
CHANGE '17
MADISON ENGINEERING
A Year of Good Through Innovation, Research, and Design
JAMES MADISON UNIVERSITY.

DEPARTMENT OF

ENGINEERING

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CISE

COLLEGE OF INTEGRATED SCIENCE & ENGINEERING

JAMES MADISON UNIVERSITY.

Acknowledgements

Albert Einstein is often quoted as saying “If the bee disappeared off the surface of the globe then man would only have four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.” Although we now know that the statement is not attributable to Einstein, it is a strong statement that feels right somehow. We know bees are critical to the big picture of life, we also know important outcomes are often the result of many smaller actions. And so it is for our Madison Engineering xChange. Our event is not only many hundreds of people coming together, but it is the culminating result of many hundreds of people working together. No other engineering program makes this happen like Madison Engineering. All students contributing. All faculty and staff contributing. If our engineering building is our hive, then the xChange is our honey. Its golden, sweet, and sticky qualities are the work of many, many hours flying around and beyond the hive. Thanks to all of you for making our hive buzz, and our honey delicious, all while letting so many curious critters explore without getting stung.

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

DISCOVER

DESIGN

BUILD

REDESIGN

DELIGHT

Welcome.

It's fitting that this year's Madison Engineering xChange is on Earth Day. Earth Day provides an annual reminder of how everything and everyone on our planet is connected. Action in one part of the system evokes reaction in another part. Earth Day is also a reminder that the world is dependent on immutable laws of nature that ultimately assist or resist the pursuits of its many inhabitants. Our engineering department is in many ways a tiny Earth. On our best days, we are a connected, supportive, thriving community. Our organizational values of excellence, respect, generosity, learning, and collaboration provide nurturing rules to elevate what's possible in each of us. Our departmental vision, to be the best undergraduate engineering program for the world, not only underscores the connectedness between the individual, organization, and whole, but also the grand engineering opportunity to influence so many different scales. The projects you will witness today at the xChange illustrate many ways that engineering works can make a positive difference in the lives of others; it is important to remember that such projects are the culmination of countless decisions and actions by many people over an extended period of time. These acts of courage, commitment, and contribution are what ultimately matter; the many examples you will see today give me hope for the future of our very special engineering department, and more importantly, the precious planet we all call home.

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

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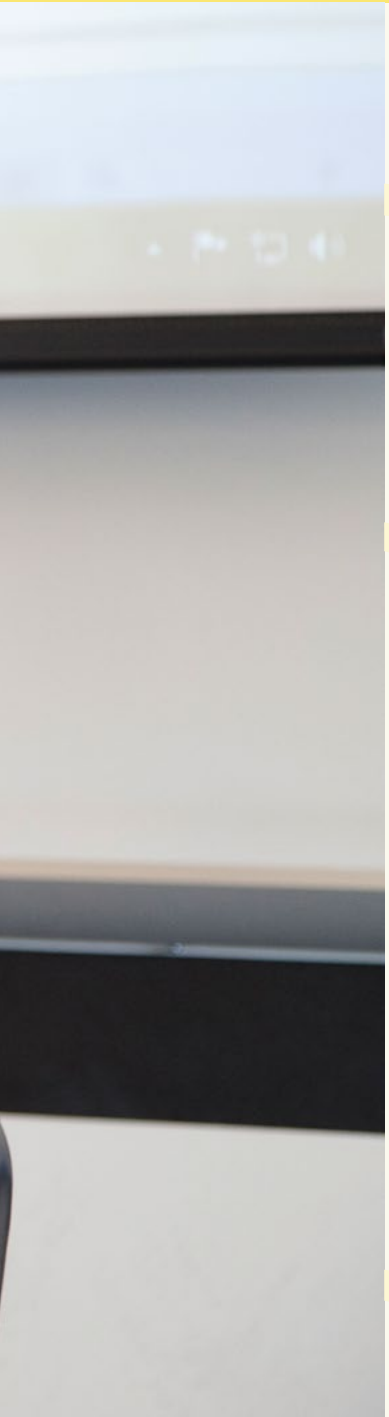


Life Cycle Sustainability Analysis (LCSA) of Polymer-Based Piping for Plumbing Applications

Increasing human needs and waste led to the development of infrastructure where fluids can be conveniently moved between two or more points. As manufacturing processes modernized, pipes started playing a critical role in waste and potable water conveyance. Benefits such as cost-effectiveness, long-term performance, and light weight placed polymers as the leading material in today's pipe market. There currently exist multiple polymers that meet similar plumbing applications; each of these have different energy and treatment requirements that make their manufacturing process unique.

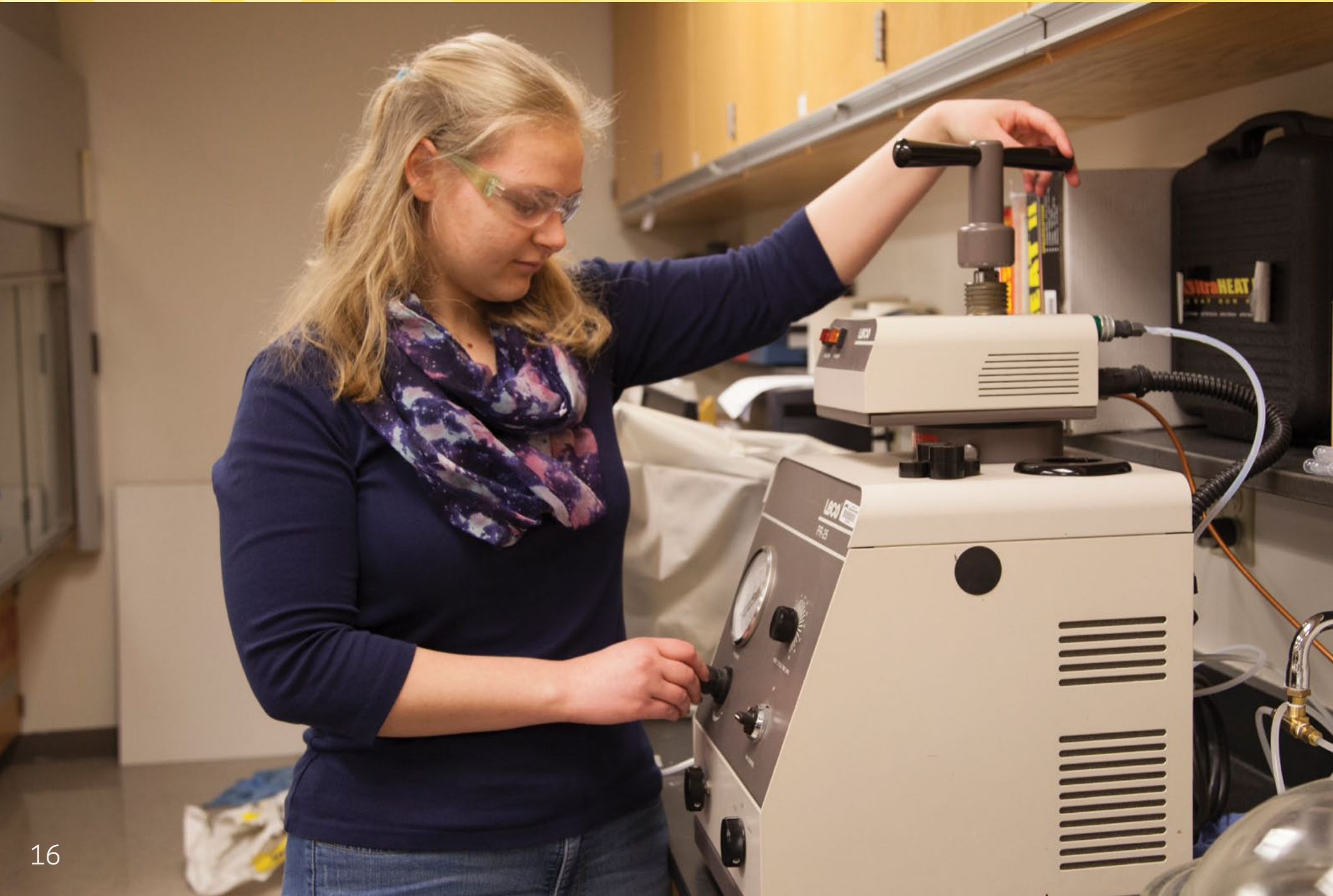
If you could choose between two products with similar costs while meeting the same function, wouldn't you rather buy the one with a lower environmental impact? Polymer treating processes not only have high energy demands to treat crude oil by-products, but also require toxic additives to manipulate end-product properties. Each step along the manufacturing process has associated impacts on climate change, ecosystems, human health, and resource consumption. This study focused on conducting a comparative life cycle analysis (LCA) of commercially available polymer piping material to determine such impacts. An LCA is a systematic tool that assesses impacts associated with a product throughout all its stages. This study used the LCA software package Simapro to evaluate process networks through a comprehensive database.

Process emissions are somewhat known, nevertheless, controversial materials such as PVC are still within the top polymers produced yet increasing in demand. Fully understanding such impacts is critical to reducing emissions associated with manufacturing processes. The polymer pipe industry is large enough to make a potential difference on our environment; a reliable assessment on how certain products perform over others could lead to reduced environmental footprint through more conscious material selection.

Advisor

Dr. Ogundipe

Andy is a senior honors student graduating in May 2017 with a Bachelor of Science in Engineering and a minor in Mathematics. Originally from Venezuela, Andy moved to the US in 2013 to pursue his higher education studies. During his free time, Andy enjoys interdisciplinary reading and calisthenics workout. At JMU, he's taken part in raising multicultural awareness on campus through organizational engagement. After graduation, Andy will be working for two years before pursuing a Master's Degree in Engineering Management and Manufacturing. In the long run, he aspires to contribute in developing the manufacturing industry in his home country through design and management experience.



Jessica Roberts

Process Development and Implementation for the Imaging of Heat-Treated A2 Steel for Consolidation into a Comprehensive Atlas

Material processes, properties, and microstructure are interconnected, often visualized as the points of a triangle. Changing the process a material goes through will in turn change the properties and microstructure of that material. In materials research and education (specifically with metals), comparison between research or experiment results and scholarly-accepted results is important. When reading textbooks addressing different properties of metals and the process of metal treatment, images are often shown of the various microstructures associated with each property or process stage. The difficulty comes in trying to compare the stages or properties to one another; often different materials and processes are used for the various images, making comparison difficult. This project took 13 treatments of one material, A2 steel, a medium alloy air-quenchable tool steel, through a determined heat-treatment process at various austenitizing and tempering temperatures, imaged the resulting microstructures, and began the organization of these micrographs in a comparable manner (for the purposes of this project, this organization is labeled 'Atlas'). The organized micrographs can then be used in further research or for educational purposes. There are many ways this research could develop further, and as a result this project will only begin the process of organizing micrographs in an Atlas, to which further projects could later add.

Advisor

Dr. Prins
Dr. Kirkvold-McLeod

Jessica is a fifth-year honors student graduating in May 2017 with a Bachelor of Science in Engineering and a Spanish Minor. Jessica declared engineering in her second year, after studying abroad in Spain for a semester. She has been involved in the Society of Women Engineers (SWE) for several years, and has participated in the Madison Engineering Leadership Program. She loves to read, knit, and has been part of the Fencing and Tae Kwon Do clubs at JMU. Jessica would love to work her way towards contributing to the Space industry, possibly working on Space habitats for exploring the solar system.

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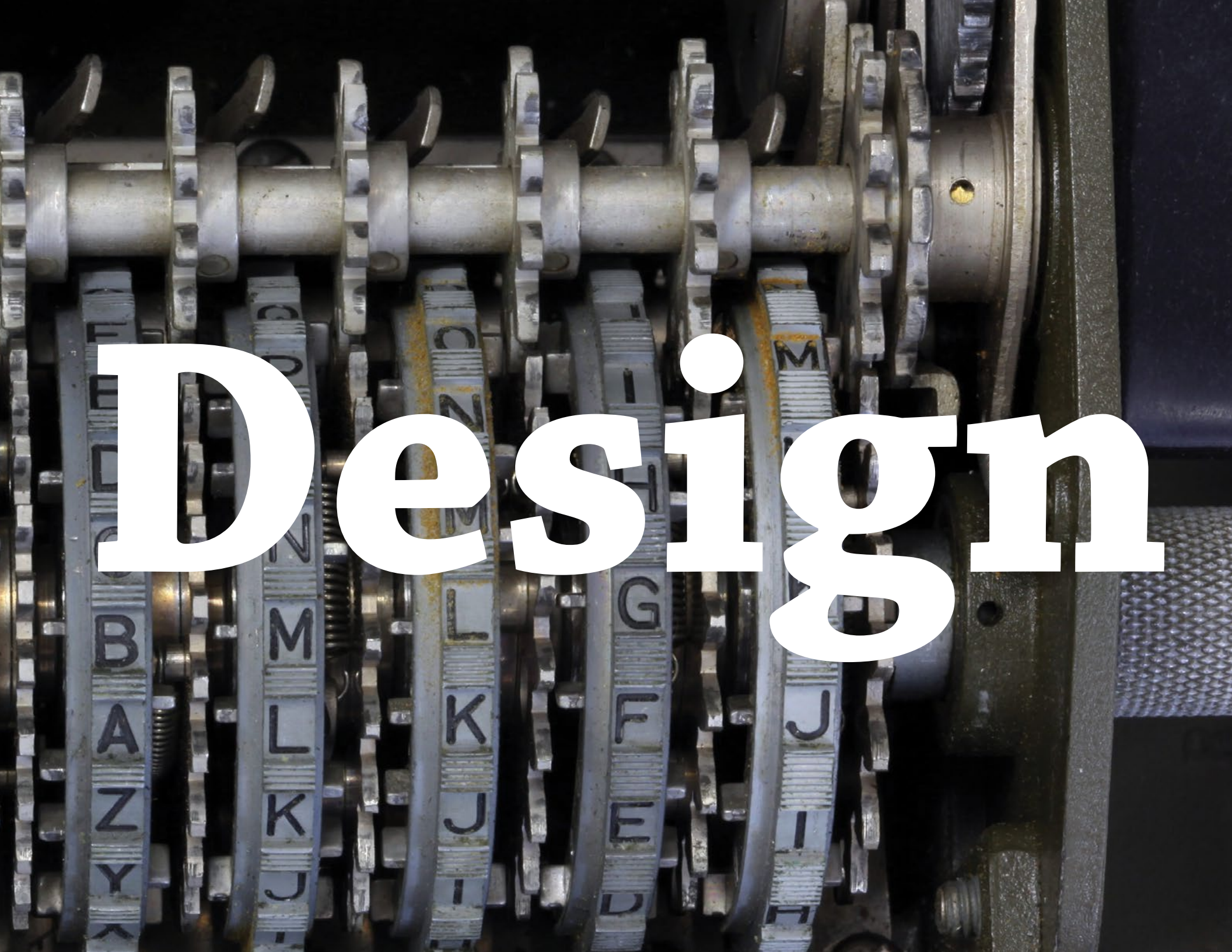

Design

Seniors
Seniors
Seniors

Child In Car Alarm

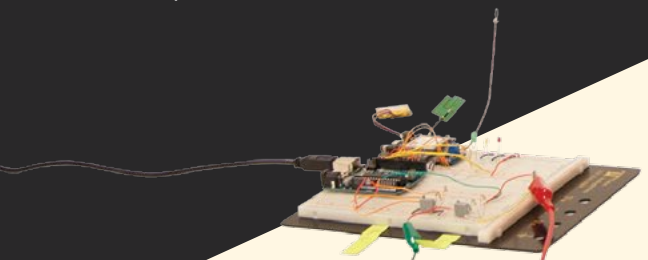
Team Members

Kevin Benecki

Tyler Jarrett

Advisors

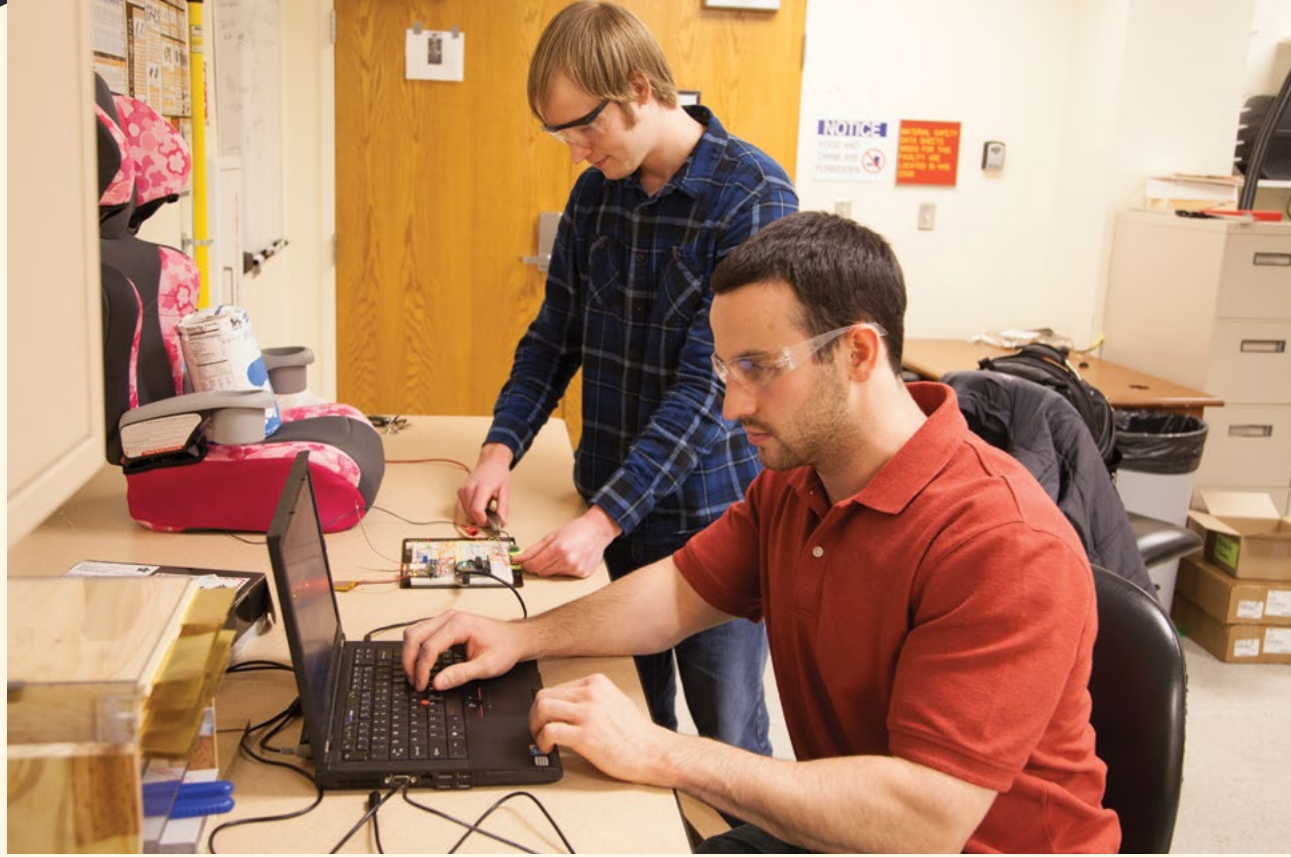
Dr. Robert Prins



The "Child-in-Car" Alarm team's prototype, which monitors the presence of a child with a pressure sensor on the seat, and sends an alert to the drivers phone if they leave the child unattended.

