XCHANGE '18

Madison Engineering

A Year of Good Through Innovation, Research, and Design

CISE
COLLEGE OF INTEGRATED SCIENCE & ENGINEERING
JAMES MADISON UNIVERSITY.

DEPARTMENT OF
ENGINEERING
JAMES MADISON UNIVERSITY.

I’d like to dedicate this xChange to our project partners; their generosity and collaboration make all the difference to our mission of creating project-ready engineers. Together we are creating one of the best undergraduate engineering learning landscapes available today. Thanks for all you do.

Kurt Paterson, Ph.D., P.E.
Head, Department of Engineering

BUILD

DELIG

DISCOVER

DESIGN

GHT

REDESIGN

“What will you do when it’s your turn?” I’ve always admired the way our engineering program mirrors life as much as it does an academic experience. Students that thrive have jumped into meaningful opportunities, created impactful work, shared their efforts, developed their expertise, expanded their networks, built a reputation, then done it all again, and again. Frankly, this is a much tougher learning process, but ultimately much more freeing. Having the autonomy to choose what to be engaged with, the freedom to choose which subjects to master, and the option to choose to contribute is what life is all about. When we ask “what will your better be?” to our incoming students, it’s not a rhetorical question, it’s a call to action.

Our college years are some of the most vital, they can be wasted, or they can be used to take action that makes real differences in our lives and those of others. The engineering faculty and staff are proud of our students efforts to ignore the noise and nonsense, do the hard work, and advance their learning, all through the pursuit of engineering works. Developing these professional mindsets as students are why our alumni have proven to be so successful, so quickly. It’s clear to me that, for many, they have come to learn that every minute of every day is their turn, all that’s left to decide is whether to do something about it. Today’s xChange is a celebration of the cumulative effects of many decisions, big and small, to take countless “turns” that the engineering landscape at JMU affords to each of our students. Now it’s your turn — make connections, provide feedback, ask hard questions, imagine new possibilities, and enjoy the day.

Kurt Paterson, Ph.D., P.E.
Head, Department of Engineering

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Jacob Nelson

The Impact of Functional Modeling on Engineering Student's Mental Models

Engineers from all disciplines rely on modeling in some form for much of their work, particularly in conceptual design. These models help engineers understand and communicate complex system principles and phenomena and inform engineering decisions. Understanding how modeling processes impact engineer's design choices and knowledge is important for the design community as engineered systems grow more complex. In addition to these models, engineers rely on mental models of the systems they work with and design, but to what extent does a structured modeling approach impact an engineer's mental models?
This project seeks to evaluate the difference in mental models of students who have learned functional modeling and those who have not using a simple set of written instruments.
Two sections of sophomore design students were instructed to draw the components that allow two systems to function, a household hair dryer, and a car radiator. This was done one before learning about functional modeling, and once after. The students were found had more intuitive and complete mental models of the hair dryer and the car radiator, and the impact of functional modeling on specific elements of the response is being investigated.

Understanding how modeling processes impact engineer's design choices and knowledge is important for the design community as engineered systems grow more complex. In addition to these models, engineers rely on mental models of the systems they work with and design, but to what extent does a structured modeling approach impact an engineer's mental models?

Jacob has been advised by Dr. Robert Nagel


WIND TURBINE ELECTRIC HUB
MANUAL BLADE OPERATOR
JMU
ENGINEERING

Jacob Ziemke

MediValley: Cough Suppression Device

Chronic cough is most commonly defined as a cough that persists for more than eight weeks and is estimated to effect more than 30 million people in the United States at any given time. Diseases contributing to the onset of chronic cough include asthma, pulmonary fibrosis, lung cancer, postnasal drip, gastroesophageal reflux disease (GERD), and bronchitis, and may include lifestyle choices such as smoking. For those who seek medical advice, pharmaceuticals and speech therapy are two common methods of combating chronic cough but serve to mask the symptoms rather than treat the problem; it has also been shown that misdiagnosis and failure of treatment occur frequently. Furthermore, chronic cough negatively impacts quality of life and often makes sleeping, eating, working, and socializing difficult. New hypotheses have been formed suggesting a relationship between hypersensitivity of the airway and certain irritating factors such as postnasal drip, GERD, and others. Though patients may experience different symptoms provoked by one or more of these factors, hypersensitivity could be a link between a large quantity of chronic cough cases. The purpose of this research project was to design a prototype based on the patent pending method submitted by Dr. Christy Ludlow to allow further investigation into the relationship between hypersensitivity and chronic cough. The device enables researchers to control and monitor varying levels of vibration stimulus applied to the tracheal region of the neck with the goal of suppressing the urge to cough in persons with lasting cough. Through multiple iterations of user-centered design, a non-invasive wearable prototype was created for the first round of participant testing to assess the feasibility of the technology. Further testing and refinement of the device will hopefully lead to a homeopathic solution to the prevalent issue of chronic cough.

Important factors contributing to the cough suppressant's design are comfort and functionality. The sensors must fit just right and remain stationary to ensure the device is comfortable and continues to work during daily activities.

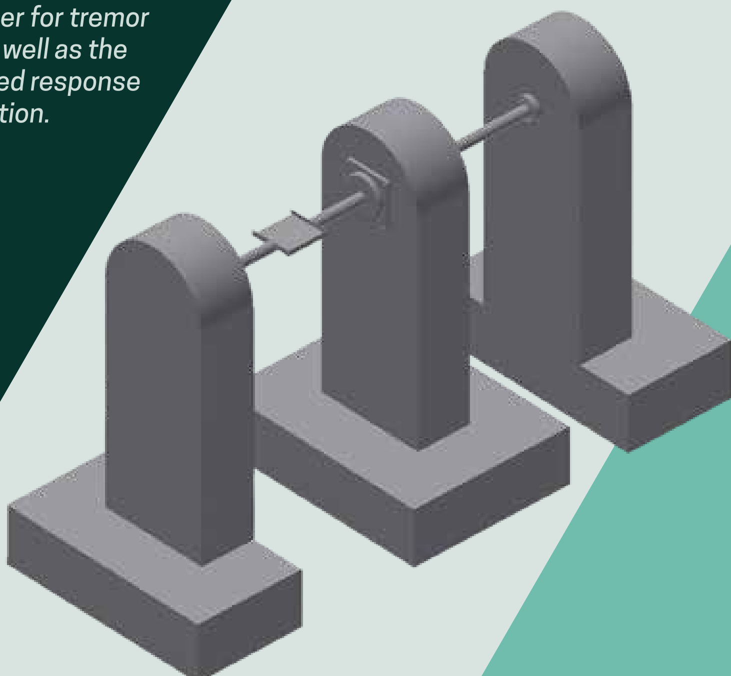
Jacob has been advised by Dr. Keith Holland

DESIGN

SENIORS

Augmented Mobility

An early 3D CAD model of the team's test apparatus, used to determine the ideal passive damper for tremor mitigation, as well as the active amplified response of desired motion.



Team Members

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Client

James Madison Innovations (JMI)

As people age, motor function and strength tend to decrease. Exoskeletons appear to excellently fulfill a common pain point (eg. strength and tremors), yet they are so rarely used. A common motor ailment inflicting senior citizens is tremors, particularly due to Parkinson's disease. The team was tasked to create a functioning prototype of a tremor management exoskeleton to assist in reducing the effects of forearm tremors. The exoskeleton combines active and passive elements, meaning the design will include electrically-powered actuation, as well as structural units that perform critical tremor mitigation functions without electrical power. The team's exoskeleton apparatus concept targets tremors that occur in a user's forearm and wrist pronation and supination-- in particular, those that occur while writing. Inspired by the Wearable Orthosis for Tremor Assessment and Suppression (WOTAS) exoskeleton created by scholars at the University of Madrid, our exoskeleton uses a rotational damper as a passive element to mitigate the user's undesired tremor motion, and a servo motor as an active element, which amplifies the user's desired motion.
The presentation at the XChange will display of a physical prototype that demonstrates the suppression of a user's tremor using both a rotational damper as the passive element.
The damper may be swapped out with the servo motor, which suppresses tremors actively based on input from a gyroscope and accelerometer mounted near the user's forearm. Tremors make menial tasks difficult and stressful; the goal of this technology is to make tasks easier, alleviate some stress, and restore normality that we all deserve in our day-to-day life.

The team discussing ideas for the alpha prototype in the Madison Engineering Analytics Room.

Custom Malting

From left to right: Germination pan, steeping vessel, kiln, unmalted barley, roasted malt.

Team Members

Kyle Butt
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Adviser

Dr. Samuel Morton

Malted barley is the essential ingredient that creates flavors in beer. Malts can vary greatly in flavor depending on the process taken to malt the barley. The malting process consists of three main steps: Steeping, germination, and kilning. Steeping is the process of soaking the barley in water to allow the rootlets to grow, germination keeps the barley and rootlets at a specific temperature and humidity to control the growth, and then kilning stops the growth by roasting the barley to remove the majority of its moisture content and give it a specific flavor. These three steps are usually taken place on a very large scale, but the goal of this project is to develop a small, customizable malting operation with the potential to create boutique malts that craft brewers can use to provide their brews with unique flavor. The group has decided to create a stand alone malting system that will run the three major components of malting all in one space. The system will also be on a cart, thus making it mobile. A large steeping vessel will be attached that will have pumps circulating water and air throughout the system, while two germination pans prepare the barley for its final step, the kilning. The coffee roaster used for kilning will be on the rear of the cart, but must be plugged in to roast the barley. The vessel will be able to create the specialty malts that are desired and also be moved around to wherever is most convenient.

Malting in action.

Designing and Managing a Microbrewery/Taproom at Montpelier Estate

The key ingredients to the Montpelier Brewery Capstone. The project requires a blend of engineering and brewery practice to produce a perfect recipe.

Team Members

Connor England
Mason Clairmont
Chelsea Walden

Adviser

Dr. Steven Harper

The craft beer industry has been continually growing over the past ten years, and it has no plans of stopping. Home brewers now have the unique opportunity of taking their own recipes and sharing them with others. This capstone explores the growing market of craft beer and designing a brewery within a client's needs from start to finish, while also diving into technical specifications and catering for specific brewery functions. A small unused barn on the grounds of Montpelier Estate, home originally to James Madison, will be the benchmark site used to draft a business and quality management plan. This space rests roughly a quarter mile from the visitor's center of Montpelier Estate and has great potential to be converted into a malting/ brewing operation with taproom. Additionally, the business and quality management plans will be made to aid brewers in starting their own breweries at any location they please. The project will work directly with the Madison Academic Brewery. This resource assisted in accurate understanding and hands-on work with the brewing process. The capstone is designing and implementing a cooling system for the Madison Academic Brewery, which will automate cooling temperatures for fermentation tanks. Designing an automated cooling system will allow for temperature control of fermentation tanks and conditioning vessels.

