CHANGE '19

MADISON ENGINEERING

A Year of Good Through Innovation, Research, and Design

Department of Engineering

KURT PATERSON

Ph.D., P.E.

HEAD, DEPARTMENT OF ENGINEERING

"I wish to thank everybody who sees the potential in the blank page; your ability to envision a better future, and trust in our students and faculty to co-create it with you, are invaluable in our quest to be the best engineering program for the world.

I'd like to offer an extra thanks for the investments in our program this year by the organizations below:"

MAAP Madison Automotive Apprentices

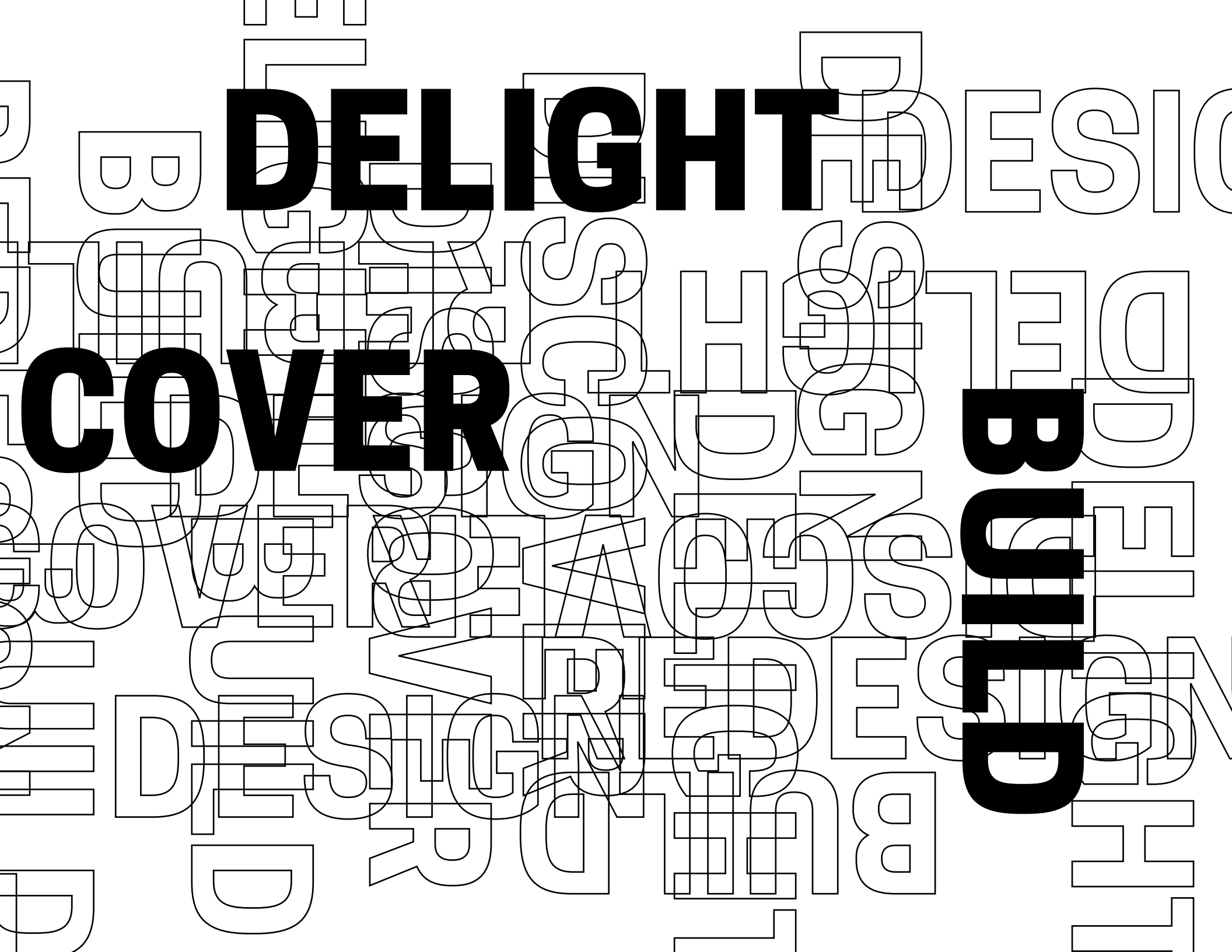
NIELSEN™

PARTNERS *of the* AMERICAS
Connect • Serve • Change Lives

U.S. DEPARTMENT OF ENERGY

K2M
COMPLEX SPINE INNOVATIONS™


DESIGN
DIS
REDESIGN


DELIGHT
COVER
BUILD

“SOME JOURNEYS ARE DELIGHTFUL, SOME GRUELING, ALL OF THEM ARE RICH LEARNING EXPERIENCES.”

I keep hearing from employers about how our graduates are notably better prepared for the realities of engineering work than hires from other universities. I am pretty sure it has to do with the projects throughout our curriculum, and in particular, navigating significant work with a team of peers and collaborators. It's hard work. It's also hard to teach, so it's often best learned by "doing," hence the team-based, project-rich Madison Engineering curriculum.

Some of the best teams in the world fall apart under the demands of working together. The Beatles "White Album" is often noted as the beginning of the end for them as a band; diverging interests and opinions, the challenges of too many leaders, and the pressures of increasingly high expectations were too much.

There are better ways forward. The foundational work of engineering projects is doing what it takes to craft a unifying purpose, engage everyone's talents fully, and produce work of which everyone is proud. While professional prototypes and presentations are the obvious outcomes, the projects shared at the xChange today deeply reflect the journeys of student teams finding their way through real opportunities in order to positively impact their partners and clients. Some journeys are delightful, some grueling, all of them are rich learning experiences. In not giving up, though, our students make the critical transformation from problem solver to solution maker, become more valuable to society and industry, and are better positioned to make "music" that inspires for years to come. Please join me in celebrating their accomplishments.

Kurt Paterson
Head, Department of Engineering
April 13, 2019

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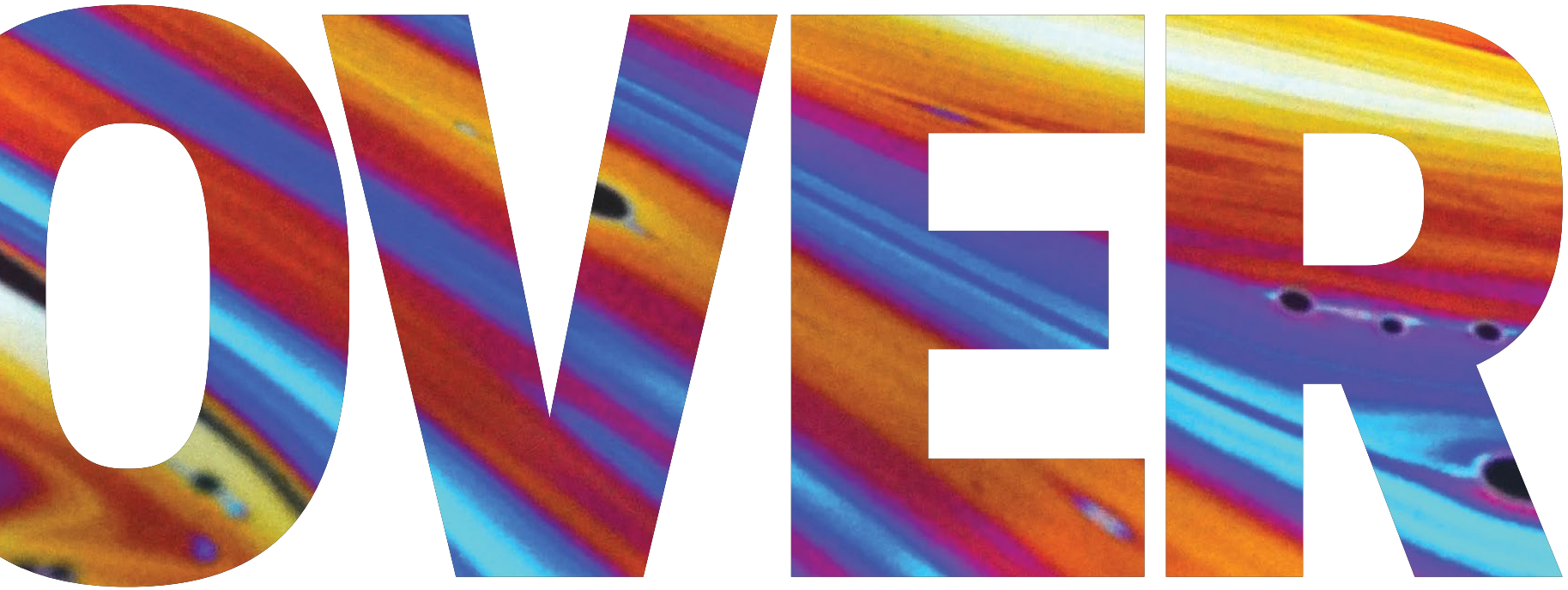
SENIORS

CONTINUE ▸


DISC


OVER

HONORS 2019

JULIA HUTCHENS

DRY RIVER WATERSHED VALUATION AND PROTECTION PLAN

Water quality is a major environmental and human welfare concern for the entire world, not just developing countries. There have been many incidences in the United States of health problems related to water quality and shortage of water. The City of Harrisonburg and the surrounding community also have a need for a well-developed watershed management plan. The Dry River Watershed Valuation and Protection Plan is focused around the Dry River because it is the main source of the city's water. The Dry River area is threatened by illegal dumping, erosion from primitive roads and future road building sedimentation, a lack of awareness of the true value of the resource, and the potential for hydraulic fracturing for natural gas. The full value of the Dry River watershed is not fully appreciated and accounted for in the public use plans of the City and United States Forest Service. The purpose of my project is to measure and assess the true value of the environmental services provided by the Dry River watershed, including land owned by both the City of Harrisonburg and the George Washington National Forest. This was done by collecting user data through game cameras and applying it to a willingness-to-pay model. Over 7,500 recreational users were counted and the estimated value of the area for the summer of 2018 is approximately $625,000. This value along with the direct water supply valuation and other information will be reported to city officials to inform further management implications.

Julia has been advised by ***Bradley Striebig*** and sponsored by the ***Trout Unlimited Embrace a Stream Program*** provost grant awarded by James Madison University

00012

Over the course of the past year, Julia has spent many hours in the woods and behind the computer collecting and analyzing user data for the Dry River Watershed.

Aaron researching the opportunities for industrial hemp to be implemented into the agro-economic model of Virginia

AARON SLOSS

TECHNO-ECONOMIC SYSTEMS EVALUATION OF INDUSTRIAL HEMP BIOMASS ON POULTRY PRODUCTION

According to the Virginia Department of Agriculture and Consumer Services (VDACS), Virginia's largest revenue-producing industry is agriculture, providing an annual impact of $70 billion and over 334,000 jobs within the state. Within this industry, the top agricultural commodities include broilers, cattle/calves, milk, and turkeys, with a combined turkey/chicken inventory of over 43 million units for Virginia as of 2012.

This project seeks to evaluate a potential industrial hemp industry, specifically, the production of hempseed, as a competitive feedstock for these high-value poultry commodities. To achieve this, the project utilizes a techno-economic analysis to characterize the economic and environmental impacts of industrial hemp production within the Commonwealth of Virginia, with respect to its implications on the agricultural and poultry industry. Additionally, this project analyzes the benefits and disadvantages of this industry, and how it could be integrated into the current agro-economic model of Virginia.

When examining hempseed as a competitive feed commodity for the poultry industry, it is critical to quantify key nutritional parameters that are deemed necessary and/or advantageous relative to other feeds used in poultry diets. Typically, poultry diets include sources of protein (canola, fish meal, soybean, etc.) and energy (from fats and oils). This study developed a framework of quantitative analysis methods to evaluate hempseed's chemical makeup and ultimately its suitability as an alternative feed for poultry, in addition to the chemical processes that may be required to modify the feed product such that it becomes suitable.

Finally, a cost comparative analysis was done against industry standard diets to provide decision-makers a basis for which hempseed can compete. Although hempseed's dietary contributions appear promising, there is still much work to be done to overcome regulatory barriers. Specifically, the pharmacological and other downstream-effects of additional chemical compounds present in industrial hemp, namely cannabinoids, must be identified and mitigated through chemical processing (if necessary).

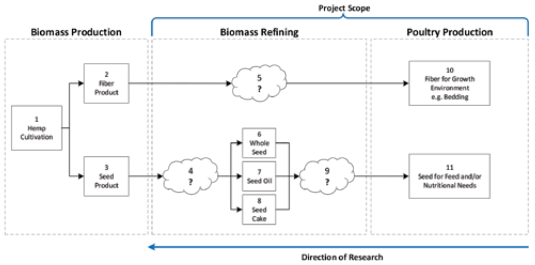


fig. 1: Research Methodology Schematic

Aaron has been advised by
Samuel Morton III

ENGR 280 SPECIAL PROJECT

BRIDGE OVER MOSSY CREEK

A series of pedestrian bridges in the Mossy Creek area in Mount Solon, VA, washed away due to historic flooding in May and September 2018. Seven students joined a special projects class coordinated by three engineering faculty to engage community stakeholders, develop a preliminary design of a bridge that is materially sustainable, and research stabilization techniques of the streambed to protect the bridge and trout habitat during flood events. The overall goal is to design new pedestrian bridges that are materially sustainable and resilient to future flooding. This project will continue as a series of future 200- and 400-level classes, including a 2-year Junior-Senior capstone design team.

TEAM

Corrine Brady
Jared Givan
Faldo Jatmoko
Ryan Lesniak
Ban Mansoor
Natalie Peterson
Brian Schieber

ADVISING

Daniel Castaneda
Heather Kirkvold
Bradley Striebig

00016


DES


SIGN


SENIOR
2019

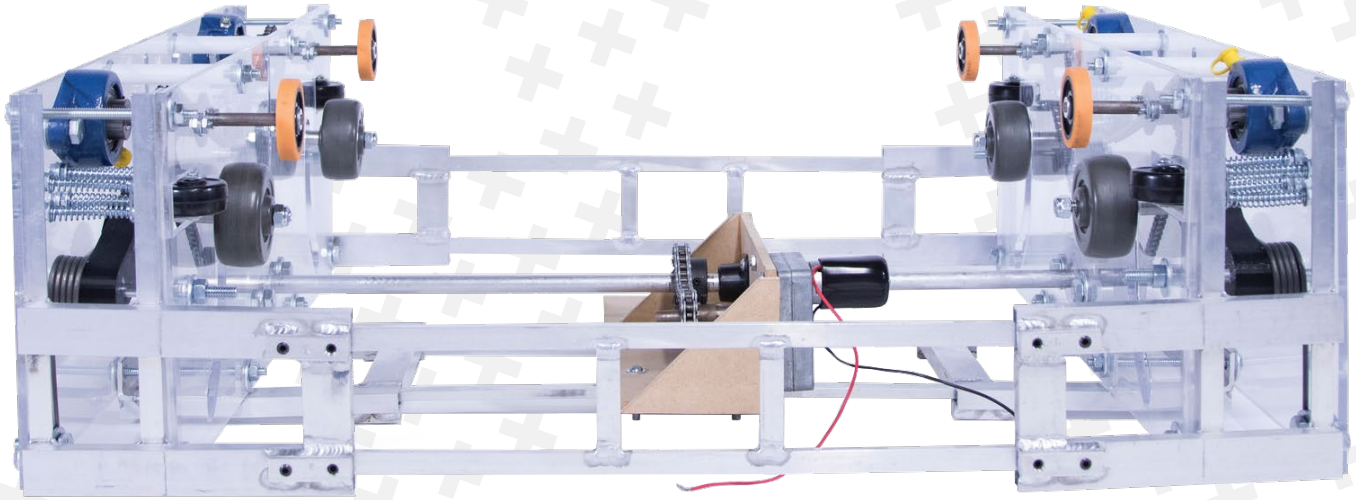
ANALYZING ARTIFICIAL WIND EVENTS FROM VEHICLES ON A HIGHWAY

TEAM

Shane Butler
Jens Byer
Braxton Faggert
Matthew Kennedy
Christopher Marcelin

ADVISING

Steven Harper



Above:
The Artificial Wind Event team's traveler device.