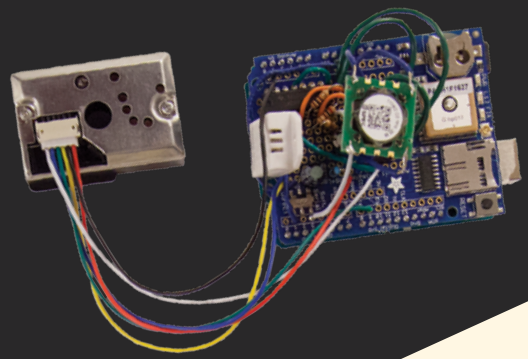
Every year, an average of 38 children suffer heat-related deaths after being left inside vehicles. A parent or guardian could be driving with the child in the back seat and may park and leave the car, forgetting that their child is still inside. Temperatures inside enclosed vehicles can rise to over 120 degrees Fahrenheit in a matter of minutes, even on a mild 70 degree day. Such conditions have proven fatal for children. The purpose of this project is to explore and potentially produce a technological solution utilizing sensor technology so that no children suffer the same consequence again.

With advisory help from Dr. Robert Prins, an associate professor in JMU's engineering program, this team has researched existing solutions on the market that address the same problem. Through benchmarking and researching customer reviews of similar designs, the team has concluded that current products are not being widely adopted due to lack of reliable and consistent performance. The team has developed a prototype which utilizes various types of sensor technology in conjunction with an Arduino microprocessor in hopes of setting a new standard of reliable and consistent performance. If the combined sensory input suggests that the child is unattended, the system will notify the parent or guardian via text message. Additionally, if the child is unattended and the temperature is dangerously high, a second message will be sent to the parent or guardian as well as alternative contacts. The final measure of success for this team will be having a fully functional and refined prototype for presentation and demonstration purposes.



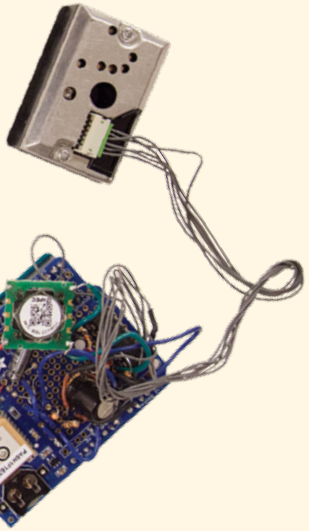
The team is testing their preliminary model to evaluate the results and prepare for development of a fully functional prototype.

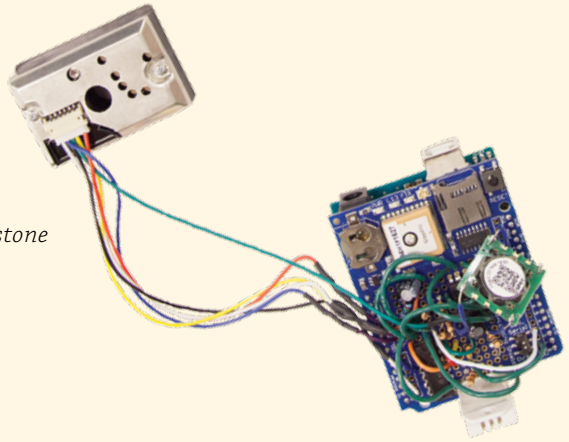
Developing Wearable Air Quality Sensors



Team Members

Nghi Dam
Dias Zhakypbay
Andy Ricketts
Ben Catlett





The Air Quality Sensor Capstone team's second prototype, the EnviroSensor 2.0.

Advisors

Dr. Justin Henriques

Clients

EPA

One of the most dangerous environmental effects on human health is exposure to air pollution. According to the World Health Organization (WHO), air pollution led to seven million deaths in 2012. Despite this, a community's local air pollution can only be imprecisely estimated. The data retrieved from traditional static air quality stations are ineffective in depicting air pollution patterns at specific locations due to the physical limitations these stations have. These stations are independently scattered, usually located outside of cities and are only able to produce data that broadly represents the surrounding area. For a more precise and localized analysis of air quality, there is a need to develop a device that can monitor air quality, while also being portable enough to be operated by the average person. This need is especially relevant in areas with a higher likelihoods of exposure to pollution, such as busy streets or a subway station, to help determine what conditions affect air quality. Developing wearable air quality sensors will enhance the understanding of air pollution in particular communities, and elucidate spatial and temporal patterns of air quality. Currently, the team has successfully developed two versions of the air quality sensors: EnviroSensor 1.0 and EnviroSensor 2.0. Both versions are capable of recording GPS location, temperature, humidity, particulate matter 2.5, and ground level ozone. The sensor packages are built on the Arduino Uno platform. Once the sensor is activated, it gathers air quality data, then exports that data to an excel spreadsheet. Data is then tabulated using visualization software including Tableau and Google Heatmap.

The Capstone team is testing EnviroSensor 1.0 and EnviroSensor 2.0. Test results allow the team to identify pros and cons of each model.

Development of a Research Scale Solar Dryer for Drying Microalgae

Team Members

Nicholas Strosnyder
Casey O'Brien
Matthew Pizzico
Sarah Thomas

Advisors

Dr. Samual Morton

Beta Prototype prior to testing.

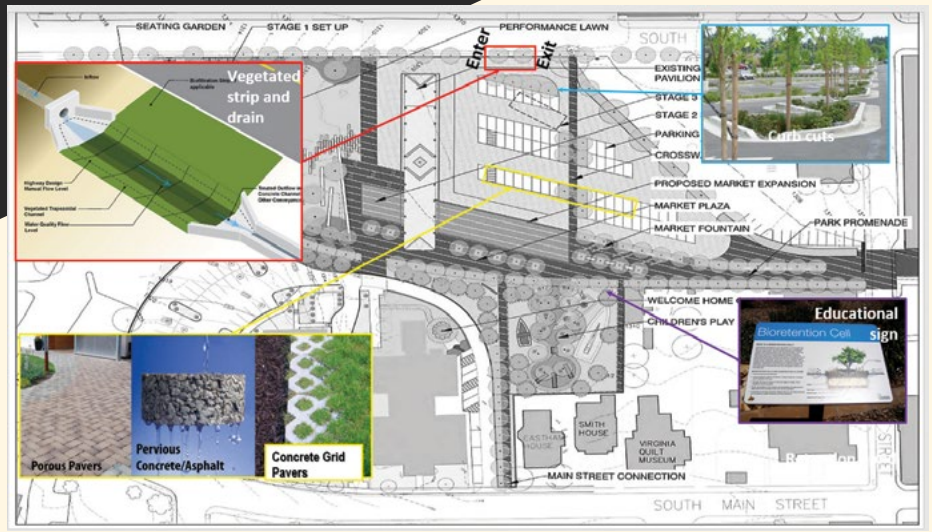
As society leans more towards alternative sources of energy, there is a growing interest in using microalgae biomass as this source. A crucial part of producing biodiesel from microalgae is efficiently removing the water from a harvested biomass. Current methods for drying, such as an electrically-heated single drum dryer, are unfortunately very inefficient. There is such a large amount of non-renewable energy used to dry the microalgae that the overall process is inefficient; it's also expensive. This is why Matthew Pizzico, Casey O'Brien, Nick Strosnyder and Sarah Thomas have teamed up to create a more energy and cost efficient drying system that will remove roughly 90%-95% of the excess water from the microalgae. This energy efficient system will use strictly renewable energy sources and produce zero carbon emissions. Having no current stakeholders invested in the project, Dr. Morton of James Madison University engineering is advising the process. The Center for Applied Energy Research at the University of Kentucky has capabilities and resources that they are possibly willing to share in collaborative settings where energy related problems are involved. Potential users of the product would be biodiesel companies, farmers, or research facilities. Currently, the Solar Dryer Team is analyzing data to discover trends in humidity changes and air flow within the chamber. The team's final model was used to gather this data by conducting several tests under different conditions. Their work has proved to be very useful for Dr. Morton's studies and will provide an excellent platform for future stakeholders to build upon.

To gather data on drying behavior and humidity changes in the drying chamber, ketchup was used in February tests due to its constant consistency and availability.

Downtown Harrisonburg Urban Park Stormwater Management Plan

Team Members

Devon Paysour
Andy Rivas
Madeline Baldwin
Jeffery Culp



Preliminary drawing of BMP placement on the proposed project site used to convey concepts to the team's stakeholders.

Advisors

Dr. Elise Barrella
Dr. Bethany Brinkman

Clients

Harrisonburg Downtown Renaissance Build
Our Park Committee

A capstone team from James Madison University's engineering department is tasked with designing an innovative stormwater management system for Harrisonburg's new downtown urban park. The future 4.5-acre park lies between Harrisonburg City Hall and South Liberty Street in the area around the farmers market pavilion. The Build Our Park (BOP) committee of Harrisonburg, Virginia has been working to design the park which will act as a sustainable model for surrounding areas and encourage the revitalization of downtown Harrisonburg. Therefore, the stormwater management system for the park must also exemplify sustainable efforts, such as naturally removing contaminants from runoff water.

Stormwater is most commonly managed sustainably using best management practices, or BMPs. A BMP is a stormwater control method that reduces pollution by filtering contaminants and prevents flooding through onsite storage. Based on site characteristics of pre and post redevelopment and local water quality regulations, a minimum of 0.42 pounds of phosphorous per year must be removed from the site runoff before it enters the adjacent stream, Blacks Run. This will be achieved through the implementation of a stormwater management system comprised of various BMPs. Additionally, the stormwater management system must be aesthetically pleasing and financially feasible for implementation and maintenance. One important facet of the project the team considered were the dynamic needs of the Build Our Park committee.

To remain flexible, the capstone team created three independent stormwater management systems consisting of various BMPs. Depending on the funding received for the park and the committee's needs when they are ready to commence construction, the committee can select which stormwater plan best suits their specifications. The three plans are as follows:

1. Permeable pavement located in parking spaces
2. Bioretention cells within the parking islands
3. Vegetated swale located between the pavilion and South Liberty Street

The team's final deliverable for the BOP committee consists of design details, cost estimates, and two-dimensional and three-dimensional graphics for each of the three systems.

The team utilizing benchmarking through analyzing the aesthetic appeal and composition of a Bioretention cell on campus.

Engineering Plan for the Construction of a Chamber that Regulates Temperatures and Relative Humidity

Team Members

Hongmyung Lim
James Read
Diego Jauregui

Team Hubo Frost's 3D Cad model of a chamber that regulates temperature and relative humidity.

Advisors

Dr. Kyle Gipson

Clients

Dr. Michael Saunders & Dr. Nicholas Luden

(JMU Kinesiology Department)

James Madison University does not yet have a human-sized walk-in chamber that regulates temperature and relative humidity. This testing apparatus would be able to manipulate environmental conditions such as temperature and relative humidity to simulate desired climate values. With a chamber that regulates temperature and relative humidity, researchers can perform experiments at specific conditions that cannot be reached easily by simply adjusting the climate values in the chamber.
The purpose of this capstone project is to develop an engineering plan that includes the design and construction of a chamber that regulates temperature and relative humidity while meeting the requirements and desired features set forth by the clients, Dr. Michael Saunders and Dr. Nicholas Luden (JMU kinesiology professors). There are many factors to consider when planning to construct a chamber that regulates temperature and relative humidity such as structural, plumbing, electrical, and mechanical components. Team Hubo Frost had the opportunity and privilege to work with professional engineers from JMU Facilities Management for this project. The team coordinated with a liaison from JMU Facilities Management, Matt Black, to receive advice and information about the potential location of the chamber, Godwin Hall, on topics such as water pipeline, egress, and electrical wire connection lines. The plan consists of a 3D CAD model of the chamber and submittals that include calculations and details about the chamber.

Team Hubo Frost Capstone team is analyzing the Architectural/Engineering plan of Godwin Hall at JMU to determine and foreshadow potential problems that may occur from using the chamber in the Kinesiology laboratory on the second floor of Godwin Hall.

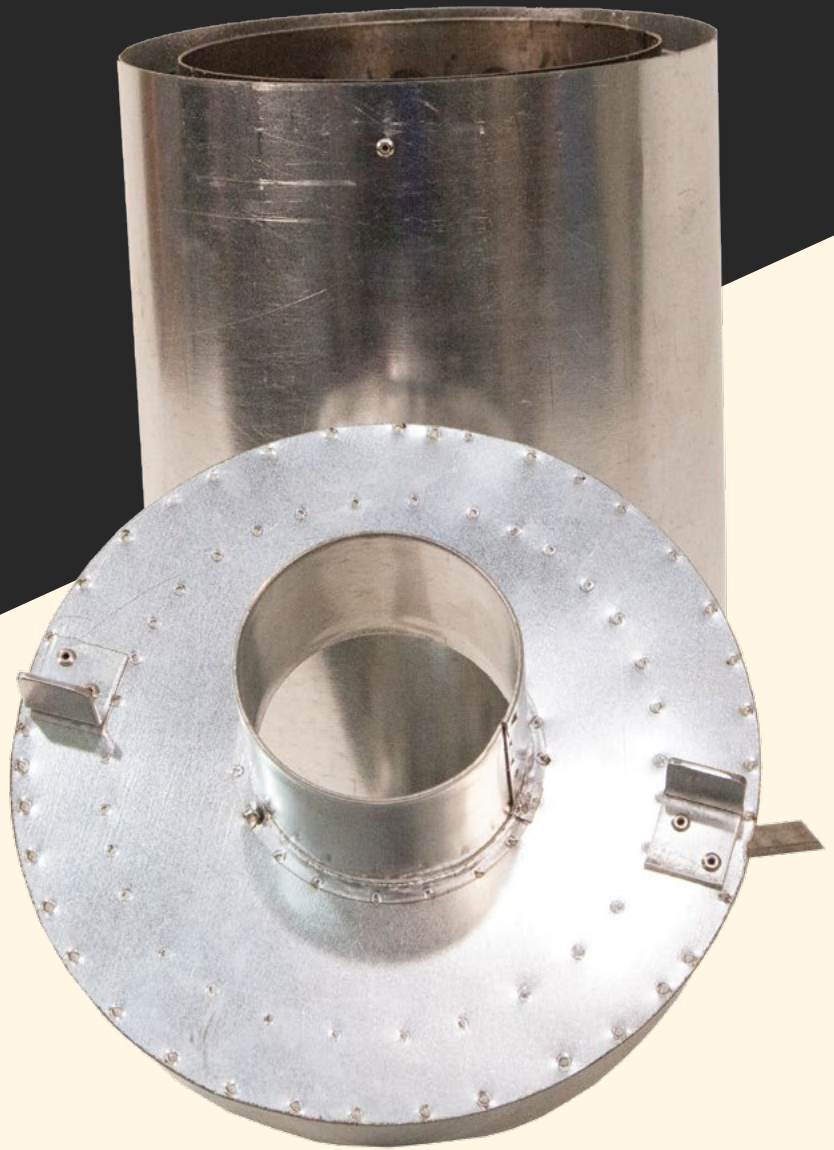
“Good” Stove

Team Members

Ryan Voss
Kevin Dawson
Daisy Becerra

Advisors

Dr. Adebayo Ogundipe



This is Team “Good” Stove’s prototype. It is a TLUD stove the team designed for the community in Longido, Tanzania.

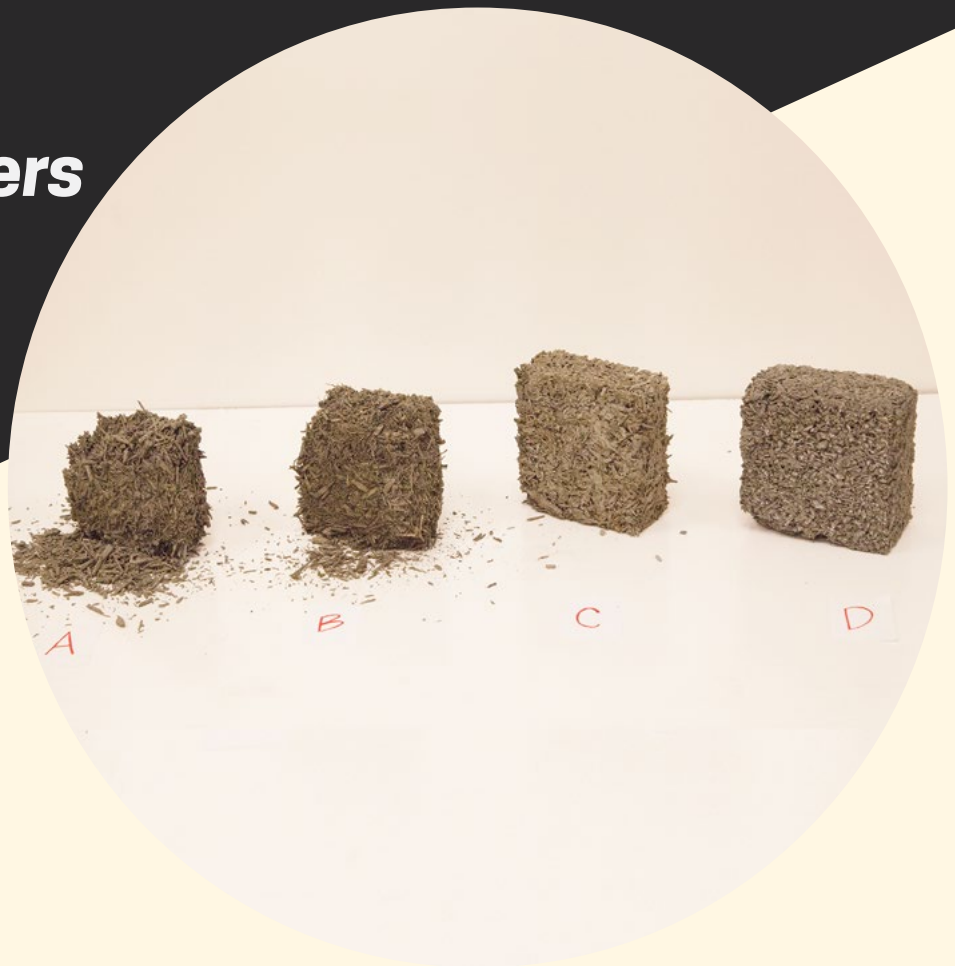
According to the World Health Organization (WHO), around three billion people use open fires and simple stoves that burn biomass as a method of cooking and heating their homes. Some of these people are the Maasai in Longido, Tanzania. The Maasai are an underdeveloped, pastoral group of people. They use a three stone stove that produces toxic smoke, which can cause health issues and shorter life spans. The purpose of this capstone project is to design and provide a "smokeless" alternative stove that allows the Maasai to cook more efficiently and sustainably. The design will introduce the community to a stove technology that has the potential to minimize toxic by-products. The project entails designing a function top lit up draft (TLUD) stove specifically for the Maasai community. The TLUD stoves burn various types of biomass through a process that creates a smokeless flame. The team designed and built a functioning TLUD stove made specifically for the Maasai in Longido. This stove has the potential to change the way this community cooks and has the potential to extend their life spans.