The team is assessing the Madison Academic Brewery's Brew-House for the implementation of new cleaning systems. They utilize 3D printing to assess fit and function of new designs.

Drones

The Drones Capstone team's drone with sensor package attached.

Team Members

Austen Hendrickson
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Adviser

Dr. Justin Henriques

The relatively recent advancements in the design and cost associated with unmanned aerial vehicles (UAVs) has opened up new potential for collecting environmental data at lower cost than traditional methods. For example, while high resolution elevation data is important for understanding the spatial distribution of risk associated with flooding, it can be costly to collect using traditional methods. For example, the cost can be prohibitive for remote coastal communities with limited resources interested in the effect of increased flooding associated with climate change. This paper describes the design of a system for use with a quadcopter that is capable of collecting elevation and location data and creating a digital elevation model (DEM). The system consists of a sensor package of a microcontroller, Light Detection and Ranging (LIDAR) sensor, and geospatial data from a Global Positioning System (GPS), as well as a process in a spatial mapping software package to convert the collected data to an elevation model. This method for data collection yields latitude, longitude and elevation. This data is used to create a Digital Elevation Model (DEM) that has high accuracy and resolution. The paper will show the preliminary result (e.g. example DEMs) from the sensor package and software tools, as well as analysis comparing the results to traditional methods.

The team is looking over the sensor package and the code used to run it.

Engaging in the Resiliency of the Chesterfield Heights Community

Project's main area of focus. Chesterfield Heights is located on the eastern branch of the Elizabeth River in Norfolk, VA. This area is susceptible to significant rainfall flooding.

Team Members

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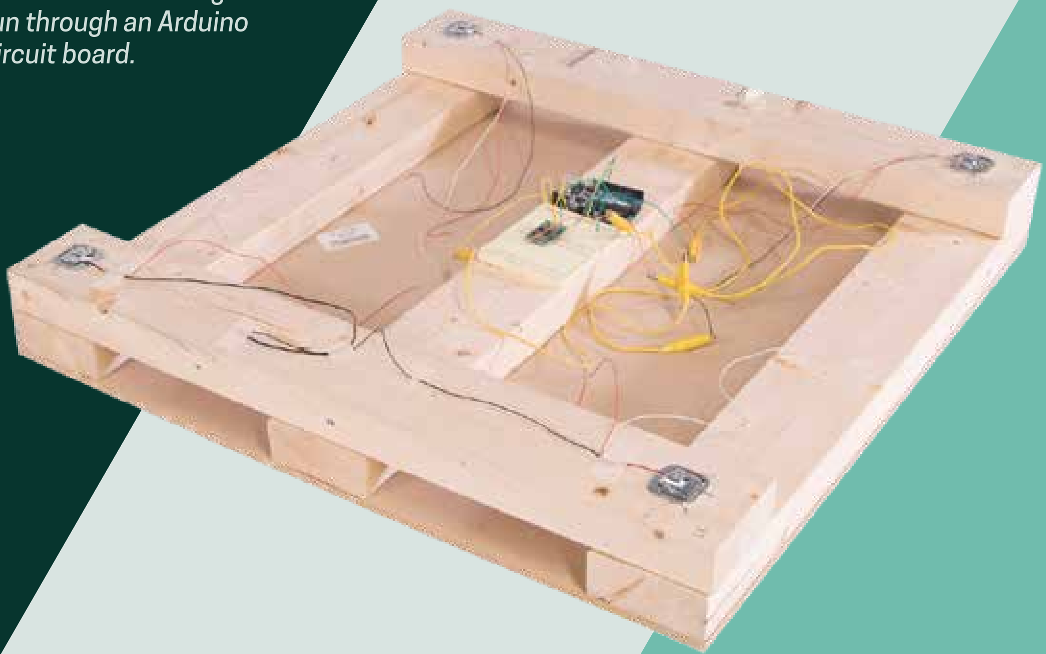
The National Oceanic and Atmospheric Administration (NOAA) has qualified the Hampton Roads area of Virginia as the second largest population at risk with respect to flooding. This has been a predominant concern as sea level rise and atmospheric conditions change due to environmental factors. This problem has had a great impact in the local community, especially in the Chesterfield Heights area, which is located in the southern part of the city of Norfolk. Encompassing an area of 0.235 square miles and having a population of approximately 787 people, Chesterfield Heights is a small-sized neighborhood along the eastern branch of the Elizabeth River. It is an older community first settled in the late 1890's that continued to grow and develop through the 1950's. Currently, this area is qualified as a lower income neighborhood and is in a vulnerable position because of its proximity to the tidally active Elizabeth River and its exposure to more frequent 100-year rainfall events in the past 10 years. The average height above sea level for the city of Norfolk is around 6.89 feet, and the average annual rainfall for the region is approximately 46.55". In 2015, the city was awarded a 1.2 million dollar grant to address resiliency in at-risk communities like Chesterfield Heights. The proposal was accompanied by preliminary designs from students at Hampton University and Old Dominion University including bioretention areas and the implementation of a flood berm in a neighboring area. Currently, the city is working on implementing a plan to aid the flooding problem. However, there is common concern among the people in the community on what to do in the meantime. This project will be focused on designing a prescriptive tool that would be accessible to the community in order to help them take appropriate action to rainfall and subsequent flooding events. Using a mathematical model and user interface tools, the team is working on building a computer based program that would take weather trends and current conditions into consideration in order to provide appropriate and accurate information. Through this work, the goal of this project is to help citizens stay in the homes they have lived in for the past 50 years or longer and prolong the life of this historical area while the city is improving the aesthetics and drainage functionality of the neighborhood.

The team is discussing the project's stormwater management sites and understanding how the community would be impacted by different levels of rainfall.

Engineering Physical Therapy

Engineering Physical Therapy's first prototype of the balance board with the wiring all run through an Arduino circuit board.



Team Members

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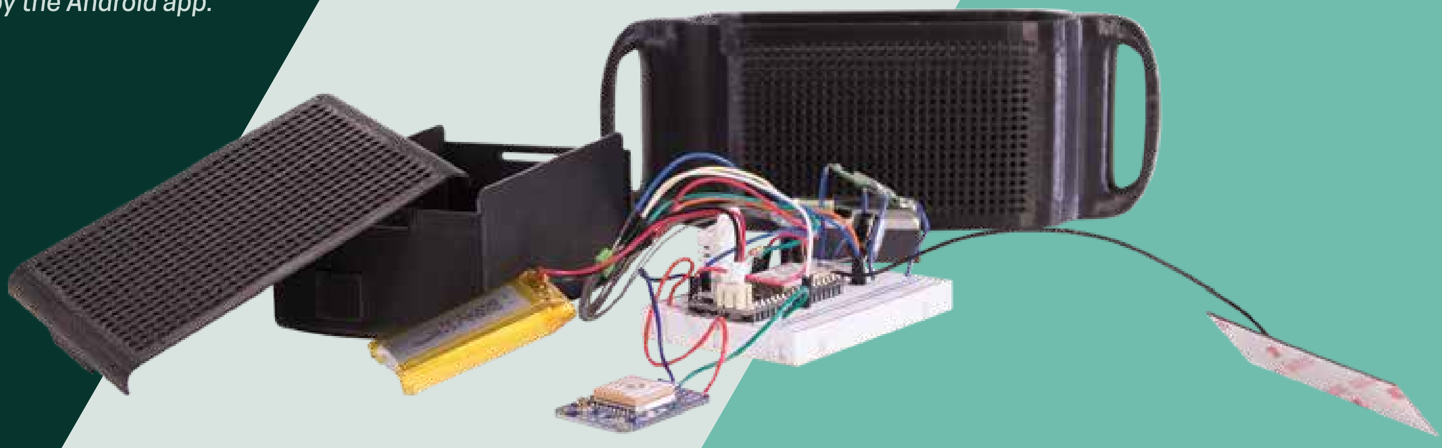
Dr. Keith Holland

Underserved populations consistently lack access to physical therapy. In particular, a large percentage of the residents in Harrisonburg and surrounding communities served by Sentara RMH Health Services may be categorized as underserved. A challenge to physical therapists as a whole is the low compliance rates, where patients do not complete prescribed rehabilitation. Some surveys show that compliance rates can be as low as 54.5% of complete adherence to the therapy plan. Location, annual income, time availability, and pain involved with therapy are all factors that affect patient compliance. This project evaluates the current physical therapy product market to discover aspects that will benefit most from an innovative device. Research and discussion with medical experts have shown many patients going through balance rehabilitation are discharged before they have recovered completely due to insurance policies. Among adults over the age of 65, falling is the leading cause of fatal and non-fatal traumatic injuries. Based on these findings, the team proposes the development of a device to target balance rehabilitation through an at home platform that is readily available to underserved populations. This human-centered design will include features such as adaptability, low cost, and ease of storage. Further, the device will be designed to motivate patients to continue rehabilitation so they can return to activities related to their jobs and recreation. The team is working with Harrisonburg Health and Rehabilitation Center (HHRC) to gain information on the local patients as well as therapeutic processes. Through deliberation and engineering decision-making strategies, the team has decided to develop a balance board device that patients can take home to improve their somatosensory system that prevents them from falling. This device is designed around the Berg Balance Test, a standard for testing balance in the physical therapy industry, to ensure the most effective training program for patients. Such a device will also allow HHRC and physical therapists alike to become more effective and efficient while more inclusively treating a larger population.

The team is discussing how the wiring and structural components will fit together to remain within the size restraints. These findings will help design the alpha prototype.

EnviroSensor

The EnviroSensor hardware, casing and cellphone application. The sensor data is sent to the internet through a cellular network where it can be accessed and mapped by the Android app.



