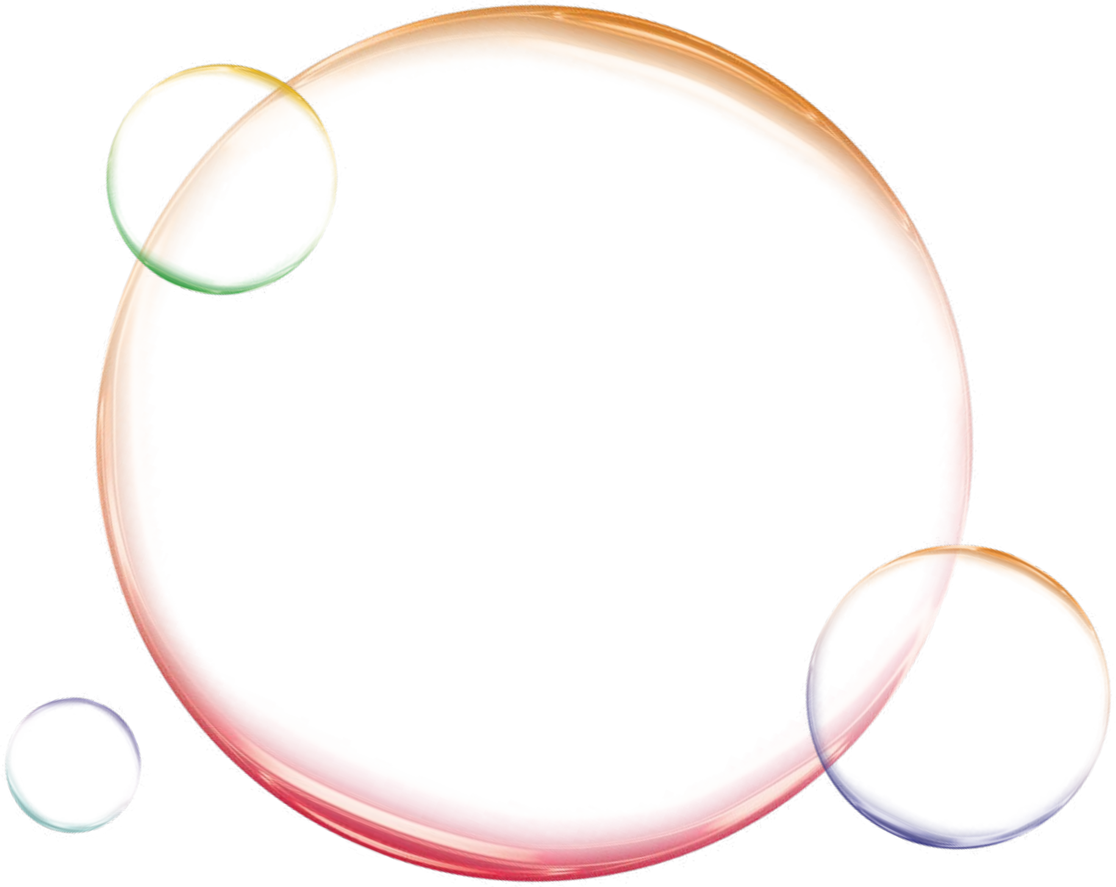

XCHANGE'23
JMU ENGINEERING
A Year of Innovation, Research and Design


JMU
Department of
Engineering



DISCOVER

We are wrapping up another year with another strong display of what makes our program unique.

We have so many reasons to celebrate.

"Every system is perfectly designed to get the results it gets." W. Edwards Deming*

An interdisciplinary engineering program like ours thrives in a culture of inclusion - one where diversity of thought, ideas, experiences, and being are not simply acknowledged - but actively sought and celebrated.

JMU Engineering is designed to exemplify a culture of collaboration that encourages and values individual support. As such, we continue to work to eliminate all barriers to true inclusion and psychological safety for all.

Engineering work depends on nurturing and diffusing diverse ideas to solve big problems and envision new possibilities. This is the theme of this year's event; a celebration of the uniqueness we each bring to this community, a celebration of our inclusive excellence.

I express my sincere gratitude to all of our project partners, sponsors, collaborators, and friends. Your support and investment in our vision makes all the difference. Thank you.

To our students, staff, and faculty - continue being extraordinary. Continue being you.

ADEBAYO OGUNDIPE, PH.D.

Head and Professor

* *This quote is often attributed to W. Edwards Deming but is disputed.*

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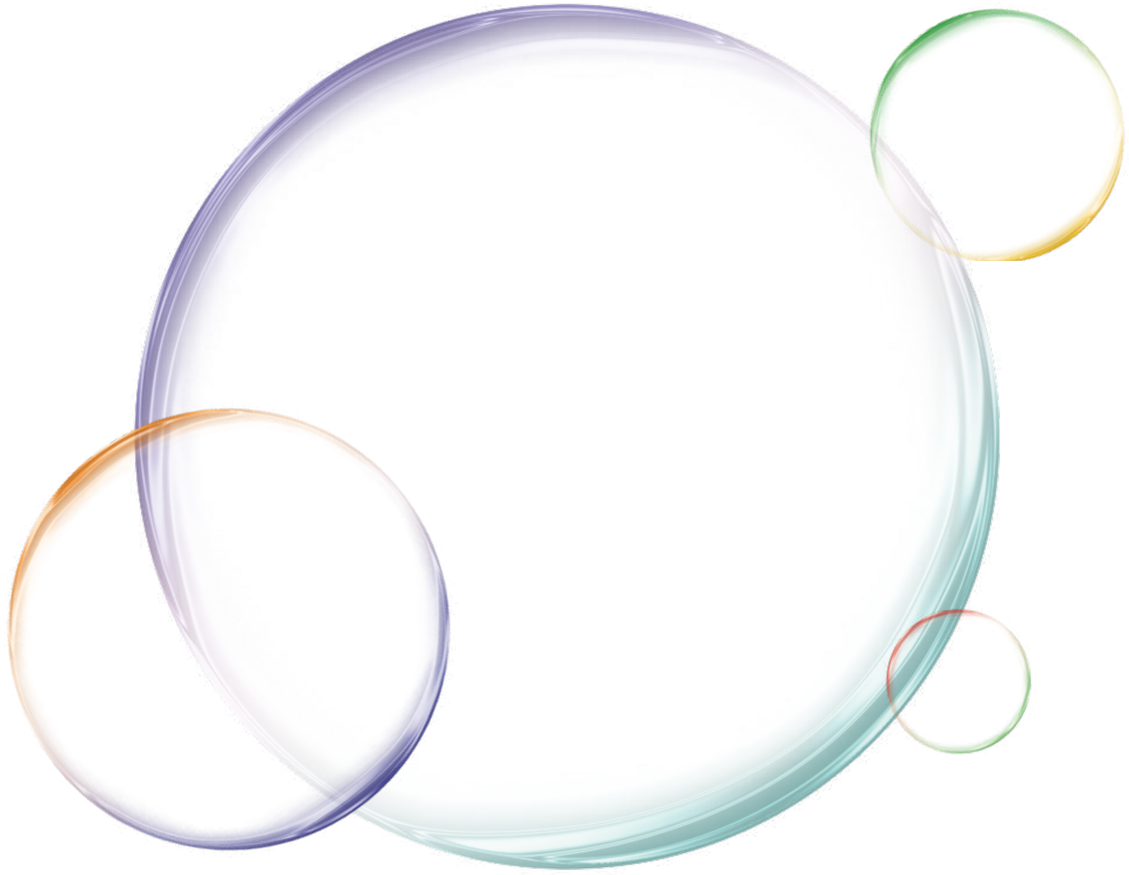


DESIGN


"Unity, not uniformity, must be our aim. We attain unity only through variety. Differences must be integrated, not annihilated, not absorbed."
– Mary Parker Follett
HONORS

AN EXPLORATION OF MENTORSHIP PROGRAMS MODELED THROUGH COMMUNITY LEARNING CIRCLES

HONORS STUDENT

Matthew Caulfield

ADVISING

Robert Nagel
Kyle Gipson
Kurt Paterson
(Arizona State University)

Matthew Caulfield presenting research to faculty participants in the Omnidirectional Mentorship Program.

Mentorship is a powerful tool grounded in the connection and relationship between individuals for personal and professional growth. Mentorship programs have shown potential in promoting growth and development in higher education, but there is a need to understand how to design and implement effective programs.

This honors project presents two studies that explore different aspects of mentorship programs, including the selection of mentorship models for desired outcomes and an omnidirectional mentorship program for faculty members at a Mid-Atlantic university. The studies provide evidence towards the benefits and transformative potential of mentorship programs in higher education, complement existing research on innovation and leadership, and explore the impacts of participants in an omnidirectional mentorship program in a higher education setting.