00022

Above: The team is investigating the propulsion sub-system on our prototype.

Everyday millions of vehicles travel along the United States interstate system. The high travel speed of these vehicles on highways produce artificial wind energy, which has the potential to be utilized to create power. However, the wind events created due to passing vehicles is a source of energy that has remained relatively undiscovered, so little is known about the airflow. The wind event that our Capstone team is tasked with investigating is this artificial wind generated by vehicles.

Harvesting energy from complex environments, such as under a bridge, requires knowledge of complex air flow fields. This project seeks to advance the knowledge and understanding of such flows under bridges. The project will result in data which can assist in analyzing and harnessing wind energy where it frequently lies untapped. The end goal of this project is to create an autonomous system of devices that can travel on a bridge I-Beam, one which lies directly over a highway overpass. The devices will collect data from the wind event created by vehicles passing underneath. This data could be used for future implementation of wind energy collection devices placed underneath bridges and overpasses to collect and preserve this unutilized energy. At the end of the project duration, we expect to develop a device to be presented to the Virginia Department of Transportation (VDOT) for approval and inspection of the system.

BIOCHEMICAL PRODUCTION SYSTEMS

00024

To date, the biochemical production systems employed in industry are used to synthesize a wide variety of products, such as beer, medicines, bio-fuels, and other consumer products. Although beneficial, these processes can be characterized as large and complex, and are typically burdened by manufacturing safety risks and associated costs. Because of this, it is important that modern managers, engineers, and operators are well versed in the tools used by industry professionals to ensure process safety, product identity, and product quality.

This project resulted in the development of a lecture-based curriculum that provides students with an opportunity to explore the fundamentals of several key operations, namely fermentation, with some consideration to separations, chilling, sterilization, etc., and engage with the corresponding process safety management and hazard analysis techniques that are commonly used in industry. Coupled with lecture, students also have the opportunity to practice topics discussed in class in a hands-on environment (i.e. a process development and safety laboratory). Here, students work as engineer/operator/manager teams to oversee an arbitrary biochemical process and utilize prescribed safety management techniques.

As a result of this project, student engineers will have the potential opportunity to study fundamental biochemical process concepts in a class-based setting with the added benefit of engaging with these topics in a lab-based setting. Because of this, these students will be better equipped to be safe and effective members in an important manufacturing industry.

TEAM

Robert Baxley
Lukas Bergstrom
Marie Marshall
Garrett McGurl
Aaron Sloss

ADVISING

Samuel Morton

Opposite:
A student takes a sample from the bioreactor to monitor fermentation performance and quantify critical process parameters to ensure product identity, quantity, and quality.

Below:
A cylindrical-conical bioreactor used for the fermentation of beer (a common biochemical product). Equipment shown is representative of many vessels used in industry, and provides students with data of key process parameters of this core unit operation used in industry.

The team works on precisely measuring the mounting position for the drive wheel on the first full scale prototype.

CASHEW DEVELOPMENT IN TANZANIA

Tanzania is one of the largest cashew growers in the world. The cashew nut is the primary focus of the cashew industry in Tanzania, because it is a popular edible nut. However, there are many other uses for the entire cashew crop, even the parts that are typically considered a waste product. For instance, the cashew apple (the fruit to which the nut is attached) can be used for juicing, the shell can be crushed for its oil, and the nut can be consumed. This project aims to assist farmers in the use of all parts of the cashew crop in a sustainable manner, by developing a quicker way to harvest the crop and retain all its useful components (fruit, nut, and shell). Our team has developed a fallen cashew apple harvester to quickly collect the entire cashew crop from the ground. The harvester has the potential to save the farmer's time and to retain the cashew apple so that it is not discarded. This will help farmers to generate more wealth from an abundant natural resource in Tanzania, the cashew.

TEAM

Gyanendra Khanal
Joseph Sorrells
Ryan Ku

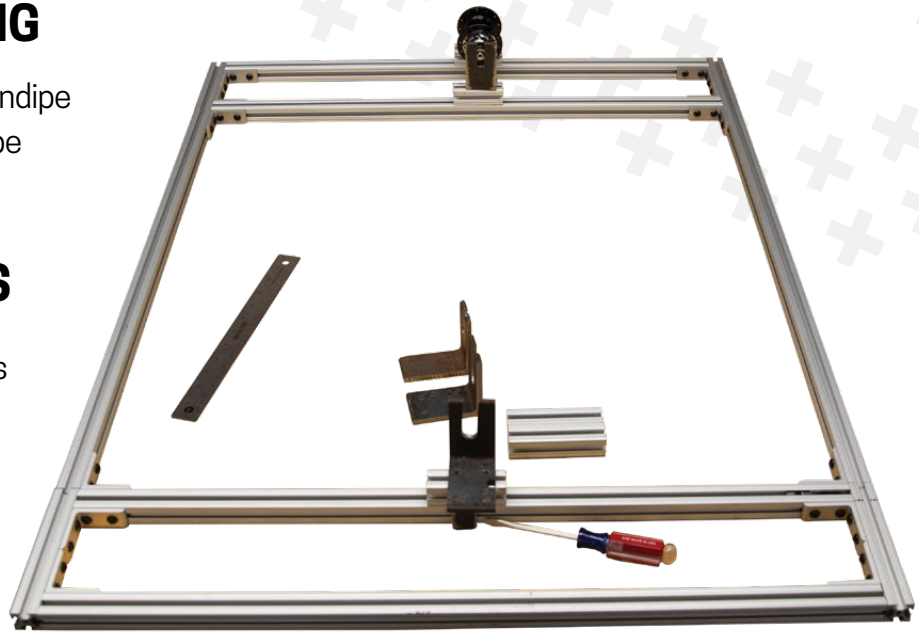
ADVISING

Adebayo Ogundipe
Divina Kaombe

CLIENTS

Partners of the Americas

Below:
The frame for the cashew apple harvester.



00027

COLLEGIATE WIND COMPETITION: ELECTRONICS & CONTROLS

As global warming becomes a greater concern, there is a need for renewable energy sources. Energy generation through a wind power system can face challenges in over speeding, power regulation, and operation of the turbine under dangerous conditions. Our team has integrated many of the electrical components and designed controls systems that enhance the performances of the turbine and solve reliability issues, while capturing more wind energy and converting it into electricity. The greater the wind speed, the more power that can be harvested; however, strong wind speeds can cause an uncontrollable rotation of blades, which may damage electrical and mechanical systems. An automatic speed control strategy is designed using Pulse Width Modulations and MOSFETs (metal-oxide-semiconductor field-effect transistor), known as an electrodynamic braking system. Based on the signal received from sensors and set values in the Arduino program, the microcontroller varies the speed of the generator by turning the signal on or off until it reaches an acceptable range. This will slow or shut down the system, ensuring safety of the turbine at dangerous wind speeds. Following our junior year design, an improvement of the braking circuit was designed to make the MOSFET withstand stressful conditions, resulting in a reliable, safe system.

TEAM

Nick Colonna
Neth Gardner
Robert Gerber
Seemran Patel
Austin Pelto

ADVISING

Keith Holland

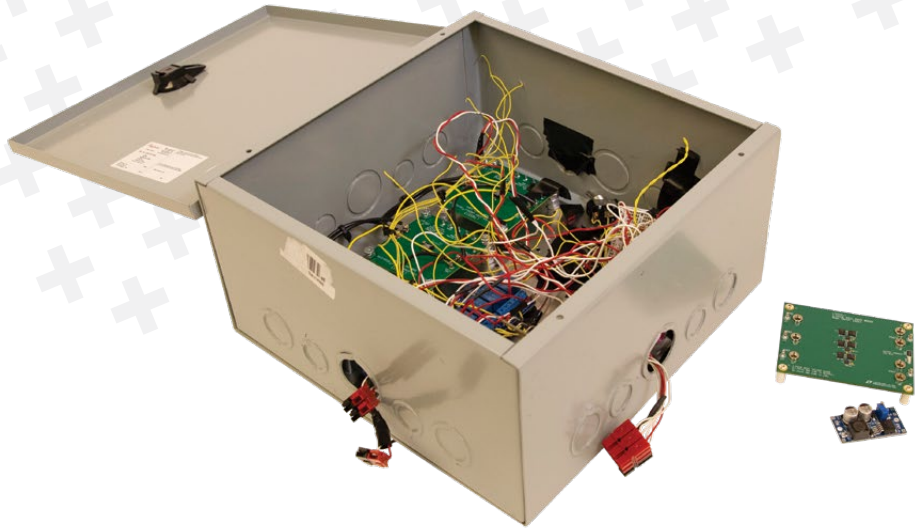
CLIENTS

Department of Energy
National Renewable Energy Laboratory
American Wind Energy Association

Opposite:
The Electronics and Controls team is testing frequency of the power MOSFETs for the electrodynamic-braking system and preparing to integrate it into the turbine.

00028

Below:
The Electronics and Controls team's first prototype of all electrical subsystems housed in an enclosure, following the National Electrical Manufacturers Association (NEMA) type 1 rating.



COLLEGIATE WIND COMPETITION: ROTOR

TEAM

Maui Ong Ante
Raphael Bellon de Chassy
Sabrina Hammell
Mathew Kerner
Alex Mironenko

ADVISING

Keith Holland

CLIENTS

Department of Energy

Left:
First iteration of pitch system accompanied by preliminary prototype to test generator functionality.

00030

Above: Team looking at previous prototype to plan for future subsystem integration.

According to the United States Energy Information Administration, 85% of the energy produced in the United States comes from fossil fuels and nuclear plants, whereas only 15% is produced from a clean energy source. There is a need for a transition from hazardous, nonrenewable resources to clean energy that poses less threat to the environment. The Department of Energy's Collegiate Wind Competition attempts to address this need by tasking colleges across the country to participate in making a small scale wind turbine. They hope that through this competition, students will become interested in the industry and will continue their work in clean energy after graduation. Through semesters of work, the Engineering Capstone Team consisting of an electronics team and a rotor team have created a small scale wind turbine to meet the constraints tasked by the DoE. The Rotor Team consists of five engineering students who work on mechanical components within the turbine and work with the electronics team to integrate the many subsystems into one functioning prototype which will undergo performance tests as part of the Wind Competition in Boulder, Colorado in May 2019

The team testing out newly developed code for the sensor package.

FREE RANGE SOLUTIONS

Virginia thrives on the agricultural industry, cultivating 3.8 billion dollars per year in revenue. The dairy/beef industry makes up 34% of this revenue, a large portion. The Free Range Solutions team is working to protect the assets of free-range cattle farmers by analyzing health data collected from their herd before conditions potentially worsen. With a unique focus on free-range cattle, our solutions are aimed at taking the workload off of the everyday life of the farmers. Our team has developed a sensor package as well as an algorithm that will help us determine if a cow is sick by collecting thermal readings and transmitting the data over radio frequencies. As a team, we have worked to bridge the gap between modern technology and older farming techniques by creating a seamless transition between the two. Using data collection and data analysis, Free Range Solutions is able to generate a visual and clear description for the farmer to check on his cattle with ease.

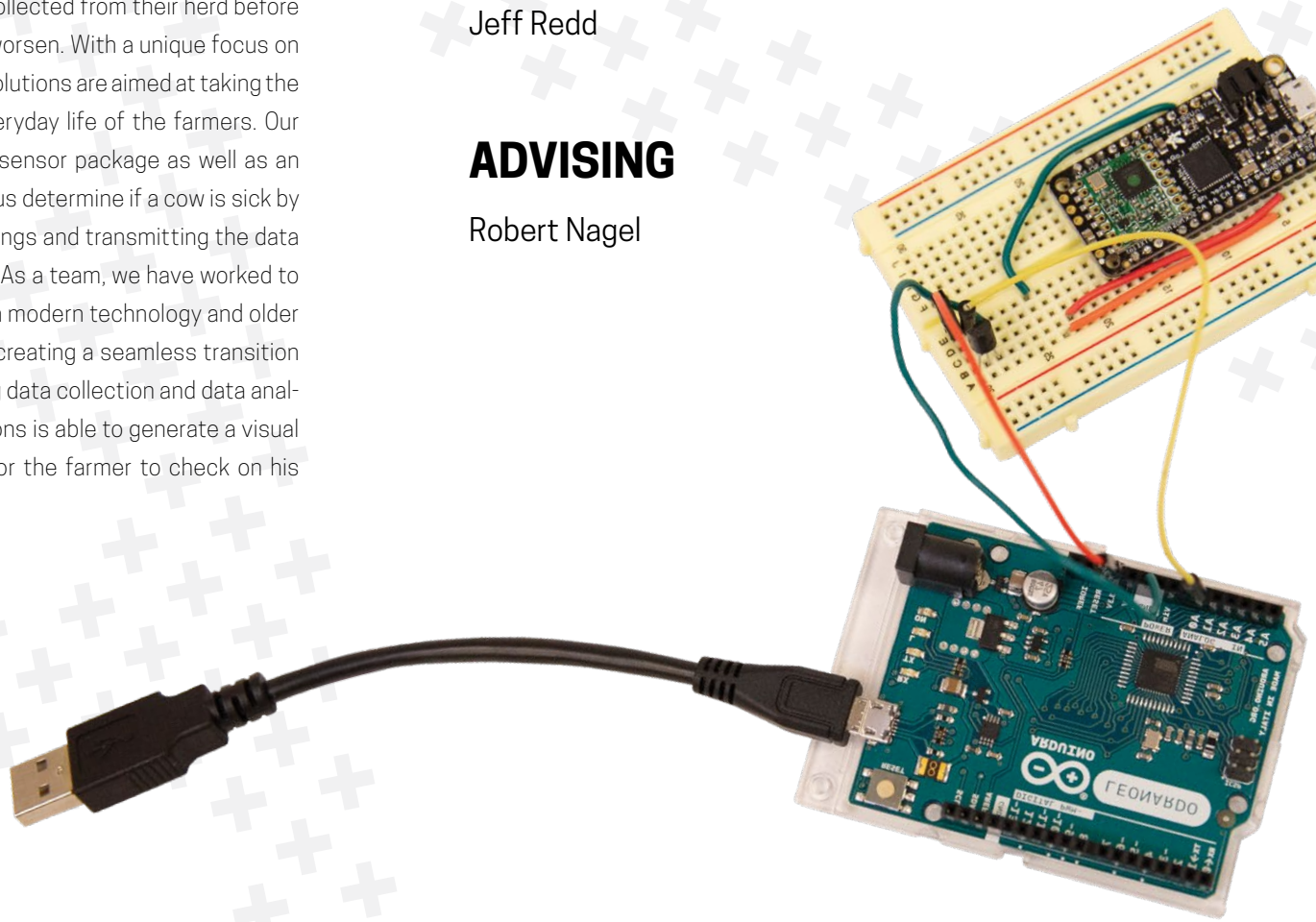
TEAM

Sean Bartro
John Codington
Wyatt Jankauskas
Jeff Redd

ADVISING

Robert Nagel

Below:
Base temperature package used for taking sample data.



