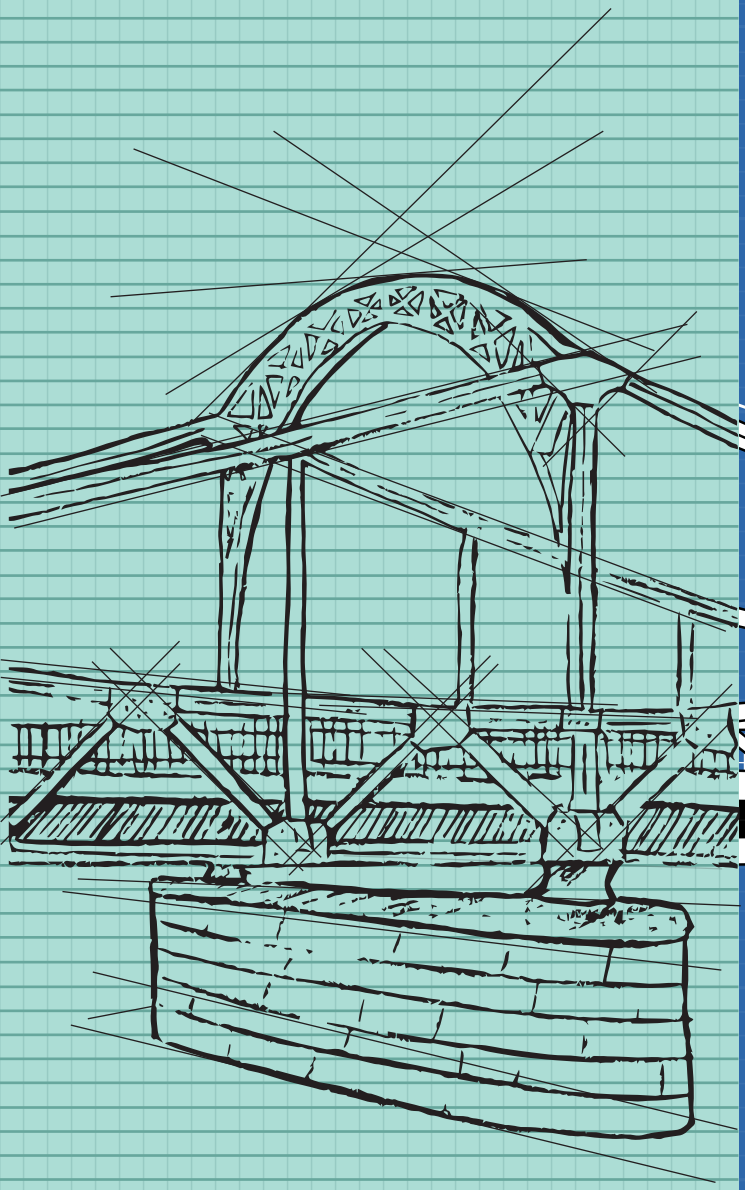
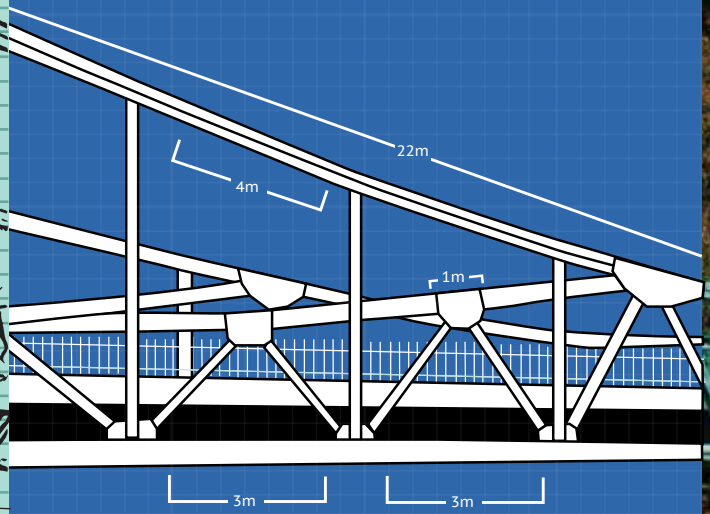
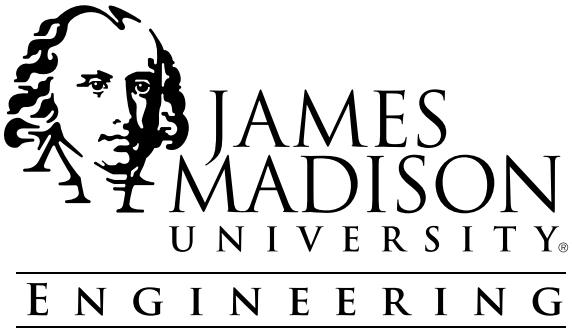




CHANGE'16

MADISON ENGINEERING

A Year of Good Through Innovation, Research, and Design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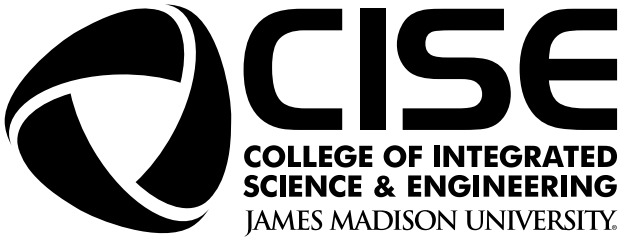
UNIVERSITY
ENGINEERING


CISE
COLLEGE OF INTEGRATED
SCIENCE & ENGINEERING
JAMES MADISON UNIVERSITY

Acknowledgements

This book and our event today are perfect examples of Madison Engineering excellence achieved through our ability to move and act as a community. The xChange book is a wonderful example of crowdsourced creation; the xChange itself is an example of people designing and coming together around a shared purpose. Neither would be possible without all of us working together – thanks to all of our students and faculty, in particular, who lovingly (and sometimes not) craft so many engineering projects throughout our curriculum to share with the world today. However, I would like to thank a few individuals by name that are absolutely critical to our xChange, yet often overlooked at such celebrations.

First, much of the beauty and style of our event is the work of our Creative Services team. Joshua See, Rebekah Bonds, and Christine Letsky-Anderson (and a team of photographers) have taken our engineering works and not only crafted this fantastic book, but countless event artifacts.

Second, our engineering staff are often our students' heroes, and rightly so. John Wild, Scott Padgett, George Lovell, Mark Starnes, and Mark Showalter (and our many studio and laboratory student assistants) are critical partners in our learning enterprise, putting in countless hours to help our students translate their ideas into physical form. All of the prototypes you will see today are touched in some way, directly or indirectly, by their dedication.

Third, Jamie Claytor, engineering academic advisor, is critical to this event in a fundamental way – students need to thrive in the engineering degree program if they are to participate in the xChange. Our students are lucky to have her steady counsel in navigating a challenging curriculum, complex institutional policy, and at times, even more complex realities of life.

Lastly, Caitlin Boyer, engineering administrative assistant, is our eye in the storm. Everything you are experiencing today would not be possible without her great talent in systems analysis, organization, and execution. Caitlin's ability to routinely transform the needs of nearly 500 people into coherent excellence, and always with a smile, never ceases to amaze.

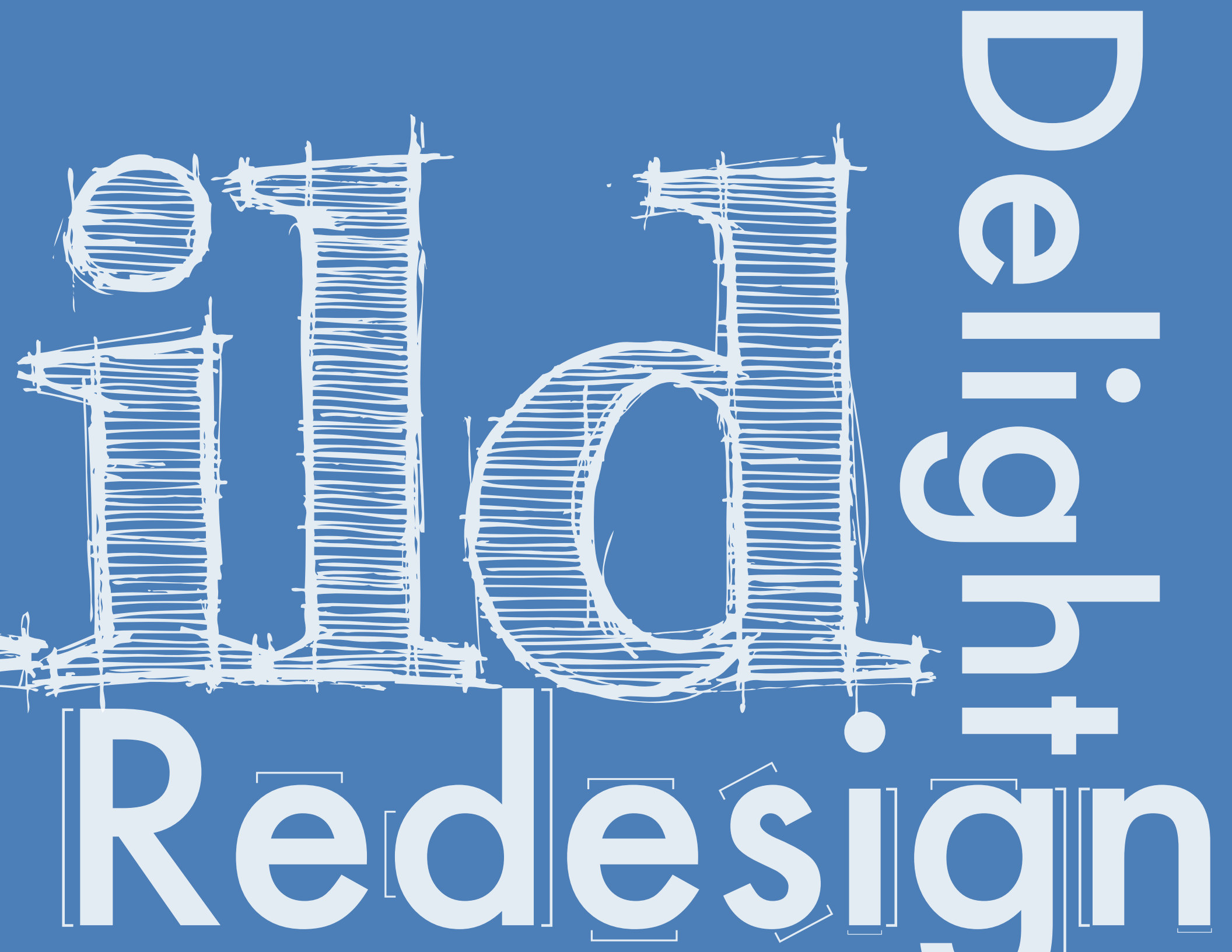
Many thanks to you all.