The results of the second study suggest that participation in an omnidirectional mentorship program can provide a safe and supportive environment for individuals to explore their personal and professional goals, and develop the skills necessary to achieve them. Additionally, the community building generated by the program provides a space for individuals to find new connections and rediscover joy in their work, which can lead to greater engagement and productivity.

Matthew Caulfield posing for a photo in front of King Hall.

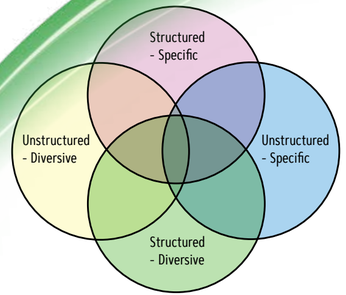
ENGINEERING STUDENTS REFLECTIONS OF CHILDHOOD EXPERIENCES: STRUCTURE AND CURIOSITY

HONORS STUDENT

Collette Higgins

ADVISING

Robert Nagel
Melissa Wood Alemán



Name	Definition	Attributes
Structured - Specific	Activities in which a particular outcome or piece of knowledge needs to be obtained through an activity that is facilitated by someone.	Organized, deliberate, systematic, attentive, enjoys routine
Structured - Diversive	Activities in which an outside mentor facilitated an activity in order to be immersed in an activity because it is new and interesting to them.	Flexible, explorative, multimodal, self-advocating
Unstructured - Specific	Activities completed solo for the purpose to gain knowledge in a particular area or skill set.	Focused, independent, goal-oriented, disciplined, purposeful
Unstructured - Diversive	Activities in which the person of interest is also the facilitator seeking stimuli from engaging in the activity.	Adventurous, creative, open-ended, inquisitive, inventive

Model developed identified types and intersections of childhood STEM activities and descriptions of four pathways.

Explorations into students' narratives of their pre-college making pathways inform our understanding of the nature of early-making experiences before entering undergraduate engineering programs.

Project one looked at interviews with 16 students and created timelines detailing their childhood experiences that influenced their decision to major in STEM. Then, it sorted them based on structure and curiosity. Data immersion was performed by reading previous interviews with 9 students before finding an interest in the commonalities and differences within each student's reflections of their STEM-related childhood experiences. The data analysis led to the creation of a matrix identifying four distinct types of activities: Structured-Diversive, Structured-Specific, Unstructured-Diversive, and Unstructured-Specific.

To validate the model, during project two, a series of 7 additional targeted interviews were done, transforming the original matrix to now encompass and exemplify the complexity of the activities and how a student's personal interest and engagement can affect the classification.

There are various influences on what activities a student completes during their childhood - this includes impacts from parental roles and peers, educational opportunities and personal interests, and understanding how these factors combine and encourage students' pathways into engineering provides insights to encouraging additional students to enter STEM and increasing the diversity of the field.

Presentation of original matrix and pathways at ASEE Annual Conference 2022 in Minneapolis, MN.

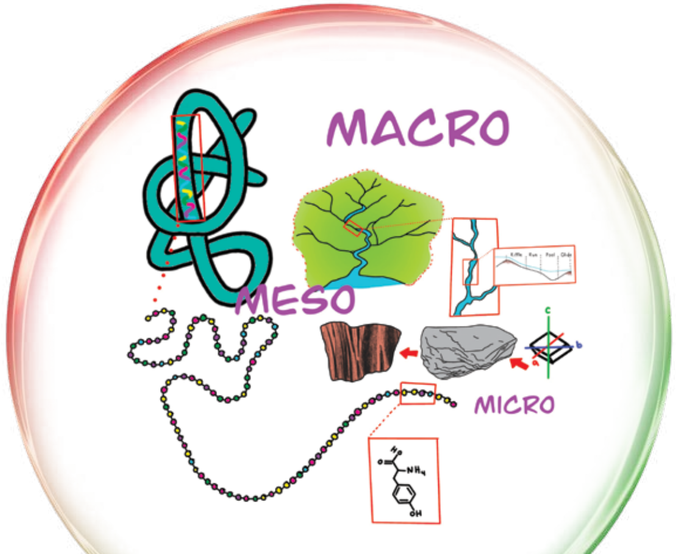
STRUCTURE, FUNCTION, AND FRAMEWORK: AN EXAMINATION OF GEOLOGY, BIOLOGY, AND ENGINEERING

HONORS STUDENT

Hailey Sauvageau-Shlaffer

ADVISING

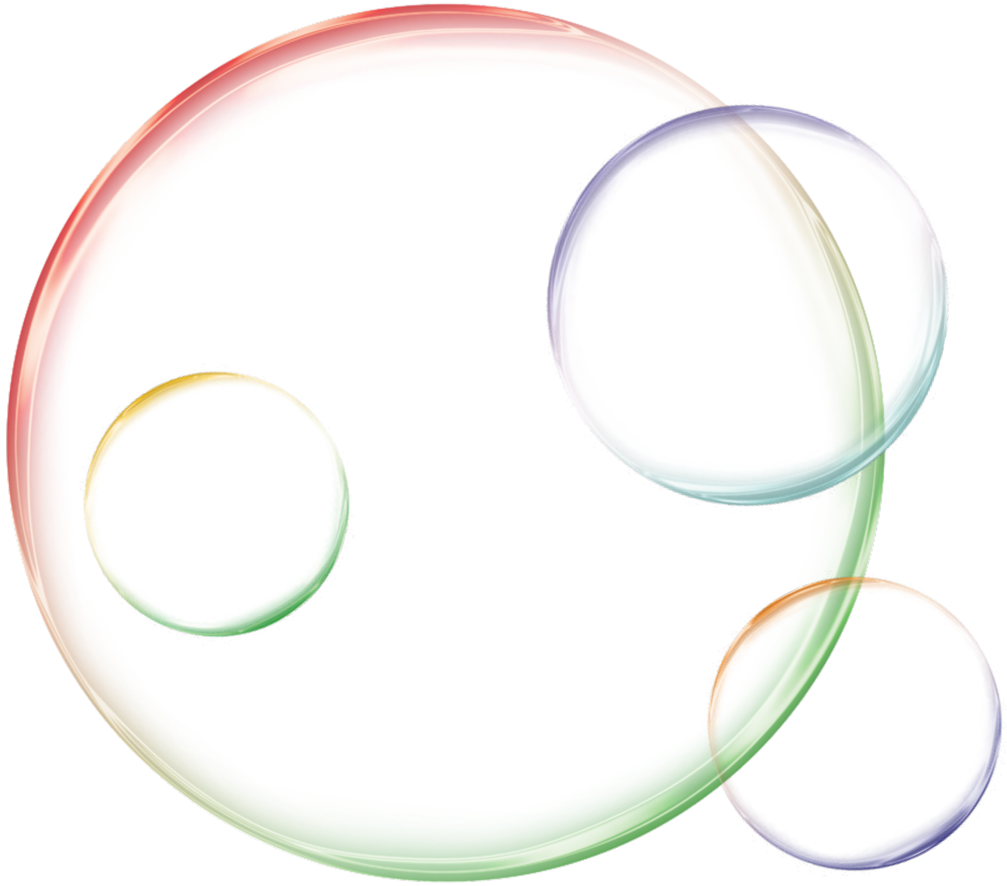
Jacquelyn Nagel



Hailey uses inspiration from biological proteins, geologic structures, and hydrological morphology for her form, function, and fit framework.

The purpose of this research is to examine the relationship between structure and function of systems found in nature and put this relationship into perspective with applications for engineering and design problems. The three primary areas of focus are biological structures, geological structures, and engineering structures. The main objective is to explore, define, and catalog structures, functions, and fits for each of the focus areas and relate them to one another in some way. The other objective is to use these definitions and cataloging to create a framework that can be used for concept generation in engineering design problems. This research also aims to explore more about the emerging area of bio-inspired design in engineering and discover how an engineer might take inspiration from nature and apply its useful characteristics to a design problem. Inspiration is taken from cellular proteins, rocks and minerals, and stream mechanics to develop a framework of information looking through lenses at a micro, meso, and macro level to describe at the very base level how structure determines function.

