide range of conservation and monitoring applications.

Guided by professors Jason Forsyth, Callie Miller, and Robert Nagel, students have worked together to create and test three buoy systems, one per class section. Within each section, students have worked as sub-teams with each focused on 1) energy harvesting and storage; 2) data collection, storage, and transmission; and 3) buoyancy, stability, and environmental conditions. To manage this project, students have organized to have engineering leads for each section, each sub-team, and each major engineering task. Through this design experience, students have learned engineering design processes, tools, and management while working remotely and engaging with Northrop Grumman engineers from across the nation to create final designs applicable to real world conservation needs for real world clients.





AN EXCERPT FROM “VIRTUAL INSANITY” *BY JAMIROQUAI*

Oh, this world
Has got to change
‘Cause I just
I just can’t keep going on in this virtual
Virtual insanity
That we’re living in
That we’re living in
And that virtual insanity is what we have
Yeah

Futures made of virtual insanity, now

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