Above is a picture of the team deciding on testing methods now that the prototype has been completed.

Infrastructure Sound Walls

Team Members

Tucker Firnstahl
Cole Click
Dan Ginolfi
Kevin Palmer



Mix designs: Moisture content and aggregate quality significantly affect final product.

Advisors

Dr. Heather McLeod

Clients

VDOT (Virginia Department of Transportation)

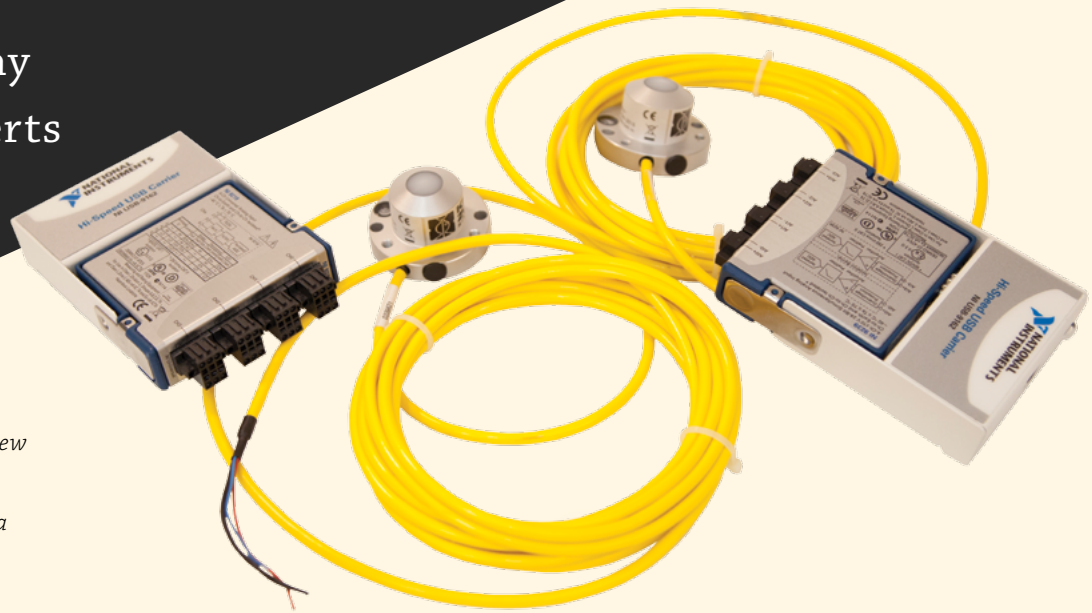
Highway sound barriers in Virginia are manufactured with a design life of 50 years and are beginning to degrade one year after installment. Premature deterioration and color variation among product suppliers are the primary concerns of the Virginia Department of Transportation (VDOT). Causes are linked to raw material selection and the manufacturing process. State taxes are used as funding for highway noise reduction projects and many current installations are not economically sustainable to repair or rebuild. Current installments cost roughly two million dollars per linear mile. The goal of this project is to extend the life of VDOT approved sound walls by providing recommendations to improve quality control management, testing procedures, and material selection during construction, and installation. A successful project will potentially save millions of dollars of taxpayer money that can be spent toward rebuilding roads, bridges and other infrastructure. Key project features involve site surveying, facility inspection, mix design experimentation, mineralization of wood aggregate with KXX treatment, freeze-thaw testing in accordance with ASTM-C666, and development of a mass-loss vibration test. Notable results include a positive correlation between moisture content and overall sample strength. A final project report including recommendations and supporting data will be provided to VDOT by May 2017.

Mixing a batch of wood-aggregate concrete for highway sound walls.

Kawneer Energy

Team Members

Alex Kroll
Zach Bartemy
Jessica Roberts
Javal Swift



Pyranometers and Labview equipment measure and record light coming into a vestibule area.

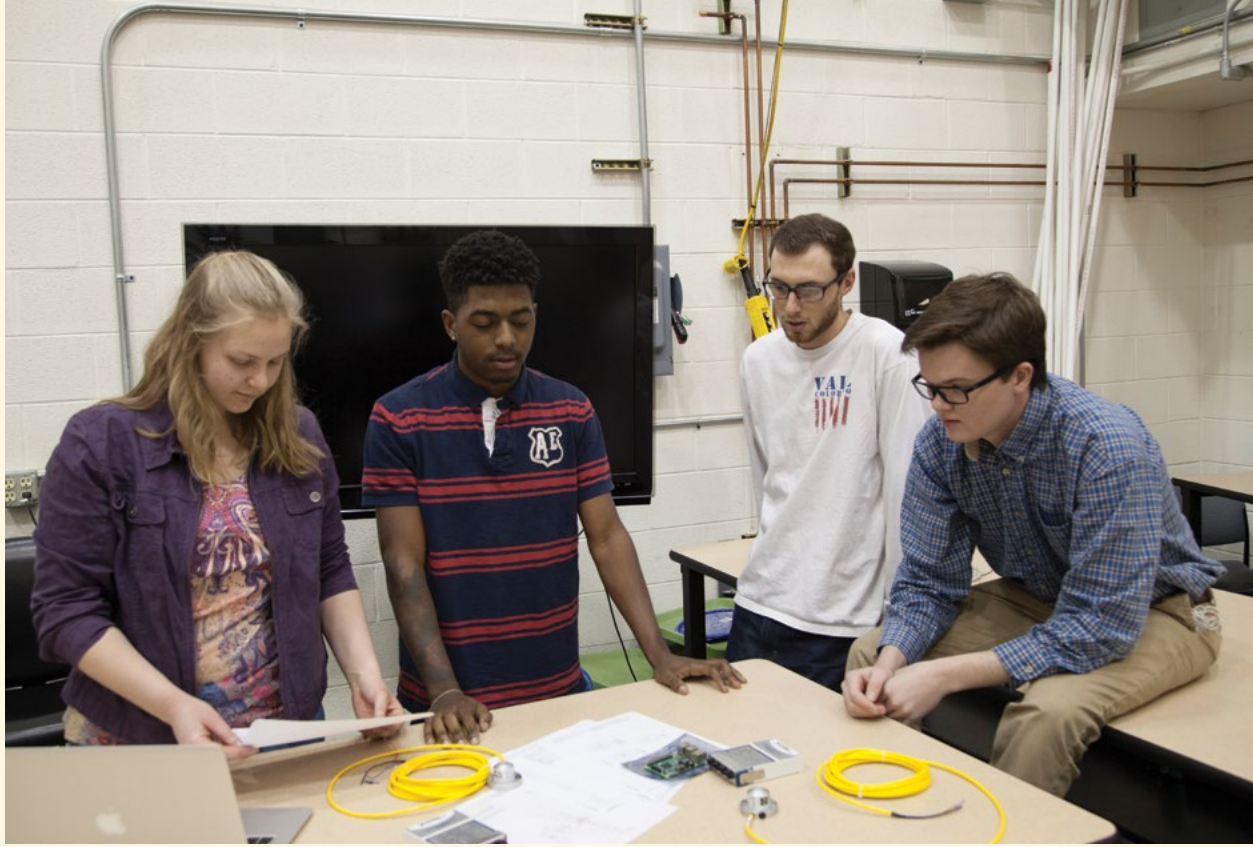
Advisors

Dr. Keith Holland
Evan Bowen

Clients

Kawneer Company, Inc.
Arconic
Earthwatch

The scope of the Kawneer Energy project initially was to provide a set of engineering recommendations leading to sustainable improvements in the mechanical systems, electrical systems, building envelope, and the activity contained within the building system. Throughout the first year of the two-year project's lifetime, the team analyzed the current state of the Kawneer building. The team conducted a site analysis and cost analysis on various products and methods that could help Kawneer save money spent on energy consumption. From the team's recommendations, Kawneer decided to move forward with improving the building envelope. Since their products are industry leaders in thermal and solar performance and could be fabricated in-house (helping reduce costs), Harrisonburg Kawneer's management suggested the team use Kawneer products and show how they could be utilized to improve energy efficiency within a confined space. Moving forward with that plan of action, the project's scope was changed to validating the thermal and solar performance of Kawneer products. By validating their performance, the team can create recommendations on how to use these products to reduce energy consumption within an office space. This energy reduction can reduce Kawneer's spending by reducing the fixed costs the company incurs from utilities expenses, and in return allow Kawneer the opportunity to reinvest saved capital in other areas. Reducing energy consumption will also have a positive effect on the environment by reducing the negative impacts resulting from the use of the building.



The Kawneer team considers the project sensors, equipment, and floor plans of the Kawneer office space. These sensors and equipment were integrated into a vestibule area of the building to measure temperature and light.

Low Speed Wind Energy

Team Members

Jamar Johnson
Matthew Mason
Michael Heller
John Walton

Using a shield allows a turbine to convert wind more efficiently. The shield will rotate to capture wind from all angles.

Advisors

Dr. Keith Holland

When people think of wind energy, their mind immediately jumps to expansive wind farms full of industrial grade wind turbines. These behemoths are designed to spin in high wind conditions, as there is a significant amount of energy present there. But what about the energy behind low speed wind conditions? Light breezes still contain energy; not enough to power a home, but energy enough for small electronic applications. Through the two-year capstone project, the team has designed and constructed a wind turbine capable of converting low-speed wind, 5-15 mph breezes, into useable energy to charge small electronic devices for recreational use. Straying away from the typical horizontal axis wind turbine, which uses the principle of lift to set the blades into motion, the team designed a drag-based vertical-axis wind turbine design. Drag-based cup shaped blades respond more readily to lower wind speeds, whereas it takes a significant gust of wind to set a lift-based design into motion. However, typical drag-based turbine designs allow incoming wind to contact the entire cross section, which prevents the turbine from reaching its maximum power output potential. To combat this problem, the team incorporated the idea of shielding into the design. The shield, a feature unique to the team's design, serves to focus the driving wind on one side of the blade cross section to maximize potential energy harvested. The entire design-shield, blades,

generator housing-was intended to be small and light enough for recreational use. In other words, you can charge your phone wherever the wind blows.

Building a generator requires finesse. Closing the gap between the two sides of the generator will be a challenge because of the strong magnets being used. If the team isn't careful, someone could have their hand crushed.

Madison Mobility

Team Members

Blaize Majdic
Danielle Wilson
Thomas Barrett

Pictured to the right are some of the components that will make up the team's final design concepts. (From left to right: 3D printed socket, pressure redistribution device, pylon and pyramid connection, cast of residual limb).

Advisors

Dr. Elise Barrella
Dr. Heather McLeod

Limb amputation currently affects 1.7 million people in the United States. Approximately half have experienced a below knee amputation. While current prosthetic leg designs provide amputees with increased mobility, the systems have limitations. Many users experience pain and discomfort at the distal end of their residual limb while using current prosthetic designs, including the pin lock, elevated vacuum, and suspension sleeve systems. The goal of this work is to develop a below-knee prosthetic system which will reduce the pressure experienced at the distal end of the residual limb and minimize pain experienced by the user, thus improving quality of life. To examine the source of discomfort, which was modeled as pressure, a static and dynamic model of the user's gait cycle was developed, and forces due to the gait cycle were measured using force plates. Two sources of impact force were investigated, the impact of the residual limb contacting the bottom of the socket, and the impact of heel strike during the gait cycle. Computational results from the static and dynamic model indicate that the impact force due to the residual limb contacting the bottom of the socket is negligible when compared to the impact force generated at heel strike. These results were consistent with both the analysis of our measured forces attained using force plates, and a study by Xiaohong Jia, Ming Zhang, and Winson C.C. Lee that analyzed the impact forces of trans-tibial amputees during their gait cycle using force plates. As a result, various design concepts have been developed that focus on the redistribution of forces experienced due to heel strike. Having developed a testing method for measuring the distribution of forces in various systems, the team is currently undergoing analysis of their test results to determine whether the new designs reduce pressure and discomfort.

Here the team can be seen applying weights to their 3D printed prosthetic socket in an attempt to understand the pressure forces an amputee might experience at the bottom of their residual limb.

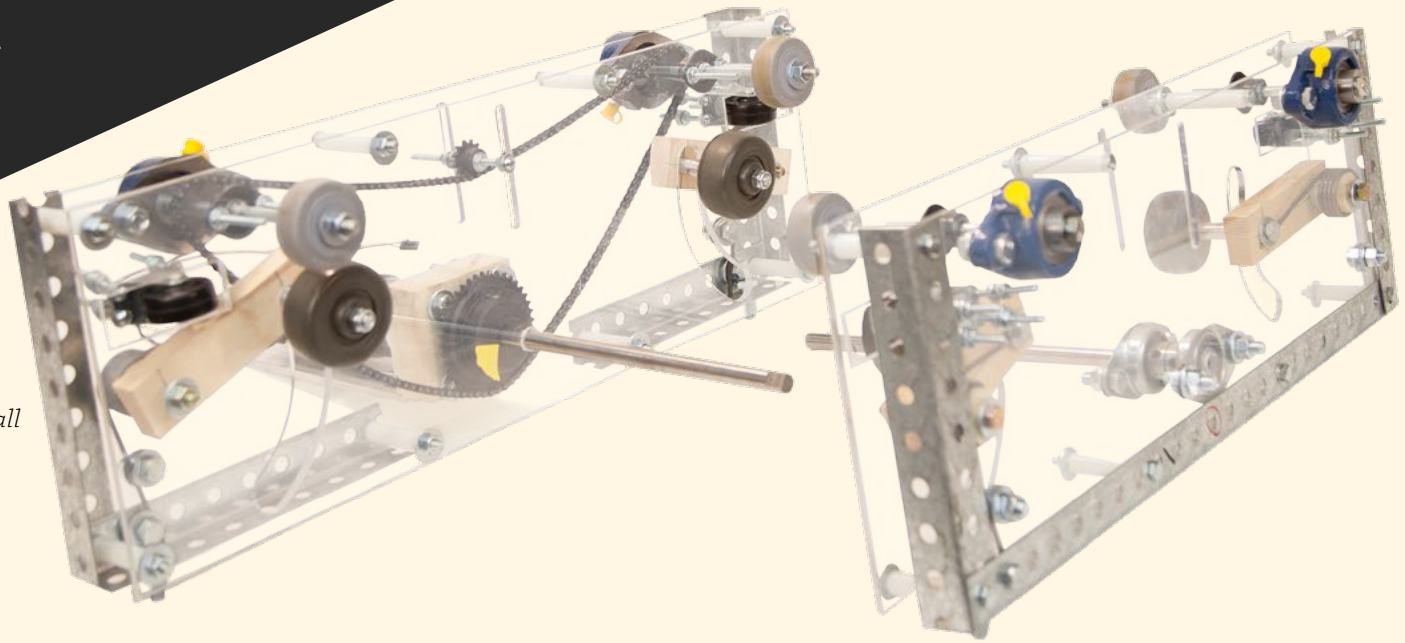
Measuring Wind from Trucks on the Highway

Team Members

Matthew Bors-Koefoed
Taylor Dillingham
Brandon House

Advisors

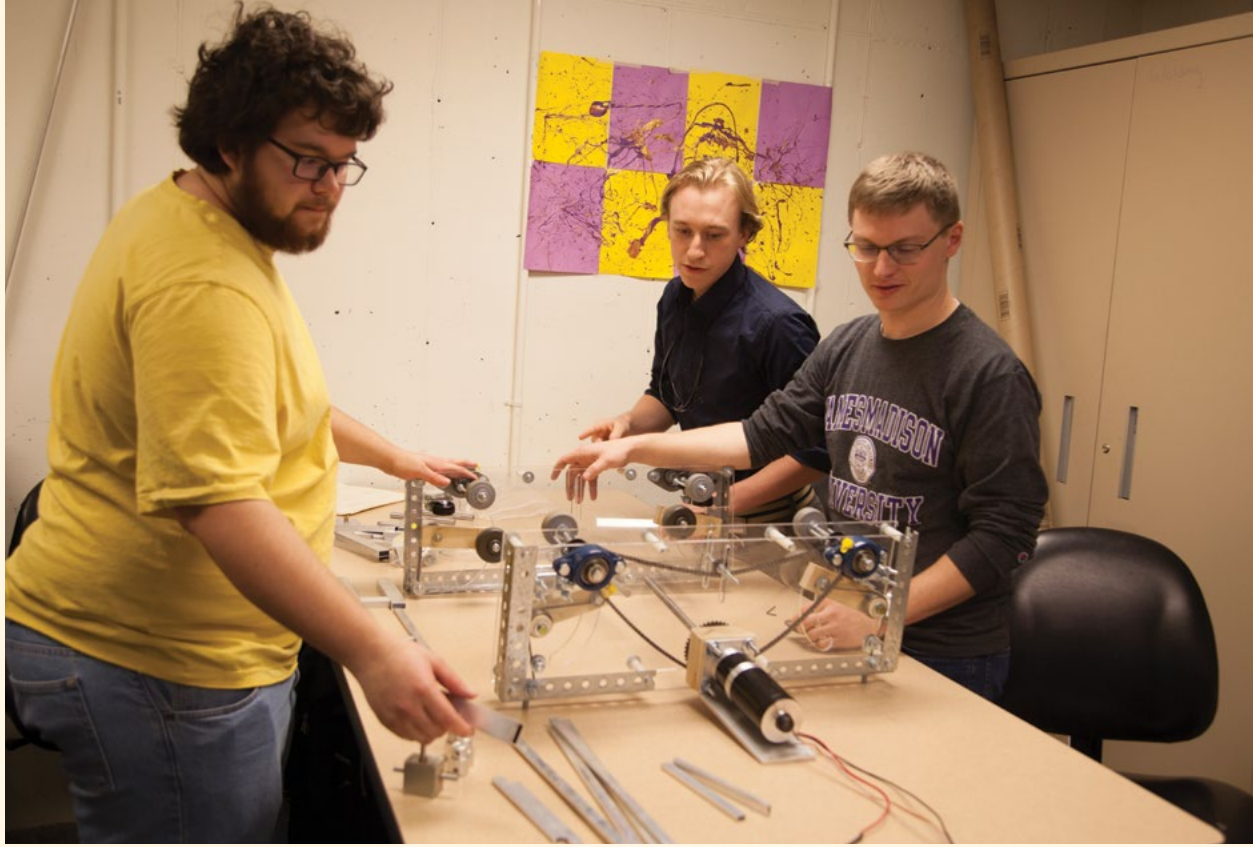
Dr. Steven Harper



A closer view of the two plates that will make up the Traveler. The overall design has since been modified, but the components that drive the Traveler remain the same.