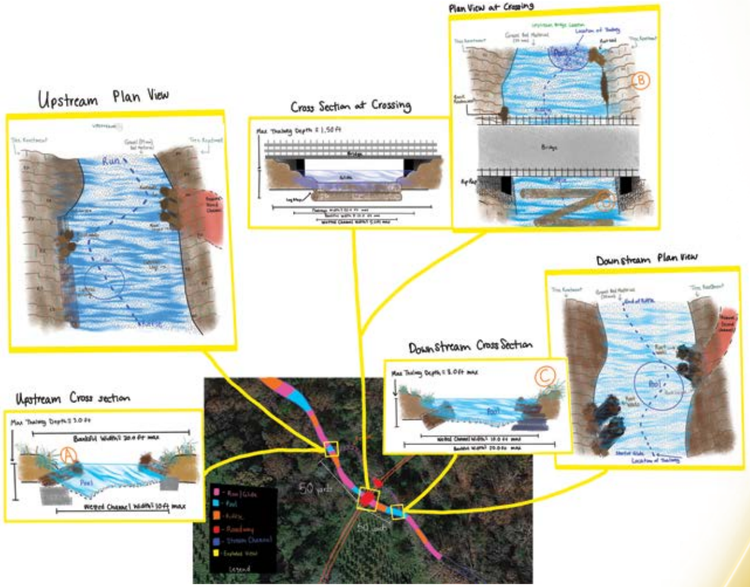
Hailey is in the geology lab viewing a sedimentary rock under the microscope to examine the external structures and features.



BUILD


"We may have different religions, different languages,
different colored skin, but we all belong to one human race."
– Kofi Annan
SENIOR

BOONE RUN AQUATIC ORGANISM PASSAGE STREAM RESTORATION



A conceptual design sketch for the restoration plan of Boone Run according to the Natural Channel Design guidelines. Including changes to channel divide upstream, stream crossing repair, and downstream features.

STUDENTS

Caleb Carney
Ayana Oancea
Hailey Sauvageau-Shlaffer
Cameron Traywick

ADVISING

Bradley Striebig

SPONSOR

Virginia Department of Forestry, Ecosystem Services, & Massanutten Chapter 171 of Trout Unlimited

More than 3,500 miles of cold-water streams contain wild trout populations in Virginia. Wild trout indicate healthy watersheds and contribute to our quality of life. Our stream, Boone Run, is a tributary of the Chesapeake Bay Watershed located in the First Mountain State Forest in Elkton, Virginia. Boone Run is one of the few streams left in Virginia with native brook trout; however, man-made alterations to the stream have halted the natural migration of the brook trout.

In this segment of Boone Run, a culvert and wet ford have become impaired, creating a split channel, excess flooding, and disruption of habitat extending 50 yards upstream and downstream. Additionally, our client, the Virginia Department of Forestry (VDOF), needs the restoration of the crossing to access the timber crop they have established on that land.

Using Natural Channel Design and aid from Trout Unlimited, we developed a restoration plan to regrade the stream bed, install a bridge, log rollers, reinforced root wads, and fill the additional channel to provide access across the stream, bank protection, and habitat enhancement. We passed our restoration plans to the VDOF and Ecosystem Services. They will finalize and implement the restoration plans in June 2023. The final design will allow VDOF to access necessary land and Boone Run to function naturally to restore the brook trout population and riparian ecosystem.

The team is doing a comprehensive survey of the Boone Run reference site in George Washington National Forest.

AISC STUDENT STEEL BRIDGE COMPETITION - DUKES OF STEEL

STUDENTS

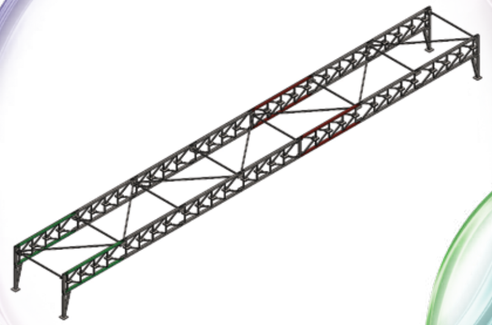
Maggie Bouch
Ryan Groel
Gabe Hindle
Timmy Hunter
Raylen Jones
Patrick Kaczmarek
James Stopa

ADVISING

Daniel Castaneda

SPONSOR

Shickel Corporation



Solidworks model of the K-Truss Bridge the team designed.

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, approximately two hundred schools have competed each year across the country - creating a hands-on steel structure that grows interpersonal and professional skills in civil and structural engineering fields. The competing teams design and fabricate a bridge that is rapidly assembled and judged on the day of the competition. Teams abide strictly by a rulebook and are scored in various categories such as stiffness, construction speed, lightness, and aesthetics.

Our project explores conception and design through fabrication, erection, and testing. We reviewed and understood the new 2023 rules, released in late August, before beginning our design. We used SAP2000 and SolidWorks software to help model and test loading conditions that will be applied at the competition. Once the design was finalized, fabrication began. Our team connected with Shickel Corporation, a local company specializing in high-end metal fabrication and installation, who sponsored the project and provided the necessary materials to build our structure. We started by prototyping and later built the entire bridge structure, made entirely of steel. Finally, we practiced assembling the bridge to become familiar with the assembly, following competition guidelines and regulations.

The team creating a jig to attach gusset plates to the rest of the member.

EMBEDDED SYSTEMS FOR HEALTH

STUDENTS

Justin Blevins
Olivia Bucciarelli
Ritavash Chowdhury
Michael Chung
Dylan Gnagey
Thomas Wasylenko

ADVISING

Jason Forsyth

HydroSense team working on their prototype and collecting hydration data through wrist contact. The system collects data from the sensor and sends it over WiFi to the display to inform the user. Photo: Justin Blevins, Olivia Bucciarelli, & Thomas Wasylenko.

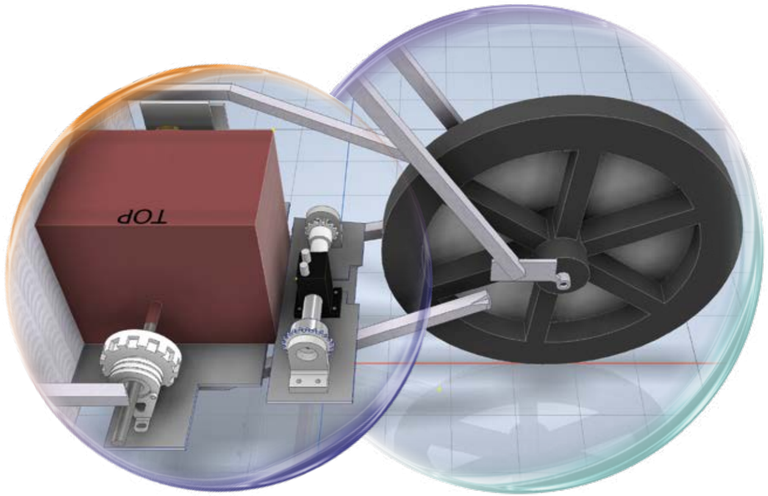
The Embedded System capstone team aims to design a wireless and/or embedded system: a computer network with various sensor systems integrated with storage, processing, and energy requirements. The team split into two to explore different areas of interest to sense, collect, transmit, and analyze data to address critical issues related to health and safety.

One area explored was monitoring hydration levels in individuals with dementia to alert in the case of dehydration to induce the user to hydrate, promoting the highest possible cognitive performance. Even mild dehydration can impair cognitive function and has been shown to be a major contributing factor to cognitive decline in those with dementia. When dehydration occurs, the blood becomes more concentrated. Hydration levels can be measured using a bio-electrical impedance analysis (BIA) technique.

The second area of interest is the improvement of bench press posture for lifters. It was reported in research by the British Journal of Sports Medicine that around 50% of all reported pectoralis major tendon injuries occur during a bench press exercise. Without proper form, there is an even greater chance of injury as this rupture occurs during the maximum eccentric contractions of the exercise when the barbell comes back down towards you. The team aims to design a prototype to help lifters practice proper form by providing feedback based on data collected from their posture, which will help reduce the risk of injury.

The GymSense prototype uses wearable gloves with AruCo tags to track position, and an accelerometer on the bar to measure tilt with a camera to monitor proper form. Photo: Michael Chung, Dylan Gnagey, & Ritavash Chowdhury.

2023 JMU SHELL ECO-MARATHON



A CAD representation of the drivetrain in the engine bay.