00033

HARRISONBURG GREENWAY SYSTEMS 2.0

TEAM

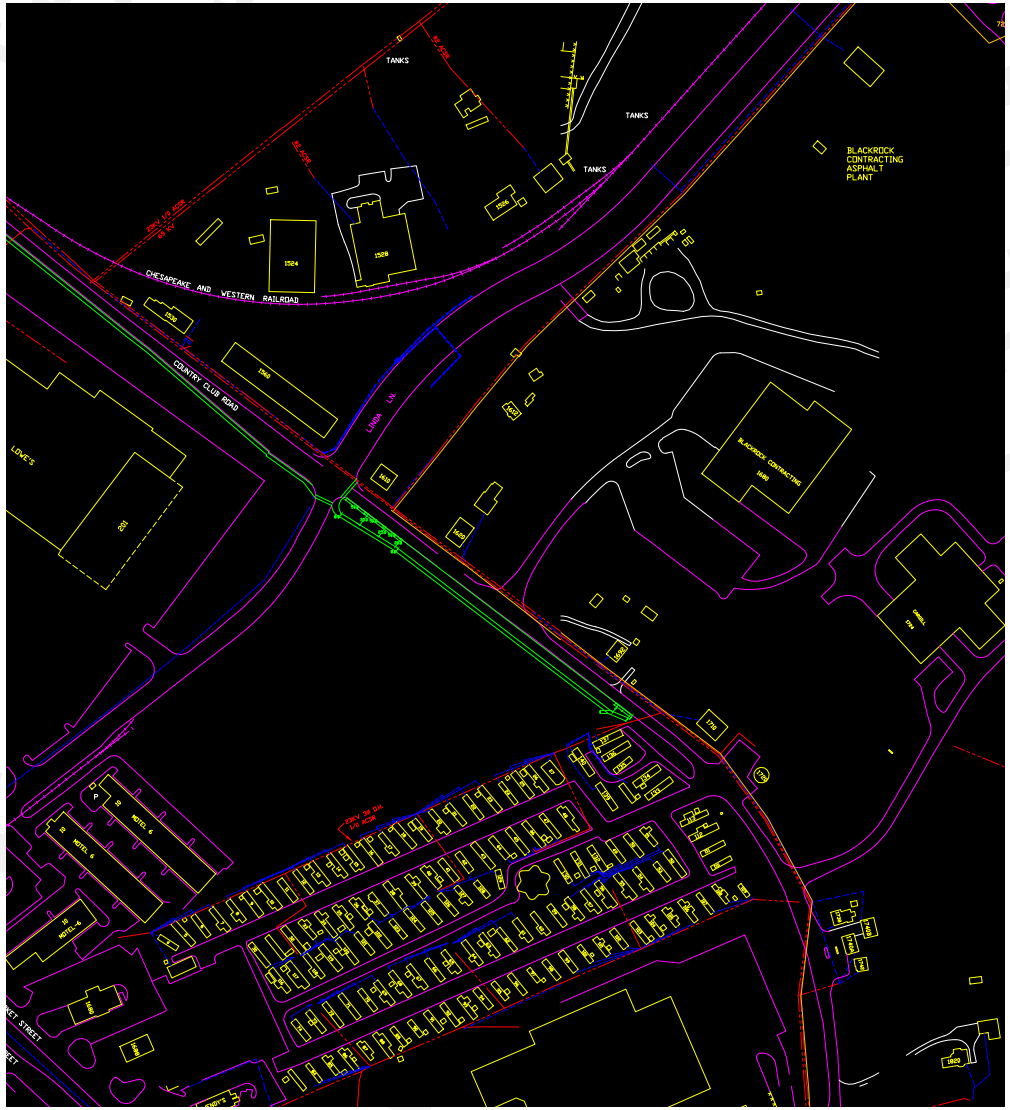
Keefer Hensel-Smith
Julia Hutchens
Kevin Partlow
Bradley Ritchie
George Shumeyko

ADVISING

Heather Kirkvold

CLIENT

New Community Project,
City of Harrisonburg



Left:
The team's AutoCAD drawing of the path connecting Spotswood Homes Trailer Park to the intersection of Country Club Road and Linda Lane. This along with other drawings will be included in the final deliverable to the City of Harrisonburg.

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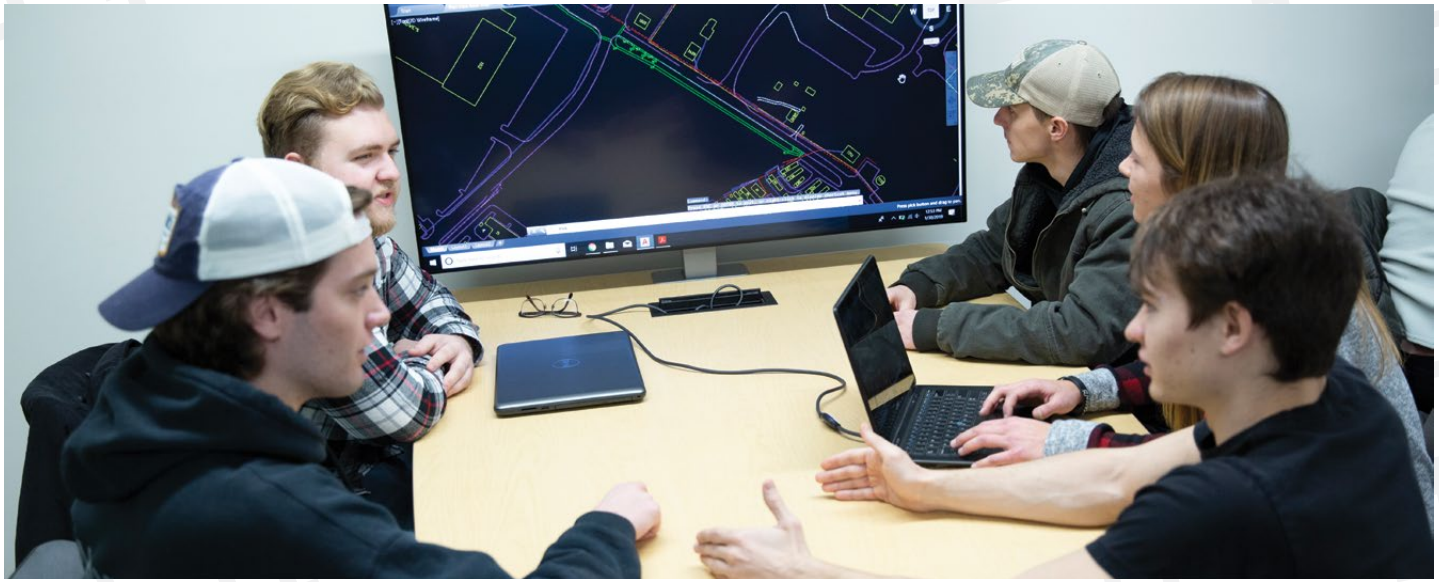


Above: The team is identifying areas of the design that require cross sections to be drawn, and from which locations to gather elevation data.

Harrisonburg lacks infrastructure for students to bike or walk to school safely, especially around lower socio-economic class communities. Skyline Middle School, in particular, is surrounded by major arterial streets, many without connecting sidewalks or paths for students in surrounding communities to use. With these students and two other stakeholders in mind, a shared-use path is being designed to connect Skyline Middle School and the surrounding communities, specifically Spotswood Homes Trailer Park and Reherd Acres. The stakeholders include New Community Project, a non-profit in the City of Harrisonburg, along with the City's Department of Public Works. Shared-use paths have the ability to create social, economic, and environmental sustainability in the communities in which they are built. The shared-use path system designed around Skyline Middle School will allow students to travel to school safely, as well as provide an opportunity for alternate methods of transportation and recreation to the broader Harrisonburg community. Ultimately, the city wants to see a full shared-use system to connect throughout Harrisonburg, with a route to Skyline Middle School included.

K2M SURGICAL INSTRUMENTATION

TEAM

Jack Dominick
Nathaniel Lucas
Kerry McCullagh
Thomas Milkowski
Jason Renalds

ADVISING

Jacquelyn Nagel
Callie Miller

CLIENT

K2M, Inc.

Left:
Examples of tools the team has developed.

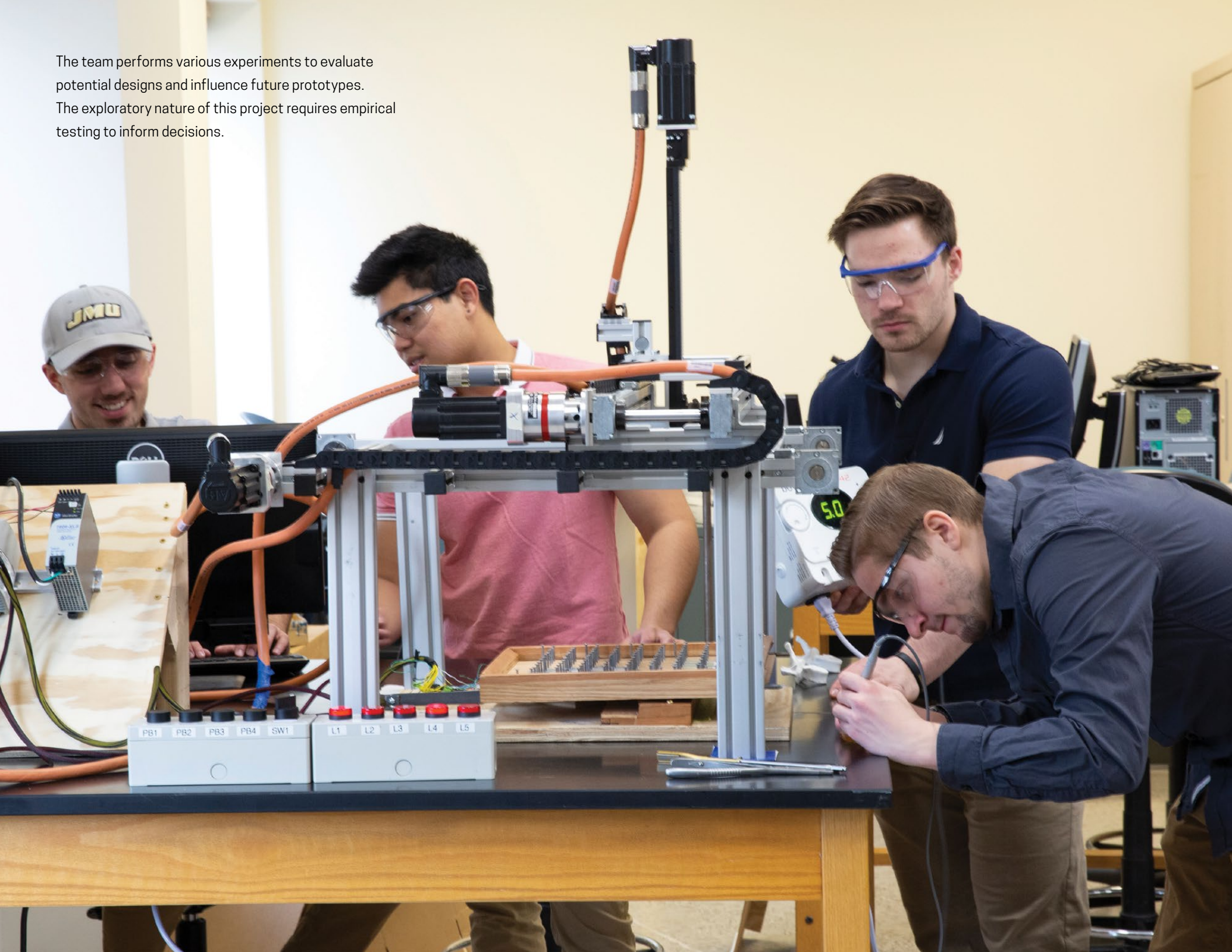
00036

Above: The team tests their tools on a model spine.

Spinal fusion surgery is a highly detailed surgery that aims to correct large misalignments in a patient's spine due to scoliosis or hyper-kyphosis, which are severe curvatures in the spine. During these corrective surgeries, surgeons bend a rod to the curvature similar to that of a healthier spine. Then, surgeons screw two pedicle screws into each side of every vertebra that needs to be corrected all the way down the patient's spine. Surgeons then use deformity reduction jacks ("crickets") that lower (reduce) the rod into the screws. These jacks are simply a way to force the rod down into the screw. One problem surgeons may face is that a patient's scoliosis can be so severe that the current device (cricket) can no longer reach far enough over the rod to reduce the rod into the screw as intended. Surgeons currently need a tool that will both persuade the rod laterally (move it over) and axially reduce it into the rod.

The goal of our Capstone project is to create a tool that meets the surgeon's needs of both laterally and axially moving a rod into its respective pedicle screw during spinal fusion surgery. When surgeons are unable to reach a screw, they must work backward, starting from the bottom of the spine, screwing and loosening each cricket. After this time-intensive process, the cricket can finally reach over and reduce the rod. It is imperative to keep surgical time down because there is a direct correlation between operative time and surgical risk both during and after surgery.

The team performs various experiments to evaluate potential designs and influence future prototypes. The exploratory nature of this project requires empirical testing to inform decisions.



K2M SURGICAL ROBOTICS

Spinal fusion is the most conducted spinal surgery in the United States, with an average of over 480,000 surgeries performed each year. Due to the high volume and high cost of these surgeries, surgeons are searching for technological methods to decrease human error, reduce the occurrence of revision surgeries, and minimize repetitive use injuries. This project explores the frontier of robotic surgery as a possible solution to these problems by creating a proof of concept system that models a single level spinal fusion surgery. Copious amounts of article reviews, technology evaluations, and stakeholder interviews were conducted to correctly create a project scope. After this, team efforts were divided to program the cartesian robot, design and manufacture the robotic end effector, build the tabletop testing environment, and test the system. Though only a low-fidelity model, this proof of concept system provides evidence that robotic implementations will improve accuracy and efficiency in the operating room, which will result in fewer revision surgeries for patients of the future.

TEAM

Troy Fries
Alexander Gellios
Faldo Jatmoko
Cameron Robinson

ADVISING

Jacquelyn Nagel

CLIENT

K2M, Inc.

Below:
This layout shows traditional spinal surgery tools and vertebrae models. These materials help to visualize the anatomy and understand the procedure of a traditional spinal fusion surgery.