Most people are familiar with the phenomenon of traffic-generated wind. When a large truck passes by at a high rate of speed, there is generally a strong short gust that can be felt following it. This is a result of drag created by the moving vehicle. It is evident that highways experience a very large amount of fast-moving traffic every day. This would imply that there is also a large amount of traffic-generated wind. If hundreds of thousands of acres of land are already dedicated to collecting wind energy, why isn't this seemingly abundant traffic-generated wind being collected as well?

It is the Highway Wind Team's belief that this wind needs to be better understood before an effective solution for energy capture can be implemented. Therefore, the team's goal is to build a modular device that can collect various kinds of data from this traffic-generated wind so that it may be analyzed and better understood. The device is designed to be fitted on I-beams underneath highway overpasses and is controlled wirelessly to allow for data collection from multiple positions. If this data shows that traffic-generated wind carries a significant amount of energy, it may pave the way for solutions to be implemented that allow for some of the energy employed in vehicles to be recaptured and used elsewhere.



The team is constructing the alpha prototype for the two plates designed to grip and travel along I-beams beneath highway overpasses. The team calls the whole structure 'The Traveler.'

Medical Sterilization System for NASA Space Exploration Missions

Team Members

JP Gaffney
James Watkins
Zach Duda
Chris Graves
Quin Moore

Capstone Team M.O.B's prototype model of a sterilization device utilizing cold plasma technology.

Advisors

Dr. Jacquelyn Nagel

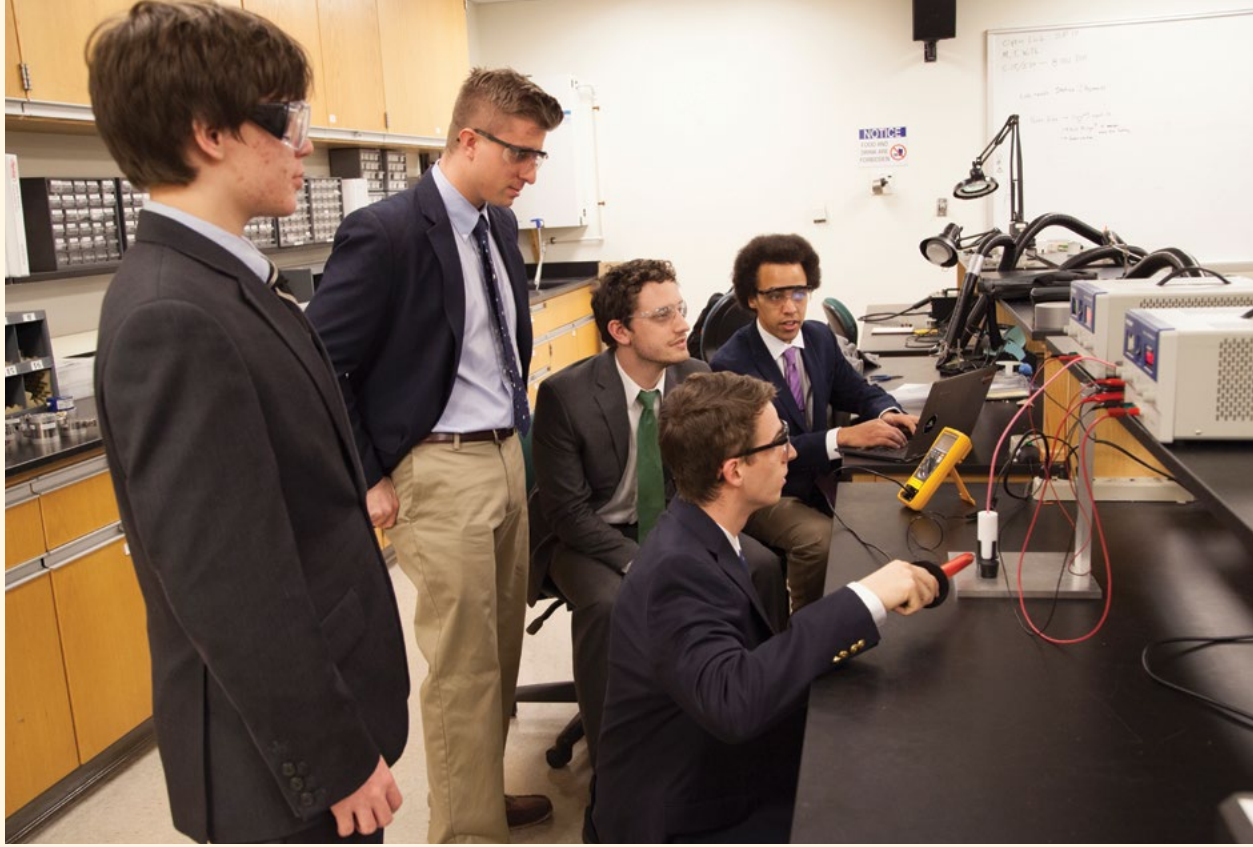
Clients

Matt Simon
Kara Latorella
John Mcquillen

Sponsors

NASA

With the goal of sending humans to explore asteroids and Mars in the near future, NASA aims to improve its medical capabilities for long duration missions. In particular, NASA needs to increase sterilization capabilities while reducing medical payload mass, volume, power, and costs. The medical payload contains small medical devices, such as scalpels and forceps; as well as disposable items, such as sanitary wipes. On the International Space Station, all carried medical equipment is disposable to ensure sanitation. However, this approach must be analyzed against a sanitize-and-reuse strategy for long duration missions. This project is sponsored by the Exploration Medical Capabilities project within NASA's Human Research Program, and supports that effort's objective to provide medical capability for astronauts in long duration space exploration. To address the problem, a cold plasma sterilization system capable of sterilizing small medical devices and other surfaces, such as skin, aboard spacecraft is developed. Benchmarking current technologies on the market provided a better understanding of the possible technologies to produce cold plasma sanitization. System requirements were defined based on information gathered during literature review and input from NASA clients. In order to rank system requirements in order of importance, the team used the analytical hierarchy process. Mass and tradeoff analyses are performed to evaluate feasible plasma technologies. Evaluation of the different cold plasma technologies resulted in selecting the Floating Electrode Dielectric Barrier Discharge (FE-DBD) configuration for the system. In this configuration, there are both mechanical and electrical subsystems. The electrical subsystem contains a high voltage multiplier unit, a high voltage switching unit, and a signal generator. The mechanical subsystem contains the application device, which encompasses an outer polytetrafluorethylene housing, a copper electrode, and a quartz dielectric. The device will generate pulsed plasma species in the discharge gap between itself and the substrate. Having this cold plasma system will allow for the sterilization of surfaces and eliminate all microorganisms from the applied area. Experiments were conducted to evaluate dependent measures while varying the number of doses, the voltage, and the air gap distance from the quartz dielectric to the grounded source, in this case the surface of the medical device. The test substrate was K-12 strain of Escherichia coli, or E. coli. At the conclusion of testing, the team will quantify the rate of sterilization of the system, as well as the number of doses and usage time required to sterilize microorganisms.



Team Mars or Bust is evaluating the strength of the electric field around the cold plasma sterilization device. They are preparing for the initial sterilization tests of medical devices.

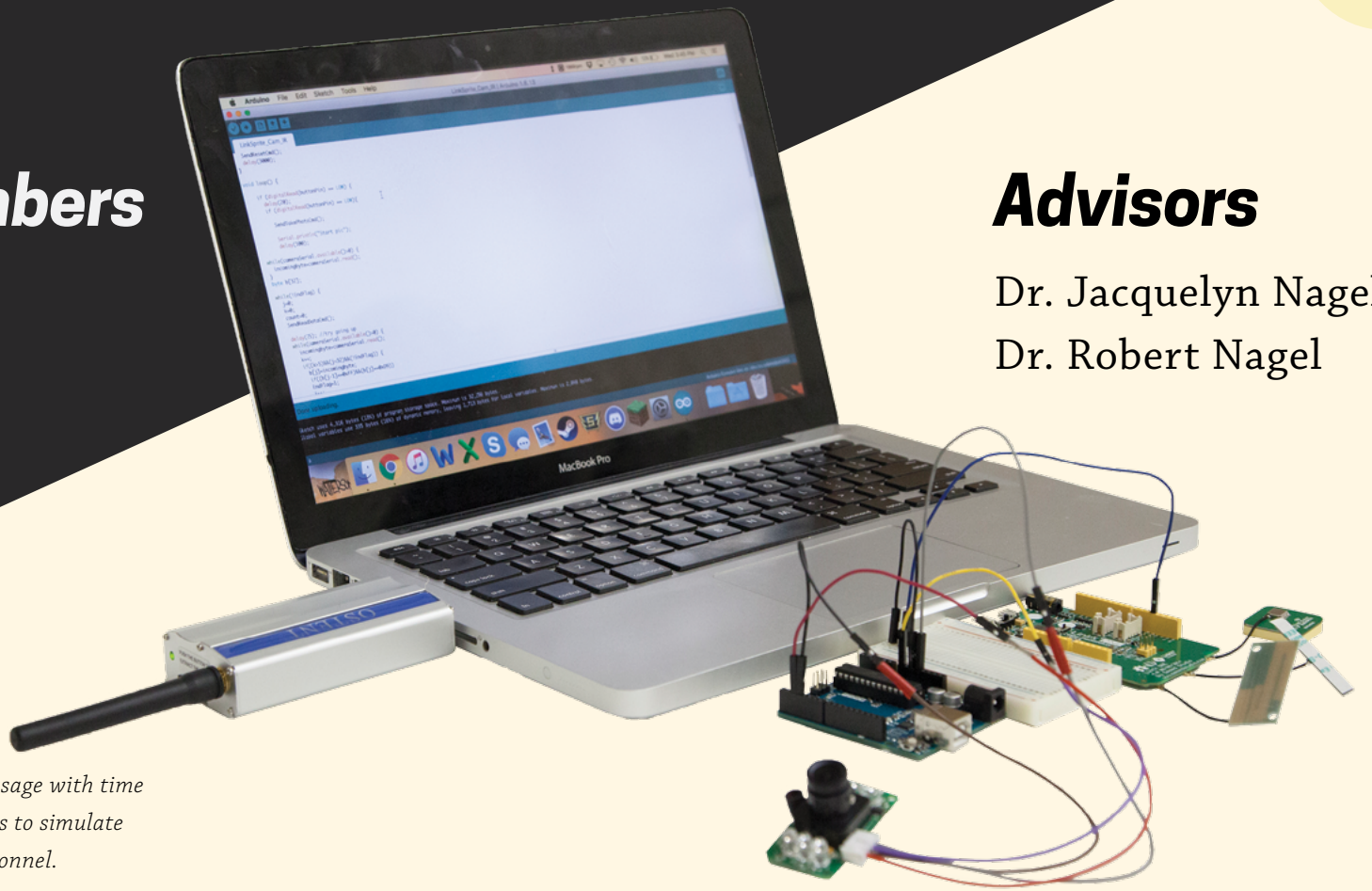
RescUAV

Team Members

Maxwell Painley
Scott Stone
Joseph Kellum
Adam Warren

Advisors

Dr. Jacquelyn Nagel
Dr. Robert Nagel



Team RescUAV's prototype for automatic human detection using thermal imaging. This system will send a text message with time of detection and GPS coordinates to simulate notifying search and rescue personnel.

According to the Journal of Travel Medicine, 15,537 people were stranded and required rescue in national parks between 2003 and 2006. Despite helicopters being the most capable search and rescue tool, they were only used in 15% of these operations due to shortcomings such as high expense and potential endangerment of rescue personnel. The purpose of the system designed by this team is to mitigate these risks by innovating sensor technology in conjunction with unmanned aerial vehicles to safely and efficiently locate persons in diverse environments. The design of this system was carried out using the engineering design process, beginning with problem definition and research where the team analyzed current rescue methods to understand the process and identify pain points. From there, the team developed requirements of a system to address these pain points and began developing potential solution concepts. These concepts culminated in a design for a testable prototype which the team used to gather data and help in iterating the design of a final, usable product. This prototype utilizes both optical and thermal imagery to autonomously detect a person and send a notification in the form of a text message to the user. This notification includes the GPS coordinates of the package at the time of detection as well as time and date of the detection. The ultimate goal of this project is to design numerous packages which are individually suited to different environments in an effort to improve search and rescue operations in all possible ecosystems. Though the team does not have the resources to construct these final environmental packages, the results of testing the prototype under different conditions allowed the team to improve the final designs. In the end, the work done on technology like this will allow organizations like national parks to revolutionize the way they perform search and rescue so that it is less expensive, more efficient, and is no longer unnecessarily dangerous.

The team is working to integrate the data from the detection, notification, and gps subsystems into a single comprehensive program. This program will detect a target, determine the gps coordinates of that target, and send a notification with critical information.

Sustainable, Accessible, and Feasible Energy for Mobile Coffee Establishments

Team Members

Darby Brooke
Michael Scrogham
Travis Weeks
Breanne Martin
Aidan Ryan

Advisors

Dr. Justin Henriques

A prototype for exploring detailed design integration between solar, mechanical and electrical systems. By examining physical artifacts during an iterative period of design, the veil drawn between designer and user can be pulled back.

Coffee is one of the most traded and consumed beverages in the world. Although coffee is affordable to many people, the brewing, transportation, and harvesting are costly to environmental health. In fact based on a Gallup poll, roughly 64% of Americans drink two cups of coffee per day. From testing data, an average cup of coffee made in a French press with water heated via an immersion coil, each cup requires roughly 290 watts of energy. Expanding this to a national level, the U.S. uses roughly 111.4 gigawatts of energy per day on coffee consumption. To shift the focus of energy away from drawing grid power, which is utilized every time the Mr. Coffee machine is plugged into a wall, this JMU capstone team is implementing solar technology for brewing coffee in a mobile setting. While engineering topics may seem more focused on areas of technical sustainability, this project also seeks to explore the benefits within social sustainability. As more effects of climate change are becoming apparent, the need to remove dependence on fossils fuels becomes more prevalent to society. This project seeks to use readily accessible technology and demonstrate how effective alternative energy sources can be. Through interacting with a commonplace activity (brewing a cup of coffee) which did not directly draw from electricity generated by unsustainable means, many individuals may find inspiration to apply this technology in their own lives. With a physical artifact demonstrating functionality, conversations can be spurred, relationships can be started and coffee can be enjoyed.

With a primary focus of this project being the demonstration of environmentally sustainable habits, these engineers go beyond designing and paperwork. This physical artifact acts as a conversation catalyst to promote sustainable practices with everyday things, like brewing coffee!


Build

Juniors

Juniors

Juniors

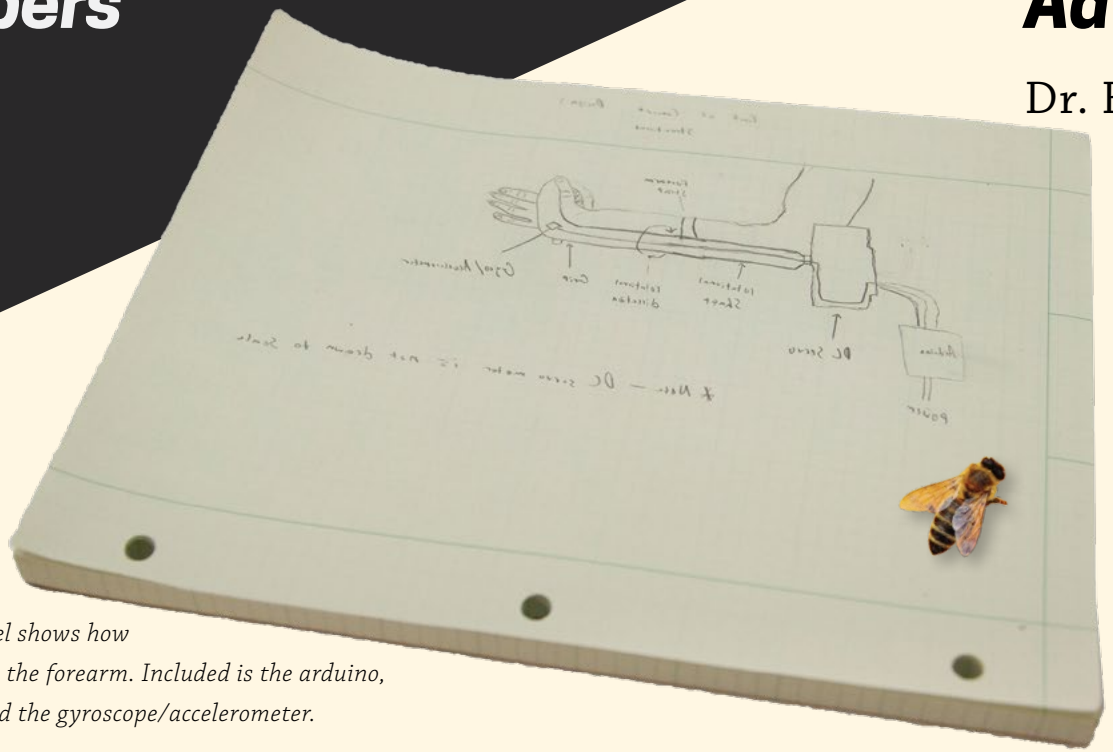
Augmented Mobility

Team Members

Gray Cline
Stetson Kniff
Greg Mayo
Matt Liebl

Advisors

Dr. Keith Holland



The team has decided to focus on the supination and pronation of the forearm for their first tremor suppressant exoskeleton. This model shows how the device system will interact with the forearm. Included is the arduino, DC servo, rotational shaft, grip, and the gyroscope/accelerometer.

The Augmented Mobility Capstone Team is tasked with improving current exoskeleton technology. Wearable technology and exoskeletons are an exciting new field that is rapidly expanding with unprecedented impact. Exoskeletons provide external strength and additional body control. Exoskeletons in the marketplace, as well as those developed for academic research, provide this external strength through means such as electric motors, pneumatic (air) pumps, or hydraulic pistons. Current exoskeletons are typically used in four areas: military, medical/rehabilitation, industry, and civilian use. Upon investigation of the exoskeleton industry and target markets, the team identified a need to improve the accessibility of exoskeletons to the senior citizen demographic. 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 will create a functioning prototype of a tremor management exoskeleton to assist in reducing the effects of forearm tremors. The exoskeleton will combine active and passive elements, meaning the design will include electrically-powered actuation, as well as structural units that perform critical functions without power. The design has been segmented into three modules: 1) the pronation and supination, or forearm roll, 2) the extension and retraction of the elbow joint, or forearm pitch, and 3) the flexing up and down of the wrist joint, or forearm yaw. The proof of concept displayed at the Xchange is the forearm roll module. The actuation is provided by a DC motor with an integrated position sensor. Information used to detect a tremor is gathered by a gyroscope and accelerometer. The information gathered will be analyzed by an Arduino module to differentiate a tremor from regular arm movement. 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 is discussing options for their proof of concept. They are evaluating an initial CAD model and performing back of the envelope calculations to inform the specifications of the DC motor.