STUDENTS

Robert Coleman
Jack Gavin
Luke Marcus
Ryan Peacock
Mitchell Roudybush

ADVISING

Rob Prins
Jacob Brown

SPONSOR

MAAP
Hogan Tire

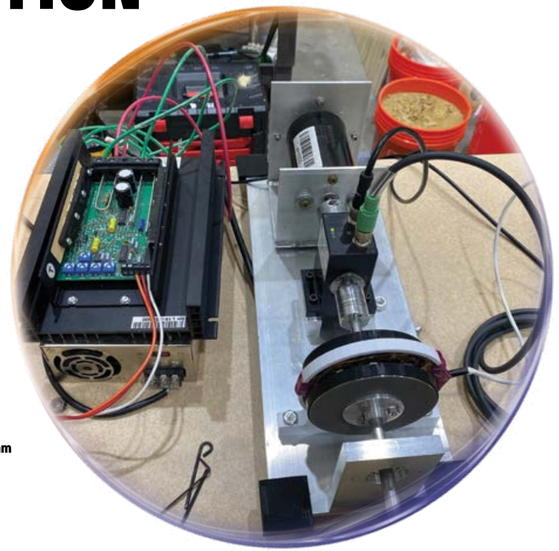
This project aimed to increase the reliability and fuel economy of our prototype vehicle while meeting all technical requirements set by Shell. This is being addressed by implementing a more robust drivetrain inclusive of a more powerful engine and more robust power transmission components.

Our team designed, manufactured, and installed custom power transmission components comprising a new gearing system, starter system, jackshaft, and drive shaft. Additionally, the new engine required conversion to electronic fuel injection (EFI) by implementing a fuel injector and engine control unit (ECU).

Our secondary objective was to ultimately take this newly optimized vehicle and pass technical inspection in order to compete at the Shell Eco-marathon competition.

The team inspecting and finalizing the new drivetrain placement.

OFFSHORE WIND TURBINE PROTOTYPE FOR THE 2023 COLLEGIATE WIND COMPETITION



A dynamometer was used measure the torque and rotational speed characteristics of the team designed generator under electronic load.

STUDENTS

Nicholas Gartner
Brandon Landes
Yazeed Salameh
Josh Savage
Joseph Scully
Mary Wari
Jack Williams
Austin Zicafoose
Alex Ziemke

ADVISING

S. Keith Holland

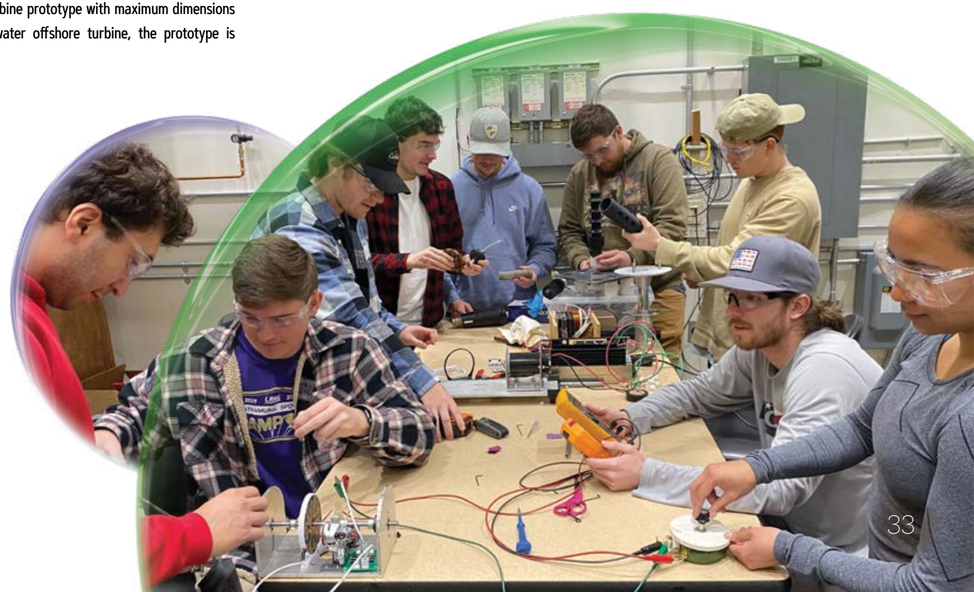
SPONSOR

U.S. Department of Energy

The U.S. Department of the Interior, U.S. Department of Energy (DOE), and U.S. Department of Commerce recently announced a shared goal to deploy 30 gigawatts of offshore wind energy in the United States by 2030. The Coastal Virginia Offshore Wind Project, which will begin offshore construction in 2024, will install a 2.6-gigawatt wind farm comprised of 176 turbines. To support these wind energy deployment projects and goals, the DOE and National Renewable Energy Laboratory created the Collegiate Wind Competition (CWC) in 2014 to challenge students from multiple disciplines to explore the wind energy field. JMU is one of thirteen teams selected to participate in the 2023 CWC.

The 2023 CWC student team designed, fabricated, and tested a fully operational, three-blade, horizontal axis wind turbine prototype with maximum dimensions of 45 cm. To simulate a shallow-water offshore turbine, the prototype is mounted on a 1 m tower affixed to a student-designed foundation structure that is installed in a water tank with a sand bed. A custom-designed 3-phase generator, blade pitching mechanism, and an electronic control system was developed to maximize turbine power production at low wind speeds (3 – 11 m/s). At high wind speeds (11 m/s – 22 m/s), power production and foundational overturning forces are controlled by adjusting the blade pitch.

The JMU team will demonstrate the prototype turbine in a wind tunnel on May 15 – 19, 2023, at the competition at the University of Colorado, Boulder Campus.



The CWC prototype design team prepares to test the team-fabricated generator with a dynamometer to measure its rotational speed, torque, and electrical power production characteristics prior to integration with the blades.

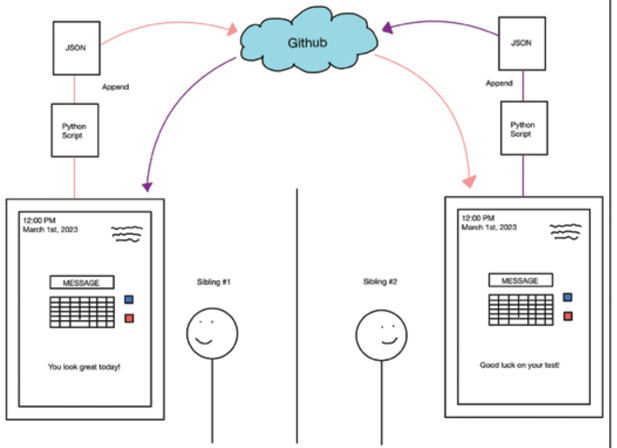
CONNECTING SIBLING RELATIONSHIPS WITH IoT

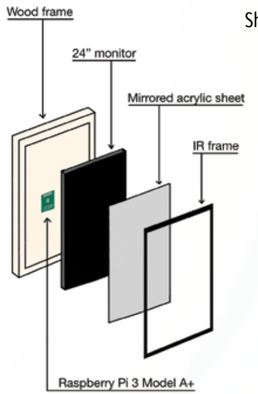
STUDENTS

Matt Marini
Jack Navarrete
Tia Stamp-Q
Chris Ondoua
Sherinne Zhang

ADVISING

Shraddha Joshi





A sketch of the Magic Mirror Communication (left) and how the messages and information are transferred from one device to the other. The frame construction (right) shows how the mirror is put together to allow touch-screen interaction.

Internet of Things (IoT) technology uses microcontrollers, sensors, and various software to connect and exchange information and data with other devices over the internet. Since 2010, the growth and usage of IoT-developed devices have helped separated families and friends around the world find connections. This project aims to use IoT technology to help people develop and enhance meaningful connections, specifically focusing on sibling relationships.

The problem chosen by the team involves strengthening sibling relationships. Sibling relationships are often affected by the separation experienced when one leaves home for the first time, for example, an older sibling going to college and leaving the younger sibling behind at home. Studies show that a healthy relationship between siblings can improve aspects of a person's socioemotional and psychological health.

We are using the Internet of Things to create Magic Mirrors that allow for meaningful connections by using more interpersonal sensory stimulations that current communication methods, such as talking on the phone or video calls, do not provide. The Mirrors will allow siblings to bond with each other by using the surprise element of sending and receiving compliments.

The team is discussing their plan for integrating the parts of the mirror as they test the fit of the frame.