Kurt Paterson, Ph.D., P.E.
Head, Department of Engineering
April 16, 2016

Discover

Design

Bu


Redesign
Redesign

Learning by re-doing

As much as I share the wonders of our Madison Engineering curriculum, I am even more impressed with our department. We aren't perfect, but it's great to be part of a thriving learning organization; one that is truly focused on the best undergraduate engineering education possible, not just in our classes, but everywhere in our program. None of this would have happened if the founding faculty, staff, and administrators had not built our culture on doing – this is not only a critical practice for successful new ventures, but also a powerful way to teach and learn.

Doing requires the courage to create, share, and deliver; we act because we recognize the price of inaction is greater than the fear urging us to follow the status quo, the easy path. Learning by doing is typical in Madison Engineering. In fact, it seems strange that a modern engineering education could be any other way, and if we stopped at doing it would put us in rare company nationally.

However, it is the willingness to go beyond doing that is the basis of my pride in our engineering community. Learning by doing might be an act of bravery, but learning by re-doing is an act of caring. The faculty and staff care enough about our students to get to know them as individuals, mentor them on countless projects, and professionally nurture them during and after their time with us; each of these efforts requires continuous engagement. Our students care enough about their work that they listen, question, ideate, design, analyze, build, test, then re-listen, re-question, re-ideate, re-design, re-analyze, re-build and re-test again and again to ensure their best work is delivered to clients, customers, and partners. Our alumni care enough to share their time, money, and wisdom, effectively building upon their earlier contributions to our program. And through these iterative efforts, learning by re-doing cultivates critical professional habits – chief among them curiosity, humility, empathy, persistence, growth and reflection – that continue to position our department's faculty, staff, students, and alumni as engineering leaders.

The Madison Engineering xChange is our annual celebration of the good that engineering can do for our world. It's easy to think that the many prototypes and stories shared today are the culmination of getting things done. In fact, they are a testament to the joy of getting things re-done. Enjoy our xChange today, and may this book help you re-enjoy it later.

Kurt Paterson, Ph.D., P.E.
Head, Department of Engineering
April 16, 2016

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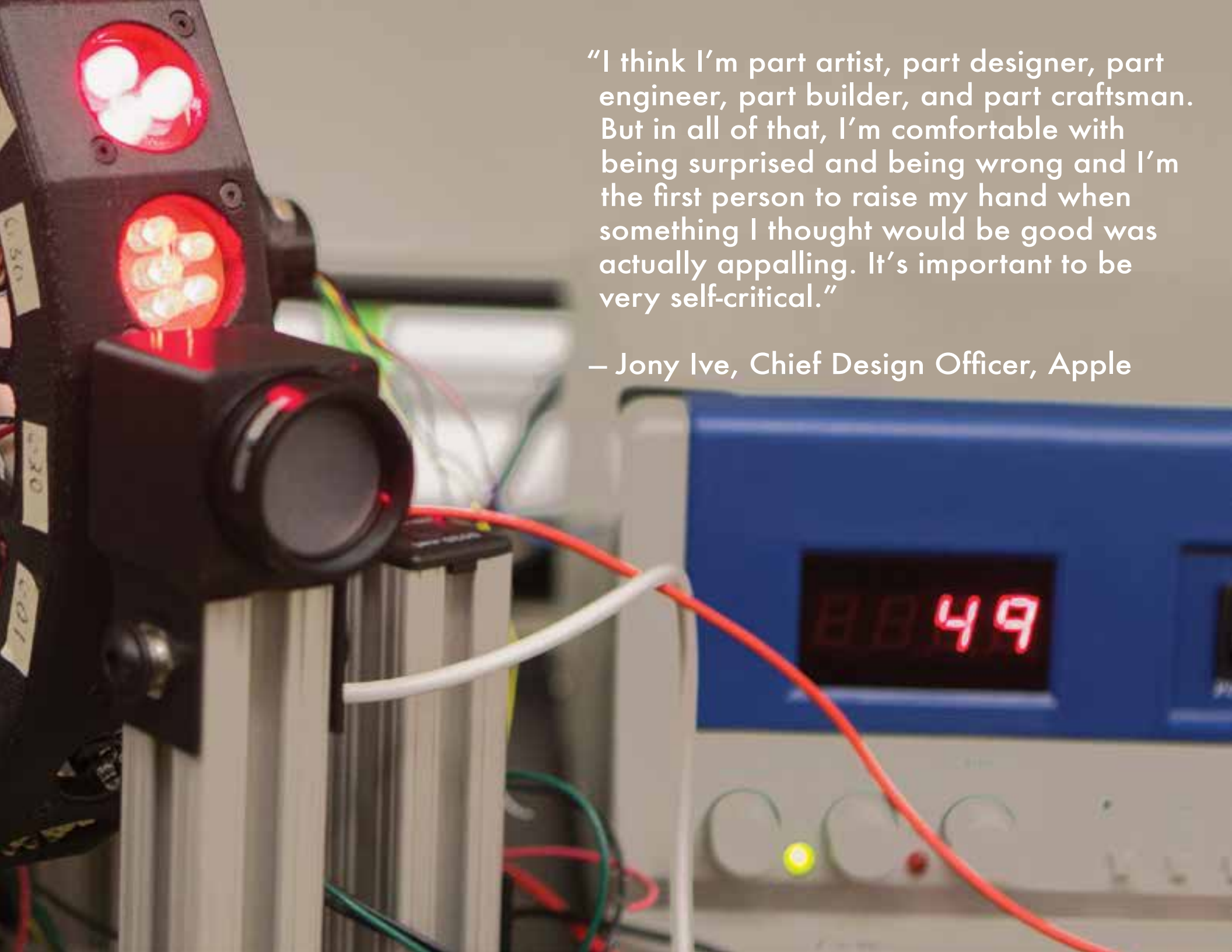


"I think I'm part artist, part designer, part engineer, part builder, and part craftsman. But in all of that, I'm comfortable with being surprised and being wrong and I'm the first person to raise my hand when something I thought would be good was actually appalling. It's important to be very self-critical."

– Jony Ive, Chief Design Officer, Apple

Honors

Brian Groener

Brian has been a part of the honors program since freshman year and his experience with the study abroad honors program in South Africa was one of the highlights of his college career. He started his research in the spring of 2015 with Dr. Pierrakos and Dr. Wunderlich after becoming interested in biomechanical engineering during his junior year. His passion for sports and running in particular provided the motivation for completing this project. He will be graduating in May 2016 with a Bachelor of Science in Engineering and a minor in mathematics. Upon graduation in May, Brian will be taking time off to travel and then plans on pursuing a career in environmental engineering.

"The East Germans first used biomechanics. This meant that rather than guessing about technique and form, they could apply changes to athletic performance based on science." - BIll Toomey

Running has grown tremendously in popularity over the past century, especially the past two decades. Unfortunately, injuries such as plantar fasciitis are still prevalent in runners despite efforts to design footwear to alleviate the impact of running and to reduce the number of injuries. In the past 5-10 years, minimalist running shoes have received considerable attention, causing debate amongst runners and scientists as to their utility in injury prevention. While minimalist shoes generally replicate barefoot running by reducing initial impact force on the body, the claim that they lower injury rates remains inconclusive. It is speculated that the intrinsic muscles of the foot have an increased workload in minimalist running due to the forefoot strike that results when runners use minimalist rather than traditional shoes. These muscles may be important in supporting the bony and soft tissue structures of the foot and may help prevent inflammatory conditions such as plantar fasciitis. It is the aim of this study to design an experiment to determine how minimalist runners, in contrast to traditional and barefoot runners, use mechanisms (e.g. foot kinematics and intrinsic muscles) that influence load on the plantar fascia and therefore the acquisition or prevention of plantar fasciitis. The experiment involves participants running on a treadmill for five minute intervals barefoot and wearing traditional and minimalist running shoes. Participants will be equipped with electromyography (EMG) electrodes to measure muscle activity and pressure mapping insoles to measure the force exerted over the contact area. A motion camera system will be used to capture foot and ankle kinematic data. For validation, preliminary EMG data show results corroborating previous studies.


Columbia
TKE
YELLOWSTONE
BROTHERS
CRAFT BREWING

Sierra Hahn-Vantrell

Sierra is an honors student, majoring in Engineering and Computer Information Systems and a member of the JMU Varsity Volleyball Team. She will be graduating in May 2016 with a Bachelor of Science in Engineering and a Bachelor of Business Administration. Sierra is the president of Engineers Without Borders and was involved in starting the James Madison University chapter as well as being a tutor for JMU student-athletes and local high school students. Sierra attended Bethesda-Chevy Chase High School in Bethesda, MD and after graduation plans to work for Deloitte Consulting with a focus on Digital Design.

The culture of Madison Engineering fosters collaborative growth and learning. Young engineers have the opportunity to receive assistance and learn from their upperclassman through tutoring, club involvement, and workshops offered throughout our program.

Madison Engineering is a unique and young program. As a student-athlete and double major in business and engineering I was interested in the connection between the academic success of our program in relation to the culture of our program and the leadership styles of those in our department. In my thesis I analyzed the U.S. News and World Report rankings of Engineering Programs around the country and cross examined the rankings and ranking criteria with detailed data gathered from further analysis of our identified seven sister schools. The goal of my thesis was to provide an understanding of the relationship between program culture, leadership, and academic success in hopes to provide the Madison Engineering leadership with insight and suggestions to further develop and advance the program in coming years.


MADISO

Kelsey Lineburg

Kelsey will be graduating in May 2016 with a Bachelor of Science in Engineering and minors in both Mathematics and Business. After graduation, Kelsey will continue to pursue her passion for education and service by working as an Americorps City Year Member in Baton Rouge, Louisiana, where she will be serving as a mentor and tutor to youth in the area.