Custom Malting

Team Members

Kyle Butt
Dillon Celinski
Andrew Ward
Matt Wolcott
JJ Feden

Advisors

Dr. Samuel Morton

On the right is a sample of Cargill malted barley. On the left is crushed malted barley.

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. 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. An opportunity has arisen in Orange County, Virginia at James Madison's home, Montpelier, to create a malting and brewing operation site. An empty stable barn, located in James Madison's backyard, has the opportunity to increase tourism and revenue for the national park. A malting operation such as this would be the first of its kind in the state of Virginia, malting barley for beer. The challenge of this location along with the malting and brewing processes is scaling both processes down to fit within the 1000 square foot space of the barn. Currently, the group is creating a model version of the system desired using other instruments, such as coffee roasters and brewing vessels, to create the same effect larger malting operations have. This project is partnered with Dr. Harper's Brewery Operations capstone team, vto link the two systems together at Montpelier.

On the left is a mill, where the malt is crushed. On the right is a steeping tank.

Design and Construction of a Low-Impact Agricultural Dwelling

Team Members

Julie Strunk
Ryan Thompson
Connor Scott
Winifred Opoku
Peyton Pittman
Joe DeLuca

The farm that the structure will be built on. Strawberries are already planted for the season.

Advisors

Dr. Elise Barrella

Clients

New Community Project

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. New Community Project, a local non-profit organization, has contracted our engineering capstone team at James Madison University to design and construct a low impact agricultural structure on a parcel of land in Rockingham County, Virginia. This structure will primarily be used as a storage space for farm produce, farming equipment and a produce preparation station. The vmulti-functional 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 working on their preliminary AutoCad Drawings of the structure. They are preparing several different concepts and floor plans to run by their client to see which is preferred.

Design of a Sustainable Desalination System for Chumbe Island Coral Park

Team Members

Branden Gross
Myles Fogleman
Jamie Woodall
Tyler Leitman
Mazna Bilal
Jessie Smith

Advisors

Dr. Adebayo Ogundipe

Clients

Chumbe Island Coral Park (CHICOP)

Testing water quality of an unknown seawater sample.

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 growing at a faster rate than engineers have been able to compensate. Seawater desalination has become a popular way to produce clean water in coastal communities that can afford the material and energy costs of desalination. This process entails 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 greater 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. Their existing methods of providing freshwater on this island lie in a rainwater catchment system – which can be unpredictable. CHICOP 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. There is currently a risk of the Tanzanian government ceasing funds for CHICOP due to dissatisfaction of local fisheries, as fishermen are prohibited from fishing near CHICOP. However, when the educational capacity of CHICOP increases, the government can view the island as a more valuable asset. The risk of halted funding is minimized with more educational opportunity on CHICOP. Rather than producing a higher volume of fresh water to make visitors more comfortable, it is significantly more valuable for the preservation of the island to emphasize education over output.

Through client constraints, and the team's chosen emphasis on education and simplicity, the proposed desalination system will benefit CHICOP directly by providing them with freshwater, as well as other connected communities through education in technology transfer. At this point in the design process, the capstone team has narrowed down the potential solution space to three different design concepts that would satisfy the specific requirements and constraints of Chumbe Island Coral Park.

Generating solutions for sustainable water generation.

Designing and Managing a Microbrewery/Taproom at Montpelier Estate

Team Members

Mason Clairmont
Connor England
Chelsea Walden

Advisors

Dr. Steve Harper

Only a single cog in the brewery, the fermenter brings elements of barley and hops together to create a unique beer.

Montpelier Estate has been standing since 1764, originally home to James Madison. The estate is currently owned and operated by the National Trust for Historic Preservation. Located in Orange County, Virginia, the estate is a hub for tourism and education in the Shenandoah Valley. Montpelier offers several different tours appealing to a predominantly mature audience; an audience the estate management looks to capitalize on. An unused barn rests roughly a quarter mile from the visitor's center at the estate and has great potential to be converted into a malting/brewing operation with taproom. With an attractive placement and easy access, the successful conversion of the site looks to provide additional revenues, tourism, and an authentic historic atmosphere.

The Brewing Operations team job is to design a shovel-ready operation plan for the development of the site. This operation plan is to include necessary materials, implementation, quality control, business practices, and operational procedures. A plethora of planning, testing, data logging and research all leads the team to refinement and optimization of the proposed plan and the science behind brewing beer. Over the course of the project, the team is to experiment with different ingredients and different beer styles to hone in on the taste of brewing.

The team is doublechecking the assembly of a newly purchased fermenter. The new fermenter will be used in the team's pilot brewery.

Drones

Team Members

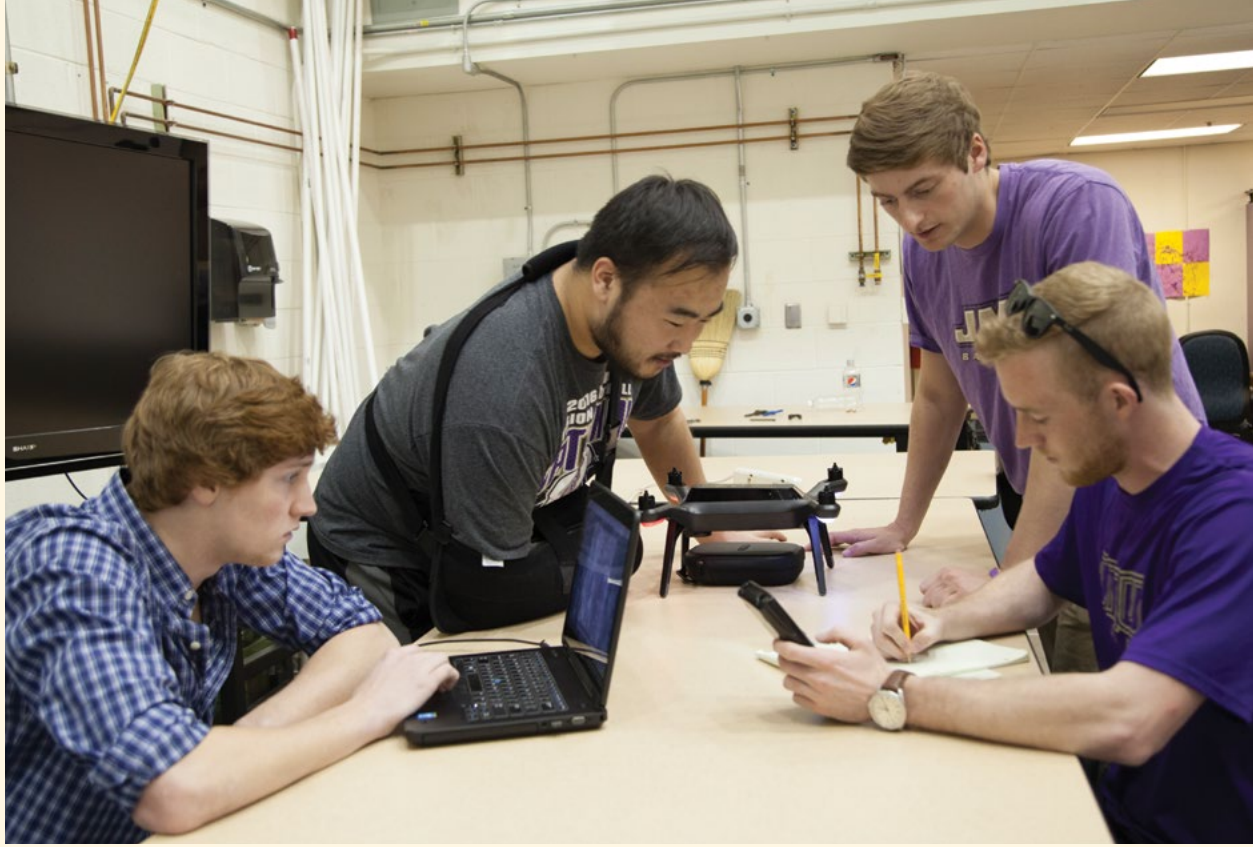
Austen Hendrickson
William Metzler
Daniel Pinson
Richard Xu

Advisors

Dr. Justin Henriques

This 3DR Solo Quadcopter (No Gimbal) was used for initial prototyping for the LiDar based sensor package testing.

Elevation mapping is a useful way to understand a landscape's surface. There are a number of diverse types of digital maps and each has its unique advantages and disadvantages. A Digital Elevation Map (DEM) is a digital model or 3D representation of an environment's terrain. The Drones capstone team looks to create a drone sensor-package solution to compete with the expensive alternative of companies already in the market space. The Drones capstone team is specifically designing for developing third world countries' coastal communities that either do not have or have poor quality resolution mapping. For this application, the Drones capstone team must use the DEM approach because this type of model is used to collect spatial data that allows the team to identify low elevation areas and specifically areas of concern for water accumulation from many environmental factors in the area being surveyed. During initial investigation of the subject, it was determined that the availability of high-resolution DEMs in developing nations are practically nonexistent. Also, the most affordable way to develop DEMs at a high resolution is with a LiDar (Light, Imaging, Detection, and Radar) based sensor package and either a fixed wing or multi-rotor drone. This way of collecting data is currently the best practice in the market but very expensive. The Drone's team goal is to design a low-cost quadcopter drone, equipped with a LiDar-based sensor package capable of collecting high-resolution elevation data, in order to generate Digital Elevation Maps. Using ArcGIS (a software program, used to create, display and analyze geospatial data) the design team will be able to import the elevation data coupled with GPS data to generate DEMs of the area surveyed. The importance of creating high quality DEMs for a cheap price is that it allows a third party to use and apply the maps the Drone team generates to identify risk points for possible catastrophes in the areas surveyed.

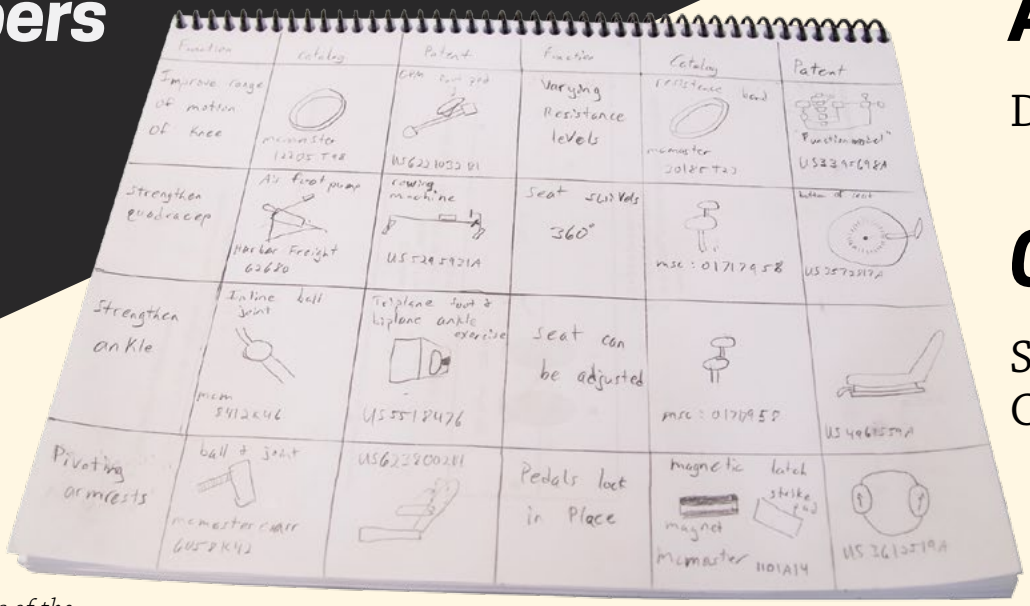


The team is analyzing the feasibility of incorporating the sensor package internally to the drone vs having an outside sensor casing during preliminary conceptual design.

Engineering Physical Therapy

Team Members

Kyle Jenkins
Matthew Thomas
Jacob Ziemke
Michael Zurn



A morphological matrix helped the team compile concepts that serve different funtions of the overall proposed device. These subsystems will be later organized and ranked to determine the best combination of concepts.

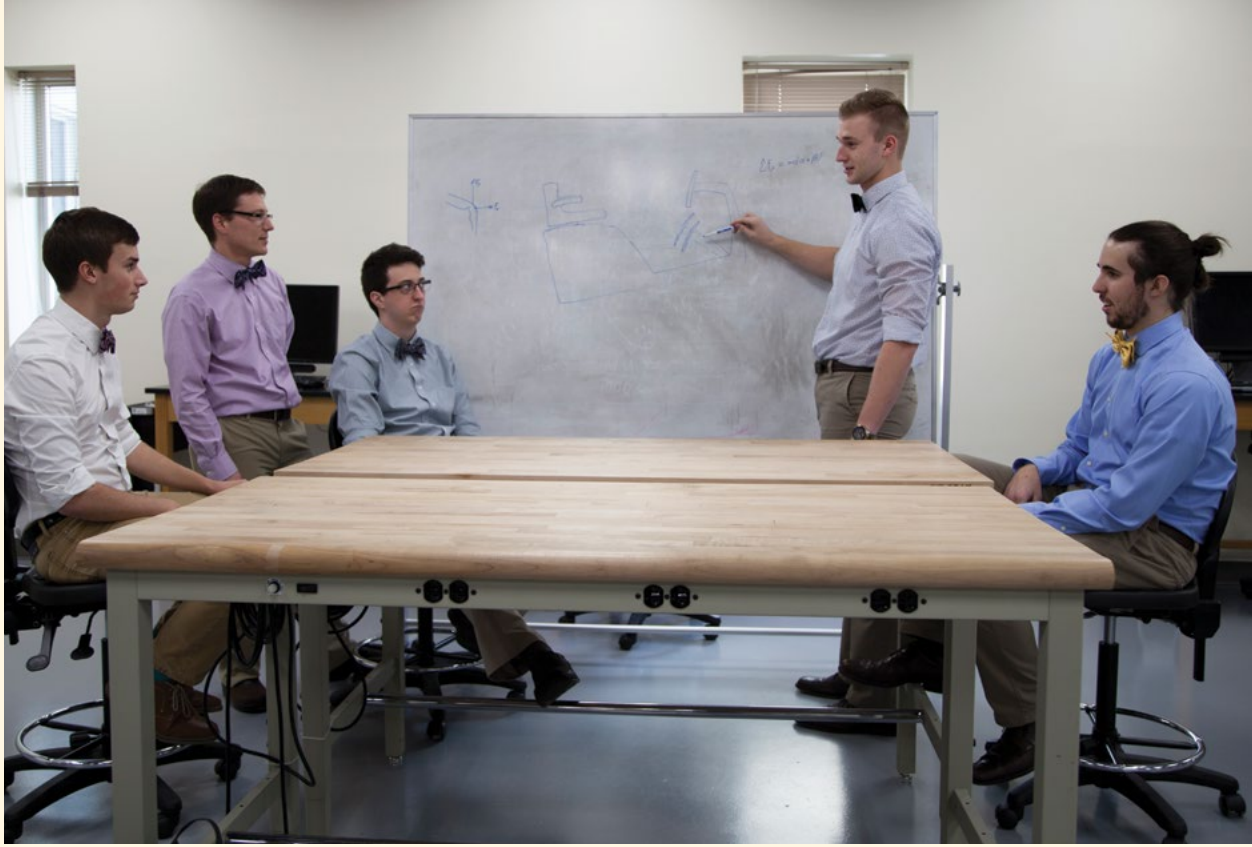
Advisors

Dr. Keith Holland

Clients

Sentara RMHS
Orthopedic Center

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 are 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, 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 the knee to be a common source of pain and injury. Based on these findings, the team proposes the development of a device to target low extremity movements 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 Sentara RMH Orthopedic Center to gain information on the local patients as well as therapeutic processes. As device design and development continues, the team will use the Sentara Med-Approval process to determine if the device meets the standards required for use by the orthopedic center. Since Sentara RMH has a system for leasing out equipment, an at-home therapy device will fit seamlessly into their existing system. Such a device will also allow Sentara RMH to become more effective and efficient while more inclusively treating a larger population.



The team met with their advisor, Dr. Holland, to discuss a semester timeline as well as a potential design for one subsystem of the proposed device.