*LEED*ING BUILDINGS

According to a study done by Advancing Sustainable Materials Management, nearly 500 million tons of debris were generated due to building demolition in 2015 alone. Not only is this a lot of waste, it is also potentially lost history. Meanwhile, with over 9,000 buildings on the National Historic Register lying vacant, it seems there is a disconnect. The Dallard/Newman house located in Downtown Harrisonburg is in the hands of the Northeast Neighborhood Association (NENA) and serves as a perfect case study to showcase how green building technologies and historical diligence can come together to revamp an old home and turn it into a functional and forward-thinking building. LEEDing Buildings has been working to generate proposals for how the Dallard/Newman house could be repurposed into an energy efficient office, library, living museum, or community space. The team and NENA are currently discussing previous plans and potential new plans to see if they are feasible for implementation.

TEAM

Nick Butts
Kamden Clemmer
Danny Utrera
Sophia Welch

ADVISING

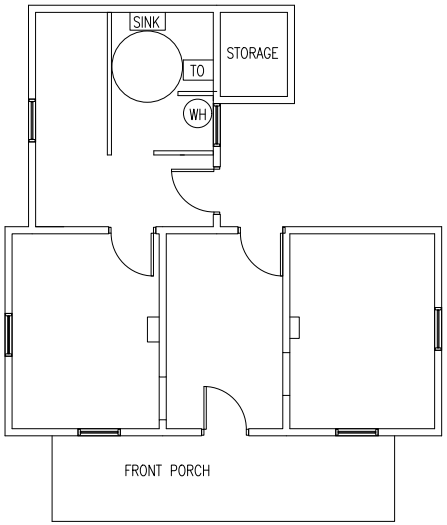
Kyle Gipson

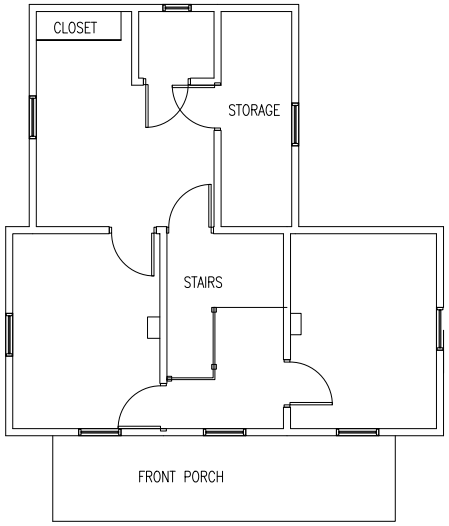
CLIENT

Northeast Neighborhood Association (NENA)

Opposite:
The team is reviewing interior renovation plans to gather information that can be applied to their final recommendations for NENA.

Below:
The floor-plan for the Dallard/Newman house with a potential ADA-compliant bathroom design incorporated. This drawing would be used to generate demolition and construction drawings for the final renovation plans.





LION ELECTRIC MOTORCYCLE

TEAM

Peter Condro
Ben Cotton
Carlos Cox
Emma Drummond
Adam Pinegar
Kyle Vickery

ADVISING

Rob Prins
John Wild

CLIENTS

MG Motorsports

Above:
The stock frame from which the team has taken benchmark measurements and functional inspiration for their electric motorcycle.

00042

Above: The Lion team disassembles the instrumentation cluster from a donor vehicle for the purpose of installing custom gauges and rider diagnostics onto the final Lion motorcycle.

We can no longer rely on fossil fuels to satisfy our needs in the future and with the strong push for solar and wind generation for electricity, it only makes sense to create something that can use the cleaner energy from these renewable sources. Electric vehicles (EVs) are becoming more commonplace, leading to more EV and EV subsystem related engineering opportunities for engineers. However, since the subsystems of commercially available EVs are not "open source", commercially available EVs do not make good platforms for the development of systems knowledge which we aim to provide to the students involved in this project as well as future students.

Retrofitting an existing chassis with EV components compromises optimal positioning and grouping of components. These problems will be addressed through the development of the Lion Electric Motorcycle, designed with accessible sub-systems fitted to a purpose-built chassis to allow for modifications, testing, and further learning experiences not only for the students working on this Capstone, but also future generations of engineering students interested in the future of electric vehicle technology.

The final system required integration of several subsystems including a chassis, traction battery pack, battery management system, motor, and motor controller. The project also required significant design alterations to address the interfaces between subsystems as well as the design and physics of the chassis. For the purposes of this project, modification of an existing chassis by replacing the existing frame with a frame designed to accommodate the selected EV components was the most promising solution. Successful design, fabrication, integration, and certification of the Lion Electric Motorcycle will provide current and future Madison engineers with a foundation to build off of in order to further develop technologies involving renewable energy.

MADISON MOBILITY 2.0

There are nearly 2 million people currently living with limb loss in the United States. Our client, Gregory Jansen, is among the 2% of these people who experienced lower limb amputation surgery due to cancer. His specific surgery, Van Nes Rotationplasty, allows his ankle to effectively function as his knee, significantly enhancing mobility compared to having a below knee amputation. The current prosthetic he wears on a daily basis however, causes him to experience significant discomfort and sometimes pain on the top surface of his foot when standing for extended periods of time. As a team, our goal is to redesign the socket of his prosthetic to redistribute these forces, alleviating the painful pressure on his foot. Through methodologies like static analysis, compression, and force sensor testing, MM2 was able to analyze how our solution would successfully result in a more comfortable prosthetic for Greg. Likewise, other innovative technologies such as 3D modeling and printing, not only brought our design to life, but can act as an easy and low cost approach to providing effective solutions for amputees living with limited mobility and discomfort.

TEAM

Callum Morton
Matthew Mumford
Natalie Peterson
Ashlie Veronie

ADVISING

Heather Kirkvold
Callie Miller

CLIENT

Gregory Jansen

Opposite:
Extracting 3D printed proof of concept from 3D printer.

00044

Right:
Full alpha prototype of rotationplasty prosthetic limb.

00045

SHELL ECO-MARATHON 2019

TEAM

Michael Bruce
Farris Jarrar
Mark Livingston
Federico Meersohn
Greg Schmidt

ADVISING

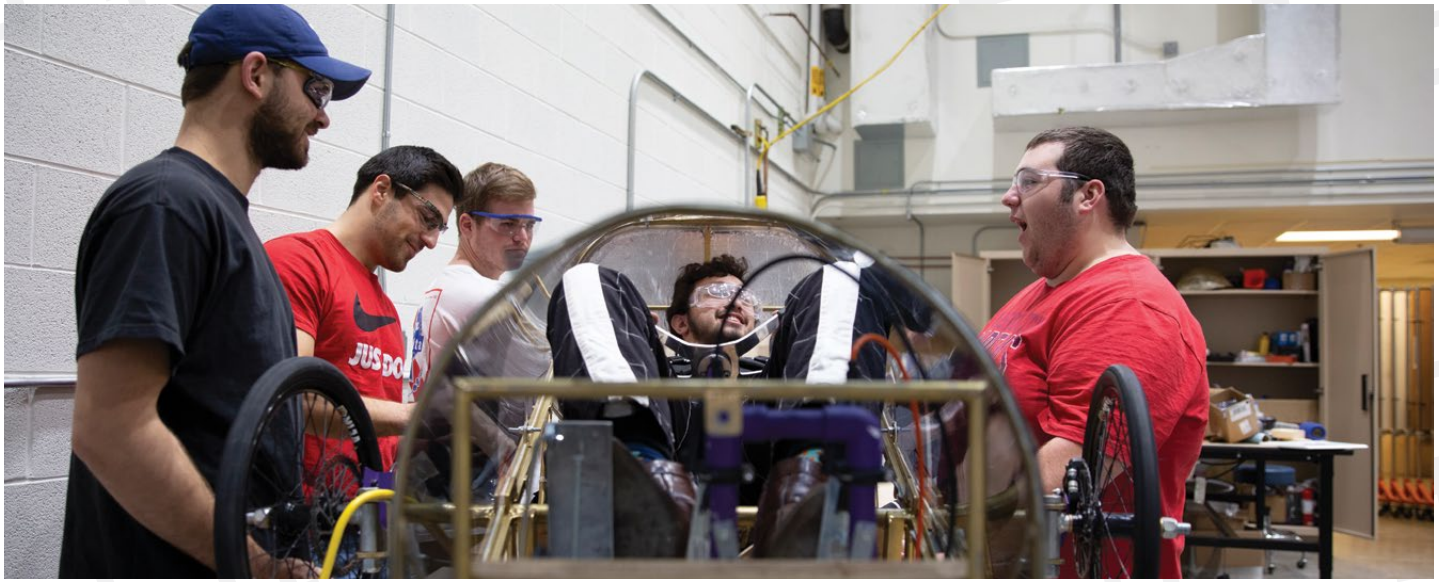
Robert Nagel
Rob Prins

CLIENT

Shell

Left:
Team vehicle undergoes various tinting tests.

00046

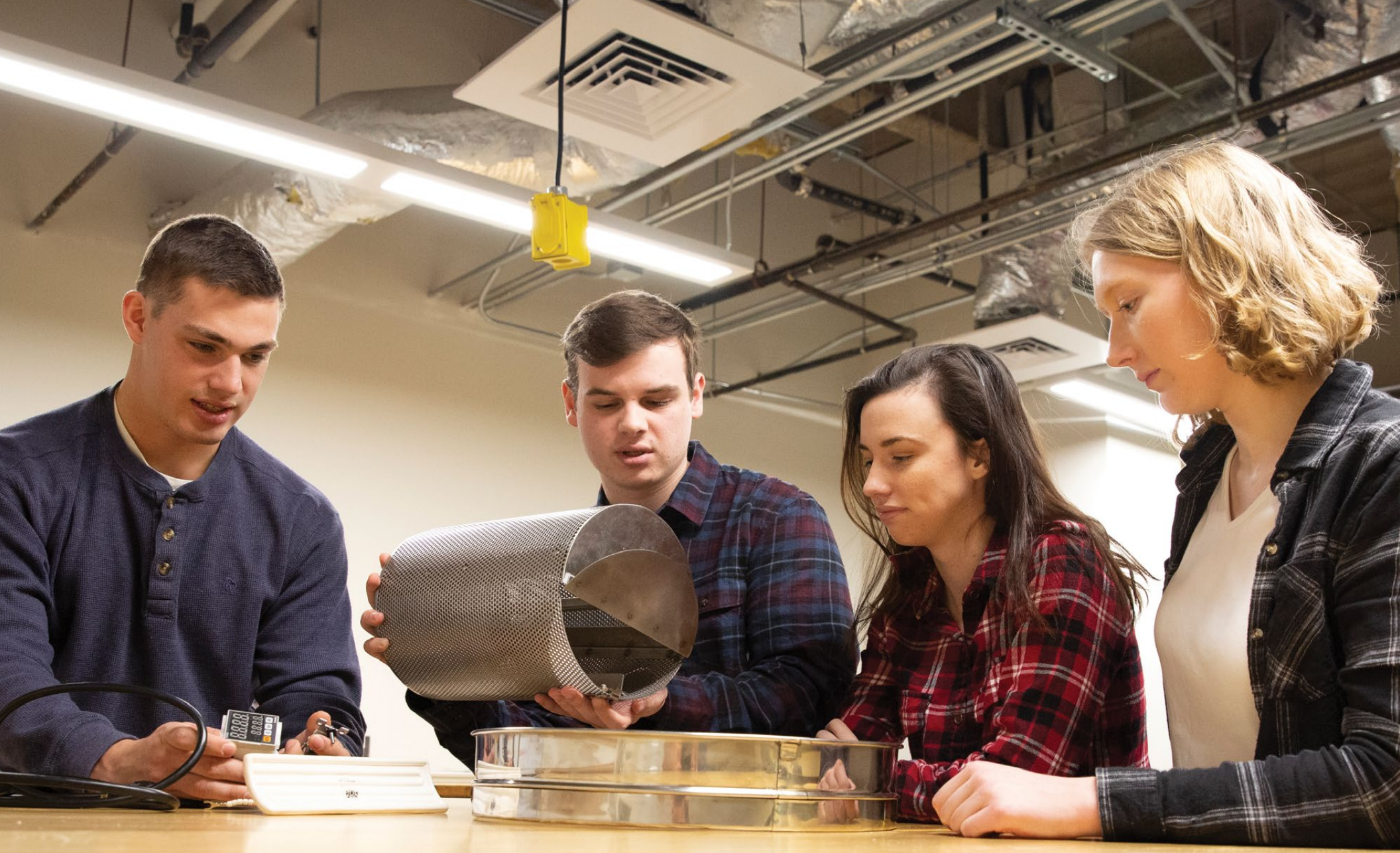


Above: Team tests drive fit and visibility in prototype vehicle.

The goal of this capstone team is to compete in the annual Shell Eco-Marathon Americas Competition April 3-6, 2019 at the Sonoma Raceway in Sonoma, California. This competition provides students an opportunity to create something out of the ordinary and inspires development of new technology in various fields such as alternative energy vehicles and high mileage internal combustion vehicles. JMU's first team competed in April 2018.

The 2019 team has faced new challenges while racing to finish the prototype vehicle. Our goal for this project is to optimize the fuel efficiency of the JMU Supermileage vehicle by optimizing the aerodynamics and reduce the weight of the body, or shell, of the vehicle. The knowledge gained from this may be useful in the advancement of a more fuel efficient vehicle production. Our target is to increase the fuel efficiency from the previous year's vehicle by 10%.

We used an estimated 300 mpg as a basis for our goal, meaning the goal is to reach at least 330 mpg.



Simulation of integration between coffee bean drum and cooling tray of roaster.

SMALL BATCH COFFEE ROASTING

With over 30,000 specialty coffee shops in the United States, coffee shops rely on roasting their own coffee to assert their position in the greater coffee industry and their local communities. This project is focused on the design, testing, and building of a small batch coffee roaster for the needs of Pitstop, the coffee shop within Madison Automotive Apprentices (MAAP) in Harrisonburg, Virginia. This design can be applied and implemented into other local coffee shops that struggle to find an appliance within the batch size and price range needed for their company. The team has completed a structural and electrical design based on the needs of the client that includes two motors, ceramic heating elements and a temperature controller to evenly roast coffee beans and cool them down. The energy consumption, footprint, and use of pre-manufactured components have posed limitations to the design of the roaster to ensure compatibility with functional requirements. The creation of an electrically, mechanically, and structurally established roaster design accompanied with operation test results and a fully detailed construction plan increased the potential of small batch roasting. This was also made possible by the successful compilation of materials required to heat, rotate, and cool coffee beans with the accuracy necessary for a coffee shop to commence their own roasting.

TEAM

Madison Anderson
Kristen Heaton
Caleb Hoehner
Zack Leonard

ADVISING

Justin Henriques

CLIENTS

Madison Automotive Apprentices

Below:
Collection of roasting machine mechanical and electrical components with a mixture of raw and roasted coffee beans.

The team is using a spectrophotometer to test the iron concentration of a mock solution before and after treatment. They are gathering data about the iron removal efficiency of bone char based on total treatment time.

WATER IN AFRICA

The World Health Organization estimates that 2.1 billion people worldwide lack access to safe drinking water at home. Every year, there are millions of preventable deaths due to waterborne pathogens and contaminants. This project addresses water scarcity at the Nasaruni Academy for Maasai Girls near Narok, Kenya by improving the collection and treatment of water from two local sources: rainfall and a borehole located on the academy's campus. Fluoride, iron, and microorganisms have been identified as the key contaminants that need to be addressed for the collected water to be considered safe and to minimize aesthetic quality issues such as taste and color. Because rainfall and borehole water have different treatment needs, this problem was approached using systems analysis to minimize cost while reaching water quality goals. A variety of treatment methods were considered, but the team decided upon a multistage process that removes the suspended iron, dissolved fluoride, and microorganism populations in different stages. Our conclusion is that it is not only feasible but significantly cheaper in the long run for the academy to use locally collected and treated water to meet their potable water needs rather than trucked in water from Nairobi.