Team Members

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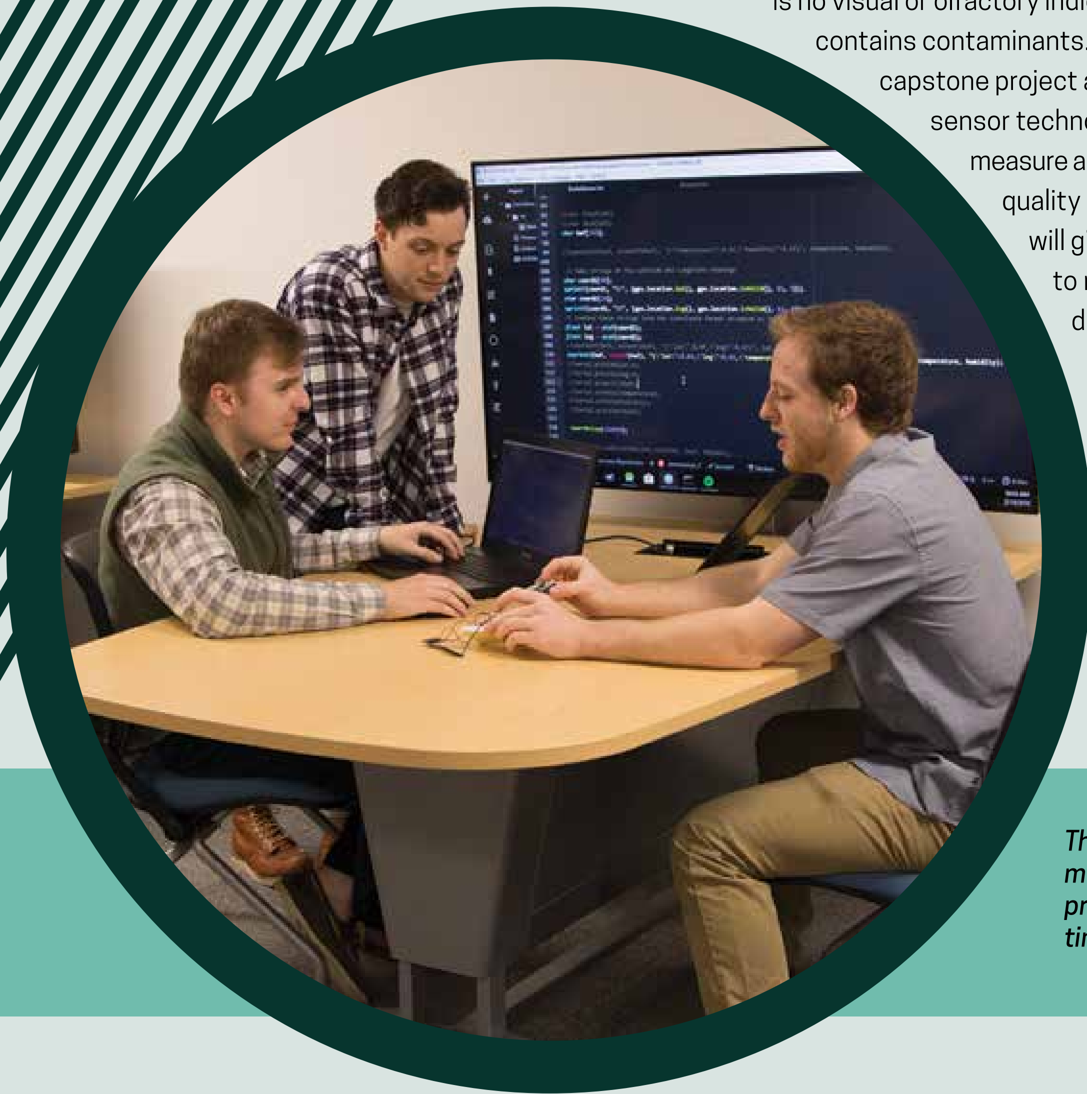
All day, every day, we are immersed in air. But what is air? Air is made up of 78% nitrogen and 20% oxygen by volume. But what about the rest? The remaining 2% of air may seem insignificant, however the makeup of this remaining 2% can be crucial when it comes to breathing. There are serious human health implications involved with breathing polluted air. These implications are even more serious for sensitive populations such as infants, the elderly, and those with respiratory illnesses like asthma. But how do you know when the air is polluted. Often there is no visual or olfactory indication that the air contains contaminants. The EnviroSensor capstone project aims to use wearable sensor technology to allow a user to measure and view the ambient air quality in real time. This ability will give the user the ability to make informed decisions about their activity outdoors and possibly save the user from experiencing negative health effects from breathing in polluted air. Furthermore, this project aims to crowdsource air quality data by collecting and compiling the data from the IoT sensor network to enrich the quality of air quality data available to the public.



The team is reviewing the code that runs on the EnviroSensor microcontroller and captures sensor data. They are also programming the Android application that displays the real time air quality data on a map.

Equestrian Body Protectors

Testing Capstone Project Team's Impact Testing Apparatus, used to evaluate the effectiveness of equestrian body protection.

Team Members

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Advisers

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Sponsors

Contra Threat Sciences LLP and TE Connectivity

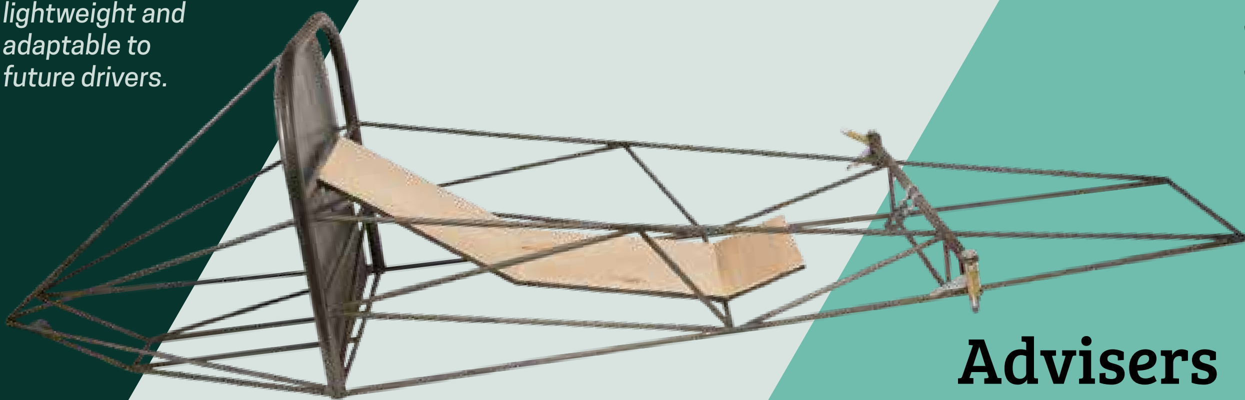
Equestrian sports are inherently dangerous. In 2015 alone, it was estimated by the National Electronic Injury Surveillance System that over 56,000 people were injured while participating in equestrian sports in the United States. Of these injuries, nearly 8,000 equestrian athletes were hospitalized or killed. In a survey conducted by Ball et al., it was found that only 31% of injured equestrian athletes were wearing protective gear at the time of their accident. While there are numerous studies detailing the frequency of equestrian body protector usage, relatively little information is available regarding the effectiveness of equestrian body protection.

Voluntary performance standards established by organizations such as ASTM International [ASTM] and the British Standards Institution [BSI] provide methods to test equestrian body protection, but these tests only provide pass/fail thresholds that are considered to be minimum requirements. The objective of the Equestrian Body Protectors - Testing Capstone Project is to create an impact testing apparatus that will inform equestrian body protector design. To achieve this goal, the capstone has been divided into two phases, Phase I and Phase II. Phase I involves the design and construction of the impact testing apparatus and the preliminary testing of equestrian body protection, while Phase II will likely utilize the data collected during Phase I to design an improved equestrian body protector. The Phase I team began by performing a thorough review of ASTM F1937-04, which is the standard that the impact testing apparatus and a portion of testing conforms to. This allowed the team to develop a detailed list of requirements for the impact testing apparatus system. Several iterations of Proof of Concept and analytical prototypes were constructed, garnering feedback from industry professionals with each iteration. Utilizing the fabrication and machining facilities available through the Madison Engineering Department, the impact testing apparatus was constructed. With the impact testing apparatus completed, the Phase I team reviewed the test methods outlined by ASTM and BSI and looked for ways to improve upon or add new testing procedures. By updating and refining the testing procedures, this Capstone Project will progress towards Phase II. Likely, this new team will conduct further material analysis using the testing methodologies discovered in Phase I. These tests, along with the preliminary data collected in Phase I, will help guide the Phase II team through the engineering design process to create a more effective equestrian body protector.

The team is preparing to perform the Shock Attenuation Test on a Proof of Concept Prototype of an equestrian body protector. They want to determine how much shock would be delivered to the athlete under similar impact conditions.

JMU Supermileage: Chassis

The JMU Supermileage: Chassis Team's frame and seat sub-systems that will support vehicle components and the driver while being lightweight and adaptable to future drivers.



Team Members

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Advisers

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Dr. Robert Prins

Sponsors

Gibson Industrial
Valley Engineering

Unsustainable fossil fuel consumption is an ongoing problem that affects everyone equally. According to the Institute for Energy Research, energy dependence on fossil fuels in the United States is projected to increase to 80% by the year 2040. In order to increase the amount of time for society to find an alternative source of energy, current rates of fossil fuel consumption must be decreased. Fuel consumption can be reduced by improving vehicle aerodynamics. Furthermore, a recent MIT study found that a 2% weight reduction results in approximately 1% fuel efficiency increase. The mission of JMU Supermileage is to reduce fossil fuel consumption rates by increasing the fuel efficiency (miles per gallon) of vehicles through the optimization of an internal combustion engine while reducing vehicle weight and losses such as drag. Many of the same methods used to make the supermileage vehicle more fuel efficient can be applied to other mechanical systems, giving the team the opportunity to apply their knowledge in the field of engineering. The project goal is to deliver a fully operable vehicle that exceeds all competition rules of the Shell Eco-Marathon. Specifically, the chassis team will be responsible for putting forth frame and body prototypes while also helping the propulsion team to integrate the engine and any related components. The team focused on the design and optimization of several subsystems through analysis of material, structural, and dynamic properties. The team has finished embodiment design of the vehicle and is working through the fabrication and assembly of the various subsystems. Successful design, fabrication, integration, and competition of the team's vehicle will increase visibility for Madison Engineering and establish a foundation that future capstone teams can build off to further develop fuel efficiency technology.

The team is gathering user preferences for steering system controls with the frame and seat sub-systems fabricated and mounted. They are continuing to integrate the various sub-systems to reach an operable vehicle.

JMU Supermileage: Propulsion

The team uses this setup to test and tune the electronic fuel injection system. This standalone system was designed to run tests on the engine while the rest of the vehicle was being fabricated.

Team Members

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Hydrocarbon fuel source consumption is increasing exponentially. A large portion of the consumption is attributed to personal vehicles equipped with internal combustion engines. The global reliance on fossil fuels creates financial burdens as prices rise, and a burden on the environment through the production and combustion of oil. In 2011 the White House made an agreement with the 13 largest auto manufacturers to increase average fuel economy to 54.5 miles per gallon by 2025. There is a global and national goal to reduce fossil fuel usage and create new clean energy. The Shell Corporation created a competition in which students from around the world compete on an urban circuit to achieve maximum fuel efficiency in a passenger vehicle. The shell eco-marathon has many categories ranging from internal combustion engine "urban concept" vehicles to hybrid prototype vehicles. As part of the James Madison University's Engineering department two year capstone program, six engineering students have undertaken the task of designing and manufacturing the propulsion system for a vehicle going to compete in the Shell Eco-Marathon prototype division. The competition is to take place in late April 2018 with competitors representing institutions from all around the North American continent. In order to be competitive in the prototype division, the propulsion system must employ mechanical technologies integrated with electronic components that effectively employ thermodynamic and stoichiometric principles. All these systems integrated within the propulsion system must combine to make the chosen 49-cc 4-stroke engine as fuel efficient as possible.