USING LIQUID COOLING TO IMPROVE SOLAR PANEL POWER OUTPUT

STUDENTS

Ben Love
Joe McGinn
Ryan Ulmer
Zach Wynn

ADVISING

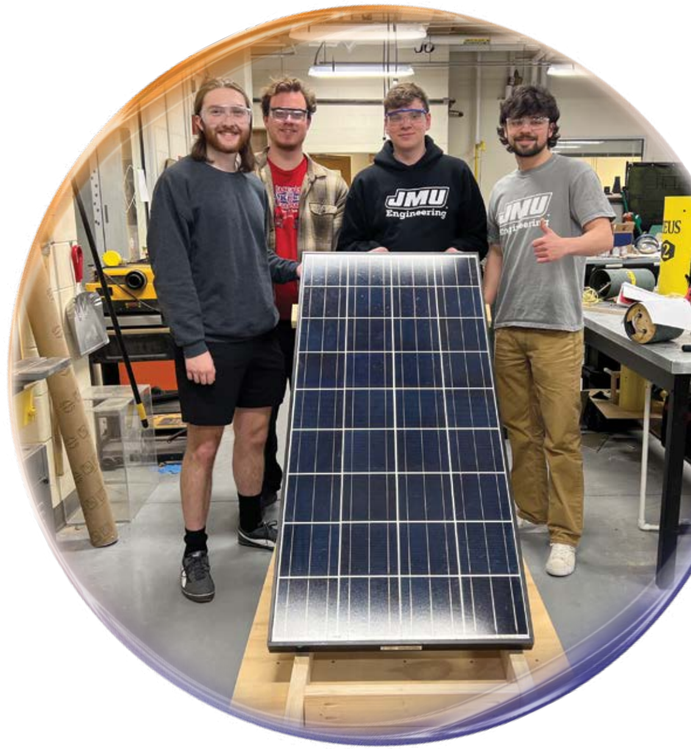
Jacquelyn Nagel

SolidWorks model of the complete system.

Virginia's average temperature in the month of July is 77°F, which negatively impacts the power output of solar panels. The hotter a solar panel becomes, the less power it produces.

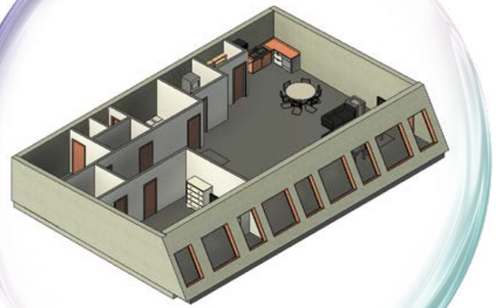
Our project addresses the issue of decreasing energy production from solar panels that experience internal temperatures rising above 25°C (77°F). For homeowners in Virginia, this issue is prevalent in the summer months. A liquid cooling system regulating the panel's internal temperature inspired from lichen, the symbiotic organism comprised of a fungus and algae that lives in extreme climates, is one approach to addressing this issue.

Our team is designing and prototyping a fully-automatic liquid cooling system based on thermal convection that utilizes antifreeze. The thermal properties of antifreeze allow for this system to be adaptable in a climate that reaches very hot temperatures in the summer and very cold temperatures in the winter. This system is activated by a surface temperature sensor and operates in cycles to conserve power. However, for the system to be viable, the energy being recovered from the deficiency must be greater than the energy spent to operate the system. Finding this balance presents a new challenge.



Capstone project team with system prototype.

REPURPOSING SAWDUST TO DEVELOP MODERN EARTHSHIP HOMES



A blueprint of a Potential Earthship.

STUDENTS

Caitlin Chamberlain
Juliana Cruz
Owen Plimpton
Rachel Cole
Zach Scheuer

ADVISING

Justin Henriques
Kyle Gipson

An Earthship is a passive home built upon six principles necessary for a harmonious life on earth: food, energy, clean water, shelter, garbage management, and sewage management. These homes are made out of upcycled materials, can harvest energy and water from the environment, grow food, and manage waste all on its own. With the rise in emissions and pollution around the world, solutions such as Earthships are becoming more attractive. These eco-friendly and sustainable homes are designed and constructed to be self-sufficient and made with green materials.

Inspired by Earthship principles and how they're built, our capstone project focuses on the application of repurposed materials and passive heating and cooling to design modern, single-family residential homes. We specifically focus on replacing sand with waste sawdust in a traditional concrete mix for Earthship walls.

We are testing multiple sawdust-concrete mixes to validate whether a mix with a repurposed material is within a 15% strength margin of traditional concrete and less thermally conductive than traditional insulation materials used in residential homes and buildings.

Testing sawdust-concrete mix samples.

INTERACTIVE BIOPHYSICS MACHINES

STUDENTS

Jacob Brothers
Collette Higgins
Mason Ong
Alex Sedley

ADVISING

Nathan Wright
Callie Miller
Samuel Morton

Interactive machines explaining steps of muscle contraction process. In clockwise order: neural impulse, action potential, Sliding Filament Theory and conversion of electrical to mechanical energy.

Engagement and access to STEM, especially for rural communities, is a complex problem that has become more important as the need for skills like problem-solving and critical thinking are increasingly necessary in the workforce. This project created four interactive machines and workshop facilitation guides to explain a familiar biophysical concept: the brain signal to stimulate muscle contraction, via Sliding Filament Theory. Using various engineering manufacturing, prototyping and design techniques, we fabricated custom machines to engage and educate children (2-99 years old) on the body's electrical to chemical to mechanical system, and how bioengineers can use these innate signals to build myoelectric prosthetics. In conjunction, we facilitated multiple workshops for local, rural 6-8th grade students, presented our designs at the Rockingham County Fair to a wide array of children from the surrounding rural community, wrote guides for other outreach efforts at JMU to continue using our designs and programming, and submitted a paper in a national journal for other educators and universities to consider a similar, prescriptive process for engaging in other rural communities.

Our team running a workshop with local high schoolers to not only demonstrate our machines, but also talk about how we used the engineering design process to prototype and fabricate our designs.

NASA STUDENT LAUNCH INITIATIVE - JMU ROCKETRY TEAM

The Project Zeus II Team's sub-scale rocket launching in 3..2..1..

STUDENTS

Matthew Caulfield
Finn Otto
Tyler Emory
Hemant Patel
Hanim Ibrahim
Patrick Foreman
Grace Klein
Aakash Girdhar

ADVISING

S. Keith Holland
Jacquelyn Nagel

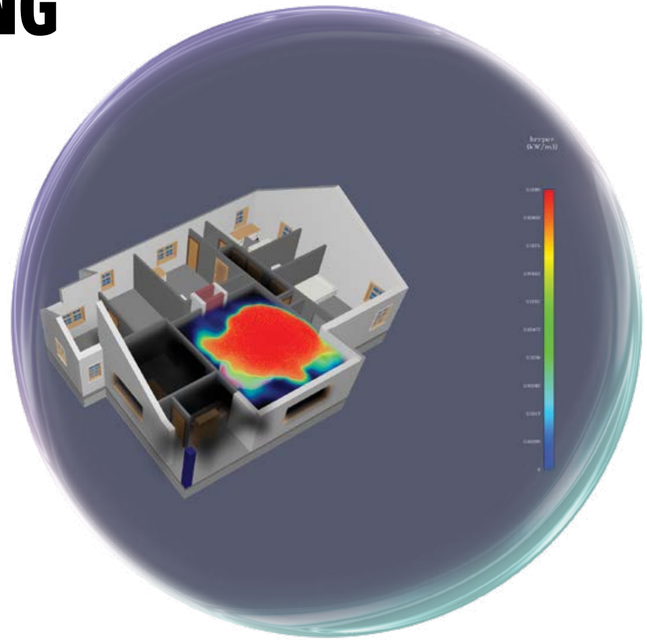
SPONSOR

Northrop Grumman
Virginia Space Grant Consortium

Each year, NASA hosts a Student Launch Initiative (SLI) competition, giving students an opportunity to engage in a research-based, experiential project to develop and launch a high-powered rocket (HPR) vehicle and payload system. Additionally, the student team presents detailed design, technical, and safety reports for review, presentation and approval by NASA officials, maintains an online presence, and hosts STEM engagement events to reach a minimum of 250 pre-college students within their community. Students must design, fabricate, test, launch, recover and obtain data from a scientific payload at the competition launch site in adherence with competition requirements. The payload objective changes each year. For example, for the 2023 competition, the payload must self-orient to be perpendicular to the ground and upon landing autonomously receive RF commands and perform a series of tasks with an on-board camera system.

This is the second year that JMU has competed in this fast-paced competition which has required simulations, modeling, subscale modeling, establishing relationships with local rocketry experts, fabrication work, fulfilling requirements, and project management. The 2023 JMU HPR vehicle is a 125in long, 43.59lb, Blue Tube 2.0 rocket comprised of three sections that utilize a dual deployment recovery system. The predicted launch height is approximately 4600ft above ground level. The team will travel to Huntsville, Alabama in April 2023 to participate in Launch Week to demonstrate the finalized and fully functional HPR vehicle and payload in the final competition launch.

FIRE REDUCTION METHODS FOR FRATERNITY HOUSING



Simulation model of an exemplar fraternity house fire in PyroSim. Results indicate the rate of fire spread when the house is retrofit with hardwood flooring.