Kelsey spent much of her time reviewing existing sustainable transportation literature to better understand the current gaps within this field of study.

Take a moment to think about what you did today. Did you go to work? Did you go to the grocery store? Did you go to school? If so, how did you get there? Transportation plays an integral role in our everyday lives. It provides us with the opportunity to travel regionally, nationally, and even internationally with efficiency and ease. Transportation infrastructure has historically shaped our geography, economy, and society through the spread of new ideas, innovations, and opportunities. It has the ability to connect cultures and regions by creating access beyond an individual's immediate surroundings. As Bill Shuster, chairman of the US House Committee on Transportation and Infrastructure, states, "Transportation is important. It's about people and how they live their lives…Our national transportation system binds us together." But could it also have the potential to tear us apart?

This thesis aims to explore the social sector of sustainability in transportation design and engineering. Along with establishing a definition for social sustainability in transportation from existing literature, this thesis also includes a comprehensive analysis of current sustainability rating systems based on their evaluation of social sustainability metrics. The goal of this project is to inform transportation professionals about the existing social sustainability gaps in transportation literature and sustainability rating systems to ensure that "no community is left behind."


START SOMETHING THAT MATTERS
TOMS
BLAKE
BE A CHANGE CHAMPION
SUSTAINABLE TRANSPORTATION
PROBLEMS AND SOLUTIONS
WILLIAM R. BLACK

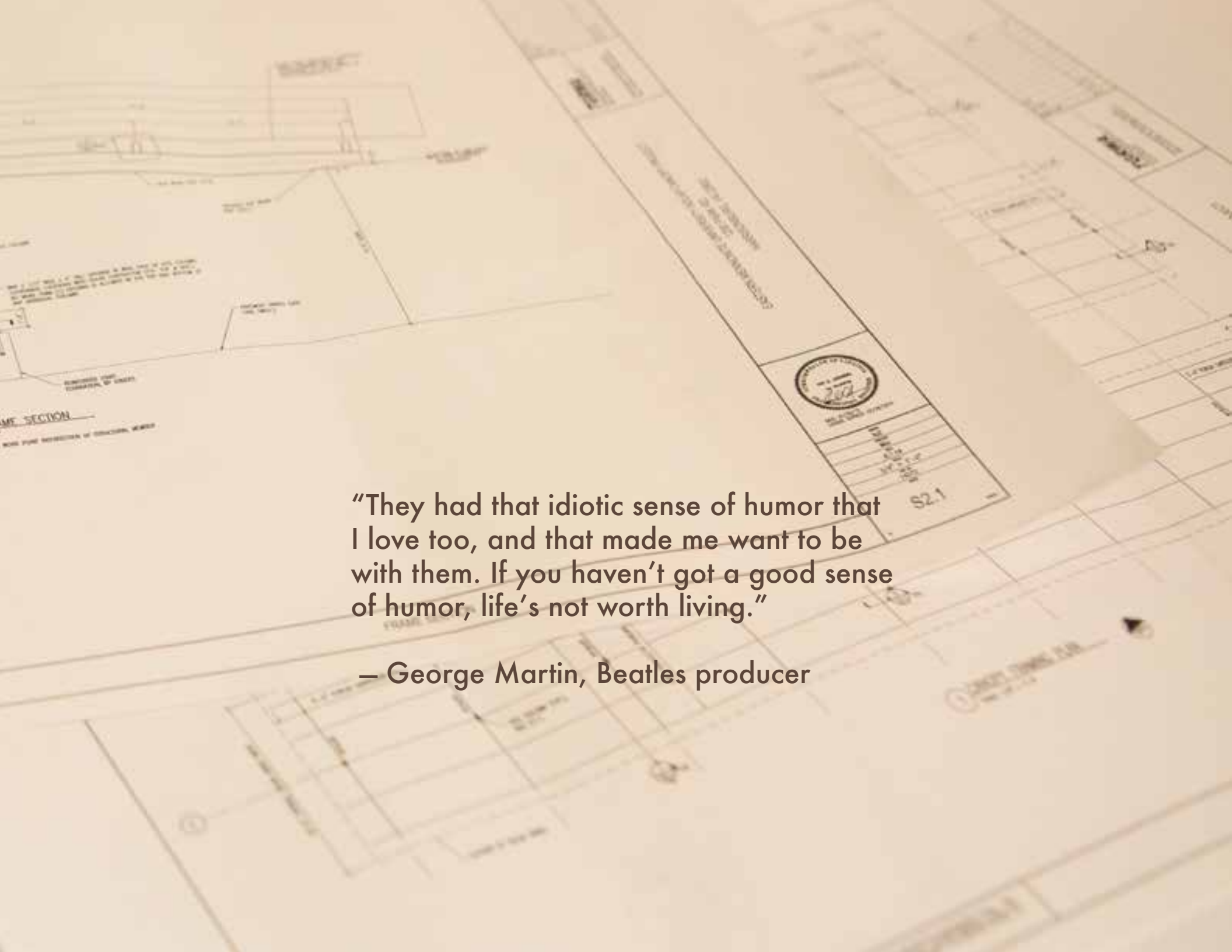
Kylie Stoup

Kylie is a senior engineering student at James Madison University graduating in May 2016 with a Bachelor of Science in Engineering and a minor in Mathematics. She is pursuing transportation planning after graduation, working in the industry for a few years before eventually enrolling in a master's program in urban planning. Kylie chose to explore engineering identity as a result of her interest in engineering education and previous research involving engineering psychology and education for Dr. Pierrakos. Kylie is originally from Hagerstown, Maryland. She considers herself a "people-person" and enjoys singing, playing music, and road trips.

Kylie is analyzing data collected from engineering freshmen and seniors about their personality and authenticity in engineering and non-engineering settings.

Despite many efforts, women continue to be underrepresented in engineering. Herein, this work is a contribution to the body of knowledge impacting female engineering student recruitment and retention challenges. Using a theoretical lens of identity theory and self-concept differentiation, an exploratory approach was used to assessing freshmen and senior engineering students' personality across engineering and non-engineering contexts. First, personality profiles were found among engineering freshmen and seniors in engineering settings, and then were compared to their personality in nonacademic settings and authenticity between the two. Personality and authenticity methods, of which were the Big 5 and Authenticity scale, were used in a survey to determine personalities of participants between academic level and gender in their engineering and nonacademic environments. From collecting and analyzing the data, results show that engineering students mainly described themselves as agreeable (i.e. helpful, trusting, considerate), conscientious (i.e. thorough, reliable, follows through with plans), open to experience (i.e. curious, inventive, deep thinker). This study also showed that female engineering students show a significant difference in extraversion factors between the freshman and senior classes, and senior females show the greatest personality and authenticity variation between environments. Further exploring engineering identity, personality, and authenticity will develop a better understanding of engineering students of how they perceive themselves in and out of engineering contexts.


Design



"They had that idiotic sense of humor that I love too, and that made me want to be with them. If you haven't got a good sense of humor, life's not worth living."

— George Martin, Beatles producer

Seniors

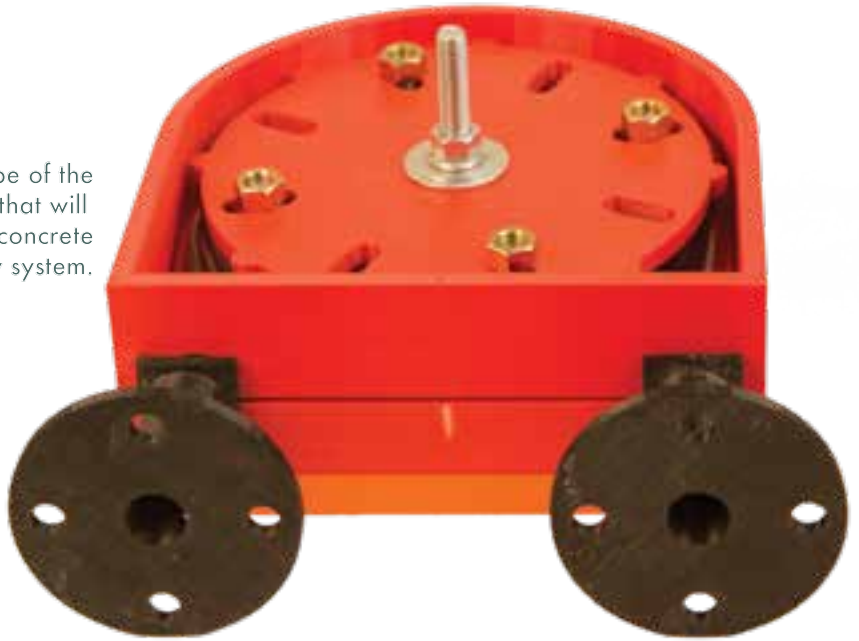
3D Printing with Concrete

Team
Andrew Perry
Andrew Read
Garret Brown
Michael Caple
Nizar Kamel
Rene Najera
Meredith Penney
Ryan Taylor
Lisha White

Advisors
Dr. Robert Nagel
Evelyn Tickle

Client
JMU Industrial
Design Department

Photo Caption: We hope to create a truly mechatronic design, blending mechanical engineering, electrical engineering, and system control.



The final prototype of the peristaltic pump that will be used in the concrete delivery system.

Additive manufacturing is a rapidly advancing field that is revolutionizing a number of industries. The combination of rapid prototyping and reduced production costs has allowed companies to shorten production cycles and get new products to market faster. While plastic has been the predominant material choice for additive manufacturing, this project will create a 3D printer which uses a concrete-based material.

Simulated, mathematical, and physical prototypes have all been created to help develop an understanding of the systems involved. Computer aided drafting and mathematical models were made to analyze static and dynamic stresses on the frame and linear motion components.

A prototype pumping system was made to test feasibility. Through investigation of existing designs and prototyping, the system found most suitable was a peristaltic pump. Software components were tuned to work on a larger scale printer than tradition desktop plastic machines. To observe the extrudability of the concrete, a concrete dispensing apparatus was utilized to test various mixtures of a standard, pre-packaged concrete mix. Insights that were gained include different aspects of the concrete, such as the cement-to-water ratio, nozzle size, and the bonds between each layer. Working with the JMU Industrial Design department a variety of admixtures are being tested to achieve the desired mix of concrete. This printer will open the door for printing technology for component materials and facilitate the creativity of people all over the globe.