The team is evaluating the feedback from the fuel injection system. This information will be used to create a tune that will optimize the engines fuel efficiency.

Low-Impact Tiny House for a Housing Insecure Individual

One of the team's first prototypes. This prototype helped the team understand the layout of the house and how the team should orient the house once built.

Team Members

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Advisers

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Sponsor

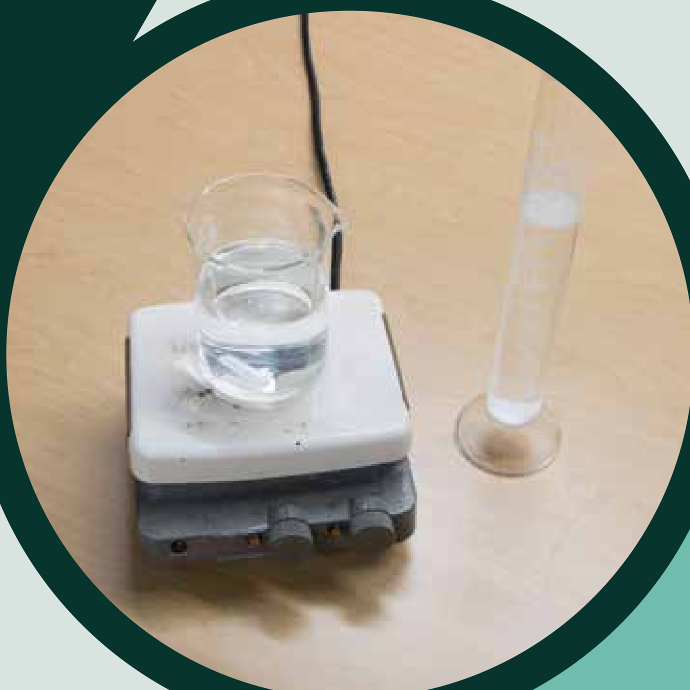
New Community Project

The tiny house movement is a trend in the U.S. to create a sustainable house smaller than 400ft^2. These houses come in a variety of styles such as permanent structures or moveable trailers, which opens up numerous possibilities for design. The capstone team's project scope is to design, build, and test a sustainable tiny house for a housing-insecure individual living in Harrisonburg, Virginia. Sustainability entails three pillars: socially sustainable, economically sustainable and environmentally sustainable. The goal is to create an easily adaptable house for future residents with little operational and maintenance costs, and use eco-friendly materials, renewable energies, and low-impact design to reduce the home's environmental footprint. The team used AutoCAD to create conceptual designs to communicate the design to the team's clients, consultants, and other stakeholders. The team has worked with a local structural engineer to approve the structural integrity of the tiny house. The team will be guided by the local carpenters guild to construct the house. The team hopes this project will provide a model for future James Madison University engineering students as well as other individuals who are interested in following the tiny house movement for economic, environmental, or other reasons.

The team is reviewing their AutoCAD drawings of their tiny house. They are preparing to use these drawing during the construction phase in late March.

Sulfate Removal From Mine Impacted Waters

Some of the equipment used during lab testing.



Team Members

Anne Hunter Stephens
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Adviser

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Sponsor

Freeport-McMoRan

Mine sites all over the country use large amounts of water for daily operations that can be reused for various operations until the mine closes permanently. At this point, the water is required to be discharged as groundwater into the surrounding environment. A common constituent in mine water is sulfate, which typically comes from pyrite or other sulfur-based bodies in the ore and oxidize during mineral processing to release sulfate. Because the effects of sulfate in water are aesthetic rather than having an impact on human health, they have not been heavily enforced by the EPA in the past.

However, with more mines releasing this water into the environment, it is becoming a growing concern. This problem was defined by WERC for the International Design Competition in New Mexico, which our team attended in early April and competed against ten other teams from across the country. In response to the problem, our team chose to investigate the use of chemical precipitation to reduce sulfate levels so the resulting water can be safely released into the environment. After researching and testing four different chemicals, we chose to use barium hydroxide as it is the most effective at precipitating out sulfate and does not result in any harmful leftover sludge. The entire system will consist of a mixing vessel, a clarifier tank where the chemical precipitation will occur, a filter, and a collection chamber. This process will result in 60% water recovery, sulfate removal to below secondary drinking standards, and will be cost effective for large-scale operations. The full scale model is designed for the Sierrita Mine, a copper mine owned by Freeport McMoRan located in Arizona.

The team testing for sulfate and barium levels in a water sample.

Sustainable Desalination for Chumbe Island Coral Park

Pre-assembled materials for desalination system.

Team Members

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Tyler Leitman
Justin Smith
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Adviser

Dr. Adebayo Ogundipie

As the global population continues to increase, the need for access to clean drinking water grows along with it. The need for this access is increasing at a faster rate than engineers have been able to compensate for. With the abundance of ocean water on the earth's surface, desalination has become a promising method of obtaining drinking water. The desalination process involves separating dissolved solids from seawater into a clean volume of water that is safe for drinking, cooking, and other human activities. One community in need of access to fresh water is Chumbe Island Coral Park (CHICOP). CHICOP is a small, privately operated coral and forest reservation eight miles off the coast of Zanzibar, Tanzania. Chumbe has requested a desalination system which utilizes renewable sources of energy to provide the community with potable water, having no impact on the surrounding coral preservation area, and can be constructed on the island with materials readily available in the area. A thermal distillation system has been fabricated as a potential solution for the island's water problem. The system utilizes a recycled oil drum, salvaged aluminum and PVC, and other components that are commonly available online. The system was modeled by creating a system of equations that defined the inputs and outputs of the system. After the mathematical models were finished and the system modeled, the construction of a proof of concept was created using the materials listed above. The system created is designed to produce 65 liters of clean water a day for an average eight hour working time. With this system, the island's water needs will be met in a sustainable and environmentally friendly manner.

Team is mounting condenser into desalination system together.

Tiny Garden House

A spread depicting all technical drawings of the project including the site plan, elevation plan, floor plan, floor framing plan, wall plan, roof plan, and foundation plan.

Team Members

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Connor Scott
Julie Strunk
Ryan Thompson

Advisers

Dr. Heather Kirkvold
Dr. Elise Barrella

Harrisonburg is home to a number of refugees from all over the globe. In their former areas of residence, some of these individuals have previously held agricultural occupations and have expressed interest in continuing these practices. Farming was a method to feed their families and gain income by selling their product. Restaurants and schools within the greater Harrisonburg area have also expressed interest in obtaining locally grown sources of fresh produce. Therefore, New Community Project, a local non-profit organization has contracted our engineering capstone team at James Madison University to design and construct a agricultural structure on a parcel of land in Rockingham County, VA. This structure will primarily be used as a storage space for farm produce, farming equipment, and a produce preparation station. The multifunctional requirements must be integrated into a single structure to minimize the building's footprint. The final design will ensure the structure is economically, environmentally, and socially sustainable to adhere to New Community Project and Madison Engineering Program's core values. Passive solar techniques, a water catchment system, geothermal cooling, and recycled materials will be prominent features.

The team is looking through the site and building plans to make sure all details are present and ready for the construction phase.

VRTUE

Team vrtue's lathe control box employs real lathe handles that intensify the immersive learning experience. The layout of the handles is integral to creating an environment where users can get a feel for the real thing.

Team Members

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Natalie Dillinger
Erin Schwartzmiller

Adviser

Dr. Keith Holland

Client

James Madison University Machine Shop

Team vrtue has developed a virtual reality based training method for novice machine shop trainees to enhance their overall learning experience as they undergo the lathe tools training at James Madison University. Standard training for the lathe requires professional assistance, which translates to limited access for students. Through the creation of a virtual environment, this simulation allows students to access the lathe outside of regular machine shop hours in order to gain a fundamental understanding of the lathe and its controls. The team made the simulation realistic by creating a custom control box that mimics the real machine and the relative locations of the X, Y and Z control handles. Force feedback is incorporated into the custom controls to further enhance the virtual machining experience using a pass through stepper motor, Arduino and coding. In order to understand the broader academic need for this project; team vrtue investigated the machine shop practices within other universities' engineering departments, conducted a student survey specific to James Madison University Engineering that highlights the pain points within the existing tools training methods. Additionally, the team conducted interviews with key stakeholders, investigated how virtual reality has been used in education and training and used feedback gained from MadE xChange 2017. Using the information and feedback, the team employed improvements such as Leap Motion, which uses infrared to track users' hands. This allows users to see their hands in the virtual environment, which reduces the likelihood of possible motion sickness. Upon completion of this project, team vrtue will have extensive documentation of the work that has been to allow others to continue the development of the project.

Team vrtue inspects and compares the lathe control box with the virtual lathe asset. Matching the real and virtual worlds is key to providing users with a realistic and immersive lathe tools training experience.


BUILD

JUNIORS

2019 Shell Eco-Marathon

Carbon fiber testing.

Team Members

Federico Meersohn
Farris Jarrar
Greg Schmidt
Mark Livingston
Michael Bruce

Advisers

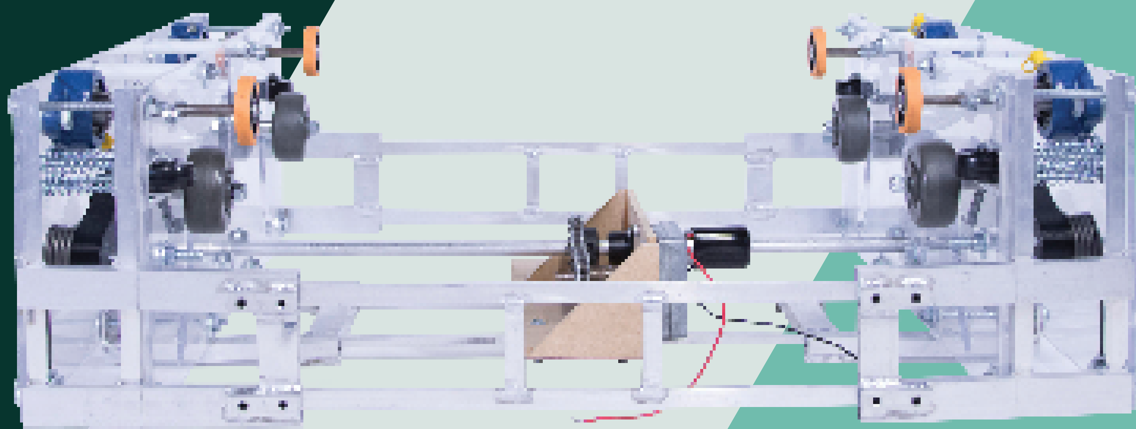
Dr. Robert Nagel
Dr. Rob Prins

The goal of this capstone team is to compete in the annual Shell Eco-Marathon Americas Competition in April of 2019 in a TBD location. This competition provides students an opportunity to create something out of the ordinary and to inspires development of new technology in various different fields such as alternative energy vehicles and high mileage internal combustion vehicles. JMU's first team plans to compete for the first time in mid-April of 2018. However, the team is expected to face a few challenges while racing to finish the prototype vehicle. For this reason, the 2019 team will refine the aerodynamic and performance of the internal combustion engine powered super mileage vehicle for the competition by completely redesigning the body of the vehicle. The 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 more fuel efficient vehicle production. The main goal is to increase the fuel efficiency from the previous year's vehicle by 10%. Since the 2018 competition team has yet to start testing, the 2019 team will be using an estimated 300 mpg as a basis for its goals, meaning the goal is to reach an mpg of at least 330 miles/gallon. Stakeholders include those affected by climate change as well as the project advisers, Shell, and JMU itself.