STUDENTS

Nicholas Colavita
Hunter Hayden
Manav Mehta

ADVISING

Heather Kirkvold

SPONSOR

Harrisonburg Fire Department

Approximately 2,600 people die yearly in the United States from house-related fires (National Fire Incident Reporting System). In Harrisonburg, VA, student members of Greek fraternities attending James Madison University do not have on-campus fraternity housing and live off-campus, often in single-family residential rental units. According to local fire code officials, large social gatherings of students occur at these residences, creating extreme fire-risk conditions. In preparation for these parties, furniture is usually relocated to increase open floor space and control entrance to the property during the gathering. An outbreak of fire under these conditions (overcrowding and egress blockage) could prove catastrophic.

This project aims to deliver a validated plan for structurally reducing risk to life safety in fraternity housing in Harrisonburg, VA. This project does not address human-behavior-related issues. Instead, it focuses on passive strategies that structurally reduce risk to human life safety regardless of human behavior.

A parametric analysis of candidate structural intervention strategies was conducted aimed at identifying strategies for delaying the spread of fire should one occur. The three candidate strategies tested include replacing flooring, furnishings (furniture), and installing sprinkler systems, which are not required by Virginia code in this case.

An exemplary fraternity house in Harrisonburg was modeled using Revit. Testing of the modeled residence was performed using PyroSim, an innovative industry software tool for evaluating the spread of fire. Analysis of the results informs the recommendations included in the risk reduction plan.

The team is making adjustments to the furnishings, couches in this case, in the PyroSim model.

MOBILE STEM EDUCATION VENUE

Side-view image of the Mobile STEM Educational Venue.

STUDENTS

Riley Allison
Chris Canonica
Mason Horton
Trevor Ferares

ADVISING

Steven Harper
Samual Morton

The Mobile STEM Educational Venue project is an outreach and community engagement platform which will provide auxiliary and complimentary hands-on learning experiences for students in the K-12 schools. The mobile feature will ensure that the platform can deploy on-time instruction modules to a broad range of schools efficiently and cost-effectively. In addition to the platform's core technical design, which consists of multiple sub-systems like electrical and structural designs, the team will also design and implement some STEM-based, interactive activities that can be easily deployed once the platform is completed.

The team is standing at the front of the STEM Educational Venue.

REDESIGN


"Infinite diversity in infinite combinations... symbolizing the elements that create truth and beauty."
– Commander Spock
JUNIOR

STREAM RESTORATION IN THE NORTH RIVER WATERSHED

STUDENTS

Zachary Abdeen
Jacob Cornwell
Nick Dagostino
Emma Fox
Lindsey Hall
Emily Kamp
Zachary Neal
Ragan Trask

ADVISING

Bradley Striebig

This site was chosen for restoration efforts due to channel braiding and bank erosion.

The Dry River, located along Route 33, supplies the drinking water to the City of Harrisonburg and surrounding residential areas. In addition, the river is home to a variety of aquatic species, including the brook trout.

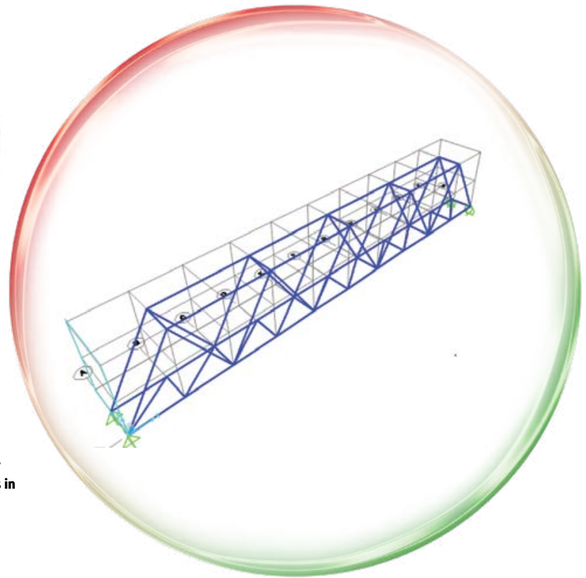
In collaboration with Trout Unlimited, we hope to repair the eroding banks, improve the ability of trout transportation, reduce sediment deposition, or reduce the braiding of channels through a restoration effort along a section of the Dry River in Riven Rock Park.

To complete these tasks, we assessed several stretches of the Dry River using NRCS Stream Visual Assessment Protocol (version 2) and the Rosgen Stream Classification technique. We analyzed and compared the Aquatic Organism Passage, riparian buffer quality, water quality, canopy cover, bank erosion, and downed trees of stretches along the Dry River to find the site most qualified for stream restoration.

Overall, our capstone project provided valuable insights into the design of effective restoration plans and demonstrated the potential to restore degraded stream reaches. The estimated completion date for our stream restoration design is May 2024.

The team is visiting Riven Rock Park to assess and characterize various sections along the Dry River for potential restoration efforts.

AISC STUDENT STEEL BRIDGE COMPETITION - MADE OF STEEL



Utilizing the SAP2000 software, the Junior Steel Bridge Team has analyzed basic truss structures in order gain familiarity with the software.

STUDENTS

Michael Duncan
Luis Estrada
Joseph Frank
Sarah Gaudet
Josh Locascio
Pierre Mbala
Jacob Myles
Spencer Steinour
Nick Stoetzel

ADVISING

Daniel Castaneda

The Student Steel Bridge Competition has undergraduate students come together as teams to design, fabricate, and construct a mid-scale steel bridge based on the competition's rules, guidelines, and specifications. The competition challenges students to apply the theoretical concepts they learn in the classroom to a real-world challenge. Engineering students undertake a very specific learning experience - allowing them to further develop their understanding of statics, mechanics of materials, structural analysis, finite element analysis, project management, teamwork, communication, technical writing, problem-solving, and professionalism.

As the Junior team, we benchmarked other university's bridge designs from past years' competitions and analyzed those structures for their strengths and weaknesses. In addition, we have trained ourselves with steel fabrication techniques in the JMU Engineering fabrication lab and machine shop so that we are masters at cutting, fabricating, grinding, and welding steel members and joint connections.

To prepare for our competition in AY2023-2024, our team is shadowing the Senior team where they are, using the 2023 competition rules. We are challenging ourselves to design an analytical prototype of a bridge conforming to the 2016 competition rules using structural engineering software (SAP2000). We physically prototyped one structural member and one structural joint for this year's Xchange to showcase how we have gained the necessary skills to compete successfully in the 2024 offering of the Student Steel Bridge Competition.

Analyzing last year's final design for future success: Steel bridge team dissects last year's finalized structure to gain insight and prepare for next year's competition.

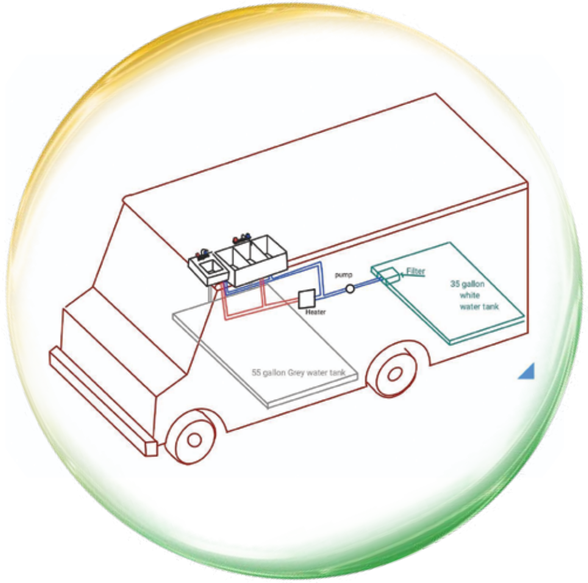
BOX TRUCK TO FOOD TRUCK CONVERSION (SHORTY'S FOOD TRUCK)

STUDENTS

Drake Cauthorne
Zachary Longerbeam
Jake Mennes
Luis Perez
Justin Petersen
Jackson Plott
Jakob Roscopf
Trenton Shaffer

ADVISING

Adebayo Ogundipe



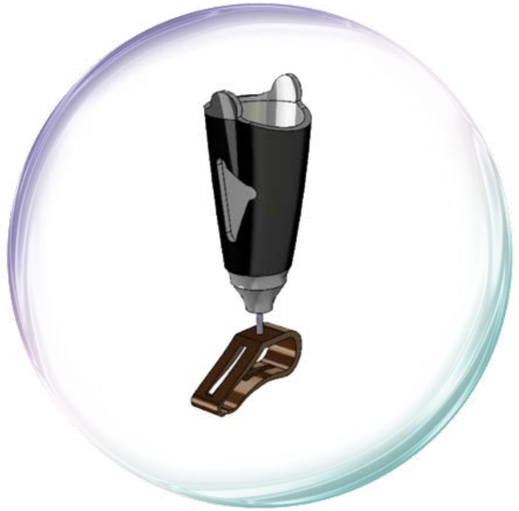
Sketch of proposed truck with plumbing system.