Composite Aircraft Seat Legs

Team
Alex Anderson
Trevor Bond

Advisor
Mark Showalter

Client
JAARS, Inc

Photo Caption: The team prepares to perform a vacuum bagging seal on the carbon fiber design.

Carbon fiber-balsa wood composite leg after buckling test

Recently, JAARS, a Christian non-profit organization, has decided to investigate methods to make their Quest Kodiak airplanes lighter in order to carry more cargo. As part of this initiative, JAARS has come to James Madison University with the objective to make the legs of their airplane seat lighter. However, FAA regulations for aircraft seat legs must still be met while limiting cost increases over the original 4130 steel legs. To this end, the legs were requested to be made primarily of carbon fiber in order to be more compatible with potential future composite based designs for the rest of the seat. The team is exploring the feasibility of using carbon fiber seat legs within the constraints of the original seat design to reduce costs for the legs without significantly increasing cost. Feasibility has been assessed using a combination of finite element analysis, and physical tests examining qualities such as strength under compression and impact strength. Costs are also being considered using the material costs and the labor hours required for leg construction. Upon completion of the feasibility study, JARRS and Quest can use its results to inform whether or not composite legs would be worth the cost of FAA certification.

Compression Techniques for Carbon Fiber Manufacturing

Team
Daniel Carrier
Wheeler Dey
Tyler Shaw
Andrew Levering
Felipe Melivilu
Curtis Hendrick

Advisor
Dr. Jacquelyn Nagel

Client
Sentien Robotics

Photo Caption: The capstone team is evaluating the results of their preliminary tests of the compression mold. They are preparing to lay up their initial run of carbon fiber for testing and analysis.

Carbon Fiber is a unique material that can come in many different shapes, weaves, and strengths. The composite material creates an extraordinary opportunity to make a material that is extremely strong and yet lightweight. The uniqueness of this material presents particular challenges to overcome in its construction. The team's preliminary investigation of the subject determined that designing a compression mold would be the best way to create a low-cost manufacturing system, while also creating a way to test the properties of carbon fiber. It is this capstone team's goal to develop a solution that reduces the cost of high-grade carbon fiber manufacturing and also research how the properties of carbon fiber change under different pressures. Changing the pressure that a piece of carbon fiber is manufactured at decreases the amount of matrix that the composite contains. The compression mold that the team designed is capable of testing pressures up to 3,000 psi. The ability to create test samples under a wide range of pressures, applying different resins, and varying the carbon fiber weave orientations allows for the discovery of an ideal composite for structural applications. Carbon fiber has many potential applications in the UAS, automotive, and aerospace industries.

3000 psi, applying different resins, and varying carbon fiber weave orientation allows for the discovery of the optimal molding conditions for manufacturing structural carbon fiber components.

Design of a Laboratory Scale System to Simulate Commercial Building HVAC Systems and Test Air Purification Equipment

Team
Luke Haskins
Ricky Baier
David Harootyan
Hunter Sandridge
Josh Kay
Matt Russell

Advisors
Dr. Keith Holland
Dr. Samuel Morton
Dr. Bradley Striebig

Clients
Charley Waddell
Kevin Haskins

Photo Caption: The team continues the construction phase of the project, discussing the two main sub-systems of the apparatus, the chamber and the HVAC system.

Laboratory testing
apparatus for a scaled
down commercial building

This project is comprised of two main objectives. The first objective is to design and construct a testing and measurement system that simulates the air speeds and flow rates within a commercial HVAC system and building space. Once designed and constructed, a second objective of the project is to measure how the inclusion and placement of a cold-ion plasma generator, such as the equipment produced by Global Plasma Solutions (GPS), within the HVAC system affects the particulate matter in the occupied building space. Such cold-ion plasma generators are purported, based on anecdotal evidence, to improve the air quality and reduce particulate matter within a building space; however, extensive testing of such systems to validate these claims has not been performed. This work initiates the development of a testbed and testing protocols for such air purification devices. Additionally, such data may provide companies such as GPS a better understanding of how to best market and install their devices.

Educational Microbrewery Design

Team
Kyle Byrd
Rachel Hollenbeck
Brock Warinner
Tyler Symons
Joseph Taylor
Caleb Kim

Advisors
Dr. Steven Harper
Dr. Samuel Morton

Photo Caption: The design team gets hands-on experience working with the brewing equipment currently owned by James Madison University. Knowledge acquired from participating in brews is invaluable to the team and to the project's success.

With the rapid growth of the brewing industry, the demand for trained brewers is increasing at an equally rapid rate. James Madison University is looking to provide students with education and experience to be competitive in this growing field. A team of six students from the Department of Engineering was devised with a goal of designing an on-campus microbrewery; to eventually be utilized for educational and research purposes.

Room 0117 of the Health and Human Services building on JMU's campus has been determined to be a location that contains the appropriate infrastructure to house this microbrewery. In order to assess the feasibility of using this room, the capstone team sought to determine the brewing equipment that the school already owns, and whether or not the room could support future equipment upon expansion. Then by performing experiments in the microbrewery on: space, electrical flows, air quality, and fluid flow, data was collected and analyzed to confirm this feasibility.

Codes from OSHA and the FDA were taken into account in an analytical model to determine the spatial footprint that the proposed equipment would have on the room. The model has been applied to the current equipment, along with an additional 31 gallon boil kettle and 14 gallon fermenter; results were within the capabilities of the room. Through analysis of the outlets in the room, it was determined that the room can provide three 220 V outlets with 30 A each and seven 110 V outlets split up among two 15 A circuits, which falls within the range of the current equipment. An analysis of certain fluid flows will need to be conducted as well to justify that the floor drains can handle the waste flow. Depending on the type of beer, the wort has to be crashed from 212 to 72°F then chilled further and held at ideal temperature for fermentation; the correct size of chiller needed is still to be determined. Air quality issues need to be addressed regarding: safe CO 2 levels as a result of fermentation, grain particulates in the air from milling, and fumes from the processes of boiling and mashing. The initial capital cost was calculated to be $4,000 with a return of investment on capital of 37.6% over the course of 5 years.

The project team has gotten the opportunity to brew and experiment with JMU's 20 gallon electric brewing system, plans for the future microbrewery consist of expanding to a 30 gallon, and then possibly even to a 50 gallon system.

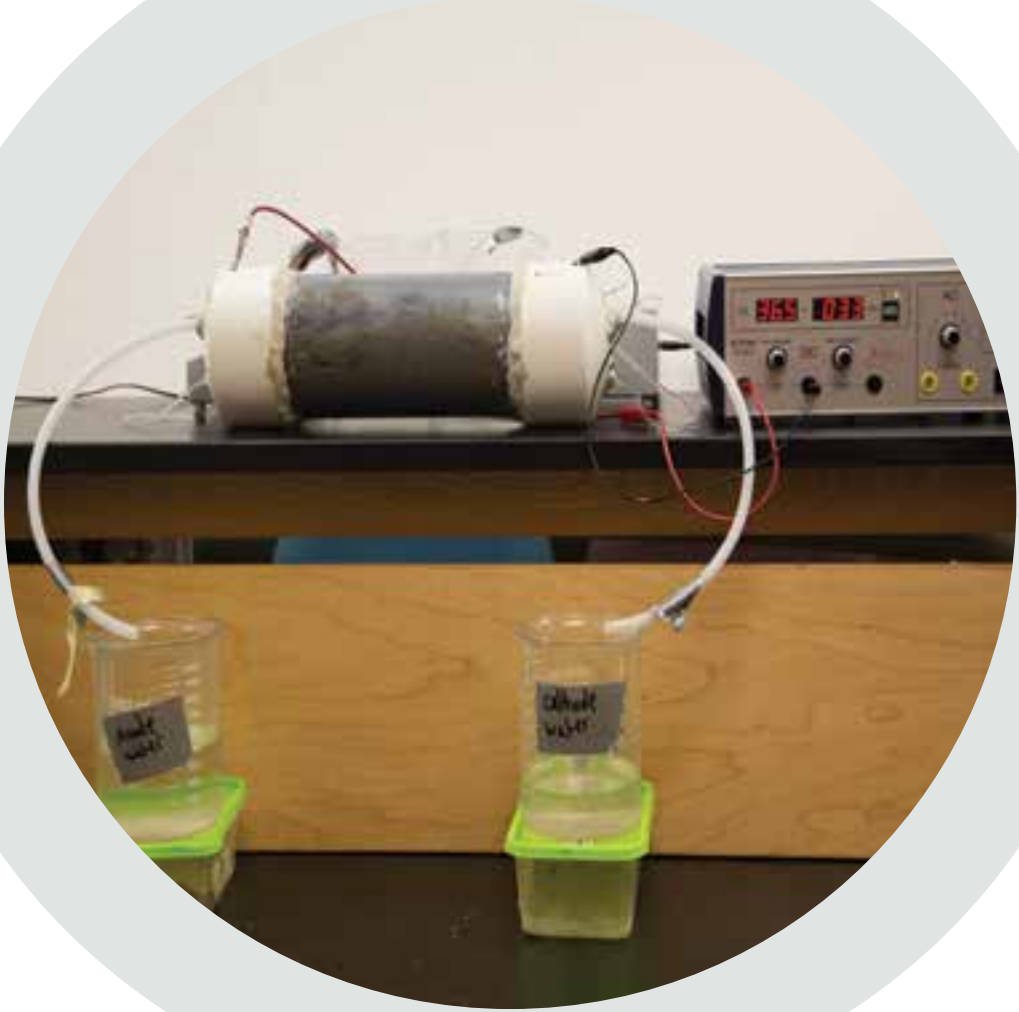
Electrokinetic Remediation of Heavy Metals from Electronic Waste Contaminated Soils

Team
Aaron Andrews
Daniel Cracovaner
Maryam Ekbatani
Jillian Leary
Tyler Shannon
Abraham Yoslov

Advisor
Dr. Adebayo Ogundipe

Photo Caption: The capstone team is working on taking and recording XRF readings of soil samples.