Shell Eco-Marathon Team prepping to create a fiberglass part.

Artificial Wind Event

Close up of wind data collection device.



Team Members

Braxton Faggert
Shane Butler
Matthew Kennedy
Christopher Marcelin
Jens Byer

Adviser

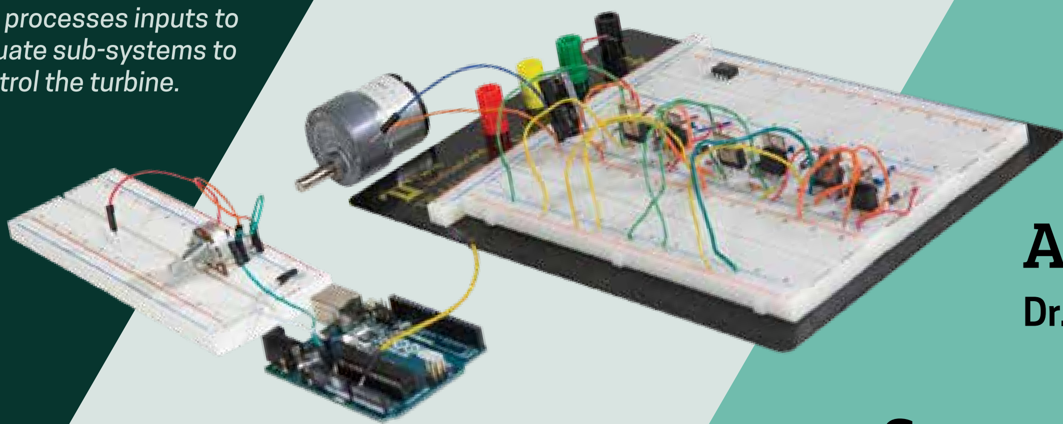
Dr. Steven Harper

Everyday millions of vehicles travel along the U.S. interstate system. The high travel speed of these vehicles produce artificial wind, which may 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 the capstone team is tasked with investigating is the 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 device that can travel on a bridge I-Beam, one which lies directly over a highway overpass. The purpose of this device is to be able to collect data from the wind event created by vehicles passing underneath. This data could be used for future implementation of wind energy collection devices underneath bridges and overpasses to collect and preserve this energy that's being unutilized every day. At the end of the project duration, the device will be developed and presented to the Virginia Department of Transportation (VDOT) for approval and inspection of the system.

Wind data collection device being worked on by the Artificial Wind Capstone Team.

Collegiate Wind Competition: Electronics and Controls

This is the three-phase ideal diode rectification circuit that converts Alternating Current to Direct Current. On the left is the Arduino, which senses and processes inputs to actuate sub-systems to control the turbine.



Team Members

Robert Gerber III
Seemran Patel
Austin Pelto
Neth Gardner
Nick Colonna

Adviser

Dr. Keith Holland

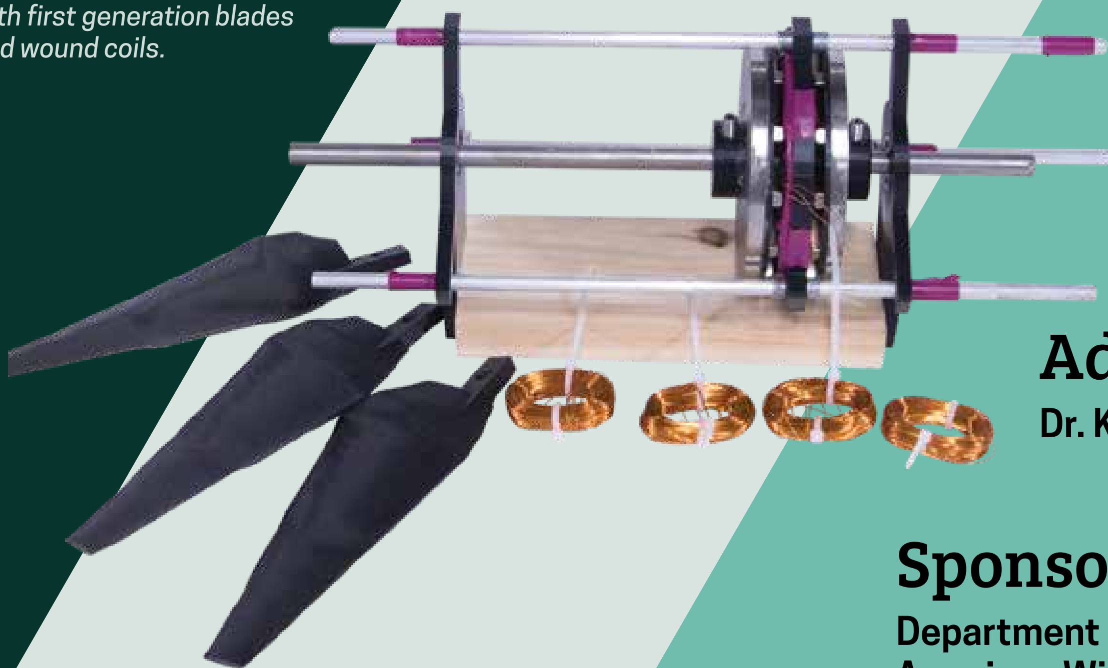
Sponsors

Department of Energy
American Wind Association

JMU was selected as one of 10 teams nationwide for the 2018 Collegiate Wind Competition. A multidisciplinary student team, comprised of engineering, ISAT, and business students, will design a wind turbine for testing in a wind tunnel, present a business plan for the deployment of their design, and respond to a wind energy siting challenge. Two engineering capstone projects are offered to support the JMU Collegiate Wind Competition team. The Electronics and Controls Design team will be responsible for designing, prototyping, and testing the sensor and actuator systems required for maximum power generation from the wind turbine. This includes AC power rectification, yaw control, maximum point tracking, and over speed control. The team will use numerous electronic sensors and a microcontroller platform to integrate the competition required functionality. To achieve proper control of the wind turbine, this team will collaborate with the Rotor Design team to ensure that both team's design responsibilities are compatible with each other and with the competition rules and regulations. Students will travel to the American Wind Energy Association National Conference in Chicago in May 2018 to present and test the prototype wind turbine at the competition event. Following the competition, the team will work to refine the design for production, apply the design to a different market, and/or refine the design to compete in a follow-up technical challenge at the National Renewable Energy Laboratory (NREL) in Boulder, CO in May 2019.

The team is debugging codes for control algorithm for the wind turbine.

Collegiate Wind Competition: Rotors



Second generation generator with first generation blades and wound coils.

Team Members

Maui Ong Ante
Alex Mironenko
Matthew Kerner
Sabrina Hammell
Raphael De Chassy

Adviser

Dr. Keith Holland

Sponsors

Department of Energy
American Wind Energy Association

JMU was selected as one of 10 teams nationwide for the 2018 Collegiate Wind Competition. A multidisciplinary student team, comprised of engineering, ISAT, and business students, will design a wind turbine for testing in a wind tunnel, present a business plan for the deployment of their design, and respond to a wind energy siting challenge. Two engineering capstone projects are offered to support the JMU Collegiate Wind Competition team. The Rotor Design Team will be responsible for designing and constructing the blades, generator, and blade pitch system of the wind turbine to optimize electrical power production performance in the wind tunnel challenge portion of the competition. This team will collaborate with the Electronics and Controls Team to ensure that the turbine maintains safe operating speeds and withstand the harsh testing conditions imposed by the Collegiate Wind Competition requirement. Students will travel to the American Wind Energy Association National Conference in Chicago in May 2018 to present and test the prototype wind turbine at the competition event. Following the competition, the team will work to refine the design for production, apply the design to a different market, and/or refine the design to compete in a follow-up technical challenge at the National Renewable Energy Laboratory (NREL) in Boulder, CO in May 2019.

Team discussing how to improve generator testing.

Drones for Shenandoah

The Drones for Shenandoah Capstone Team explores the capabilities of the FLIR "E30bx" Infrared Thermal Imaging Camera by identifying hot spots on team member, Jeff Redd.

Team Members

Jeff Redd
Wyatt Jankauskas
Sean Bartro
John Codington

Advisers

Dr. Robert Nagel
Dr. Justin Henriques
Dr. Stephen Holland

Virginia thrives on the agriculture industry, raking in 3.8 billion dollars a year in revenue. The Shenandoah Valley is a primary economic driver, making up one-third of Virginia's total revenue, creating 1.2 billion dollars annually. More specifically, James Madison University is located within Rockingham County which is the state's leading county in revenue with a total of over 2000 farms. Times have changed since the early 21st century and traditional farming methods are becoming outdated. As technology improves, uniting sustainability and productivity has become a desire of many industry professionals.

Through careful research and interviews with experts in the field, The Drones for Shenandoah capstone team has been able to analyze various issues within the agricultural industry which led to the creation of a concrete problem statement. "Agricultural commodities are susceptible to disease and sickness. As a result, producers of agricultural goods suffer when the yield of their assets decrease." With this in mind, the Drones for Shenandoah capstone team has embarked on a journey to utilize and integrate new technologies to ease the labor and increase the yield of free-range farmers. Through purposeful design, the team will create an innovative product that detects the health of agricultural commodities more timely than the human eye.

Team Members are in the process of reviewing the motivation and justification of the project. The team plans to utilize the infrared thermal imaging camera to conduct field tests and detect the health of agriculture assets.

Drones for Tanzania

The Drone for Tanzania Capstone team's drone, which will be flown in farms to collect data through visual.