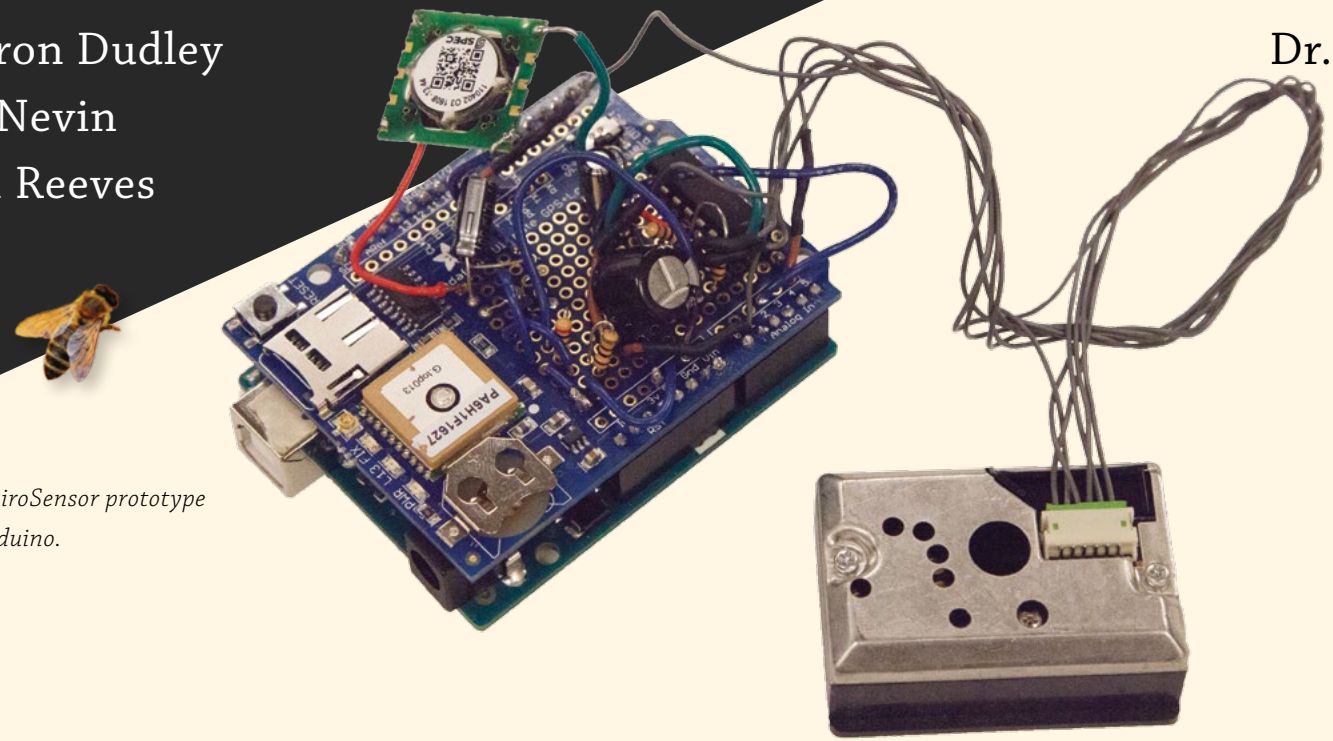
EnviroSensor

Team Members

Cameron Dudley
John Nevin
Ethan Reeves

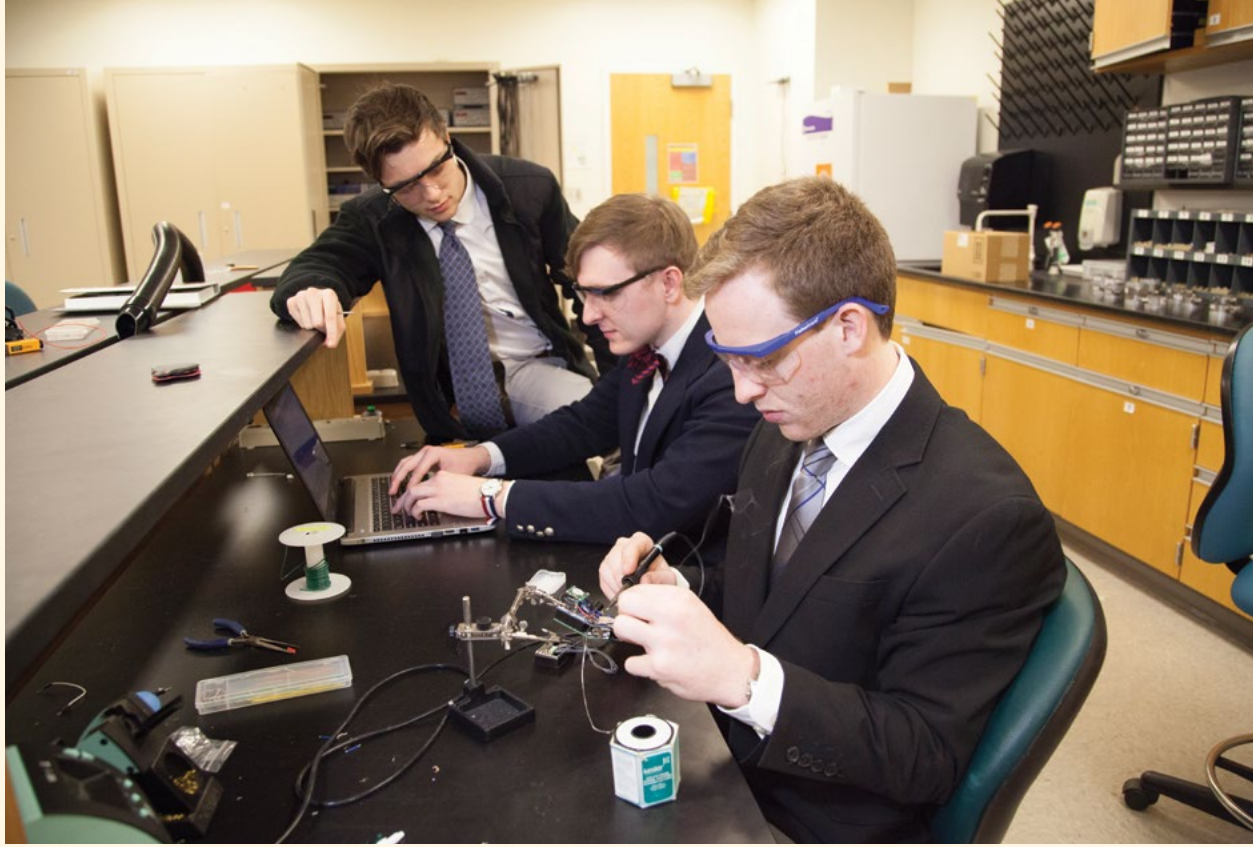
Advisors

Dr. Justin Henriques



Testing EnviroSensor prototype with the Arduino.

The Envirosensor capstone consists of a three person group of bright young engineers by the names of Ethan Reeves, Cameron Dudley, and John Nevin. These individuals have undertaken the evolution of a pre-existing Wearable Sensor capstone comprised of a senior team who awaits imminent graduation. Over the course of the past year, The Envirosensor capstone group has worked furiously to obtain the expertise of the proceeding team, while making enormous strides towards the technological advancement of the Wearable Sensor to better serve its user. Furthermore, the responsibility of integrating a sustainable device with a specifically selected user falls within the scope of this project. While a working sensor has already been constructed, the group expects to expend a great deal of time iterating this device to perfection over the course of the next year. Because this team is the first to target a user for the wearable sensor to serve, they are tasked with modifying the sensor to meet their specific requirements. This entails integrating a continuously progressing wearable sensor with a continuously progressing data dashboard that will ultimately allow the user to interact with the data in a constructive manner. While this is just the tip of the iceberg for the team, they have a full understanding of what the scope and project work ahead entails. There is no doubt in the program's mind that these individuals have the ability to produce a successful end product by the end of their time with us here.



The EnviroSensor Capstone team building prototype sensors.

Equestrian Body Protectors

The Equestrian Body Protectors' first physical material for benchmarking and testing.

Team Members

Cole Potridge
Austin Marrs
David Furman

Advisors

Dr. Heather McLeod
Dr. Callie Miller
Dr. Bethany Brinkman

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, it was found that only 31% of injured equestrian athletes were wearing protective gear at the time of their accident. While equestrian protective gear is effective at preventing injury, it is also expensive and uncomfortable for some riders. The goal of the Equestrian Body Protectors capstone project is to develop an equestrian body protector that is economical, comfortable, and aesthetically pleasing. The design and construction of an equestrian body protector is only the first part of the team's two-part scope. The second part of the team's scope is to design and construct an impact testing apparatus that meets the ASTM Standards that govern equestrian body protection. To facilitate the design process for the equestrian body protector, beginning, intermediate, and expert level equestrian athletes were interviewed to garner input on current designs and frequency of body protector usage. From these interviews, the team determined that the cost of equestrian body protection is an issue for beginning to intermediate level riders. In addition, the style of riding that the equestrian athlete participates in makes a difference on whether or not body protectors are utilized. In English riding, the appropriate dress is more formal, so equestrian athletes are less likely to wear intrusive body protection. To help with the design of the ASTM Certified impact testing apparatus, the team had to first thoroughly review the appropriate ASTM Standard.

The ASTM subcommittee that established the standard was also consulted to clarify the team's points of confusion. Through client interviews and a thorough review of the ASTM standards, a full list of requirements for the body protector and testing apparatus was generated. With the requirements of the testing apparatus clear, the team was able to go about the process of actually designing the testing apparatus. The team's body protector design allows beginning riders to invest in their own safety at a reasonable price. Even though it will take many years to bring down overall equestrian injury rates, the team believes the design can have a positive impact on local beginning riders immediately. Also, riders can wear the body protector with the added peace of mind that their protector has been tested and certified to reputable standards.

The team is evaluating one of the preliminary design concepts for the project. They are preparing to construct the first body protector prototype of the project.

Investigation of Stormwater Management Systems for the area of Norfolk, VA

Team Members

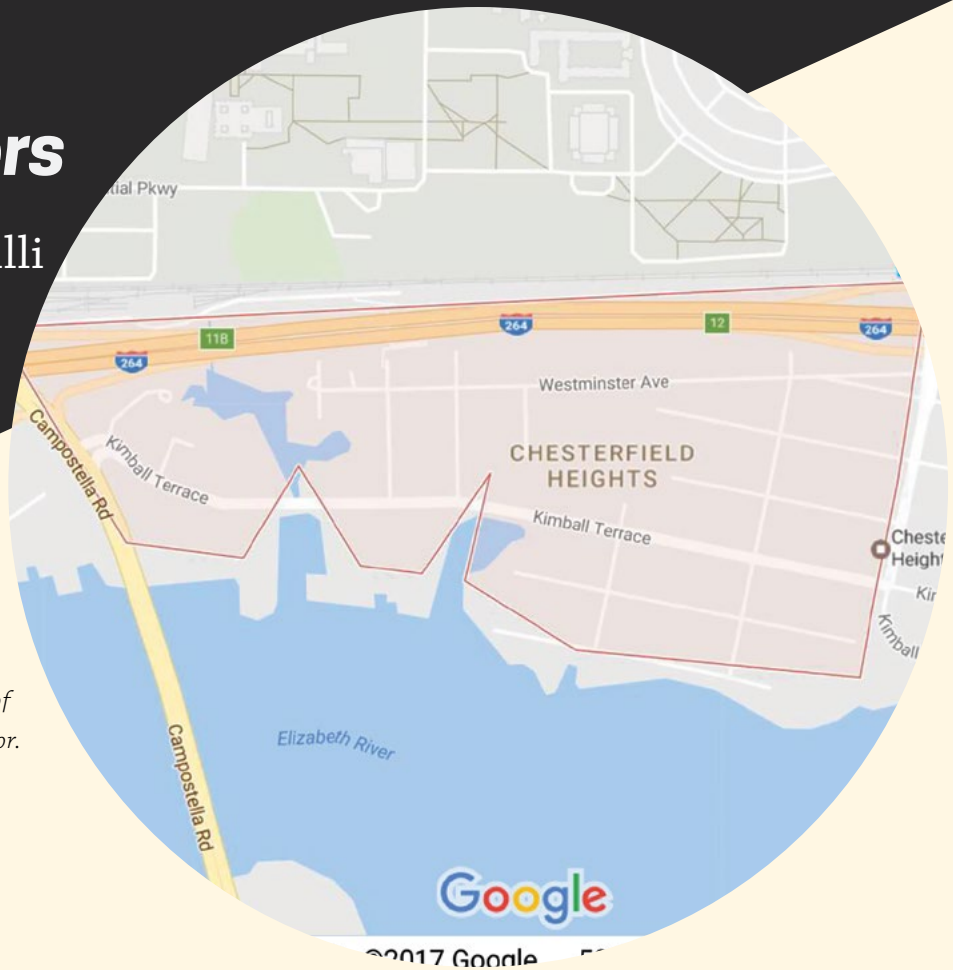
Maria Alejandra Parilli

Bryan Barnes

Morgan Felix

Advisors

Dr. Kyle Gipson



The picture represents the broad layout of the area in which the team is designing for. Providing maps to go along with the data helps relay the information.

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 levels 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 1890s that continued to grow and develop through the 1920s and 50s. Currently, this area is qualified as a lower-income neighborhood 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 bio-retention areas and the implementation of a flood berm in a neighboring area. Another design from the proposal was a submerged cistern to be implemented underneath the pavement within this neighborhood but had not been fully developed at the time of proposal. This project will focus on designing a sustainable cistern that would aid the already installed storm water management system and relieve the stress caused by the overflow and undersized geometry of the current drainage. The team is currently evaluating different types of materials as well as performing a series of concept evaluation techniques in order to approach the best possible design for the community. With this research, some future work to consider is the development of SWMM modeling and GIS mapping techniques along with CAD modeling and prototyping. 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 possibly improving the aesthetics of the neighborhood in the process.

The team evaluates a city map to help determine potential areas for the implementation of cisterns to help reduce the effects of flooding due to storm water and its impacts on the Chesterfield Heights area of Norfolk, Virginia.

JMU Supermileage Chassis Team

Team Members

Jack Boone
Daniel Rauch
Bryan Browne
Jacob Nelson
Joseph Winn
Mark Castro

Advisors

Dr. Keith Holland

An adjustable seat design allows the team to determine optimal angles for driver seat position. The prototype also includes a steering column that adjust vertically as well as with a telescoping motion to determine the orientation of the steering wheel for our driver. A 3D printed pedal subystem is used to determine pedal orientation.

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. 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 chassis weight and losses. Fuel efficiency can be improved by optimizing the propulsion system of a vehicle as well as designing a chassis that is lightweight while reducing aerodynamic and frictional losses. Many of the same methods used to make the vehicle more fuel efficient can be applied across different vehicle sizes and types, giving the team the opportunity to learn from and about existing automotive systems. The current capstone teams' project goal is to build a vehicle that can compete at the 2018 Shell Eco-Marathon. Specifically, the chassis team will be responsible for putting forth the frame and shell, as well as helping the propulsion team to integrate the engine and any related components. The team is currently focusing on the design and optimization of several subsystems through analysis of material, structural, and dynamic properties. The team has finished preliminary design of the vehicle and is working through the detailed conceptual design of the various subsystems. Moving into next school year, the team aims to begin fabrication and the eventual integration of propulsion and chassis systems. 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 Chassis team of JMU Supermileage uses an iconic model to determine key angles and measurements necessary to understand driver characteristics.

Low-Impact Tiny House for a Housing Insecure Individual

Team Members

Clay Bomberger
Wade Knaster
Marilyn Lehmuller
Martin Mekhail
Lauren Hafer

The structure displayed is an existing tiny house located on the New Community Project property downtown.

Advisors

Dr. Elise Barrella

Clients

Tom Benevento

Partners

New Community Project

The tiny house movement is a trend in the U.S. to create a sustainable house smaller than 400 square feet. 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 to no operational and maintenance costs, and use eco-friendly materials, renewable energies, and low-impact design to reduce the home's environmental footprint. The team is using AutoCAD to create conceptual designs based on the 2012 Virginia Uniform Statewide Building Code and the Harrisonburg Municipal Code. As outlined in the Harrisonburg Municipal Code, the tiny house will be able to be moved from different zones, including R-1 Single-Family Residential District, R-2 Residential District and M-1 General Industry District, to suit the needs of future residents. These concepts were presented to the team's sponsor and client to ensure the stakeholders' needs and wants will be satisfied. 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 tiny house capstone team is benchmarking off of existing blueprints. They are preparing to create a floor plan for their tiny home and potentially apply for a building permit.

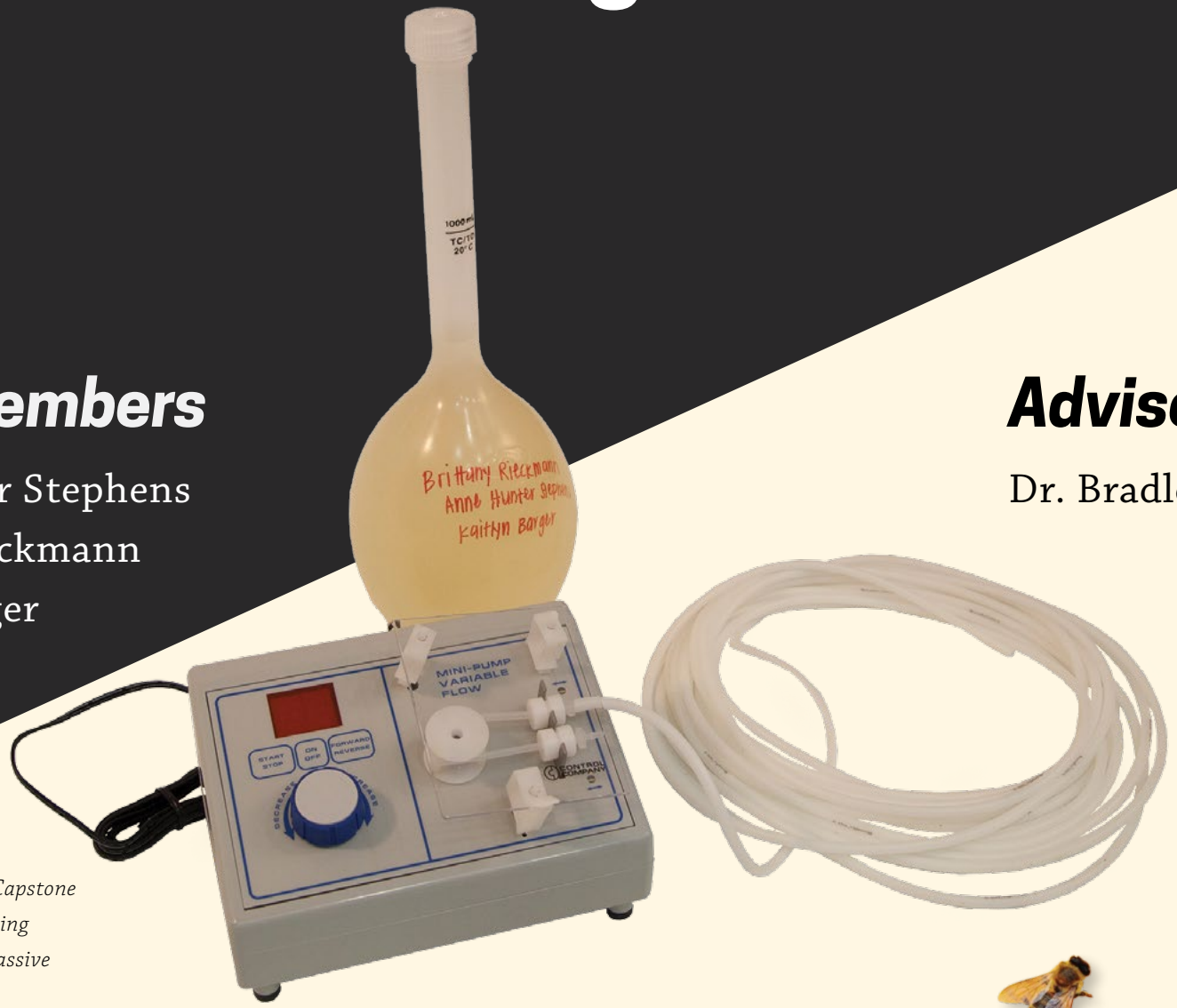
Passive Solar Distillation for Acid Rock Drainage Waters

Team Members

Anne Hunter Stephens
Brittany Rieckmann
Kaitlyn Barger

Advisors

Dr. Bradley Striebig



Some of KAB Solutions Capstone team's tools used for testing and prototyping of the passive solar distillation.