Electronic waste (e-waste) is becoming one of the most rapidly growing environmental issues in the world (Widmer, 2007; Hester et al., 2008). This waste is often composed of both heavy metals and toxic organic matter. To avoid costly recycling methods at the end of the lifetime of an electronic device, manufacturers and consumers often times irresponsibly dump the waste. In 2007, it was found that approximately 80% of e-waste disposed of yearly eventually makes its way to a landfill; despite the presence of a landfill's protective lining, contaminants may still leach to the surrounding areas (Wong, 2007). As a result of this, heavy metals such as lead, cadmium, chromium, nickel, plutonium, arsenic and uranium are deposited into the soil. In addition, polycyclic aromatic hydrocarbons (PAHs) make their way into the soil (Reddy et al., 2004). The aforementioned chemical species have the potential to leak into and contaminate water supplies, as well as cause infertility in soil. This may cause adverse health effects to local human and wildlife upon consumption of the water (Liulin et al., 2011). The presence of heavy metals in soil, specifically copper, nickel, and lead, can cause significant damage to the environment and human health as a result of their mobility and solubility. The goal of this research is to relate voltage gradient and removal efficiency of Lead, Copper, and Nickel in soil to advance the understanding and application of electrokinetic technology. The objective of this project is to investigate the effects of varying voltage gradients on removal efficiency of lead, copper, and nickel in sand and peat soils. A series of experiments with voltage gradients will be conducted.



Electrokinetic prototype test 3 with 1.2 volt per centimeter voltage gradient.

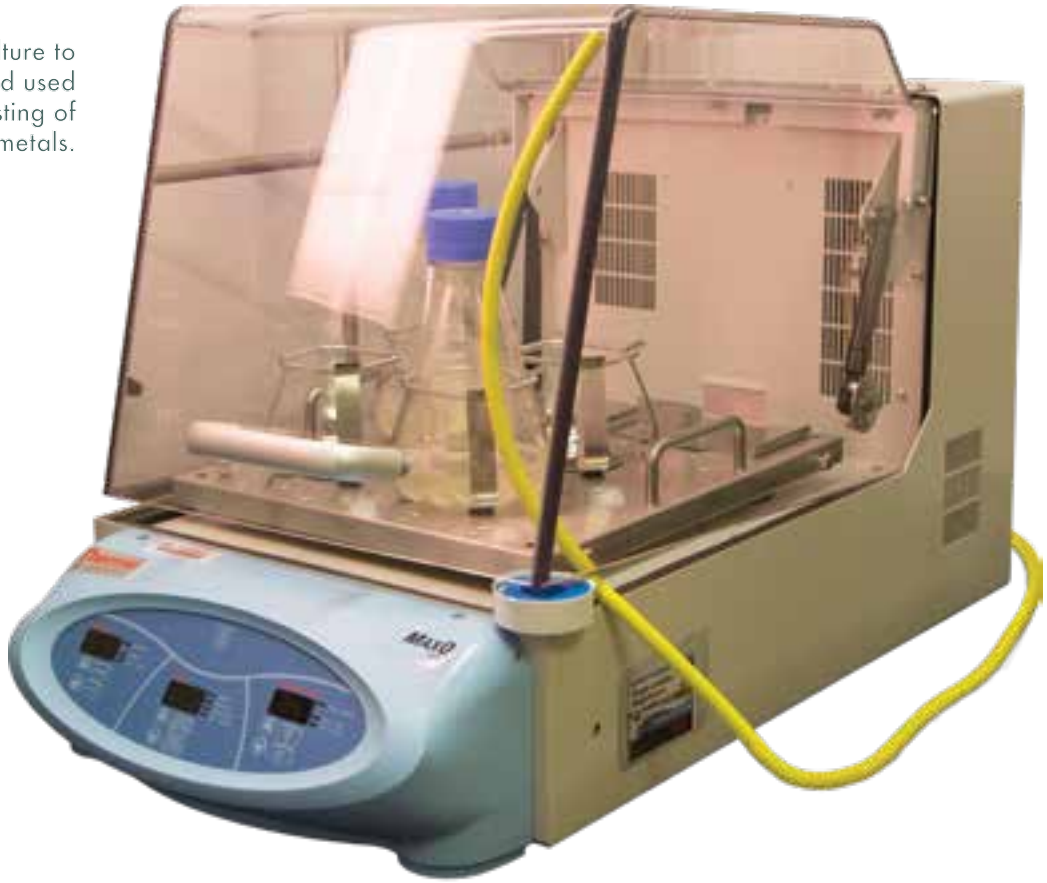
Feasibility Study of Algal Remediation of Heavy Metals in High Saline Water Applied to Hydraulic Fracturing Wastewater

Team
Edward Powell
William Smythe
Robert Swope
Andrew Walker
Timothy Katz

Advisors
Dr. Samuel Morton
Dr. Bradley Striebig
Dr. Heather McLeod

Photo Caption: The capstone team working together in the lab.

Starting an algal culture to be proliferated and used in flocculation testing of heavy metals.



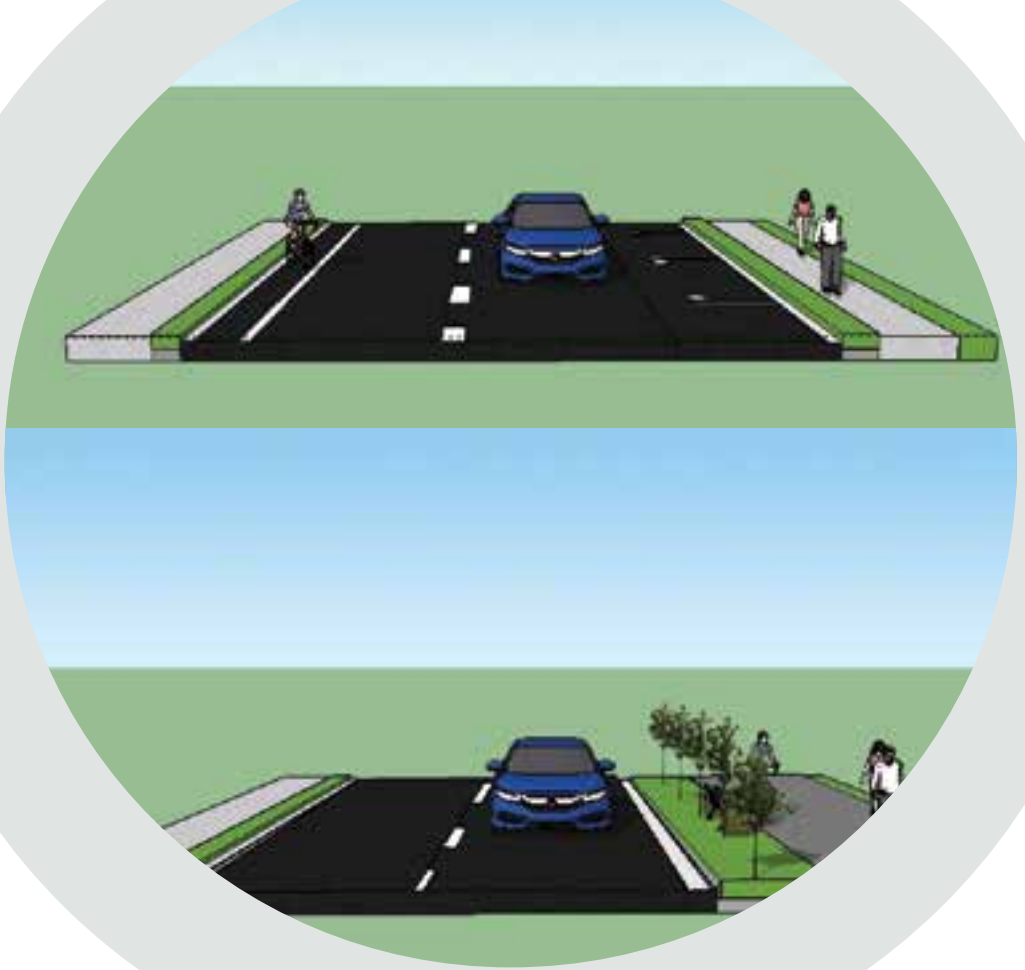
Hydraulic Fracturing WasteWater (HFWW) has limited oversight in its treatment process compared to typical wastewater discharge and is often pumped back into a well after the natural gas is extracted. Existing fissures in the rock created in the extraction process also engenders the risk of contaminants seeping into groundwater and polluting drinking water supplies. The objective of this project is to determine the feasibility of algal remediation of HFWW with high concentrations of heavy metals, specifically focusing on iron, manganese, and barium and the chemical flocculation step within the treatment process. To establish an algal culture, algae was gradually climatized from a test tube to a Morton flask, and finally a photobioreactor. Using algae from the developed culture in flocculation testing, type II settling is expected to be observed as the algae coagulates and flocs the heavy metals in solution. Imhoff cones will be used to make this settling easily visible. Concentration levels will be measured four times over the course of an hour at the surface and midpoint of all test solutions. Comparing algae's experimental results against those of ferric chloride will determine the feasibility of using algae as a flocculant. The use of algae as a flocculant instead of ferric chloride would be more compliant with Pollution Prevention laws. This has the potential to reduce CO 2 emissions and modify the process by eliminating toxic ferric chloride and implementing nontoxic algae. The HFWW will be treated to the Maximum Contaminant Level (MCL) allowed by the EPA under the National Pollutant Discharge Elimination System (NPDES) enforced by the Clean Water Act (CWA).

Harrisonburg Greenway

Team
John Boccagna Elder
Daniel Hallinan
Kelsey Lineburg
Kylie Stoup
Cole Turner
Sergio Yabeta

Advisors
Dr. Elise Barrella
Dr. Heather McLeod
Mr. Tom Benevento

Photo Caption: Students analyzing spatial analysis files in accordance with original system map of Harrisonburg.



Developed cross sections in Google Sketchup visualize existing versus implemented greenway infrastructure.