Team Members

Gyanendra Khanal
Joseph "JT" Sorrells
Ryan Ku

Advisers

Dr. Adebayo Ogundipev
Dr. Siya Rimoy
Dr. Divina Kaombe

Sponsors

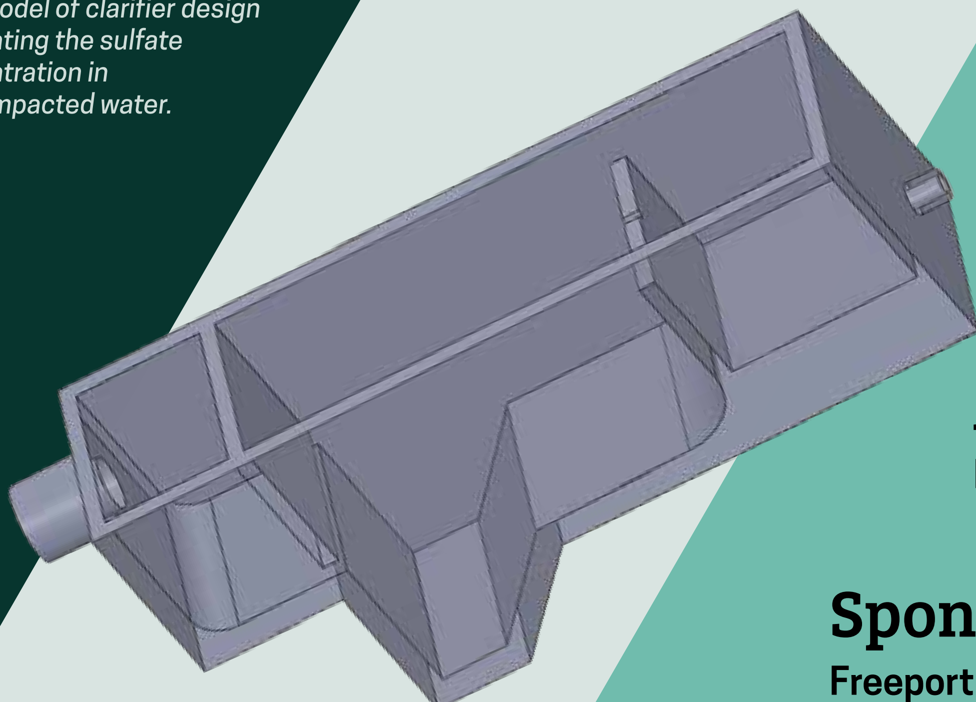
James Madison University (CISE)
U.S. Department of State
Partners of the Americas
University of Dar es Salaam

The project, Drones for Tanzania, is focused on the application of drone and geographic information system (GIS) technology, in agricultural practices, to benefit Tanzanian cashew farmers. There is a need for visual data and regional maps for farmers to make informed decisions. A drone equipped with sensors can help fulfill this role. A drone can collect real-time visual data that can be utilized by farmers. The main crop of focus, for this project, is the cashew; an abundant natural resource located primarily along the coastal regions of Tanzania. Cashews make up a significant portion of Tanzania's exports. Currently, cashew farmers are exporting most of their crop yield unprocessed to the Indian subcontinent for processing. The goal of this project is to assist Tanzanian farmers, in determining better cashew farming practices, through the use of drones to collect data. By helping Tanzanian cashew farmers generate more value from the cashew, the aim is to promote entrepreneurship among Tanzanian cashew farmers.

The purpose of the project is to provide a data collection package (including a drone, software package, and instructions) that can be utilized by the individual farmer or a collective of farmers, to better understand their agricultural practices. We are collaborating with faculty and students at the University of Dar es Salaam for the project. We will be visiting Tanzania as part of a study abroad program where for four weeks, we will be testing our process for collecting and analyzing data. During our trip, we will be immersed in the culture, which will aid our understanding of our stakeholders, potential clients, and the project as a whole.

The team is preparing for a drone flight by checking the drones and talking about a flight plan.

Environmental Design Competition



A 3D model of clarifier design for treating the sulfate concentration in mine-impacted water.

Team Members

Brianna Palazzola
Christine Gatto
Jared Givan
David Sydnor
Arie Bradley

Adviser

Dr. Bradley Striebig

Sponsor

Freeport McMoRan

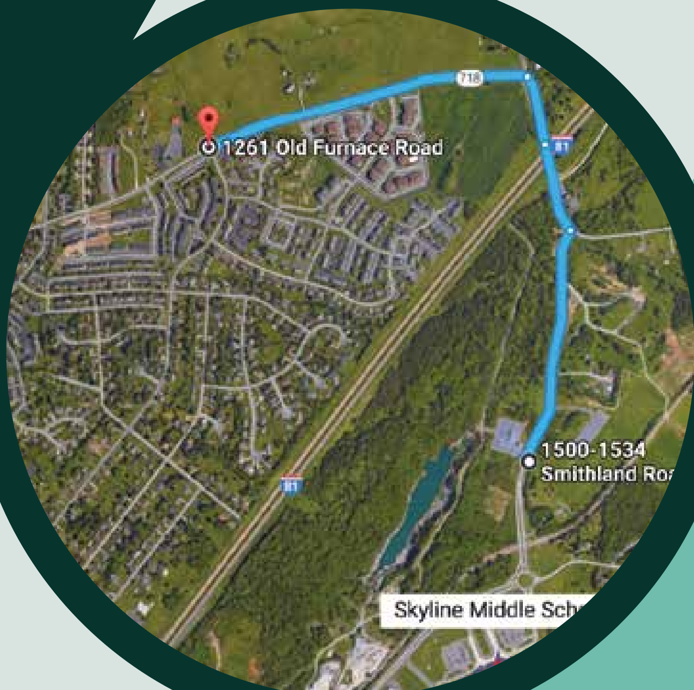
Contaminated mine water drainage is a common problem faced by mining towns and may slowly infiltrate public water supplies. Water produced from mining operations is formed when excess sulfate reacts with water and air, creating a natural oxidation process. This water is then pumped above ground and may flow into various waterways used by towns for drinking purposes and recreational activities. While contaminants in mine impacted waters, such as sulfate, do not pose serious health effects on humans or biodiversity, it does cause laxative effects and dehydration when consumed by humans. Once evaporated into the air, however, this water can cause acid rain, therefore, this is a problem that needs to be addressed.

In response to the problem statement defined by the WERC International Environmental Design Competition, this junior team has joined together with a senior team in order to propose a water treatment technology for the Sierrita Mine in Arizona under the ownership of Freeport McMoRan. A bench-scale model was produced to test the proposed system that can be scaled up to fulfill full-scale mine operations in which 2,000 gallons of water can be treated per minute in order to reach EPA standards. The proposed system utilizes chemical precipitation in which chemicals are added in order to cause a reaction that creates solids; such precipitates can then be filtered from the water in order to reach the goal of no more than 250 milligrams per liter of sulfate present in the water. These filtered solids will be disposed of properly and the clean water will be released back into the environment.

An Imhoff cone test is being conducting by the Environmental Design Capstone team to calculate the time it takes for the Barium Sulfate precipitation to settle out of the solution.

Harrisonburg Greenway Systems 2.0

A map of Skyline Middle School showing a connection point to the surrounding community.



Team Members

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

Adviser

Dr. Heather Kirkvold

The city of 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. The Harrisonburg Greenway Systems 2.0 capstone team is working with New Community Project to design a greenway, or shared-use path, to connect Skyline Middle School and the surrounding communities, specifically Spotswood Homes Trailer Park and the community around North 38 on the other side of I-81. They are also working closely with the city of Harrisonburg Public Works department to align the design with current city projects and long-term city goals. Greenways have the ability to create social, economic, and environmental sustainability in the communities in which they are built. A greenway system designed around Skyline Middle School would 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 greenway system connect all throughout Harrisonburg, with a route to Skyline Middle School included.

The team is analyzing the conceptual design provided by VDOT of the reconstruction of the Smithland Road overpass crossing I-81 in Harrisonburg.

K2M Surgical Instrumentation

Tools and models to help better our understanding of the problem.

Team Members

Nathaniel Lucas
Jack Dominick
Jason Renalds
Kerry McCullagh
Tomas Milkowski

Advisers

Dr. Callie Miller
Dr. Jacquelyn Nagel

Sponsor

K2M, Inc.

Spinal correction surgery is required for major cases of spinal scoliosis that makes up more than 400,000 surgeries every year in the United States alone. At about four to five hours of surgery time per surgery that is 2,000,000 hours of surgery time every year. 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 like 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 that lower the rod into the screws. These jacks are simply a way to force the rod down into the screw. The problem surgeon's face during this surgery is when patient's scoliosis is so severe that the current device can no longer reach far enough over the rod so that it can lower the rod into the screw as intended. Surgeons currently need a tool that will both persuade the rod laterally (move it over) and lower it into the rod. The goal of this capstone project is to create such a tool that will meet the surgeons needs of both laterally and lower a rod into its respective pedicle screw during spinal fusion surgery. This problem exists because when surgeons are unable to reach a screw, they must work backward undoing what that have previously done wasting up to an hour of time. With 400,000 surgeries every year, the invention of our tool could save 400,000 hours of surgery time which makes more surgeries a possibility and making our tool lifesaving.

The team analyzes the problem using a model spine and creates design concepts to solve the problem.

LEEDing Buildings

The Dallard/Newman House. This house was built by a former slave for his daughter upon her wedding day. The Northeast Neighborhood Association wants to turn the building into a living museum.

Team Members

Sophia Welch
Danny Utrera
Kamden Clemmer
Nick Butts

Adviser

Dr. Kyle Gipson

Client

Northeast Neighborhood Association (NENA)

There are over 85,000 buildings on the National Register of Historic places, and over 9500 of those are listed as Vacant or Not In Use. In the meantime, society is pushing for greener and more efficient buildings. Many seem to think new is synonymous to green, but according to the President of the American Institute of Architects, Carl Elefante, “the greenest building is one that is already built”. It seems contradictory to have an energy efficient historic building, and the codes and standards for each only add to that. Many green building solutions are exactly opposite of what makes a house historic, such as new vs original windows. However, the LEEDing Buildings Capstone’s ultimate purpose is to make the rehabilitation process easier and more commonplace so those vacant and unused spaces can continue to be places where history is made. To do this, the team is working with the Northeast Neighborhood Association (NENA) to create a rehabilitation plan for the Dallard/Newman house. This house was built in 1885 by freed slaves and is now on the National Register. NENA hopes to turn the building into a living museum, library, and office space. As a capstone, we strive to draft a set of plans and a cost analysis that NENA could follow to create a usable, energy efficient space that meets their needs and maintains as much of the historic fabric of the house as possible. This rehabilitation plan can then be used as an example for energy efficient historic houses in the future, making the process easier, and more common.

The team is analyzing thermal images of the Dallard/Newman house. These images will be used to compile an energy analysis for the rehabilitation plan.

Lion Electric Motorcycle

The team's most recent iteration of the 40Ah Lithium-ion Polymer plate cells and modules that the cells are housed within for the motorcycle's battery.