Acid rock drainage is a common problem in mining towns, and is slowly infiltrating public water supplies. Acid rock drainage water is produced when excess sulfates from abandoned mines react with water and air, creating a natural oxidation process, resulting in acid run off. This acidic runoff flows into streams, rivers, and ponds that towns may use for various purposes such as drinking and recreation. These contaminated waters deplete biodiversity of the surrounding environment and cause serious health problems. Short-term exposure can result in irritation and burning to the skin, lungs, and eyes while long term exposure can result in dry skin, erosion of the teeth, and in severe cases, can even be cancerous. KAB Solutions' mission is to create a passive solar distillation that treats acid rock drainage waters. This process uses evaporation and condensation to clean the water, leaving behind impurities and particulates. The treated water will then outflow back into the environment, having a neutral pH and no harmful additives. KAB Solutions plans to build a bench-scale prototype of the solar still which they will take to New Mexico to compete in the IEE/WERC's International Environmental Design Competition. At the competition KAB Solutions will be competing against eight other teams solving the same problem. In the year following the competition, KAB Solutions will iterate and refine to produce the most effective and efficient distillation process that can be scaled to full size.

The team is measuring chemicals for the mock acid rock drainage water. This solution will act as ARD waters and be tested in the solar still. KAB Solutions plans to take their bench-scale prototype to New Mexico to compete in the IEE/WERC International Environmental Design Competition.

Supermileage- Propulsion

Team Members

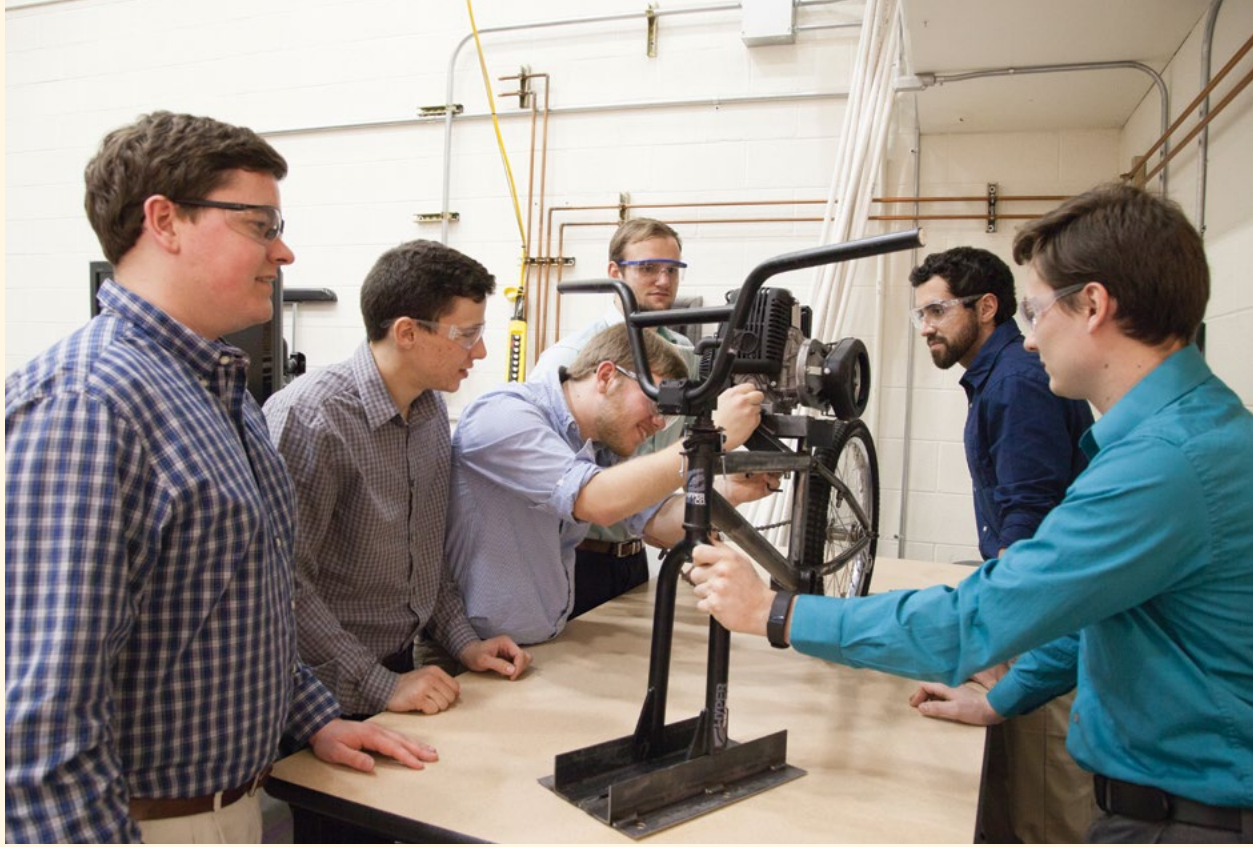
Joe Grabowski
Maxwell Adams
Matthew Dove
Mitchell Gerdau
Andrew Thoreen
Brian Calvert

Advisors

Dr. Rob Prins

This is the custom designed dynamometer with the engine attached, allowing the team to record data on the engine with the dynamometer.

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 competing in the Shell Eco-Marathon prototype division. The competition is to take place in late April 2018 with competitors representing institutions from all around North America. 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 mounting the engine to the dynamometer mount so testing of the engine can be done.

Virtual Reality Tools Training

Team Members

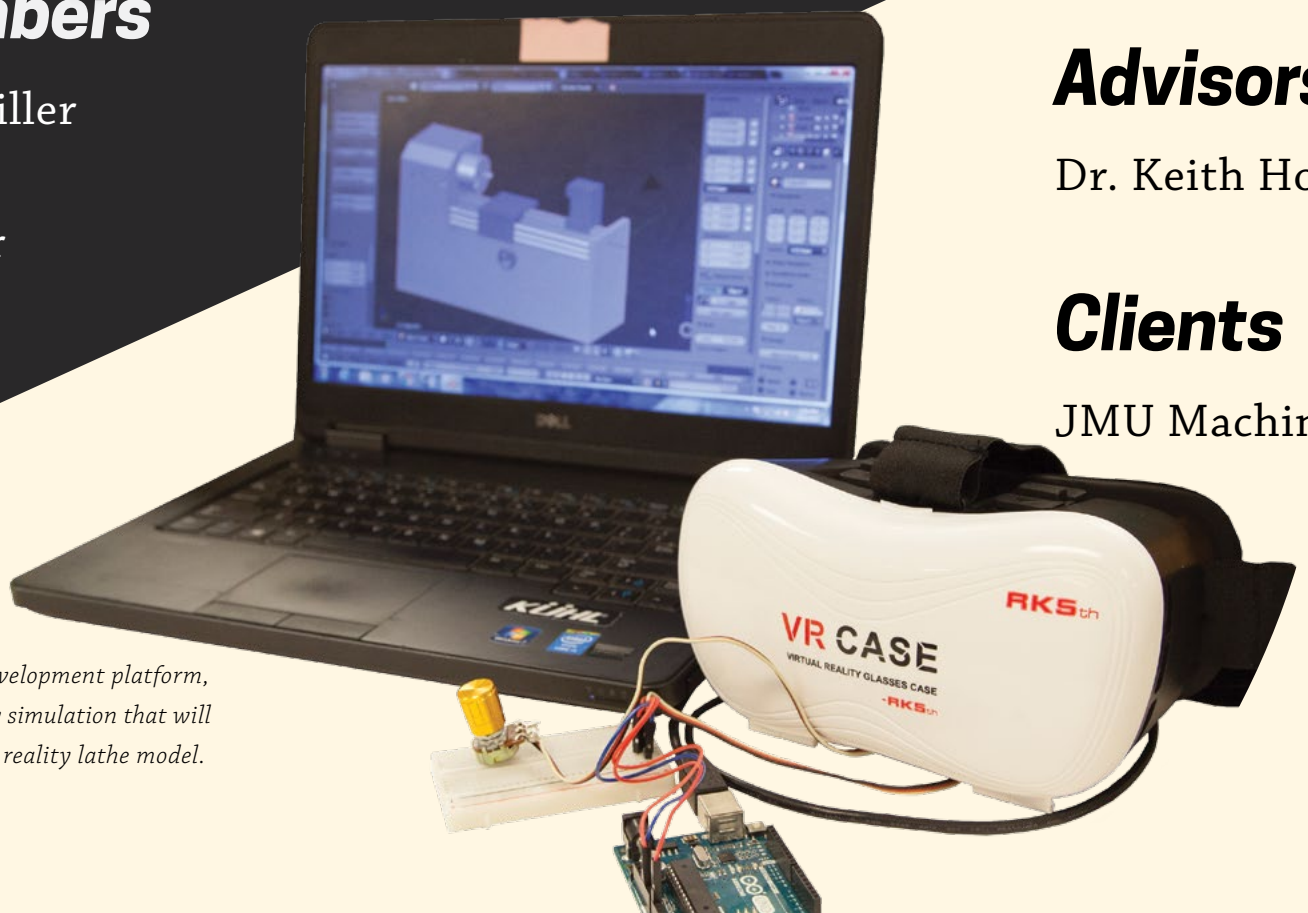
Erin Schwartzmiller
Grant Arnold
Natalie Dillinger
Nahom Fissaha
Azeem Mufti

Advisors

Dr. Keith Holland

Clients

JMU Machine Shop



Utilizing an open-source electronic prototyping platform, modeling software, and game development platform, the team created a virtual reality simulation that will enable users to operate a virtual reality lathe model.

Team Vrtue is developing a VR-based method for novice machine shop trainees to receive pre-training in order to better enhance the overall learning experience of students who undergo the machine shop tools training at James Madison University. Standard machine shop training for both the mill and lathe require professional assistance, which translates to limited access to students that want to learn the tools within the workspace. Through the creation of a virtual environment, this project will allow students to virtually access the lathe outside of regular machine shop hours. The overall goal of this virtual training is to allow students the opportunity to experience working with the fundamental controls of the lathe. Additionally, the team aims to make the simulation realistic by creating custom controls that mimic the real machine while interfacing with the VR environment. Force feedback will be incorporated into the custom controls to further enhance the virtual machining experience. The goal of this kinesthetic learning tool is to improve students' understanding of the location of the axis controls as well as how they are operated. In order to understand the need for this project; Team Vrtue has 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, conducted interviews with key stakeholders, as well as investigated how virtual reality has been used in education and training. Some of the decisions that were made based on the information gathered included choosing a virtual reality over an augmented reality platform, and creating a lathe asset instead of the mill due to the order in which students are exposed to each machine at James Madison University. Thus far; the team has been able to launch the lathe asset into the Google Cardboard VR platform, utilize a potentiometer in order to control a virtual object, and rotate a virtual object which in turn causes the translational movement of another object. Upon completion of this project, Team Vrtue will have a created a user-friendly virtual reality environment that will aid in the process of the machine shop tools training for Madison Engineering.

The team is working on integrating their software with custom hardware controls that will allow users to interact with objects in a virtual reality environment. The team hopes to include haptic feedback within the custom hardware controls in later iterations.


Redesign

Sophomores

Sophomores

Sophomores

Making Waves

Alex Gellios
Jack McGeoghegan
Kristen Heaton
Matt Dove
Ryan Williams
Sabrina Hammell
William Armstrong

madE To Last

Nathaniel Lucas
Nethaniah Gardner
Julia Hutchens
Zaki Samady
Matthew Kennedy
Madison Anderson
Jack Dominick

Cyclepaths

Marie Marshall
Jared Givan
Sean Bartro
Ernest Benner
David Sydnor
Mark Livingston
Connor Sinn

Joy Riders

Xavier Johnson
Arie Bradley
Robert Gerber
Sarah Trotter
Natalie Peterson
Stefanus Jatmoko
Seemran Patel
Raphael Bellon de Chassy

Mumford and the Engineers

Brianna Palazzola
Ashley D'Angelo
Jens Byer
Troy Fries
Kareem Ebraham
Peter Condro
Matthew Mumford
Nathan Payne

Notorious ENG

Kerry McCullagh
Anni Yang
Carlee Smith
Carlos Cox
Ian Nguyen
Alex Hasty
Tristen Spencer
Nick Liberati
James Kizler

The Spokespeople

Ethan Anderson
Bernie Baird
Emma Drummond
Farris Jarrar
Preston Liverpool
Kevin Partlow
Riley Pates
Zachary Shipman
Braxton Faggert

Chainz

Andrew Payne
Jamie Riley
Elizabeth Tafoya
Kyle Vickery
Callum Morton
Maui Ong Ante
Cole Young
Andrea MacGregor
Jason Renalds

Machalak

Christine Gatto
Austin Pelto
Aaron Sloss
Adam Pinegar
Harrison Gillock
Kathryn Nielsen
Lukas Bergstrom
Michael Bruce

The A-Team

Shane Butler
Nicholas Butts
Roman Cook
Benjamin Cotton
Hannah Daschil
James Fasano
Chris Marcelin
Sophia Welch

The Wheel-Men

Austin Trimble
Caleb Hoehner
Tom Milkowski
Alex Mironenko
Garrett McGurl
Nick Colonna
Brian Schieber
Dominic Coradazzi

The Systematic Eight

Oumaima Atraoui
Grace Carter
David Firman
Drew Farber
John Hunter
Stetson Kniff
Federico Meersohn
Ryan Thompson

Human Powered Vehicle Design

During their sophomore year, Madison Engineers focus on designing, building, and testing a human powered vehicle. This year, students built for Elena, a young lady with cerebral palsy. Through the year, students worked closely with Elena, her family, and strength trainers in the Overcoming Barriers programs to understand and fit a design to her unique needs. Students identified design objectives, constraints, and requirements; benchmarked a variety of design alternatives; developed and evaluated their own conceptual designs; built and tested prototypes; analyzed key design parameters; developed computer-aided drawings and engineering schematics; choose components; and constructed their final design. The one design from the sophomore class best suited for Elena will be selected and sent home with her following a summer of focused refinement completed during an internship by a Madison Engineering student.

Advisors

Dr. Robert Nagel, Dr. Callie Miller, Dr. Brent Cunningham


Carhartt


SCHWINN


JAMES MADISON
UNIVERSITY


Deli


ght

First Years

First Years

First Years

Advisors

Dr. Brent Cunningham
Dr. Kyle Gipson
Dr. Justin Henriques

Clients

Paul Ackerman
Kari Carpenter
Heather Eberly
Niki Miragliotta

Four Dukes

Robert McFaddin
Coco Choden
Andrew Niedringhaus
Jojo Enzmann

Blue Elephants

Chris Santanjello
Tyler Machi
Isaac Miller
Josh Lovell

804 Engineers and Friend

Tyler Bedwell
Joshua Williford
Adam Zahorchak
Lawrence Marfo

The Green Machines

Erica Denham
Nicole Morgan
Tom Ferguson
Ryan Voltz
Joey Potter

The Hungry Hippos

Caitlyn Homet
Mia Williams
Nono Choden
Conner Hazelwood
Nick Linderfeldar

Dukes of MadE

Rachael Frost
Catherine Beck
Charlie Dunbar
Jacob Ortiz
Austin Bock

Green Tomatoes

Jack Lindberger
Emalee Martin
Lindsay Levatino
Logan Zentz

Eagle-Faced Whales

Alex Biegel
Jason Souder
Demetrius Rodriguez
Zach Ourlian
George Funk

Blue Ocean

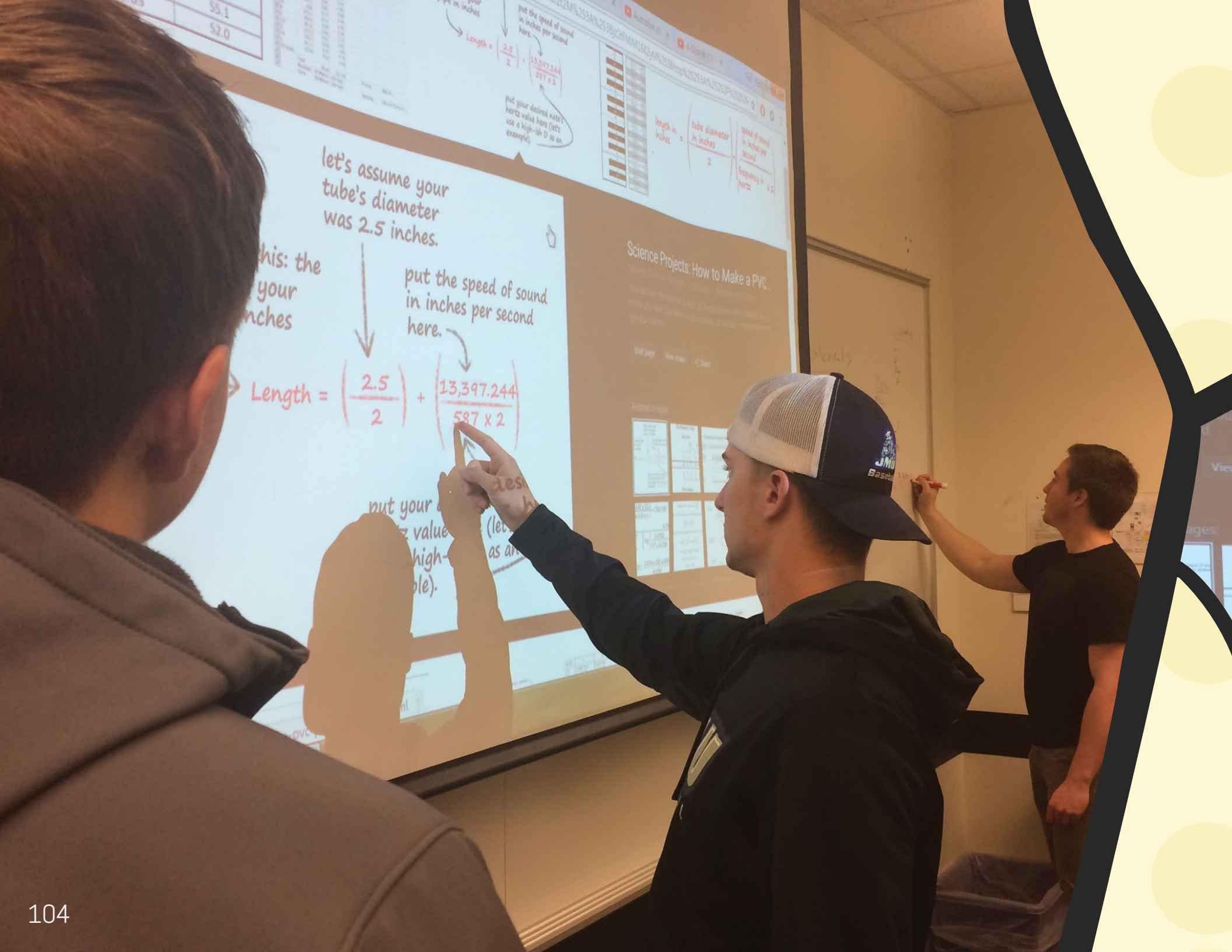
Sonny Swetz
Andrew Ryan
Kyle Castleton
Christian Detweiler
Baily Branham