Many residents and visitors of Harrisonburg currently lack infrastructure for healthy, affordable, efficient, and safe transportation methods that meet their commuting needs. A lack of connection due to gaps in the transportation network for walking, bicycling, and transit subsequently impairs their access to alternative transportation and community engagement. This project proposes a multifunctional greenway system design for the City. Greenways are linear parks used for both recreation and transportation. The project involves the plan and design of a network of paths to promote community engagement, social equity, environmental sustainability, and multimodal transportation opportunities for Harrisonburg. Methods of data collection include community feedback from team-facilitated workshops and stakeholder interviews around the local area regarding desired locations of access. Results from these meetings and additional spatial analysis indicated the highest priority access points are: downtown Harrisonburg, Valley Mall, JMU, EMU, Hillandale Park, and Our Community Place. A conceptual system map containing the greenway network and connecting these access points was developed in Spring 2015. A detailed design of the route from downtown Harrisonburg to JMU is being developed as a deliverable by the end of Spring 2016. The route itself was determined using existing infrastructure, spatial analysis, and codes and standards from guides such as the AASHTO Guide for the Development of Bicycle Facilities. The design is displayed through CAD engineering cross sections and profiles, as well as less technical planning cross sections. To evaluate the sustainability of the project, the GreenPaths rating system is being applied to the proposed downtown to JMU route. The results from this analysis will help the team make informed decisions to improve the overall economic, environmental, and social sustainability of the greenway.

Harvesting Energy from Human Movement

Team
Collier Apgar
Paul Revesman
David Hieronymus
George Schmidt
Zachary Patterson
Jacob Wild

Advisor
Dr. Jacquelyn Nagel

Photo Caption: Team members working on their respective subsystems.

Prototype of the electrical subsystem on a breadboard (left) and knee brace (right).

The design of a knee mounted energy harvesting device for USB charging was investigated. With the current longevity issues of lithium batteries in portable electronics and the reliance for consistent access to a standard electrical socket for charging, a need for a portable and sustainable energy source was identified. Human biomechanical energy from movement was identified as an emission-free and untapped source of power. Four types of energy harvesting technologies were researched for their energy output potential as well as their prior applications to wearable devices. To supplement information obtained from a literature review, prototypes based on each technology were fabricated for testing. In addition, several human movements were studied to gain knowledge about which had the most potential for generating power. Based on this review, a rotational generator utilizing a knee-mounted apparatus was selected as the most likely candidate for generating enough power for USB charging (5 VDC and 0.1 A minimum). Because the device was to be attached to the body, emphasis was placed on developing a design that provided for minimal hindrance to the user's normal gait. Following this decision, several energy harvesting products using rotational generators were purchased and benchmarked. A brushless motor was purchased to act as a generator in the knee mounted system; this decision was based on its low mechanical resistance to motion and its high back EMF constant. To actuate the generator of the system at a velocity which could provide adequate power, a gear train was designed to amplify the 1 Hz input from human gait. A key component of the knee mounted design is a ratcheting freewheel, which allows for conservation of angular momentum in the forward direction in between actuations of the gear train and prevents motion in the opposite direction. Parallel to the mechanical design process, an electronic system was designed to rectify the three phase AC voltage produced by the generator. A linear regulator was used to condition the rectified output to 5 VDC. An alpha prototype is currently being fabricated. Projections indicate the system should produce 5 VDC at a range of output currents from 0.1 A to 1 A depending on how fast the user is moving.

JMU HVAC Analysis Team

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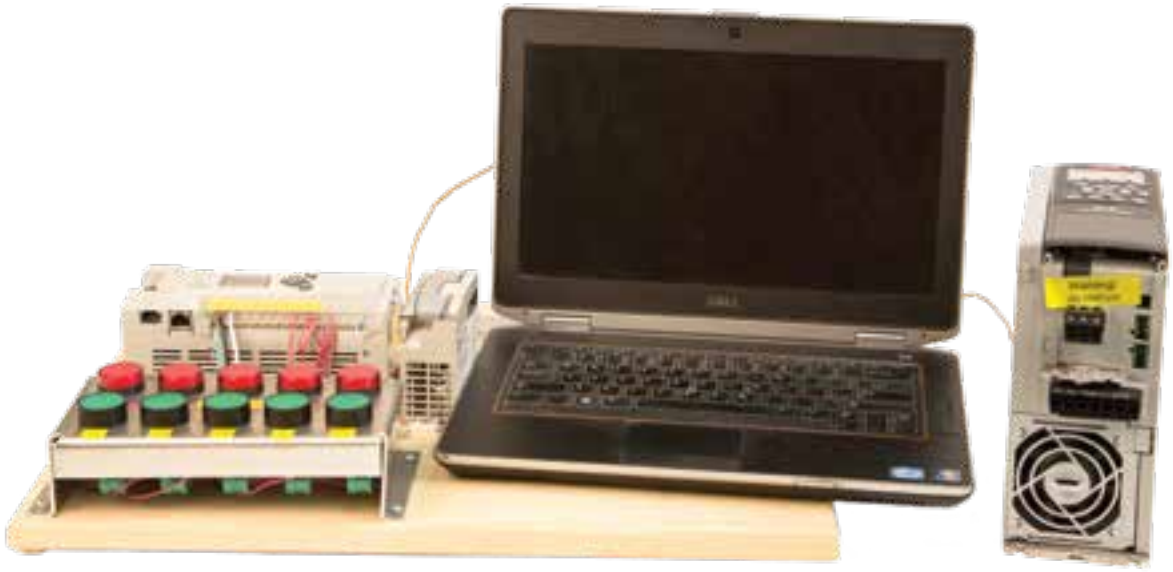
Hunter Heavner

Advisors
Dr. Kyle Gipson
Dr. Jacquelyn Nagel

Client
Nyeshu Street
MillerCoors
Shenandoah Brewery

Photo Caption: The team works on the testing model, which will be used to validate findings from a simulation of electrical power consumption of an HVAC fan with and without VFD control.

Variable frequency drives (VFDs) are able to control the speed of three phase motors which allows the motor to be operated with lower current inputs. This technology is used in the heating, ventilation and air conditioning (HVAC) arena to modulate fan operating speeds, resulting in reduced energy consumption. The Shenandoah Brewery located in Elkton, VA is operated by MillerCoors and has expressed a need for a more effective means of control for the operation of their two air handling units which regulate airflow throughout their Business Administration Office located on the brewery campus. Currently the supply fans for both air handlers operate at full capacity without variable frequency drives, regardless of the building occupancy. A systematic analysis was conducted on the air handling units looking for possible sources of the operational inefficiency and the control system of the units was targeted. Using industry simulation and estimating software a VFD schedule for operation of the supply fans of the units was developed to determine the capacity for operational cost savings for these two rooftop units, based on occupancy of the building. During weekends and non-business hours during the week, the power to the supply fans was modeled at lower percentages of the full operational capacity. The results of this analysis show that the implementation of VFDs on these two air handling units can generate savings in the electrical energy consumption in the operation of the building's HVAC system at a low initial cost to the client.



The team's programmable logic controller (PLC) and variable frequency drive (VFD) used to control the heating and cooling settings for the testing model.

Low-cost Greenhouse with Automated Systems

Team
Brian Groener
Rowen Perry
Albert Stainback
Nile Knopp
Jonathan Romero
Austin Strzelczyk
Kent Korgan
Kody Smith

Advisor
Dr. Justin Henriques

Photo Caption: The student members of the greenhouse capstone team gather for a meeting.

A rendering of the integrated greenhouse systems is provided. The following greenhouse subsystems are included: a rainwater catchment and delivery system, photovoltaic cell and battery array to provide power, a control system that utilizes an Arduino microcontroller for monitoring and regulating climate variables, and the polyethylene-covered hoop structure. The front and rear walls of the greenhouse are omitted for visualization purposes.

Food security remains a global challenge, particularly in low-income countries. In Sub-Saharan Africa, one in four are undernourished, and the region has the highest prevalence of hunger in the world. Innovations in low cost greenhouse design have the potential to contribute to increased food security, particularly in areas where global climate change is creating additional variability in local weather patterns. This project develops the design of a low-cost greenhouse that uses open source control systems. The final design is presented in the form of a user manual to facilitate easy comprehension for potential farmer stakeholders. The design takes advantage of the decreasing cost and size of sensors to automate systems, such as irrigation and ventilation, that have the potential to increase the efficiency and yield of greenhouses.

NoVeRT

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Taylor Calder
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Jay Naduvilekunnel

Advisor
Jonathan H Spindel

Photo Caption: Our goal is to increase patient retention and the entertainment value of vestibular rehabilitation therapy.

The vestibular system, located within the inner ear, works with other sensory systems to maintain one's balance. If damage occurs, a person may experience a variety of symptoms, including dizziness, nausea, or imbalance. To combat these problems, vestibular rehabilitation therapy is used to aid in patient recovery. However, the discomfort patients experience while performing rehabilitation exercises, as well as the monotonous nature of the program, may discourage them from continuing with therapy. Traditional methods of vestibular rehabilitation require refinement in order to produce more effective results and increase overall enjoyment for patients. The team spent the last two years determining a novel method for vestibular rehabilitation therapy (NoVeRT) in order to improve the lives of people who struggle with therapy by encouraging patient retention. By tailoring an engineered system specific to vestibular therapy while incorporating traditional rehabilitation exercises, the team hopes that patient motivation to follow a prescribed therapy regimen will increase. The team is working with healthcare professionals and currently conducting internal research to implement an effective approach to better address the limitations of traditional therapy methods. Based on benchmarking results, the team is developing a prototype using the Oculus Rift to simulate an immersive, hands-free environment for the end user. To best meet customer needs, the final deliverable will provide some entertainment value to encourage patient retention.

The Oculus Rift, the platform the team has chosen to use in its technology-based rehabilitation system.

Nutrient Reduction Plan for Northumberland County

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Willie Woodard

Advisor
Dr. Bradley Striebig

Client
Sharon Sharp
Northumberland County/
Bluff Point Representative
for JMU

Photo Caption: Team members analyzing data from nutrient testing.

The project aims to propose a wastewater treatment system focusing on a tertiary treatment system to reduce nutrients for the coastal region of Bluff Point in Northumberland County, Virginia. The nutrients to be reduced are nitrogen and phosphorus, which reduce the dissolved oxygen in the Bay waters and affect the aquatic ecosystems. The overall goal of the system is to reduce nitrogen and phosphorus concentrations in the forms of ammonia and phosphates from effluent wastewater to decrease nutrient loading to the Chesapeake Bay. Local economies depend on the Chesapeake Bay for a large source of income. Improving the water quality of the Bay may assist in maintaining these economies.