TEAM

Arie Bradley
Christine Gatto
Jared Givan
Brianna Palazzola
David Sydnor

ADVISING

Bradley Striebig

CLIENT

Nasaruni Academy for Maasai Girls

Below:
The Water in Africa capstone team's first prototype of a filtration system containing a combination of multiple treatment methods. Various types and ratios of contaminant-removing materials were tested using this setup.

00051


BU

JUNIOR 2019

The team discusses the integration of flight controller subsystem with hexacopter UAS platform.

AERIAL MULTI-SPECTRAL IMAGING

Agricultural fertilizers allow farmers to grow enough food to sustain our growing population; however, using these nutrients can have dangerous side effects on the environment. When too many of these nutrients are introduced to a body of water, they can cause massive algae growth which leads to water hypoxia, fish kills, and the presence of harmful bacteria. Currently, there are no low-cost methods for monitoring eutrophication across an entire body of water over an extended period of time.

Our project seeks to address the issue of eutrophication in small bodies of freshwater by monitoring pond health characteristics from an aerial platform. To do this, our team is using a multispectral camera mounted on a drone to take pictures of the water and outlying land across five distinct bands, which will later be combined to calculate multispectral indices that can be correlated to pond health and fertilizer concentration.

Our team has created a process by which a drone will fly a preprogrammed flight plan in order to capture photos over an area of interest, and has devised a system for generating false-color images containing multispectral indices. Moving forward, our team is planning to learn more about identifying characteristics of water quality and pond health in order to validate which indices are appropriate for this approach.

TEAM

Ernest Benner
Dominic Coradazzi
Zachary DeBey
Justyn Girdner
Isaac Miller
Jacob Ortiz
Parth Patel
Brian Schieber

ADVISING

Justin Henriques
Jason Forsyth
Adebayo Ogundipe

CLIENT

JMU X-Labs

Below:
A DJI F550 Hexacopter fitted with a Pixhawk flight controller and a Micasense RedEdge 3 Multispectral Camera. The transmitter alongside can override the flight controller at any time during a flight.

The team is reviewing their notes from interviews with their stakeholders at Woods Edge Farm.

AGRICULTURAL APPLICATIONS

The Shenandoah Valley is home to four of the top five agricultural producing counties in Virginia. One of these five counties is Rockingham, which is home to Woods Edge Farm LLC, the client of the Agricultural Applications Capstone Team. The goal of this project is to redesign the aquaponics system at Woods Edge Farm, which is currently out of use. The team is investigating the suspended solids that the water settlement tank must remove. Aquaponics is a closed loop system in which water from fish tanks is used to water and nourish plants. The team began by investigating and analyzing the causes of the system's previous failure.

The first system component the team plans to address is the design of the sediment removal tank. The next step will be to improve the structure of the aquaponics system. The team has benchmarked and researched existing aquaponics systems and water settlement tanks as well as interviewed the client at Woods Edge, Mr. Calvin Nolt.

TEAM

Daniel Butler
Caroline Clay
Jamie Riley

ADVISING

Kyle Gipson
Justin Henriques

Below:
The aquaponics system currently in place at Woods Edge Farm. The Agricultural Applications team is working to redesign this system.

ANALYZING THE IMPACT OF KARST FORMATIONS ON ENGEO

TEAM

Madison Gilmore
Kyle Inocco
Isabel Ledesma
Kathryn Nielsen
Clement Poole

ADVISING

Heather Kirkvold
Shane McGary

Left:
A satellite image of the ISAT/ CS/ EnGeo/PhysChem building complex, where the team will be completing their research and evaluation of the subsurface.

00060

Above: The team is planning out where to lay lines for electrical resistivity tomography (ERT) testing. This testing will evaluate the subsurface conditions under/around the ISAT/CS/EnGeo/PhysChem building complex.

Most of the Shenandoah Valley morphology is due to the limestone that lies beneath it. Limestone is a carbonate sedimentary rock that can dissolve over time. When limestone is exposed to water and air, a chemical reaction occurs that creates carbonic acid. This acid corrodes the limestone around it and can form amazing karst features, including pinnacle weathering and caverns. However, construction on this type of subsurface can be challenging and potentially harmful to a building's longevity and safety.

In May 2011, a sinkhole opened up at JMU near the Bioscience Building and Carrier Drive. Furthermore, cracked flooring, gaps in the window panes, and raised footers above flooring within the ISAT/CS and EnGeo buildings provide evidence of a changing subsurface under/around the buildings. These subsurface changes have the potential to develop into more serious structural damage in the future.

The goal of our capstone project is to develop a risk assessment report for the ISAT/CS/EnGeo/PhysChem building complex and the adjacent fields by examining land subsidence due to karst formations. Included in the methods used to complete the assessment of the subsurface is geophysical electrical resistivity tomography testing (ERT Testing). The risk assessment report will explain the current conditions of sub-surface under the east campus building complex. It aims to potentially quantify the risk associated with the subsurface conditions while offering a recommended mitigation technique(s). The purpose of our project is to ensure the safety of the public, maintain the longevity of the buildings, and create a baseline of the subsurface conditions for any future construction in the area.

CHUMBE ISLAND WATER ENERGY NEXUS

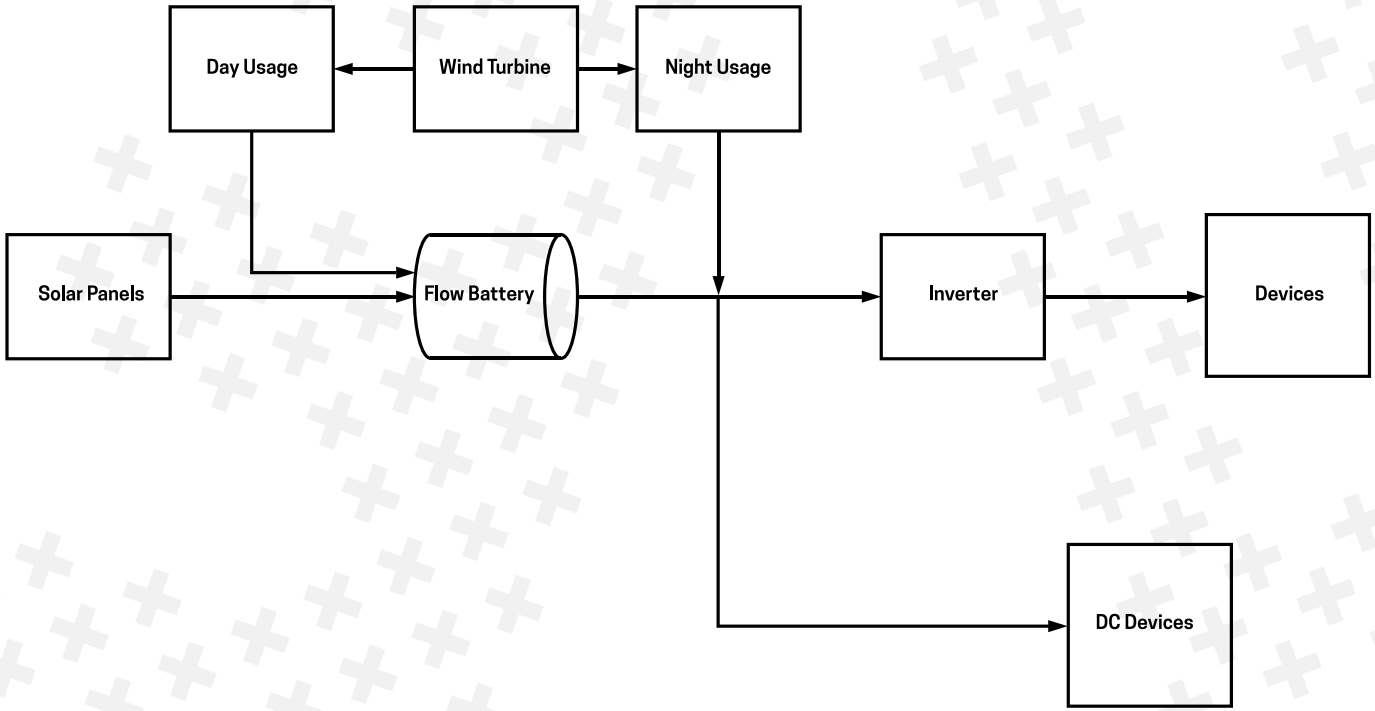
TEAM

Johannah Daschil
Joseph Gillock
Elyse Hieronymus
Preston Liverpool
Zachary Shipman
Carlee Smith
Joshua Williford

ADVISING

Adebayo Ogundipe

Left:
Diagram of transformer model in Circuit Lab.



00062

Above: The team reviewing knowns and unknowns of Chumbe's current energy distribution system.

By 2030, it is estimated that the world will be facing a 40% water deficit, meaning that 40% more freshwater will be removed from sources than will be replenished. Small communities in developing nations around the world struggle with energy and water needs more than in other, larger communities. Due in part to local geographic and geological properties, small islands have difficulty maintaining consistent sources of energy and clean drinking water.

Chumbe Island Coral Park (CHICOP) is a private nature reserve off the coast of Zanzibar dedicated to maintaining the unique coral and forest ecosystems of the area. In addition, it serves as an educational nature park for children and adults alike. In order to fund conservation efforts for the island, the park hosts tourists and visitors, which in turn strains the islands current energy and freshwater systems.

The interconnectedness and interdependence of water and energy systems is known as the Water-Energy Nexus. Our Capstone project continues to focus on producing more energy for Chumbe Island's needs, thereby also alleviating their water shortage problem. Currently, most of Chumbe's energy is generated on the island using solar photovoltaic panels for electrical energy and solar thermosiphon systems for hot water needs.

The current Chumbe team continues to gain knowledge of the island's needs by computing total energy needs, power delivery needs and storage capacity needs, in addition to designing the primary and auxiliary systems to address these needs. Using Circuit Lab, the team has explored practical participatory design while using user-centered tools to involve communities in the engineering process.

COLLEGIATE WIND COMPETITION 2020

TEAM

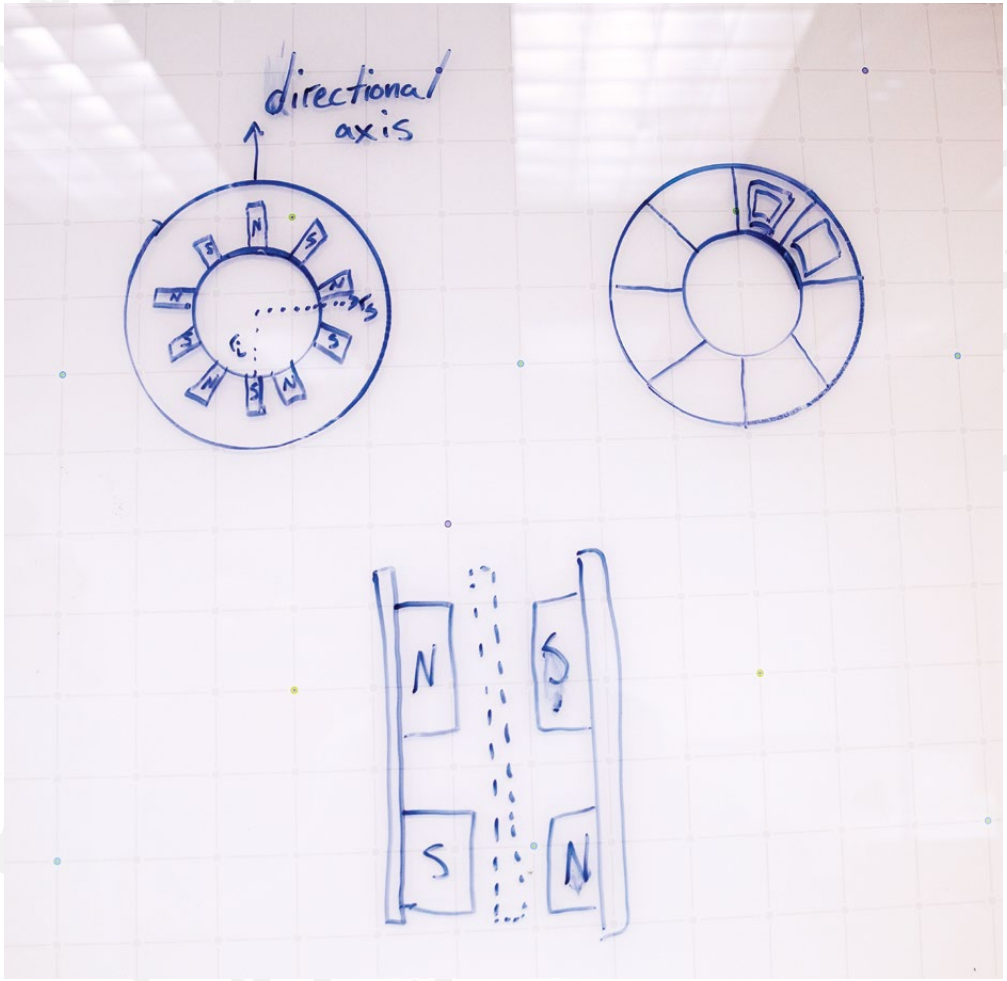
Jacob Abruzzi
Ethan Anderson
Oumaima Atraoui
Joey Carrico
Roman Cook
Jack McGeoghegan
Andrew Payne

ADVISING

Keith Holland

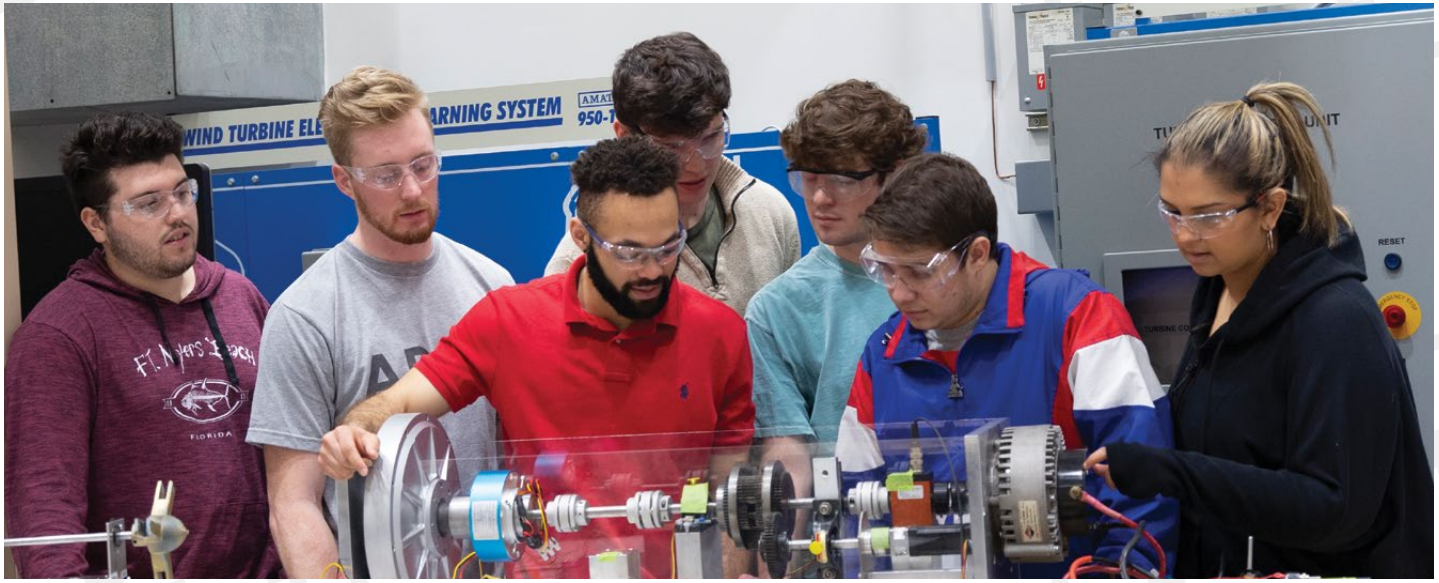
CLIENT

Department of Energy



Left:
Preliminary sketches for the rotor and stator components of the team's first iteration generator.