Team Members

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

Adviser

Dr. Rob Prins

We can no longer rely on fossil fuels to satisfy our needs into 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 will require integration of several subsystems including a chassis, traction battery pack, battery management system, motor, and motor controller. The project will require significant design to address the interfaces between subsystems as well as 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 is 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 in order to further develop technologies involving renewable energy.

The team evaluates their battery management system for the Lion electric motorcycle in preparation for integrating it within the vehicle.

Madison Mobility 2.0

Here is the client's current prosthetic leg along with a 3d printed recasting of the socket with support angles changed to the client's ideal comfort angle.

Team Members

Callum Morton
Matthew Mumford
Ashlie Veronie
Natalie Peterson

Advisers

Dr. Heather Kirkvold
Dr. Callie Miller

Client

Mr. Gregory Jansen

In the Fall of 2015, Blaize Majdic proposed a capstone project called Madison Mobility. The team aimed to address the pain and discomfort that users of below-knee prosthetics experienced due to their prosthesis. In 2017, Cal Morton proposed another project to be the spiritual successor to this team. Dubbed Madison Mobility 2.0, or MM2, the new team has begun working with team adviser Dr. Heather Kirkvold and co-adviser Dr. Callie Miller. These individuals happened, by chance, to be working with other JMU professors to design a new prosthetic leg for Gregory Jansen. Mr. Jansen, a JMU math professor, underwent a surgery called VanNes rotationplasty at the age of seven. In this procedure, the knee is removed, and the lower portion is then rotated 180° and reattached. The rotated foot acts as the knee, allowing the amputee a wider range of motion than the alternative of above-knee amputation. Mr. Jansen's current prosthetic causes him pain and discomfort, specifically on the dorsal surface of his foot, which is why he requires a new design for his prosthesis. With Mr. Jansen as the dedicated client, MM2 intends to redesign and build his prosthetic to alleviate this pain. With the Faculty Team acting in an advisery role, and working in parallel to record the process of designing the new prosthetic. The goal for the team is to have a functioning proof of concept by the end of its first year, and a fully functional prosthetic by the end of the project. With help from JMU's Dr. Roshna Wunderlich, MM2 will apply their traditional engineering knowledge in conjunction with knowledge of biomechanics to test the system and model an improved one. The design will then be constructed using traditional and additive manufacturing methods, and handed off to the client for, optimistically, long term use.

The team is comparing a 3D print with new support angles to the client's current prosthetic leg.

Small Batch Coffee Roasting

The team prototyped with rudimentary materials while referencing the concept sketches they have developed.

Team Members

Madison Anderson
Kristen Heaton
Caleb Hoehner
Zack Leonard

Adviser

Dr. Justin Henriques

Client

Michael Scrogham

The specialty coffee industry is growing with, in 2015, 31% of consumers aged 18 years or older drinking a specialty coffee within the past day[1]. Moreover, local small batch roasting is an essential part of many specialty coffee shops, of which there were 31,490 in the United States in 2015[2]. Existing solutions for small batch roasting are expensive, starting at $800 for a 120 gram (0.2645 lb) batch size[3], and often produce unreliable results. The opportunity for every coffee shop to own a coffee roasting machine with moderate batch sizes is limited due to the large upfront investment. Additionally, there are no current products that exist which aesthetically integrate the automotive shop with coffee roasting and further meet the space and batch size requirements of Madison Automotive Apprentices (MAAP). MAAP Coffee, a local shop in Harrisonburg, is requesting a small batch coffee roaster to allow them to add to their quality and include more of their coffee operation in-house. The client, Michael Scrogham, a 2017 JMU MadE alum, is working with the team to ensure that the roaster will meet the needs of MAAP. The goal of this capstone project is to connect ideas with reality by being able to roast coffee in a way that tailors to both the shop's functionality and style. To this end, the formation of unique coffee roast profiles will come as a result of the creation of this custom coffee roaster that will possess full user control that maps airflow and temperature.

[1] http://www.scaa.org/?page=resources&d=facts-and-figures

[2] https://www.statista.com/statistics/196590/total-number-of-snack-and-coffee-shops-in-the-us-since-2002/

[3] https://coffeeroastingbusiness.wordpress.com/2016/12/26/top-ten-coffee-roasters-under-1kg/

From left to right, Caleb Hoehner, Madison Anderson, Kristen Heaton, and Zack Leonard, prototype the size of the drum for their small batch coffee roasting machine requested by local Harrisonburg non-profit MAAP Coffee.

Small-Scale Biopharmaceutical Production System

Benchtop bioreactor system used to create the precise ambient conditions required during fermentation for the proper expression of desired pre-insulin products from microorganisms.

Team Members

Robert Baxley
Marie Marshall
Lukas Bergstrom
Aaron Sloss
Garrett McGurl

Adviser

Dr. Samuel Morton

To date, the production of bio-derived medicines, such as insulin, are characterized by complex, large-scale biochemical production systems. Because of this, the biopharmaceutical industry is burdened by the associated high risks and costs to the production of these medicines. As of 2013, over the 12-15 year course from drug discovery to regulatory approval, it costs approximately $5 billion dollars to develop a new drug; only 1 in 10 drugs entering human drug trials receives approval[1]. This capstone project attempts to address the issues that large-scale processes and systems experience by developing the specifications of a useable small-scale system wand mitigate these cost risks. One of many desired bio-products is insulin; insulin is a regulatory hormone produced in the pancreas to regulate glucose in the levels. In 2015, approximately 30.3 million Americans have diabetes, which is a disease that limits the human body's ability to respond to the insulin hormone[2]. Because of this, further development of safe, efficient, and effective means of human insulin production are sought by biopharmaceutical manufacturers. Specifically, this capstone seeks to develop the early processing phases (fermentation of select microorganisms) for the manufacture of human insulin precursors. These complex proteins can then be manipulated and purified to produce human insulin.

[1] Shuler, Michael. "Bioprocess Engineering: Basic Concepts." 2017 Pearson Education, Inc. Print. 3/1/2018.

[2] http://www.diabetes.org/diabetes-basics/statistics/?referrer=https://www.google.com/

The Biopharmaceutical Production System capstone team examining the benchtop bioreactors to be used for the culturing and fermentation of several microorganisms to evaluate insulin precursor expressions.

Spinal Surgery Robots

The K2M Spinal Robotics Team received these instruments and spinal models from K2M for use in their project.

Team Members

Troy Fries
Cameron Robinson
Alex Gellios
Faldo Jatmoko

Advisers

Dr. Jacquelyn Nagel
Dr. Robert Nagel

Sponsor

K2M, Inc.

Robotic implementations are finding their way into many facets of life, as they improve accuracy and reduce the time that tedious tasks take. In a surgical context, many robotic implementations (such as the Mazor X) have the ability to scan the body, prepare the site, and guide the surgeon to reduce the chance of mistakes being made in procedure. The K2M Spinal Robotics team has been tasked by K2M, a spinal instrumentation supplier, to design a robotic system that can assist in the performance of a spinal procedure. Targeting single-level spinal fusion, the team will utilize sensors, actuators, and code to provide a proof of concept to K2M that assists in disc identification and removal. In the upcoming year, the team will begin with rapid testing to further inform design requirements, ultimately solidifying a final design to provide to the client.

The K2M Spinal Robotics Team connecting sensors and actuators in the Mechatronics lab.

REDESI

GN

SOPHOMORES

Human Powered Vehicle

Each year for the past eight years, sophomore engineering students at James Madison University work 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. Mr. Les Welch of East Coast Bicycle Academy works closely with engineering students on the fundamentals of bicycle mechanics, while Dr. Tom Moran of the Department of Kinesiology and Overcoming Barriers, our project partner, works closely with the client to overcome physical limitations.

While the theme of the project remains the same from year to year, 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.

Each year, the client typically begins not being able to independently ride a bicycle to receiving a custom-made human-powered vehicle designed and built by our students to provide both independence and exercise. The impact is on the students, the faculty, local experts, machinists, and the families involved.

Team Bananas

Amadeus Kang
Gyanendra Khanal
JT Sorrells
Alejandro Mastrapa
Andrew Ryan
Elyse Hieronymus
Kamdem Clemmer
MacKenzie Gring
Parth Patel
Peter Nielsen

DukE Designs

Kristen Russell
Megan Dowgiallo
Jake Abruzzi
Bradley Ritchie
Adam Smith
Emerson Youtsey
Isabel Ledesma
Joey Carrico
Nick Pitorri
Sanarea Ali

The DesEinsteins

Catherine Beck
Thomas Giuseppe
Elizabeth Tafoya
Fox Semones
Cole Young
John Codington
Kareem Ebraham
Thomas Ferguson
Sam Bowers
Caitlyn Homet

The STEMinists

Ryan Voltz
Nicole Morgan
Zachary DeBey
Isaac Miller
Ryan Cole
Theresa Montane
Justyn Girdner
Andrea MacGregor
Adam Zahorchak
Daniel Butler

Team Human Powered Engineering

Keefer Hensel-Smith
Jacob Ortiz
Henry Banks
George Shumeyko
Joshua Williford
JoJo Enzmann
Emalee Martin
Leith Rayes
Robert McFaddin

Team Notorious ENG's

Hannah Daschil
Jamie Riley
Kyle Inocco
Mitch Crockett
Chris Santaniello
Daniel Green
Alex Biegel
Kristian Tarter
Peyton Dudley
Ernie Benner

The Breakfast Club

James Kizler
Analiesa DeRieux
Lindsay Levatino
Rachael Frost
Roman Cook
Tre Bright
Chris Smith
Ethan Anderson
Samantha Wilkinson
Sam Shoosmith

The D.I.N.G.O.S.