Nutrients enter the Chesapeake Bay from stormwater runoff and septic tank effluent. Septic tank effluent containing nitrogen and phosphorus enter drainage fields where they can enter the Bay waters through infiltration to groundwater or runoff. Typical loading concentrations of nitrogen and phosphorus from septic systems are 70.4 mg/L and 17.3 mg/L [1]. Due to Northumberland County's proximity to the Chesapeake Bay, it is important that the effluent of the treated wastewater does not increase the nutrient concentrations of the Bay waters.

Nutrient emissions from septic tank effluent and stormwater runoff were evaluated for a small coastal community in Northumberland County.

Sample vials from nutrient testing in order from left to right: Orthophosphate Sample, Orthophosphate Blank, Ammonia Blank, Ammonia Sample

The analysis resulted in larger loading rates of nitrogen and phosphorus from septic tank effluents, thus focusing the proceeding work on treatment options for nutrient reduction from septic wastewater. This nutrient reduction system would be a tertiary system in a proposed wastewater treatment plant for the studied community.

The adoption of a sustainable, cost-effective wastewater treatment plant may be suitable for replacing septic tanks in Northumberland County. A tertiary system may be a sustainable solution for decreasing nitrogen and phosphorus entering the Chesapeake Bay and subsequently improving the health and water quality of the Bay.

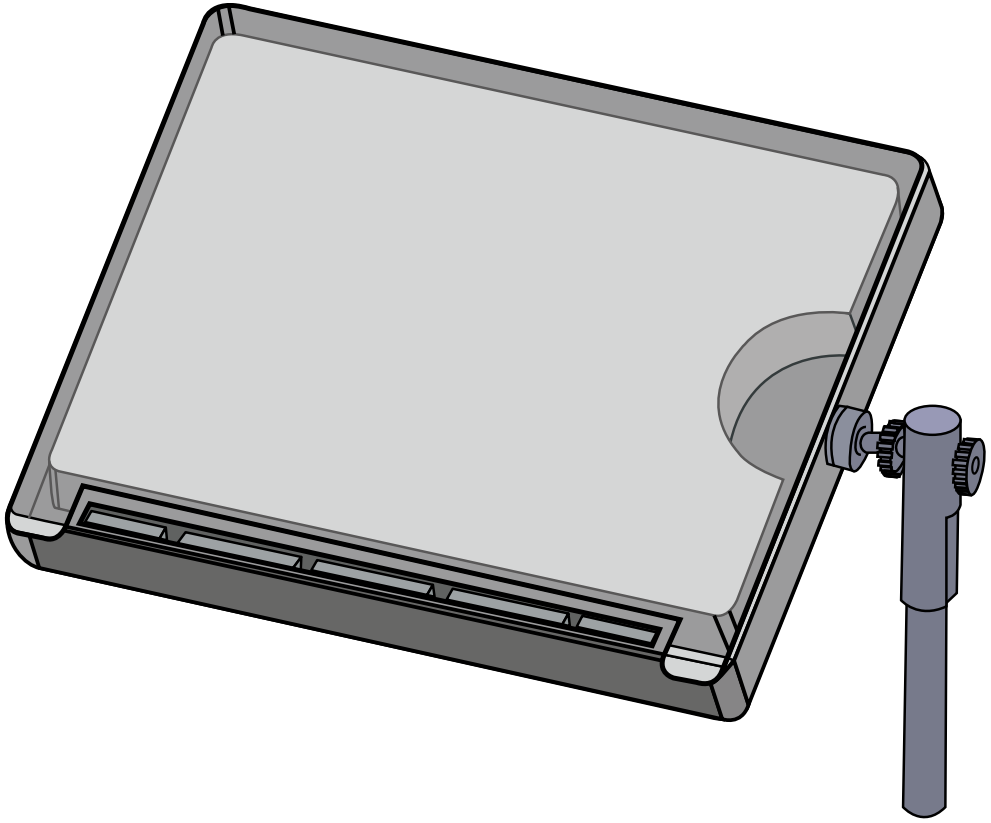
Rehabilitation Engineering

Team
Brittany Berni
Jerney Davis
Kathryn McDonald

Advisor
Dr. Robert Prins

Photo Caption: The Rehabilitation Engineering Team does iterative prototyping with physical and CAD models to develop a wheelchair attachment for manual Quickie Wheelchair users.

Individuals who have to use a wheelchair, either temporarily or permanently, do not have a wheelchair accommodation that fits all their specific needs. As engineers, the Rehabilitation team aimed to assess their needs and design an accommodation that can better the individual's quality of life. Due to the vast difference in the needs and abilities of each wheelchair user, the scope was narrowed down to individuals with Spinal Cord Injuries affecting the Thoracic Nerves T6-T12, who use the Sunrise Medical Quickie Rigid and Flexible model wheelchairs. Interacting with potential users at Wilson Workforce Rehabilitation Center in Fishersville, Virginia has helped the team define requirements and functions for the system being designed. These interactions have shown the overall specific need of the user is to gain independence. Independence includes allowing the user to accomplish tasks they might otherwise have needed assistance with in their daily lives. Through design methods such as morphological matrices and benchmarking, the team has gained insight on what is currently on the market as well as potential solutions to design functions. Along with these methods and reoccurring feedback from potential users, the team has designed, tested, and analyzed multiple prototype iterations, both physical and analytical. This has led the team to the construction of a final wheelchair tray design that is adjustable, customizable, and functional to its users.



Rehabilitation Engineering Capstone Team designed a wheelchair accommodation with a single point attachment that fits the specific needs of a manual wheelchair user.

Solar U: JMU Solar Energy System Analysis and Design

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Brett Thomas

Advisor
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Co-Advisors
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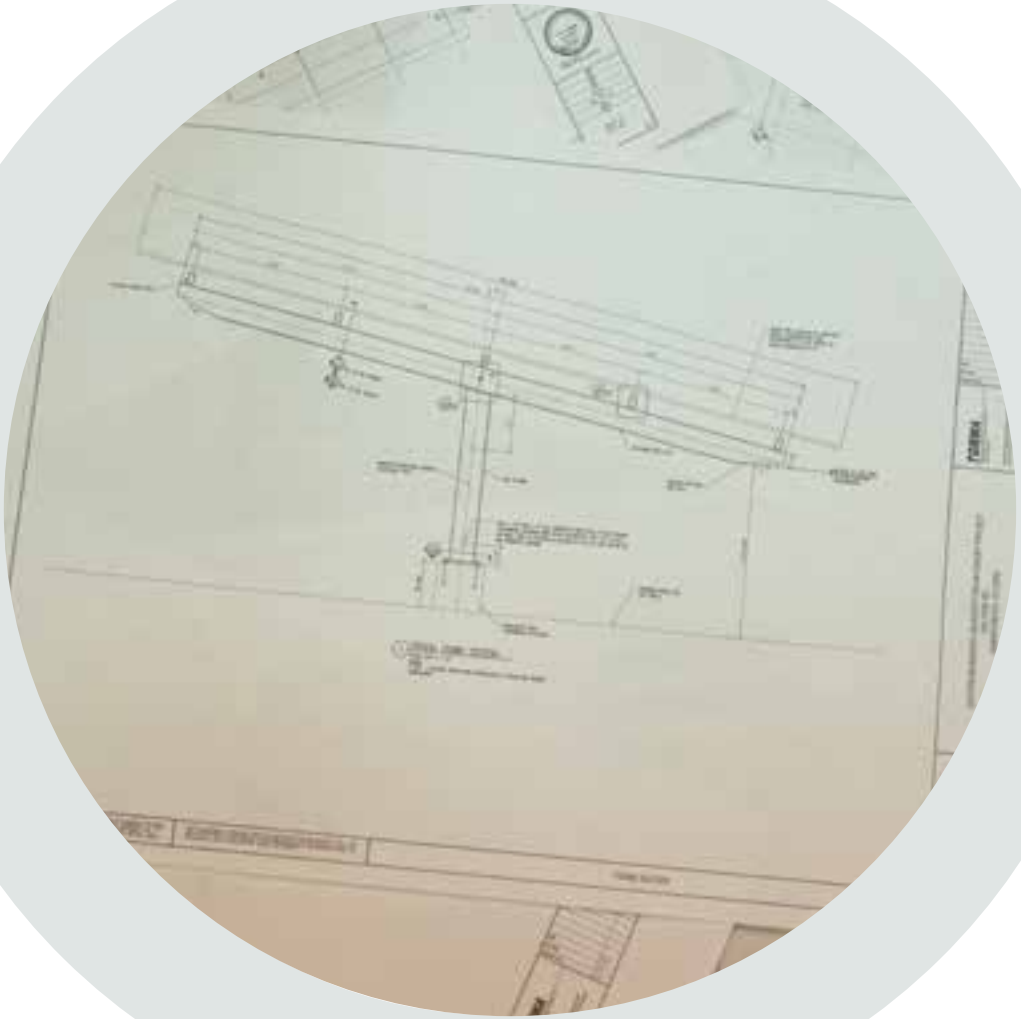
Rich Harris
Abe Kaufman

Client
JMU Facilities Management

Photo Caption: The team studies the current solar panels on campus.

The technical documents received from Eastern Mennonite University allow the team to benchmark different designs in order to develop a precise mathematical model to be used in the determination of the installations final size, power output, and cost.



On October 16, 2014 the Commonwealth of Virginia issued Executive Order 31, mandating a 15% reduction in electrical consumption by 2017 for all state facilities. The Solar U capstone project was designed to help meet this mandate by decreasing grid-tied electrical consumption at James Madison University through the use of a solar canopy integrated with the Health and Human Services (HHS) building. The project examined an adaptable approach for the solar canopy, meaning the design and research can be applied to multiple areas of campus based on the amount of funding available. This project lays the foundation for future renewable energy projects at JMU as the University continues to expand while continued reductions in power loads are required.

The proposed solar canopy installation, located over the faculty and staff parking lot next to the HHS Building, will provide power and shelter, while also showcasing JMU's 'green' campus initiative to passersby on Interstate 81. After detailed analysis it was determined that monocrystalline panels will be used due to their low cost and reasonable efficiency. The panels will also be non-rotating in order to decrease the excess associated maintenance costs. The final design specifications are presented in ranges based on different budgets to provide guidance to campus planners. Through research and benchmarking, the team has developed a mathematical model that assists the decision on the final design's total cost, power output, and size. Our hope is that the University will build upon our recommendation to develop a solar power system at James Madison University, favorably positioning the institution's finances and reputation.