Our project aims to design and convert a retired box truck to a functional food truck. It will satisfy all relevant health and safety regulations, provide a comfortable, convenient cooking and serving environment for the staff, and deliver quality food to customers in a timely and cost-effective manner. This project requires a multi-disciplinary team to create a safe and functional food truck.

Our team will design and install a commercial kitchen with electrical, plumbing, ventilation, and fire suppression systems within the confined space of the box truck. The mechanical sub-team will design and install the exhaust system and air conditioning unit for proper ventilation and temperature control. The electrical sub-team will size and install an appropriate power generation and distribution system for equipment, lighting, and appliances. The structural sub-team will ensure the structural integrity of the truck and ensure load capacity limits are not exceeded. The primary deliverable is a fully functional and commercially viable food truck for an entrepreneurial venture.

The team working inside of the retired box truck.

ADJUSTABLE CHILDREN'S PROSTHETICS



CAD model of what our design could look like. The socket will be prosthetic will be adjustable in length and volume. A universal wearable computing system will be implemented to measure and detect needed adjustments for our socket.

STUDENTS

Will Bradford
Danny Tyras
Abby Charleston
Emily Vierrether
Parker Agan
Megan Caulfield
Matrix Chen
Jack Zhao
Jack Nordstrom

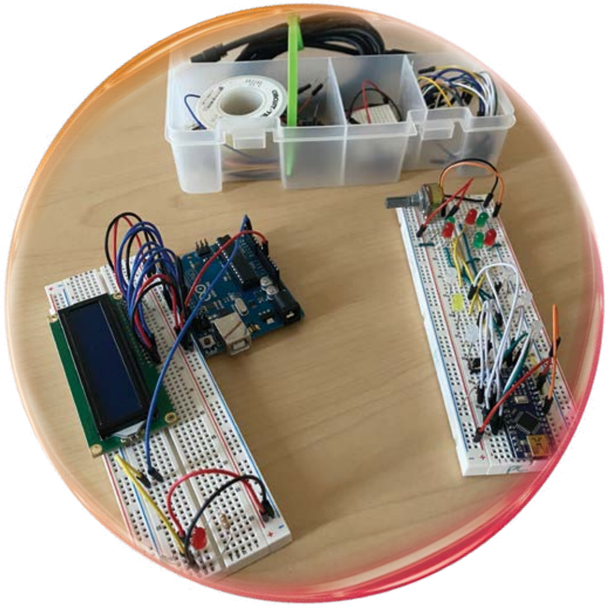
ADVISING

Jason Forsyth

Across the US, many children with below-the-knee amputations experience pain and discomfort in their residual limb due to constant fluctuation in volume and length in their limb. This project aims to solve this issue by creating an adjustable prosthetic socket with an integrated wearable computing system to detect and communicate adjustments to the user. A central problem we are designing towards is the day-to-day discomfort caused by volume change and the long-term comfort problems that come with children's rapid growth rates. Our goal is that this computing system will notify the user of necessary fit adjustments and automatically fluctuate in size to accommodate day-to-day volume changes in their residual limb.

The team inspecting and finalizing the new drivetrain placement.

SHELL ECO-MARATHON JMU SUPERMILEAGE JUNIOR TEAM



Breadboard Desktop Prototype of a brushless direct current (BLDC) Electronic Speed Controller.

STUDENTS

Micah Rice
Zachary Marsho
Paul Liskey
Christos Konstantinou
Wesley Nicholson
Elizabeth Golightly
Isaac Lohr
Jace Taylor
Chet Martinussen

ADVISING

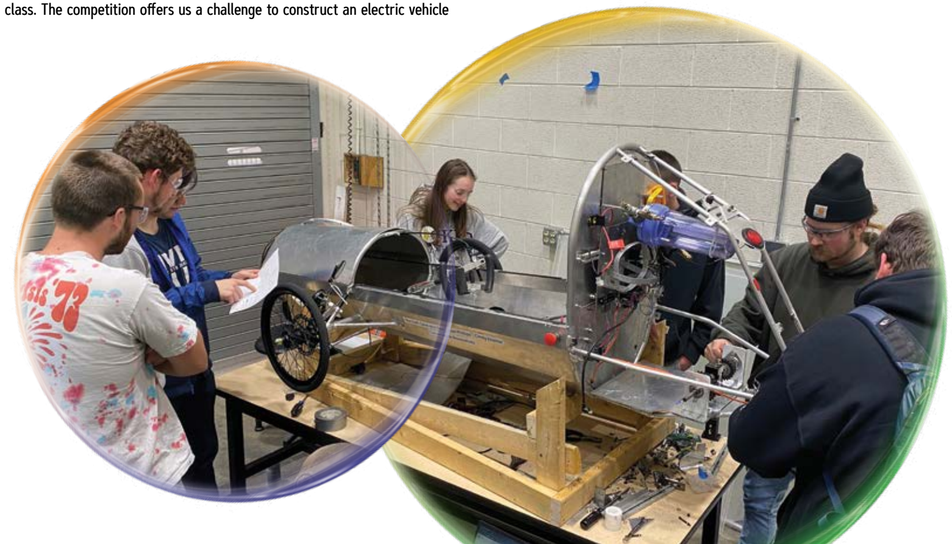
Rob Prins

Advanced Clean Cars II is a rule recently instituted in California, set to trail-blaze an automotive market that solely produces electric vehicles by 2035. While this legislation has been controversial, many states have stated their intention to follow suit in the coming years, Virginia included.

Our capstone aims to allow team members to expand their automotive engineering experience while gaining exposure to electric vehicles (EVs). Serving as the platform for team progression is the 2024 Shell Eco-marathon, a global competition encouraging students to design and build effective energy-efficient vehicles.

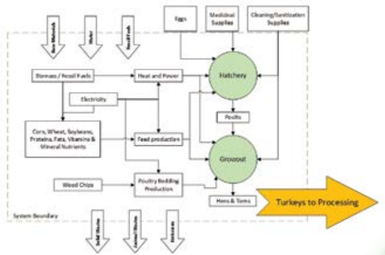
The Shell Eco-marathon provides a platform for a variety of vehicle categorizations; our team is focusing on creating a prototype vehicle, battery-electric class. The competition offers us a challenge to construct an electric vehicle while remaining in accordance with the Shell Eco-marathon rules. Over the next year and a half, we must familiarize ourselves with the knowledge and skills necessary to create a fully functional EV. In addition, we will have to consider performance requirements to balance worthwhile tradeoffs to optimize the feasibility, cost, and efficiency present in their vehicle.

We've spent this semester benchmarking, researching, and starting initial prototypes. During the remainder of this semester, we intend to prepare to begin vehicle construction by the start of the coming fall semester. This entails component research, early-stage prototyping, and performing reliable theoretical calculations to provide specification parameters.



Collaborative Group Work Session with Shell Eco Members in the High Bay.

SUSTAINABLE AGRICULTURE IN THE VALLEY



Turkey Production System Diagram.

STUDENTS

Sean Carlyle
Kevin Denmark
Ryan Miles
Bryson Naftel
Marcus Rand
Gina Sapino
Luke Schneider
Alexander Wollard

ADVISING

Samuel Morton

Poultry, primarily chickens and turkeys, is a significant and annually increasing percentage of total meat consumption in the United States. Virginia is an important participant in this industry as the Shenandoah Valley (containing 4 of the top 5 agricultural counties for the state) is the center for poultry production in the Commonwealth.

Our project explores the regional poultry industry with a focus on improving the sustainability of this critical economic sector. Because the poultry industry is large and diverse, our team focus is on assisting the turkey producers in achieving more sustainable practices and operations that could lead to improvements in this essential industry. We will perform a system analysis to identify which aspects of the poultry farming process can potentially improve different sustainability measurements for commercial poultry farming.

After completing an initial research effort and review of the general poultry industry, our team selected several subsystems of the poultry farming process that could allow for potentially meaningful improvements to sustainability in terms of financial gain, energy efficiency, waste management, or material flow. Such sustainable changes in the systematic techniques of turkey raising and processing can potentially improve the economic outlook for this important economic sector of the Shenandoah Valley. Therefore, our priorities in implementing our design will focus on environmental and economic benefits to

Project Team at Riverhill Farms.