00064



Above: The team evaluating an existing generator. They are preparing to construct their first generator prototype.

Across the United States, wind energy could supply 10% of the nation's electricity by 2020 and that number is projected to increase by 25% by the year 2035. The Department of Energy has established a competition that aims to prepare students to enter the industry for wind energy. Our project explores the design process behind constructing a fully functioning wind turbine that adheres to parameters set by the Department of Energy. Members of our Capstone team will be invited to enter their wind turbine in the 2020 Collegiate Wind Competition. For the turbine blades, the Q-Blade software was used to construct and test blades to determine possible power output and torque generation. From this, a three blade design was chosen with the specific airfoil still to be determined. The generator's performance was simulated using a simple model created in Excel, while several components were modeled in the SolidWorks CAD software and printed for construction.

DRY RUN TRAIL DESIGN

The water supply diversion dam, located on the border of Riven Rock Park, just 30 minutes west on Route 33, supplies Harrisonburg with about half its water supply every year. According to biologists from the Virginia Department of Game and Inland Fisheries and the Forest Service, the city-owned section of Dry Run, where the dam is located, also holds the largest population of wild brook trout south of Vermont. The users of Riven Rock Park and the surrounding Harrisonburg community may lack an understanding of why it is necessary for the area to be preserved for future generations. The Dry Run Trail Design Capstone Team will design panels and interactive platforms that inspire natural resource appreciation and education about the value of the Dry River and its watershed with respect to the Harrisonburg water supply, as well as why it is important to maintain the health of the Dry River Ecosystem. After several field trips, using GIS Online, the team has created a model of what the layout of panels and interactive platforms could be throughout the park and created prototypes of some of the possible interactive platforms. The team has also talked to teachers and individuals involved with the City to gain a better understanding of the limitations and attributes they should be sure to consider. They hope to end the semester by submitting components of their design to the City for approval.

TEAM

Beverly Boateng
Grace Carter
Ryan Cole
Christopher Santaniello

ADVISING

Bradley Striebig

CLIENT

Trout Unlimited
Embrace a Stream
Program, Provost
Grant award by James
Madison University

Opposite:
Group members Grace, Beverly, Ryan, and Chris (left to right) look at and discuss their layout of educational panels and interactive activities for Riven Rock Park.

00066

Below:
The main pipe that brings Harrisonburg about half its water supply is seen here from Shelter 4 at Riven Rock Park coming partially out of the Dry Run River. Being able to see this pipe and the dam it extends from further up the river are educational opportunities and much of the reason Riven Rock Park has been chosen as a focal point for the Dry Run Trail Design Capstone.

The team is evaluating the IHC Protocol in order to evaluate requirements.

IMMUNOSTAINING WELL-PLATE

Many different scientists studying all forms of tissues and cells, use the process of Immunostaining. This process can be used to study a variety of subjects such as analyzing the formation of tumors or recognizing different forms of cancer. Traditional immunostaining practices involve the staining of tissues or cells with antibodies in order to visualize a targeted section under a specialized microscope and establish biological functions. A common problem among researchers utilizing this practice is the waste of antibodies and the lack of devices that allow for free-floating tissue samples. This problem is not only specific to the client and main stakeholder, Dr. Mark Gabriele from the JMU biology department, but is applicable to any researcher using any form of immunostaining. Our project will focus on the design of an apparatus that will minimize the volume of antibodies used, saving researchers thousands of dollars that could be used for more novel discoveries. Our primary goal is to minimize client expenditures through the creation of a device that allows for the reduction of the volume of antibodies required to stain free-floating brain tissue cells. A secondary objective is to maintain the tissue slices in the order from which they were cut, also known as serial order. In doing so, the client is able to create a three-dimensional representation of the studied brain section through the use of computer software. The realization of the two goals stated above has the potential to revolutionize the field of immunostaining because the same techniques utilized by the client to analyze brain tissue can be applied to any type of tissue being studied.

TEAM

Sanarea Ali
William Armstrong
Johanna Enzmann
Nick Liberati
Tyler Machi
Theresa Montane
Nicole Morgan
Zaki Samady

ADVISING

Callie Miller

Below:
The Immunostaining Well Plate team will be using 3-D printers in order to produce their initial prototypes.

PROJECT AELOUS

Coinciding with former JMU President Linwood Rose's commitment to advancing more sustainable practices at all levels, this student-proposed Capstone focuses on engaging with the student body to generate a design that will provide lasting positive impact to JMU and the community. Simply put, Project Aeolus aims to develop an outdoor public space on East Campus that features a functioning vertical axis microturbine (VAM). This endeavor will simultaneously demonstrate how underutilized physical spaces can be optimized to provide for multi-functional purposes and how renewable energy sources such as vertical axis wind turbines are advantageous in urban settings. Partnered with the Virginia Center for Wind Energy, the project solution will offer educational and recreational opportunities, comparable to those performed through the Wind for Schools Program. Utilizing AutoDesk applications, such as AutoCAD and Revit, the team will develop an official site plan in conjunction with a final proposal document in order to actualize the design with facility engineers and JMU administration. Based upon logistical and administrative feasibility, the tentative conclusion is that the space will be located adjacent to the current Small Wind Training and Testing Facility located across Carrier Drive from Rose Library.

TEAM

Carver Johnson
Lawrence Marfo
Robert McFaddin
Emerson Youtsey

ADVISING

Justin Henriques
Kurt Paterson

CLIENT

Virginia Center for Wind Energy

Opposite:
The team is conversing on the intricacies of wind energy technology to ensure that the vertical axis microturbine is optimal for the project.

00070

Below:
The undeveloped area near the Small Wind Training and Testing Facility (SWTTF) located on East Campus of JMU is the current proposed development site.

REIMAGINING A PITCHING MACHINE

TEAM

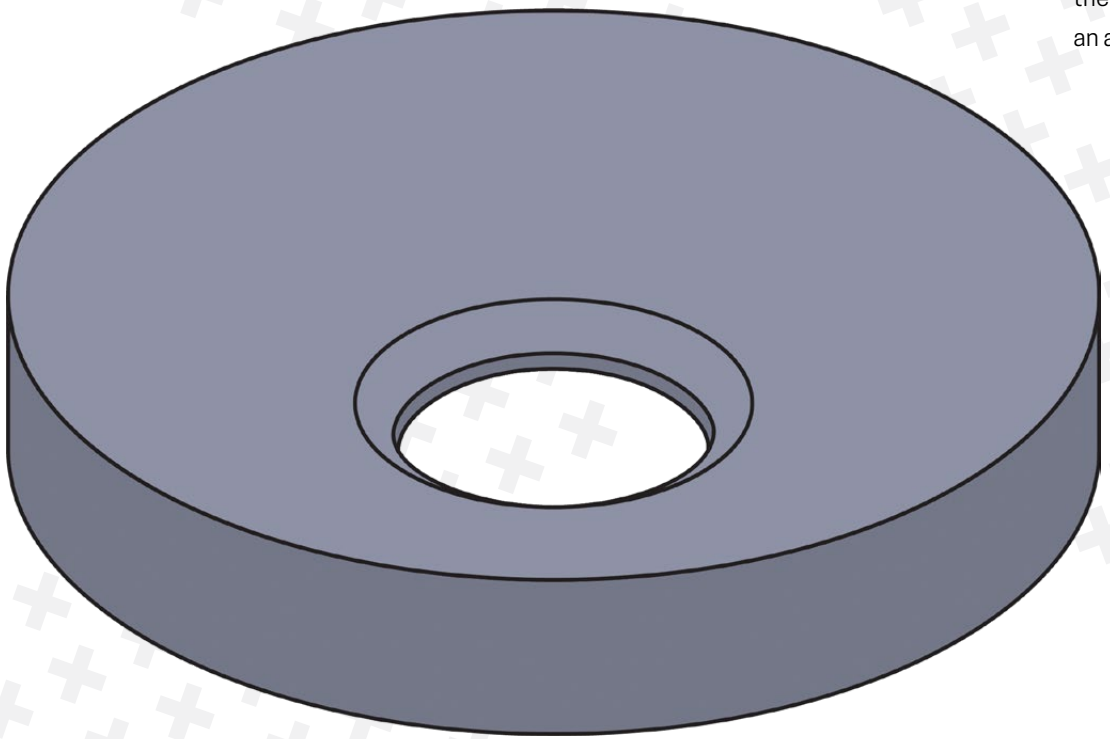
Bernard Baird
Brady Fox
Daniel Green
Fox Semones
Adam Smith
Jason Souder

ADVISING

Jason Forsyth
Samuel Morton

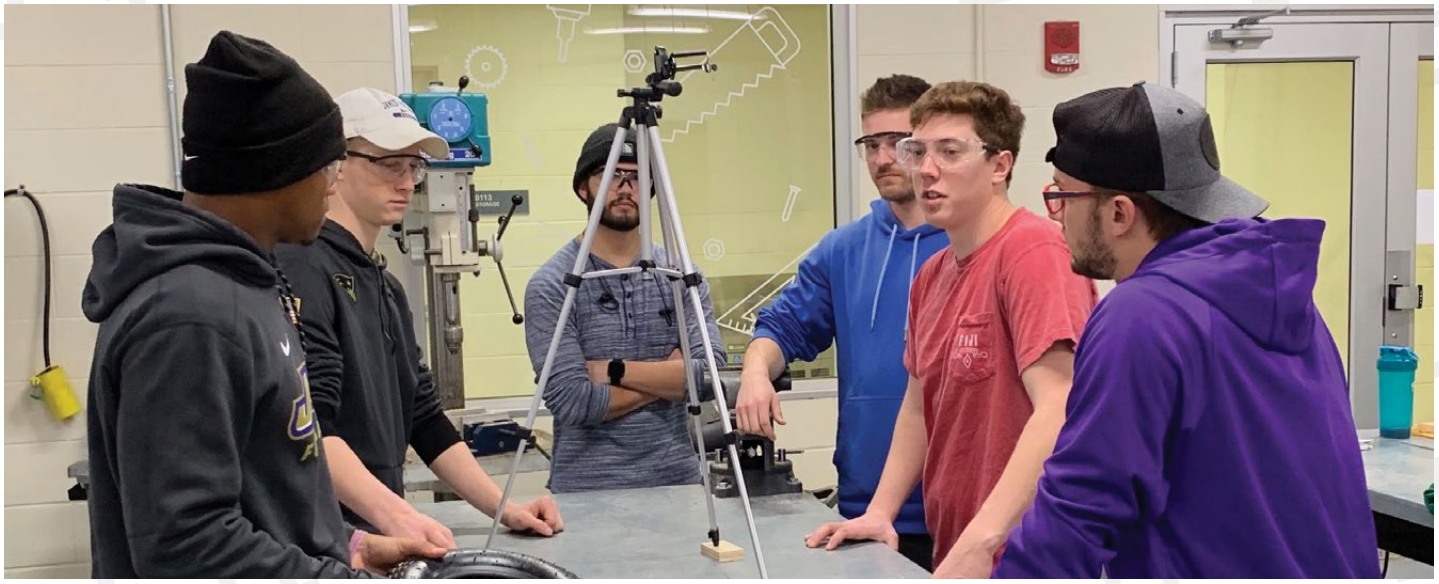
CLIENT

Brian Koerner, PE from Engineering Solutions and Construction Management, PLC



Left:
A SolidWorks model of the funnel used for the bucket to feed balls into the machine. The team is developing an autofeeder for pitching machines.

00072



Above: The team is emulating the location control interface using a tripod and platforms beneath each of the tripod legs.

In baseball, it's hard for young catchers to develop skills necessary for the position outside of game situations; pitchers aren't developed enough at that age to truly help by focusing on specific locations, and coaches have different mechanics in terms of heights and velocities from their pitches. As a result, catchers don't get much practice due to the gaps in training from coaches, players, and a lack of an equipment. With this in mind, they are thrown into the position in live game situations and struggle with the fundamentals of catching. Not only can this incite fear in players, but this can discourage the player from wanting to keep playing the position or even the sport. This project explores the national problem within baseball of fearful players and lack of coaching tools to train catchers by looking to optimize a pitching machine for use with catchers. Most pitching machines are used for hitting, and while they can be used to pitch to catchers, the machines do not allow for the appropriate coaching environment. The solution will allow the coach to use the machine from a distance to maximize coaching time while the catcher can practice some necessary catching skills ultimately resulting in a tool that will not only build confidence within the position, but also improve their game.

The SETH team with their trailer and the results of their breakdown thus far.

STEM EDUCATIONAL TINY HOUSE (S.E.T.H.)

Have you ever wondered what STEM majors do in their careers and research? What if there was a way to travel around and show people exactly what happens behind the scenes in STEM related productions and teach people the science behind the things they see every day? Our team is focused on designing a STEM Educational Tiny House that is portable and modular to teach different target audiences about what we do. Our team specifically focuses on using a brewery system that was donated to us as a proof of-concept of the feasibility of this idea. In order to do this, our team took an old camper trailer and tore it down to the frame to repurpose it as an educational space. We then used our experiences in design classes and brewery classes to design a space that was intriguing and informational for our target audience. By using stakeholders' advice and knowledge, our goal is to attend festivals and breweries to teach audiences about STEM education through the brewing process. Through our efforts we hope to spark people's interest in not only the science around brewing, but in other STEM related topics.

TEAM

Ashley D'Angelo
Andrew Farber
Alex Hasty
Sarah Trotter
Samantha Wilkinson
Cole Young

ADVISING

Steven Harper

Below:
The team is removing some of the remaining fixtures in the final breakdown steps.