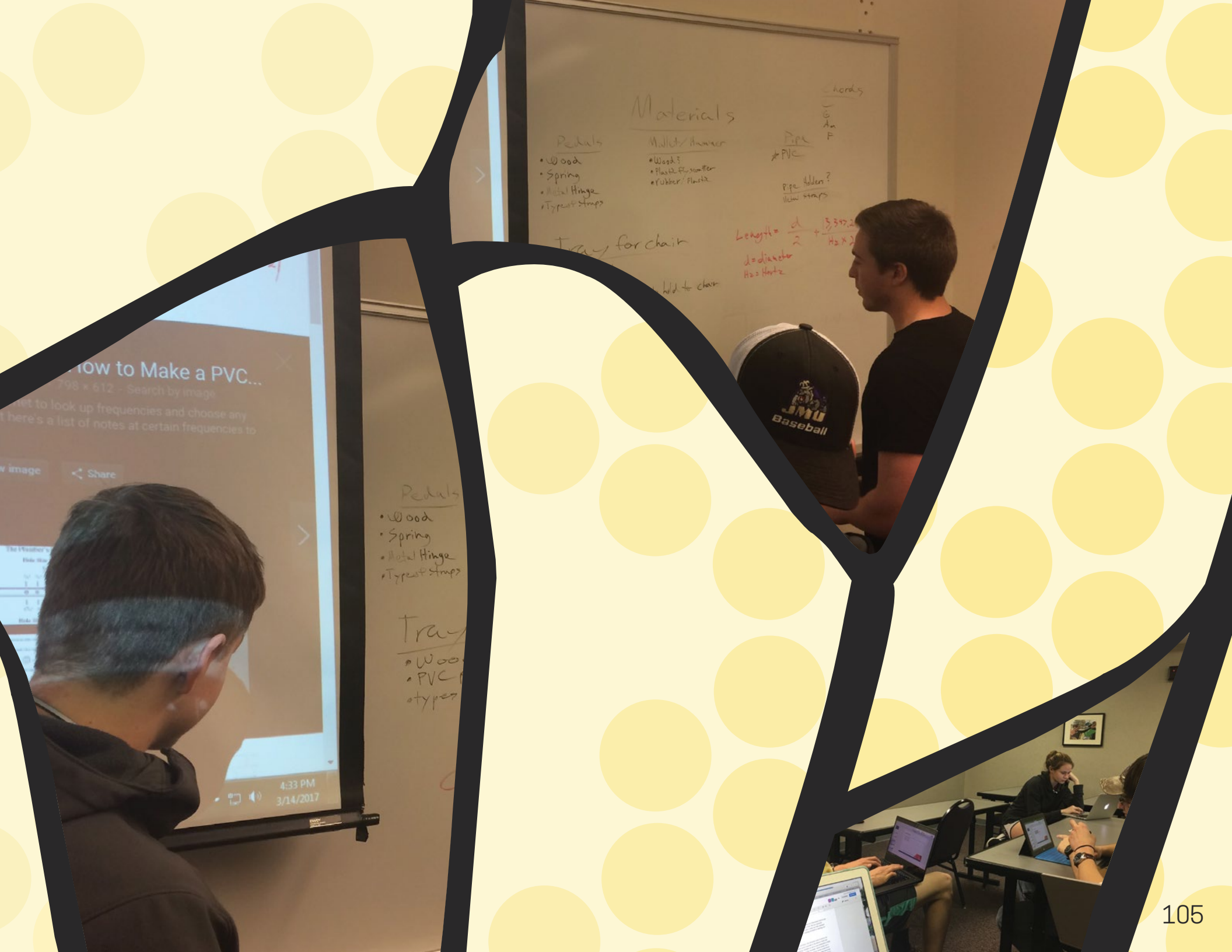
Kelvin 506

Amadeus Kang
Conor McNicholl
Josh Smith
Max Webster
Thomas Maxwell

Adaptable Musical Instruments

Four sections of ENGR 112, double the size from the previous year, have a course project that involves the discovery, design and construction of adaptable musical instruments for four local clients. The end users for the adapted instruments range from elementary school students to adults with special needs. A limited range of instruments and options for musicians with unique abilities exists. This project is an attempt to bridge the gaps between music, technology, design, and engineering for the purpose of inclusion for the end users.


let's assume your tube's diameter was 2.5 inches.
put the speed of sound in inches per second here.
Length = (2.5 / 2) + (13,397.244 / 587 x 2)
Science Projects: How to Make a PVC...


Materials
Pedals
Wood
Spring
Metal Hinge
Typical Straps
Pipe
PVC
Pipe holders?
for chair
d = diameter
Hz = Hertz
JMU
Baseball
How to Make a PVC...
Share
4:33 PM
3/14/2017

Advisor

Dr. Elise Barrella

Stakeholders

Harrisonburg Community

Sahm Azizi

Analiesa DeRieux

Madison Gilmore

MaKayla Jackson

Nathan Causey

James Dodd

Thomas Giuseppe

Tyler Wahl

Mitch Crockett

Peyton Dudley

Justyn Girdner

Chris Smith

RJ Benner

Connor Lankford

Alejandro Mastrapa

Sergio Zambrana

Zachary DeBay

Alex Montminy

Harrison Cancino

Luke Henderson

Josh Meyers

Zachary High

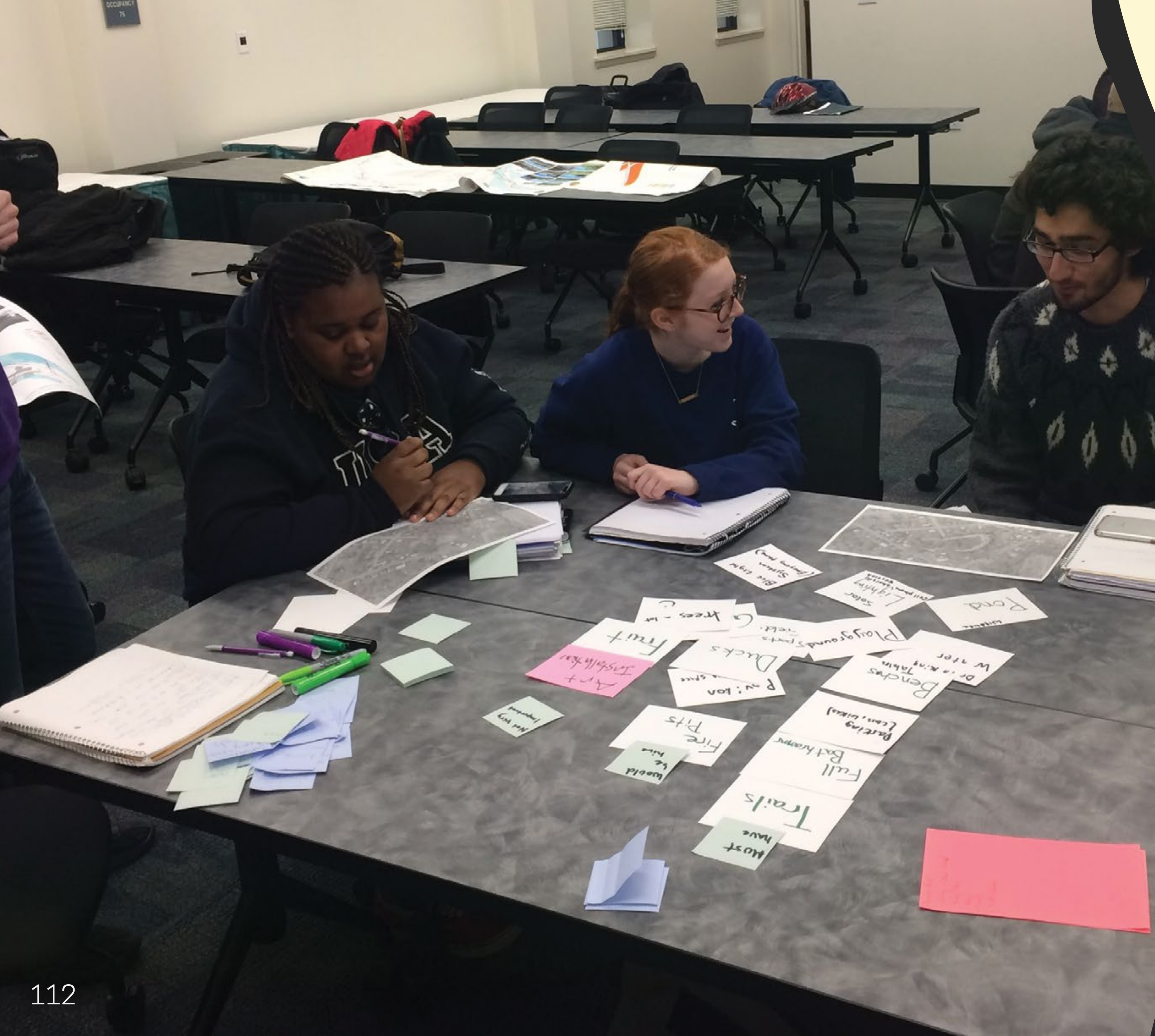
“Green” Design:

Exploring Opportunities for the Northend Greenway

What do you picture when you hear “greenway”? A greenway often combines features of a bicycle/pedestrian path with natural land and water features in order to promote environmental conservation and active transportation. Greenways can provide opportunities to intereact with our environment through environmental education, recreation, and transportation connections.

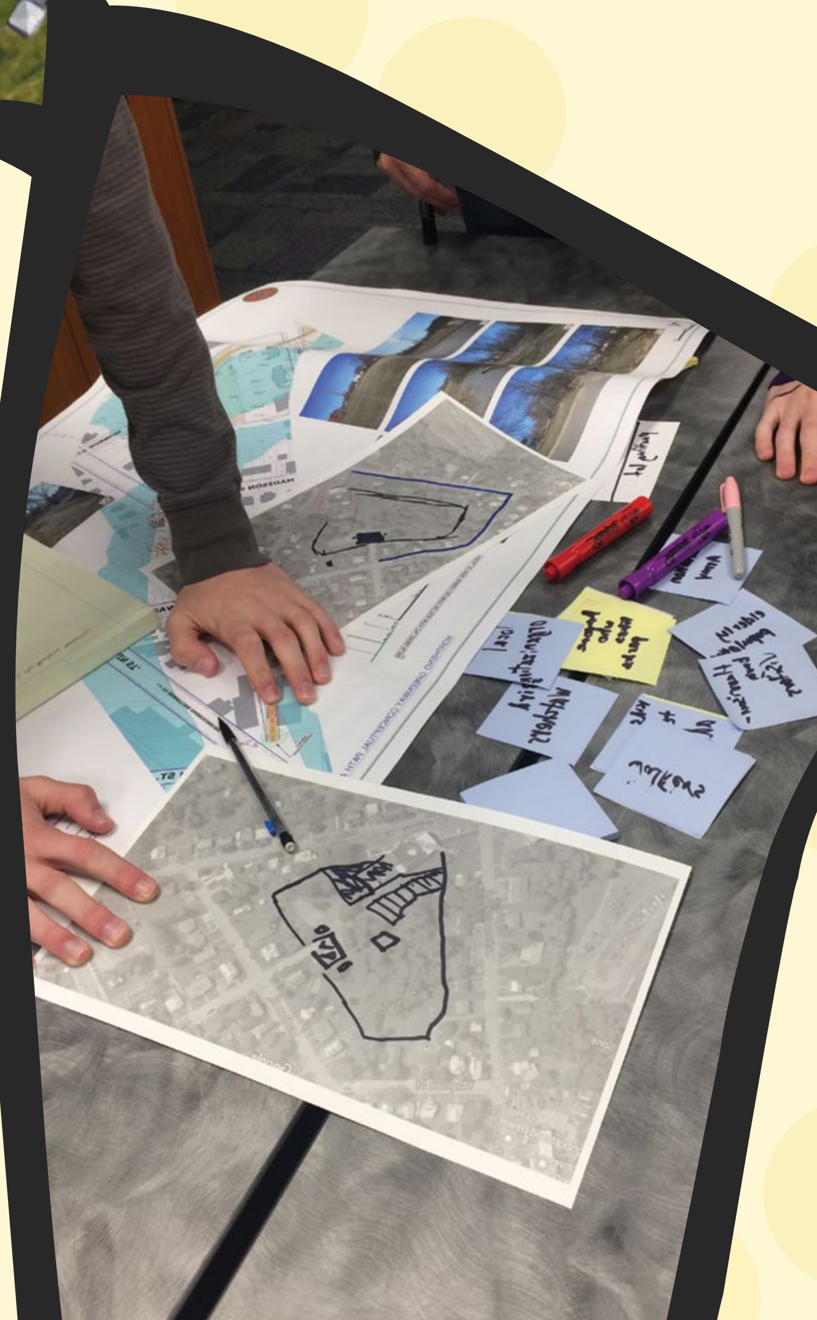
Harrisonburg is home to diverse people and also features a variety of development types in different parts of town. Currently, there are very few parks in the north end of town, and existing transportation options for those without car access can feel unsafe or be inconvenient. One way Harrisonburg and its citizens are trying to address these problems is by designing greenway connections like the Northend Greenway. When completed, the Harrisonburg Northend Greenway will run approximately 2.5 miles through neighborhoods and undeveloped land in Harrisonburg. The path will help connect diverse communities with each other, with community resources, with local businesses, and with public green space.

Engineering students in Dr. Barella’s class are working with stakeholders of the Northend Greenway to design community assets along a portion of the planned route. Over the course of the semester, the teams are using creative and analytic problem-solving processes to design and prototype solutions that best serve a variety of stakeholders. There are two “parks” with streams located in the downtown area near the proposed path. The students will study this area, its neighbors, and the surrounding cultures in order to design ways to utilize the space for more interactive activities. Their designs must consider several factors, including technical feasibility, legality, safety, health, aesthetics, affordability, sustainability, and fun for residents and visitors of all ages. What do you value in projects for your community?

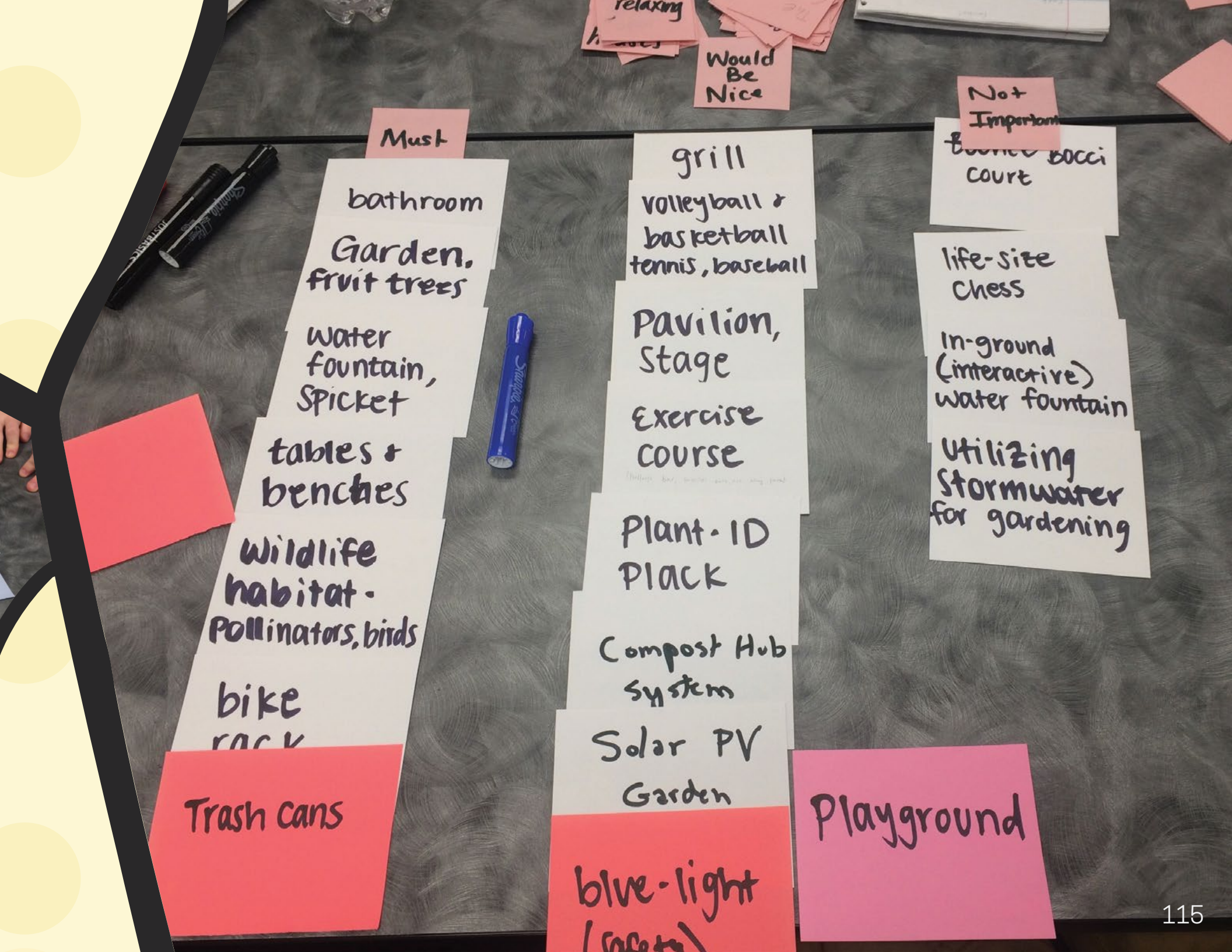

Trails
Full Bathroom
Fire Pits
Benches
Pond
Fruit
Ducks
Must have


swings
(Safe) w/mulch
bathrooms
clean & indoor)
hammocks
(Safe: mulch surrounded)
playgrounds
(sandboxes)
fields
benches
food stand
permeable paths
nets/hoops
gazebo
stage
local
Nice to Have
Trash cans + Recycling
Sleeping
Social
Safe
Welcoming
Warm
Safe


Salvation Army
Ashby Ave
Jefferson St




Relaxing
wildlife
Natural
entertaining
pet-friendly
MULTI-FUNCTIONING
Beauty (colorful)
Accessable
Verdant
Unique
Diverse


Would Be Nice
Not Important
Must
bathroom
Garden, fruit trees
water fountain, spicket
tables & benches
wildlife habitat - pollinators, birds
bike rack
Trash cans
grill
volleyball & basketball tennis, baseball
Pavilion, Stage
Exercise course
Plant-ID Plack
Compost Hub system
Solar PV Garden
blue-light
Bocci court
life-size Chess
In-ground (interactive) water fountain
Utilizing Stormwater for gardening
Playground

"Fame is a bee.
It has a song –
It has a sting –
Ah,
too,
it has a wing."

A Poem
By
Emily
Dickinson

JAMES MADISON UNIVERSITY

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