Carver Johnson
Tyler Machi
Tyler Wahl
Josh Coursen
Sahm Azizi
Jack Leary
Bailey Branham
Clem Poole
Harrison Gillock
Joey Potter

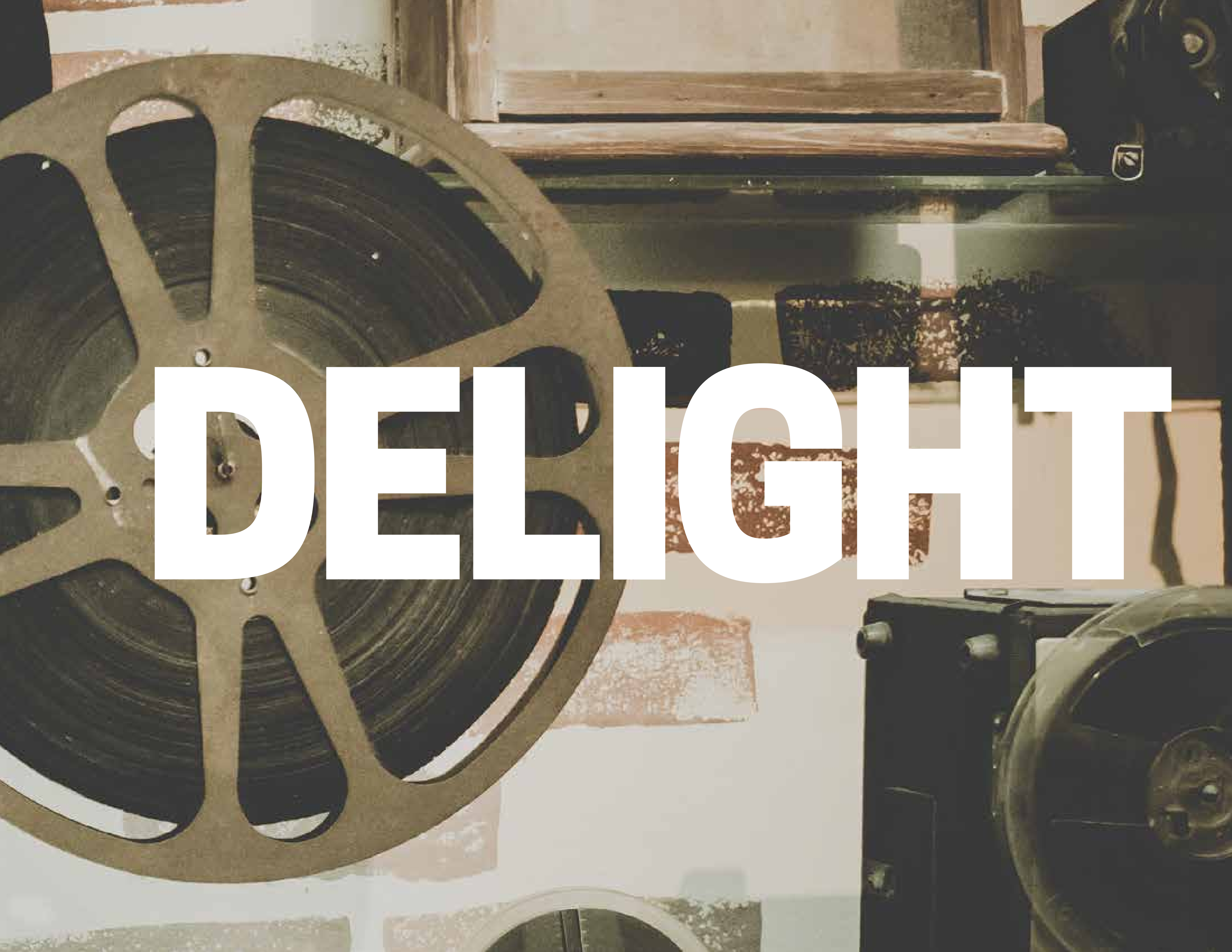
Chain Reaction

Madison Gilmore
Andrew Payne
Caroline Clay
Brady Fox
Dalton Whetzel
Jason Souder
Nick Lindenfeldar
Beverly Boateng
Zaki Samady
Lawrence Marfo


JMU


CHANTILLY HIGH


GARY FISHER


DELIGHT

FIRST YEARS

Adaptable Musical Instruments

The beauty of music is that it can unify the mind and soul. It affects our personality, our creativity, our drive. Furthermore, creating music through instruments improves motor and reasoning skills, even improves visual attention. Yet those who may benefit from interacting with musical instruments the most may find their opportunities limited. Therefore, the ENGR 112 course has embraced the chance to interact with and design for seven children with unique needs from Stone Spring Elementary School, creating musical devices so that they may be included into musical situations where they may have otherwise had limited opportunity. Each ENGR 112 section has been divided into teams of approximately four engineering students. Together students in each section will learn about their user, but as teams, they will engineer an adaptation to an existing instrument or consider making a brand new kind of instrument. Each of the seven children will benefit from up to five unique solutions, allowing them to play, learn and experience the joys of music.

This project is co-facilitated by Jesse Rathgeber, Assistant Professor, Music Education, James Madison University. Through this partnership, Rathgeber has assigned a music education student to each of the ENGR 112 sections. Assigned music students have helped to facilitate learning about the users, music theory, and the user's preferred musical instrument(s).

Paterson's Angels

John Alcantara
Nathan Carney
Casey Dreshsler
Brandon Duda

GCJ²

Jessica Besnier
Christian Bowman
Julia Merti
Gavin Tomchick

Notorious ENG

Nikola Bajs
Adam Cundiff
Zayne Luker
Wesley Quill

The Blue Bulb Company

Sarah-Margaret Andrews
Jeff Ekon
Jaclyn Riddiford
Josephine Txakeeyang

Heroes Without Capes

Joel Aquino
Michael Daubney
Erik Idrizi
Marcos Piggott

The Justice League

Nicholas Ciccone
Andrew Durham
Mitchell Jefferson
Jordan Jones
Jacob Mattson

The Big Boys Design Club

Michael Chung
Francis Chval
Andrew Heller-Jones
Ronan Higgins

Team Titans

Jacqueline Cottingham
Lance Curran
Mark Jockin
Tyrees Swift-Josey

The Avengers

Arthur Ashe
Melaney Cutler
Aiden Mock
Nathan Ritter

G72K

Julio Bermudez
Cameron Miller
Noah Munis
Preston Shealy

Old Bae(s)

Tyler Durette
Liam Jackson
David McKenney
Lana Schlesinger

X-Men

Matthew Beitel
Joshua Chapman
Allison Criss
Nathan Janney

How It's MADE

Colleen Cotter
Nikolaus Droukas
Sean Reed
Alexander Roseberry

Universal Designers

Lauren Dargan
Joshua Jones
Michael Leek
John Young

The Rhythmic Builders

Anissa Boissiere
Raleigh Martin
Tanna Walters

Quad Squad

Enrique Botteri
Dawson Peck
Connor Reed
Zachary Wenzler

JWC^2

Joseph Anderson
Wyatt DeLong
Collin Kenney
Cameron Wilkerson

The da Vincineers

Craig Garland
William Griffin
David Long
Marcus Pierce

The Treblemakers

Brady Finzel
Justin Sanders
Kathryn Smith

The Builders

Ian Logan
Sydney Moon
Jordan Sumiel
Tyler Whetzel

Three Man Team

Caleb Conyers
Matthew Lametta
Arthur Rizer

Notorious E.N.G.

Kyle Lewis
Wyatt McCabe
Jacob McClaskey
Mark Rodriguez
Ashley Vayo

A.D.A.C.K.'s

Anna Crow
Devan Jones
Aaron Scott
Charles Seaver
Kevin Sokolyuk

Jonah's Helpers

Jonathan Amaya
Jack Stephenson
Connor Feit
Thomas Maxwell

Cunning Fam

Raphael Bianchi
Josh Clements
Bryson Mira
Juwan Move
Jack Williams

The J-ABC's

Javier Rodriguez Aponte
Anthony Bruno
Breanna McLaughlin
Christopher Jones

Independents

Cassidy Anderson
Lawson Brannon
Yousef Elsiragy
Megan Fedkoe
Jordan Prax

The Cadence Crew

Sophia Cronin
Shannon Karabai
Tristan Liu
Brian Tang
Charlie Turnage

Five Guys

Paul Fortunato
Feneel Patel
Alex McCleary
Erik McIntosh
Holden Tasillo

FY Engineers

Jorge Barajas
Alex Blackman
John Gardiner
Ryan Hestmatipour

Goon Squad

Mackenzie Fisher
Jadon Rabon
Harrison Reilly
Johnny Tieng
Reid Weston

EDG5

Katelyn Anderson
Jordan Capelle
Ian Howell
Kelly Riggan
Daniel Schmuckler

Scheme Team

Ado Araque
Trevor Kraeutler
Chris Penik
Nattie Ray
Devin Smith

Skyline Engineers

Jamie Clark
Lachlan Hudson
Ethan Keck
Cailyn Lager
Adam Welch

Team Red

Jake Burger
Patrick Foreman
Matthew Kashetta
Conor McNicholl
William Roberts

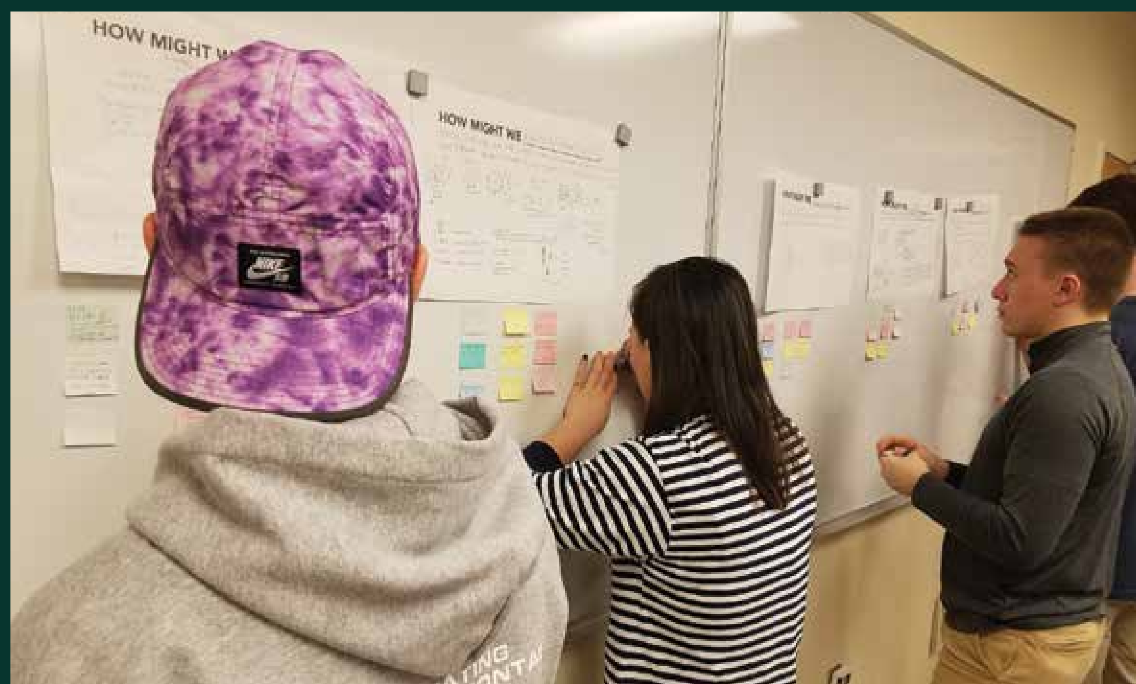
Team Stan

Bobby Albertini
Huy Nguyen
Joseph Silek
Piero Tosi


ROBOT


CHANCE
JAMES MADISON


PATAGONIA
VENTURA CA
MU


HOW MIGHT WE

xChange

2018