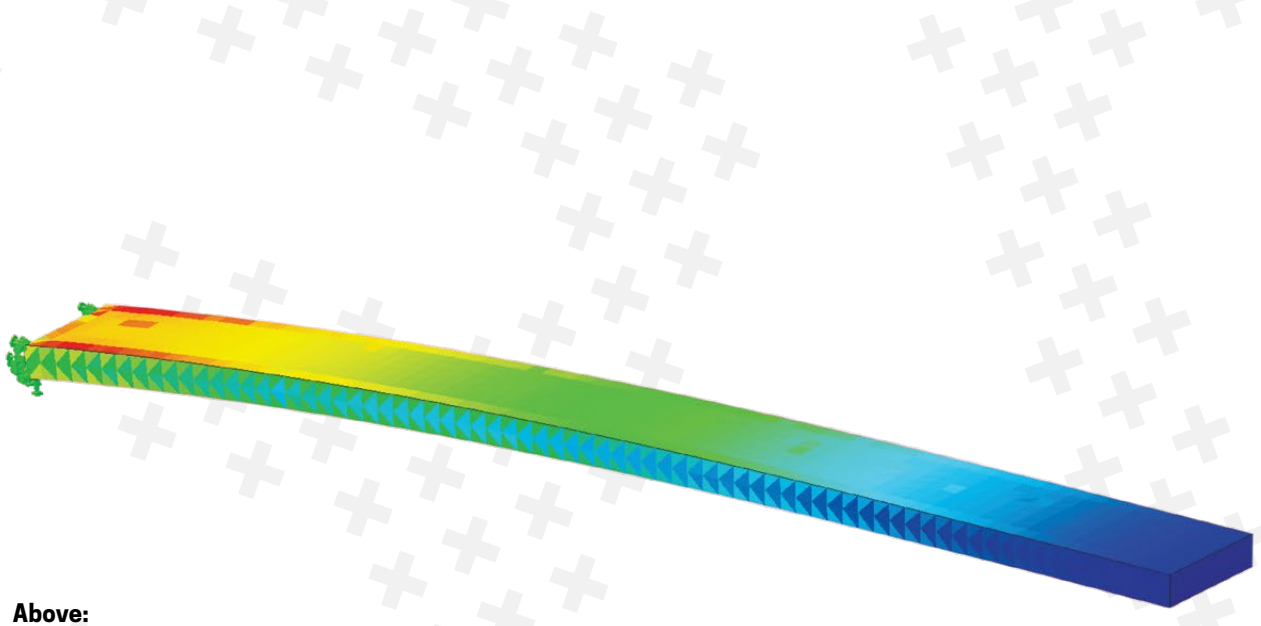
SHELL ECO-MARATHON: CHASSIS

TEAM

Sam Bowers
Tom Ferguson
Nick Pitorri
Joey Potter

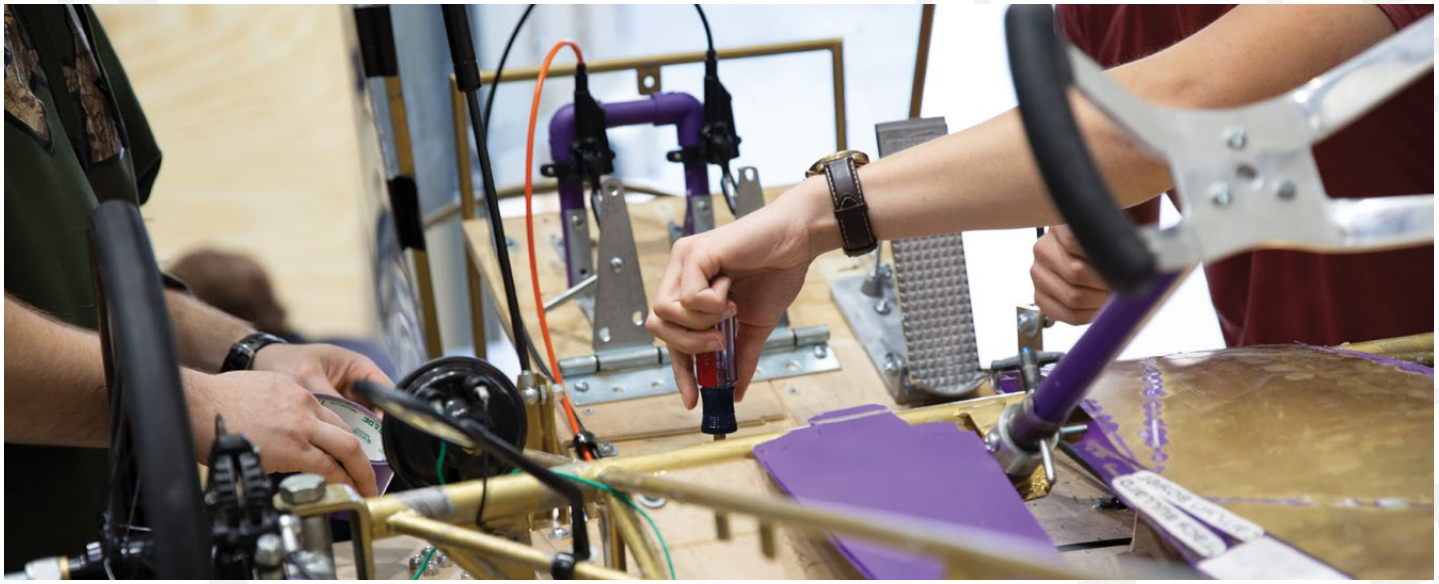
ADVISING

Robert Nagel
Rob Prins



Above:
Finite element analysis in Solid Works to determine strain in a critical chassis component.

00076



Above: The chassis team is working to understand the current Shell Eco-Marathon Vehicle to improve for the 2020 competition.

A twelve member engineering group has been divided into three sub-teams: chassis, data acquisition, and drivetrain-in order to design and produce a vehicle for the 2020 Shell Eco-Marathon Competition. With fuel emissions on the rise, engineers have been working to identify the means necessary to reduce these emissions in today's automobiles.

Our team is the Chassis Team and the chassis that we will design and construct will satisfy all rules and regulations set forth by the Shell Eco-Marathon Rulebook. Our goal is to set a competing score that will be an improvement from the 2018 team's recorded 187 MPG.

The chassis material was selected with a few things in mind. First, the chassis must be able to support the load determined by the 2020 Shell Eco-Marathon Rulebook. In addition, we wanted to design a chassis that is lighter than the 2019 JMU Shell Eco-Marathon Competition team's chassis. With this in mind, we decided to use an alloyed metal that is stronger and more lightweight than the one on the previous competition vehicle. Through the use of Solidworks, we were able to validate material properties, and by doing so, were able to select a proper material in order to satisfy the necessary strengths needed. Also with Solidworks, the team designed a chassis that will satisfy our competition requirements, as well as run static load testing in order to simulate the expected loads that the chassis will likely experience at competition time. Ultimately we are expecting the chassis that we design to be respectively more light weight and more aerodynamic than previous JMU Shell Eco-Marathon Competition Teams' chassis.

SHELL ECO-MARATHON: DATA ACQUISITION

TEAM

Lindsay Levatino
John Hunter
Nick Lindenfeldar

ADVISING

Robert Nagel
Rob Prins

Left:
The data acquisition system is designed to collect information from various sensors located around the vehicle.

00078

Above: The Data Acquisition team uses a data acquisition system they designed to measure and store different phenomena around the car, such as engine temperature and vehicle speed.

Every time you start your car and begin to drive, a vast network of sensors on your car actively measure temperatures, pressures, and other phenomena. These sensors send data into your car's computer in order for your car to run more efficiently and to provide the driver with information on the car's performance. Our project will design a system to measure and record various phenomena around the Shell Eco-Marathon car and interpret that data to help design the next iteration of the car. Using a data acquisition device and a Panasonic tough book, along with an array of sensors, and amplifiers, we have designed a system to install on the 2019 iteration of the Shell Eco-Marathon Car. This system will record data at the Sonoma Raceway in this April's competition. After this year's competition, we plan to analyze the data to assist the chassis and drivetrain teams in making informed design decisions. We will also try to improve upon the system for next year's car in order to provide data for future teams to utilize.

SHELL-ECO MARATHON: DRIVETRAIN

In today's large and rapidly growing world, the means and infrastructure we use for transportation must not only get people from point A to point B safely, but should do so in a sustainable way. Unfortunately, this is not the case. Currently there are an estimated 1,706.7 million barrels worth of oil reserves throughout the world, reserves that at the current rate of consumption, will be depleted in a little over 48 years. Furthermore, petroleum consumption accounts for roughly 30% of all greenhouse gas emissions, which drive man-made climate effect.

Accordingly, the third iteration of the Shell Eco-Marathon competition aims to help combat climate change as well as foster automotive design skills to help usher in a new generation of transportation engineers. More specifically, the drivetrain will look to past iterations of the Eco-Marathon capstones for inspiration on designing and developing a drivetrain that achieves superior fuel economy for the 2020 competition vehicle. Our team will work in tandem with the Chassis and Data Acquisition teams to ensure a seamless integration of these sub-systems as well as a vehicle that will achieve superior fuel economy at the 2020 competition.

TEAM

Rachael Frost
Henry Banks
Peter Nielsen
Chris Smith
Dalton Whetzel

ADVISING

Robert Nagel
Rob Prins

Opposite:
The Eco-Marathon Drivetrain Team analyzes and benchmarks various utility engines for the 2020 competition.

00080

Below:
The team's working model.

The group is generating concepts and organizing ideas to be implemented in the final design.

USING BIO-INSPIRED DESIGN TO COMBAT CLIMATE CHANGE

Humans and ecosystems around the world are suffering from extreme weather, rising sea levels, and increasing intensity of storms as a result of climate change. The amount of greenhouse gases throughout the atmosphere is one of the leading causes of climate change. An engineering process that simply looks at nature for solutions, also known as biomimicry, can be used as the forefront of producing and iterating innovative designs to mitigate the effects of climate change on the Earth. In this process, our team has explored biological functions which have changed through thousands of years of evolution to better suit themselves to their environments as an inspiration for modern problems. The process will be used for a product/service to combat the ever-growing threat of climate change.

TEAM

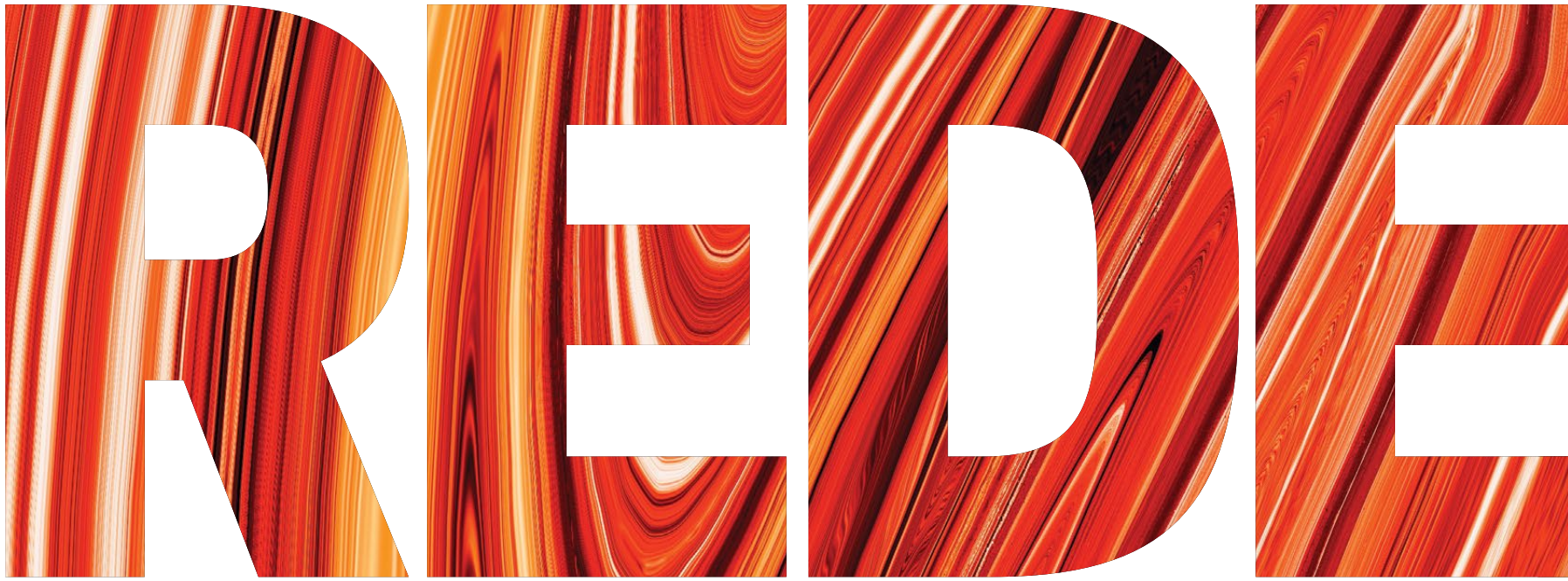
Joshua Coursen
Megan Dowgiallo
Andrea MacGregor
Kristen Russell
Elizabeth Tafoya
Tyler Wahl

ADVISING

Jacquelyn Nagel
Adebayo Ogundipe

Below:
The Biomimicry Design Challenge capstone created keychains and coasters to promote the team as the group comes up with a viable prototype.

00083


REDE


SIGN

SOPHOMORE 2019

HUMAN POWERED VEHICLE

ADVISING

Shraddha Joshi
Callie Miller
Robert Nagel

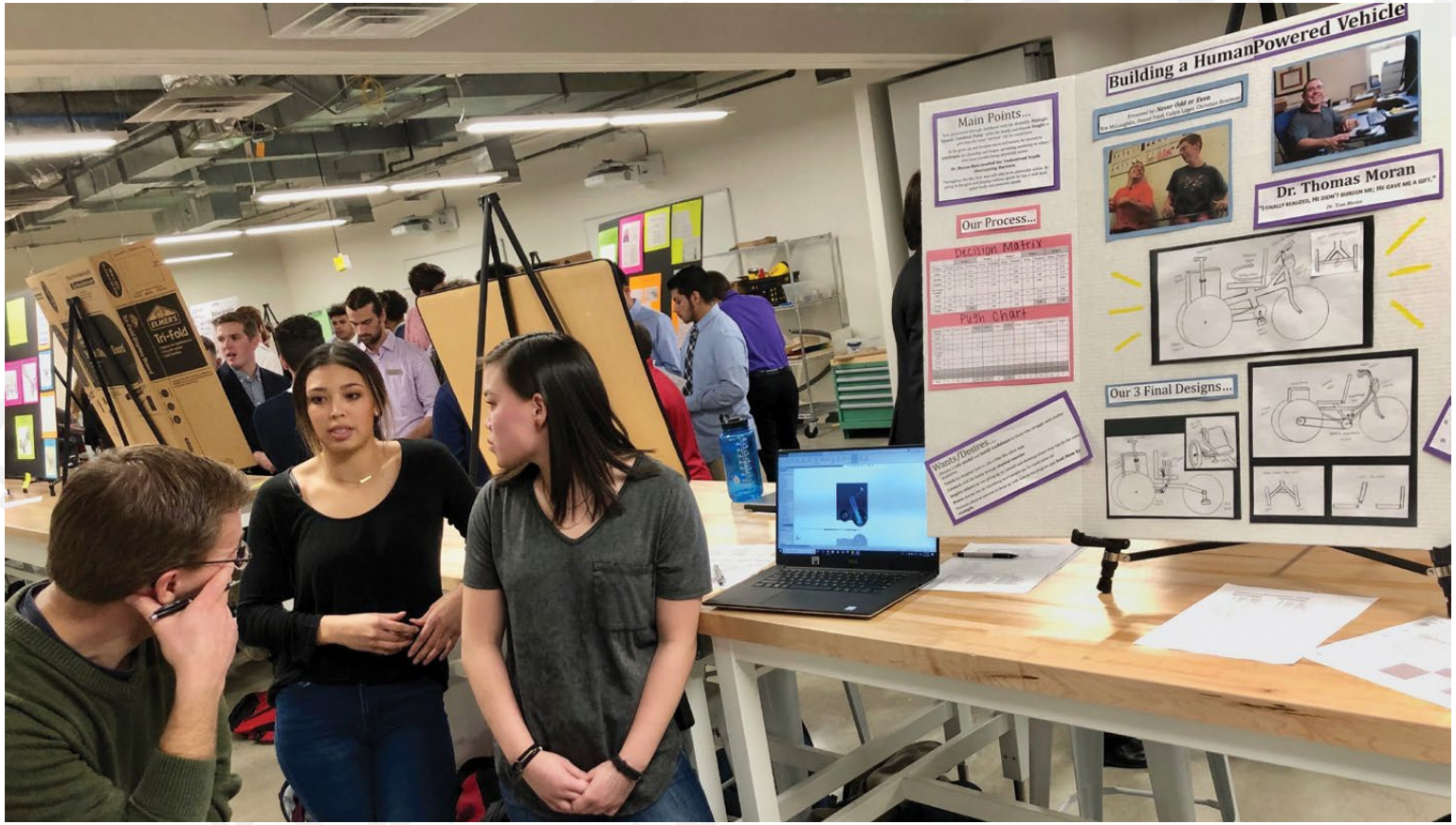
00088

Each year for the past nine years, sophomore engineering students at James Madison University have worked to design and build human-powered vehicles for a community member with needs very different from their own. This year-long, client-based, design project is interwoven with instruction in a two-course design sequence generally taken during students' second year in the Madison Engineering Department.