NATURE INSPIRED INNOVATION IN PACKAGING

Samples of brainstorming and concept generation efforts.

STUDENTS

Greer Borowczyk
John Andrew Fader
Jacob Grobe
Rafael Lopez
Logan Lynch
Katherine Marie Potocko
Emily Sturgeon
Matthew Todd
Caitlyn Williams

ADVISING

Jacquelyn Nagel

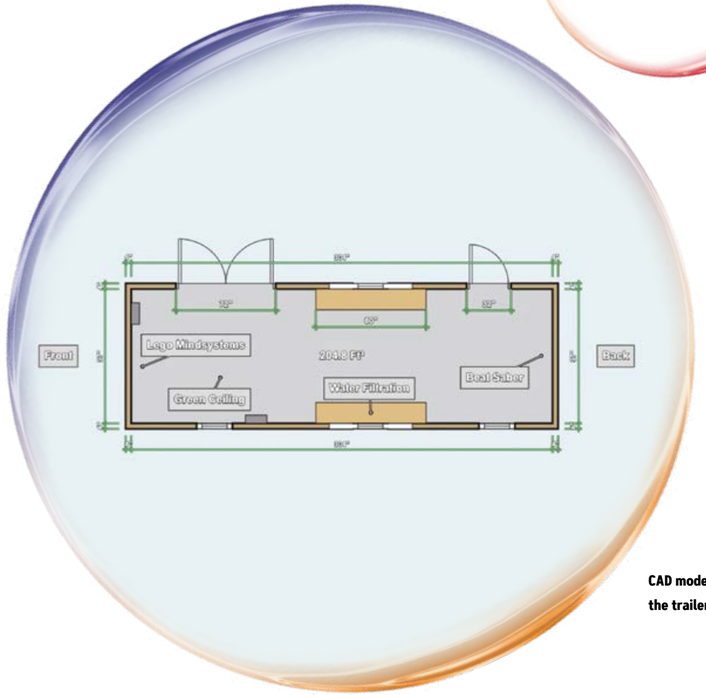
With 8.2 million tons of packaging waste generated in the United States each year alone, consumers face a challenge in responsibly managing packaging waste. In addition, the packaging industry is responsible for a significant amount of waste and pollution as most traditional materials used in packaging, such as plastic and Styrofoam, take hundreds of years to decompose.

Aligning with the United Nations Sustainable Development Goal 12: Responsible Consumption and Production as a foundation, our team developed a guiding question, "How might we reduce the burden of recycling mixed materials from packaging that consumers face in the world today?"

Our project aims to create a packaging solution incorporating biomimicry and sustainable design principles, including biodegradability and recyclability. Biomimicry is the process of studying nature to inspire solutions to human problems. With the three main functions of packaging identified, we will explore how organisms contain, seal, and protect while applying these principles to our final design.

Biomimicry team brainstorming and concept generation efforts.

STEM WAGON



CAD model displaying the interior space in the trailer.

STUDENTS

Kaylee Donnelly
Corinne Kent
Sonja Robinson
Alex Kreitzer
Arya Singh
Brian Scully
Emma Myer
Hallie Baker
Michel Kotoff-Rizzo

ADVISING

Steven Harper

In the United States, half of the high school graduates interested in Science, Technology, Engineering, and Mathematics (STEM) are not proficient in the skill sets necessary for these fields due to a lack of educational engagement. The STEM Wagon will empower the next generation of students to pursue STEM by exploring educational adventures. The senior team has finished the exterior structure of the mobile trailer, including brake lights, doors, flooring, and walls.

Our team's primary focus this semester will be finishing the inside of the trailer; this includes the walls and interior lighting. We will also create a mural on the trailer's exterior, branding it the STEM Wagon. In addition, we will be designing and implementing modular educational adventures inside the trailer, including an interactive water filtration system, a green ceiling to focus on environmental sustainability, as well as a BeatSaber on a Budget, and Lego MindSystems to teach simple block coding. We hope to see the trailer used next year in local middle schools.

The team is working on implementing their learning modules into the trailer.

ICE TO EV TRANSFORMATION

The internal combustion vehicle that is going to be converted to an electric vehicle.

STUDENTS

Scottie Hull
Bush Connor Thepsimuang
Conner Fleck
Robert Kidd III
Tyler Hayslett
Carson Lang
Rylan Gildersleeve-Price
Aidan Huff
Brian Maloney
Joe Louque

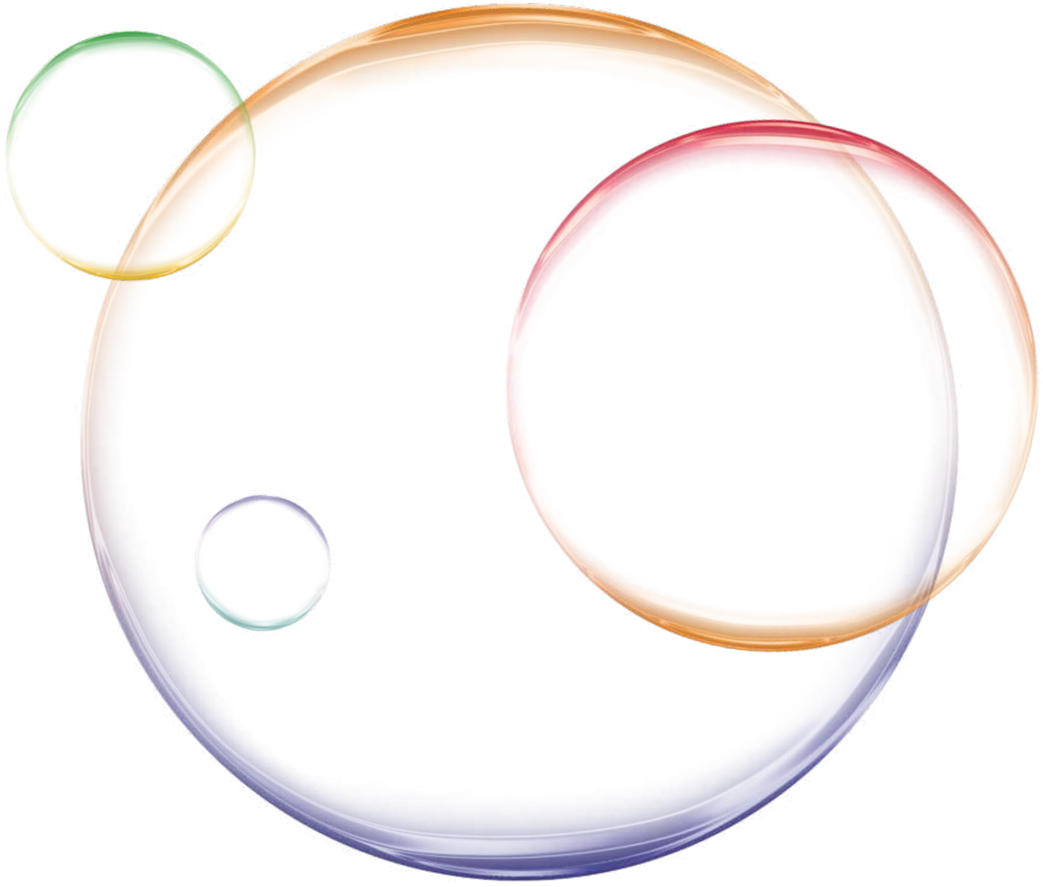
ADVISING

Steven Harper

Our project aims to address the challenges posed by the shift towards electric vehicles in the automotive industry. With governmental influence and corporate strategy driving the transition, many internal combustion engine (ICE) cars are still in use today. However, replacing them with new electric vehicles may not be feasible or cost-effective for many owners, and scrapping these ICE cars could lead to shortened life cycles and increased waste.

The cost and waste generated during the process of converting conventional vehicles to electric ones can be significant. Our objective is to develop an affordable, sustainable, and scalable approach to transform internal combustion engine cars into electric vehicles. In an attempt to achieve this objective, we have acquired a 1994 Chevrolet S10 as a test case for our project. Our plan involves removing the cylinder heads, installing an electric motor, and reconfiguring the vehicle's internal components to ensure it is fully operational as an electric car. Our goal is to explore the possibility of converting existing ICE cars into electric vehicles in a sustainable and economically practical way, in order to support the industry's transition towards cleaner transportation.

Aidan Huff and Joe Louque measuring truck pulley system.



DELIGHT

“We will all profit from a more diverse, inclusive society, understanding, accommodating, even celebrating our differences, while pulling together for the common good.”

– Ruth Bader Ginsburg

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