This year was a very special year as we made it full circle building a second human-powered vehicle for our very first client, Dr. Tom Moran, of the Department of Kinesiology and Overcoming Barriers, our project partner. This past summer, Tom and his wife welcomed their first child into the world, and this human-powered vehicle will allow Tom to ride with his daughter as she learns to ride a bicycle.

The theme for the project from year to year remains the same, but the designs vary greatly as each client's needs and requirements are different. The overarching goal is to expose the students to an experience that transcends the classroom, and in the process, not only teach the students design, but also that they are part of a larger complex system where their decisions and actions as an engineer can (and likely will) influence others.

This course project transcends the scheduled class time requiring students to meet outside of the class with the client, coordinate with the machine and fabrication shops, and work with Mr. Les Welch of East Coast Bicycle Academy to learn the fundamentals of bicycle mechanics. For this project, the impact truly is on our community.


Building a HumanPowered Vehicle
Main Points...
Our Process...
Decision Matrix
Push Chart
Dr. Thomas Moran
Our 3 Final Designs...
Wants/Desires


DELI


GHT

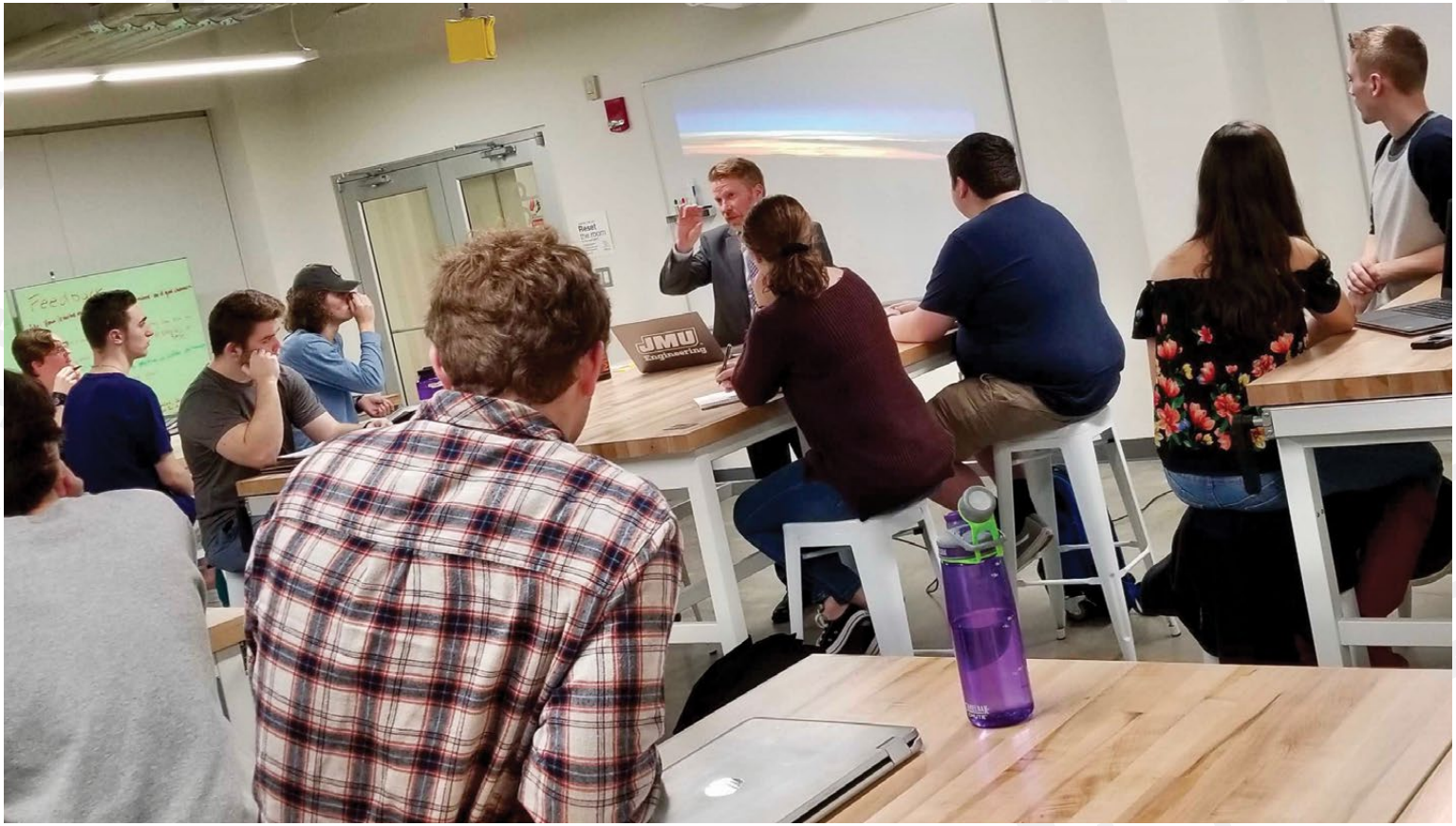
FIRST YEAR 2019

MADE TO REACH

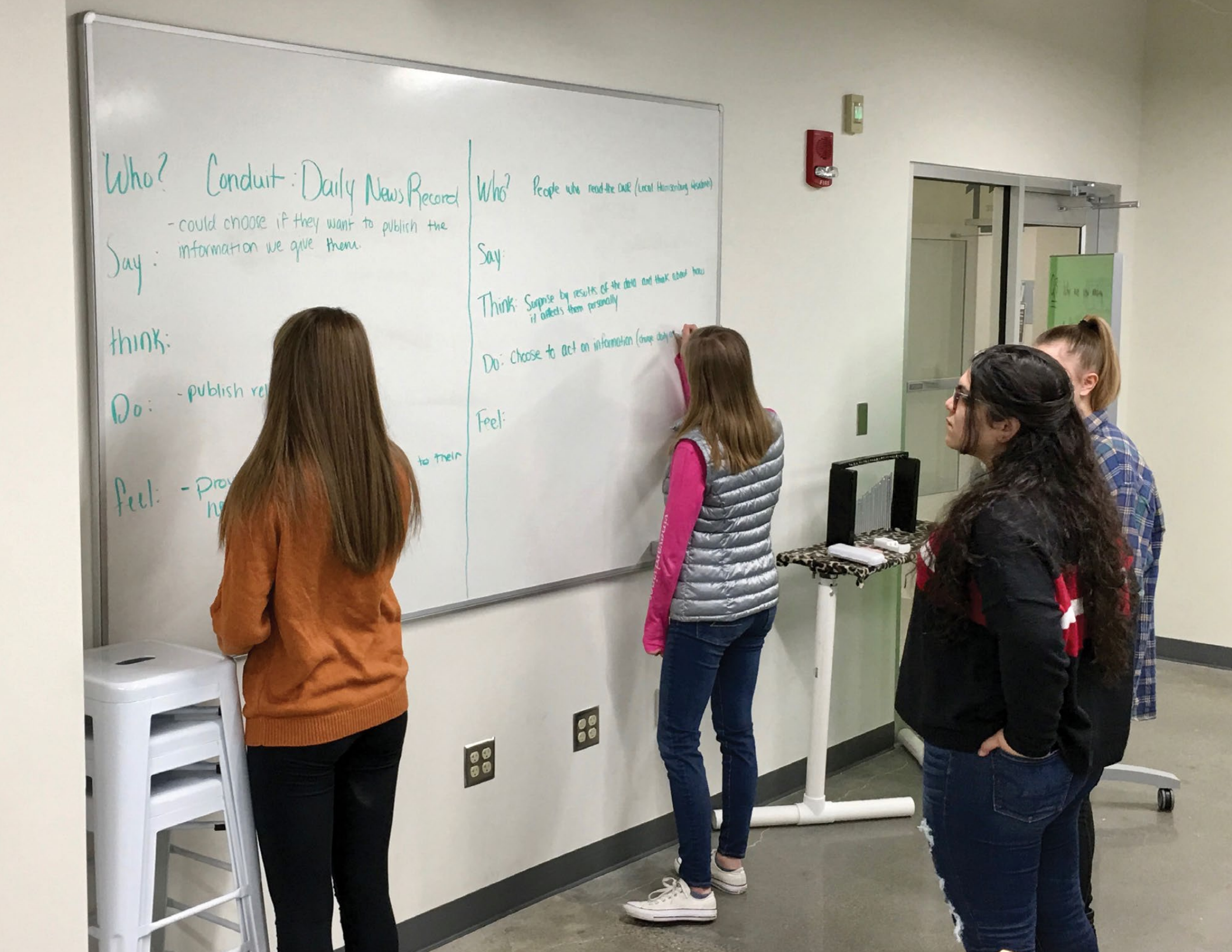
ADVISING

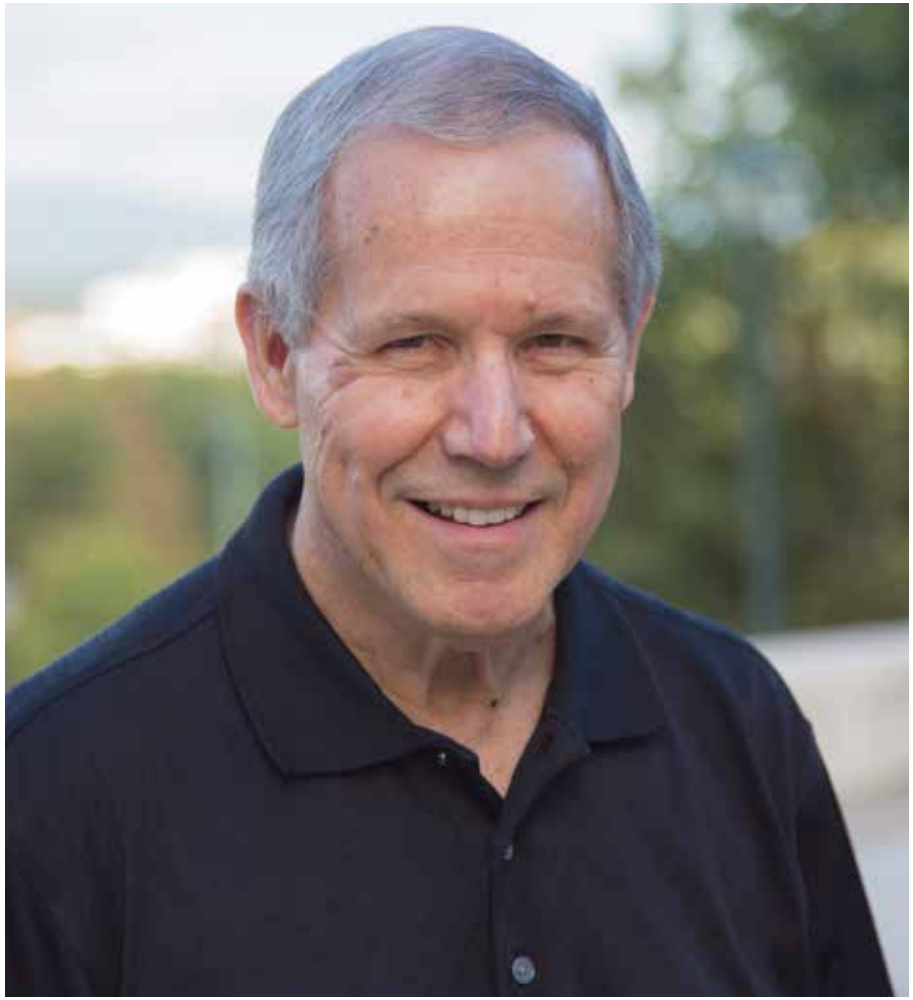
Daniel Castaneda
Jason Forsyth
Kyle Gipson
Robert Nagel

Engineering students enrolled in ENGR 112 Engineering Decisions undertook a semester-long project called MADE to Reach, which is underpinned by an open-ended prompt to engage the community in the engineering design process. MADE to Reach challenged students in three different ways: 1) to comprehend and analyze atmospheric conditions and phenomena affecting the Shenandoah Valley; 2) to design and construct a protective enclosure (i.e. payload) housing sensitive atmospheric sensors that were attached to a weather balloon; and 3) to articulate and communicate the underlying meaning of the generated data to a specific stakeholder with whom student teams have engaged throughout the duration of the project. This semester-long project challenged students to critically think beyond typical given-problem-find-solution engineering prompts. Instead, students explored various stakeholders in the region and undertook various exercises grounded in the human-centered design process – that is to say, students learned and empathized with individual and community functions, perceptions of problems, and overall values. Students coalesced into teams based around their initial findings and oriented their overall engineering effort of designing their payload to meet the needs of a specific stakeholder. MADE to Reach culminated in a pair of weather balloon launches at the Astronomy Park in April 2019 and resulted in over 30 student teams responding to the needs of over 30 stakeholders in the Shenandoah Valley and beyond. This project guided MADE students to reach outward and upward – well encapsulating the mission of community engagement at James Madison University.


JMU
Engineering


we answer the question "Who will you be designing for?" or "Who will be impacted by your design?",
both the core audience and the extended community.
particular user or community impacted by the "How might we..."
THINK
JAMES MADISON
DUKES
JMU
THE NORTH FACE


Who? Conduit: Daily News Record
- could choose if they want to publish the information we give them.
Say:
think:
Do:
- publish re
to their
Feel:
- Prov
Who? People who read the DNR (Local Harrisonburg Readers)
Say:
Think: Surprise by results of the data and think about how it affects them personally
Do: Choose to act on information (change



In memory of George Lovell (1945-2019)

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