W.O.T.A.
(Water Out of Thin Air)

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Andrew Dates
Bryan Garrett
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Kiara Pontious
Sarah Rowe
Bradley Weidner

Advisors
Dr. Olga Pierrakos
Dr. Karim Altaii

Photo Caption: Water Out of Thin Air team working on an environmental testing chamber to conduct experiments using their prototypes.

Shown is the testing chamber containing two prototypes. One using a heat exchanger utilizing ground temperature to cool the air and the other using a Peltier device to create a temperature gradient.

Water scarcity affects 1.2 billion people on a global scale, representing nearly one fifth of the human population. In some regions, current water sources are being depleted faster than they are renewed and the majority of this depletion is being used for irrigation and agricultural purposes. At any given time, the atmosphere contains 3400 trillion gallons of water vapor, which would fill 5200 Olympic swimming pools. Herein, we describe the design of an innovative solution to water scarcity in regions with medium to high humidity - Atmospheric Water Generators (AWG).
This device converts water vapor into liquid water and is designed for agricultural and irrigation purposes in regions where water scarcity exists. More specifically, two AWG concepts were developed by our team, one utilizing Peltier devices and the other a heat exchanger, in order to allow multiple design alternatives to be considered. The Peltier-based concept works by applying current to induce a temperature gradient in order to cool and condense the surrounding air. The heat exchanger concept works by cycling a coolant that is cooled by a lower ground temperature. Both AWG concepts were designed utilizing sustainable engineering principles to minimize energy consumption and cost (particularly when compared to AWGs currently on the market). The designs are estimated to create enough water daily to grow 2 fruit trees (1 gallon a week) at an example condition of 60% relative humidity and 85°F.

"If you want to go quickly, go alone. If you want to go far, go together."

– African proverb

Build

Juniors

"Child-in-Car" Alarm

Team
Kevin Benecki
Tyler Jarrett

Advisor
Dr. Robert Prins

Photo Caption: Child-In-Car" Alarm Team enthusiastically working hands-on with their project.

A proof-of-concept prototype was developed a child-detection device. A weight sensor is connected to a microprocessor, which alerts when a certain amount of weight is applied.

Every year, an average of 38 children suffer heat-related deaths after being left inside of 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 an 80 degree day. Such conditions have been proven fatal for children. The purpose of the capstone project is to explore and produce a technological solution utilizing sensor technology so that no children suffer the same consequence again. With advisory help from Dr. Prins, an associate professor in JMU's engineering program, the Capstone team has researched existing solutions on the market that address the same problem. Through benchmarking and researching customer reviews of similar designs on the market, the team has concluded that current products are not being widely adopted. The primary reason for this is that most existing solutions have a lack of reliability or consistent performance during use. For example, one product received multiple complaints on account for a high rate of false alarms. Currently, the project team is developing concepts for potential components that will be implemented in the design. It is expected that the team will be developing a sensor network paired with a microprocessor to gather information within personal vehicles in order to determine when a child is left unattended. In the event that the system detects an unattended child, a response mechanism will notify the parent or guardian. The team's goal is to learn how to improve upon the flaws of the existing systems that were benchmarked, and to implement a design solution that could be potentially more widely adopted. It is expected that the team will develop a fully functional system by April 2017. A final comparison between the capstone design and existing solutions will be the determinant of the design's success.

Cold Plasma Sterilization System for Long-term Spaceflight

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Advisors
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Dr. Robert Nagel

Client
National Aeronautics and Space Administration (NASA)

Photo Caption: Team M.O.B. discussing the specifics for a proof-of-concept prototype.

Human exploration of the Moon, Mars and other destinations beyond Earth's orbit presents significant challenges to crew health. As long-duration space flight and habitation become part of future missions, exploration of medical capabilities will need to be expanded to better meet the health care needs of crewmembers that may remain in space for extended periods of time. Currently, the National Aeronautics and Space Administration (NASA) employs disposable medical equipment onboard manned spacecraft to avoid problems associated with high temperature or chemical -based sterilization. For future long-term manned space missions, NASA wishes to employ non-disposable equipment in order to reduce payload. To accomplish this, a safe, reliable method is required to effectively sterilize medical equipment onboard throughout the duration of the mission. The objective is to develop a system that utilizes cold -plasma technology. This technology is required for several reasons. Previously, NASA has conducted studies into high temperature plasma, but deemed it too dangerous due to the risk of fire and potential for harm to astronauts onboard. Recent studies have shown the high sterilization potential of cold plasma, while allowing for other benefits such as its applicability to skin and its non-hazardous nature. Biweekly meetings with the clients at NASA have occurred to provide updates as well as to receive pertinent information. Requirements and objectives were developed based on feedback from clients, FDA standards, and a literature review. The project moved into the conceptual design phase, where solutions were generated and evaluated. Proof of concept prototypes are in development.

Various concepts generated by the team using the c-sketch method, which assists in the generation of design alternatives.

Designing an Unmanned Aerial Vehicle to Deliver Survival Supplies to Victims of Natural Disaster

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Scott Stone
Adam Warren

Advisors
Dr. Jacquelyn Nagel
Dr. Robert Nagel

Photo Caption: Team RescUAV conducting research on Unmanned Aerial Vehicle types.

When a person is lost or caught in a disaster situation (such as a landslide or avalanche), they can often go days without being found and sometimes it is too late. There are critical supplies that a person needs to survive until they can be rescued which they may not have if they did not come prepared for the situation at hand. The purpose of this project is to explore the viability of using UAV (Unmanned Aerial Vehicle) technology to help find lost persons and deliver life-critical supplies to them including some form of a beacon to transmit their location and assure they are rescued sooner. An analysis was conducted to determine how heavy an average payload would be to serve 2 people for 24 hours until a method of extraction can arrive. This payload would include a first aid kit, emergency food and water, and survival supplies like glow sticks, a multi-tool, and emergency blankets. This analysis calculated that the payload would be around 11 pounds, with room to reduce weight if the climate does not call for blankets or hand warmers. Currently the team is working to determine what aerial vehicle types are best suited to both locate the missing persons and carry the supplies, which will help lead the team into vehicle design and prototyping in the near future.

The test stand that the team will use to test the force produced by different motors and propellers.

Developing Wearable Air Qualification Sensor

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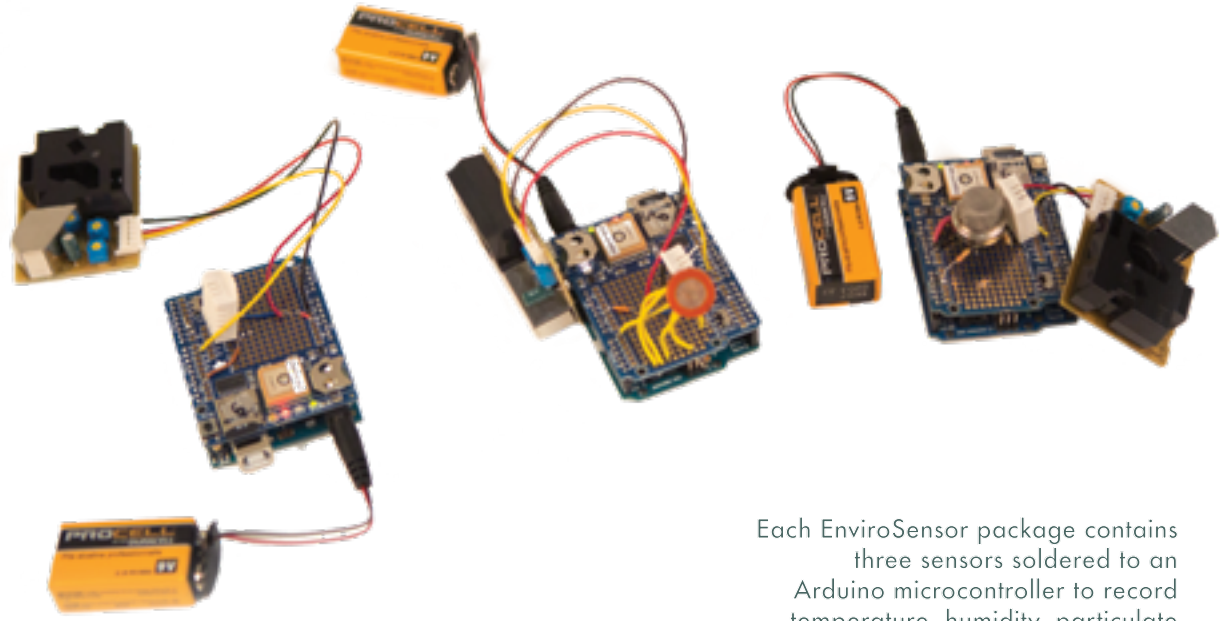
Andy Ricketts
Dias Zhakybay

Advisor
Dr. Justin Henriques

Client
U.S. Environmental Protection Agency (USEPA)

Photo Caption: EnviroSensors designers testing their prototype sensors by recording air quality data on campus.

Small low-cost microprocessors have created new opportunities to realize a variety of environmental sensing systems. Portable air quality sensors monitor the amounts of particulate matter, ozone, carbon dioxide, and carbon monoxide in air, all of which can have negative effects on human health. These air quality sensor systems include battery-operated wearable devices aimed at characterizing personal exposures to harmful pollutants as well as devices for large networked deployments of exposure data at the community level. The potential uses of these devices are broad, with applications to environmental and occupational health, community-engaged research, and urban planning. Portable air quality sensors can also help raising awareness among community members about air pollution. The team has designed, prototyped, and evaluated a portable air quality sensor device to meet the goals listed above. Through research, an Arduino Uno microcontroller board and a series of gas sensors were chosen because Arduino Uno uses a simple programing language and features a variety of interchangeable components, both of which allow the team to explode multiple ideas. The engineering of the portable air quality sensor presents technical challenges including creating robust microcontroller code to enable reliable collection and processing of sensor data, managing power efficiently, balancing battery-life versus weight, choosing appropriate sensors, developing sensor signal processing algorithms, and designing an aesthetic enclosure.



Each EnviroSensor package contains three sensors soldered to an Arduino microcontroller to record temperature, humidity, particulate matter, and ozone data.

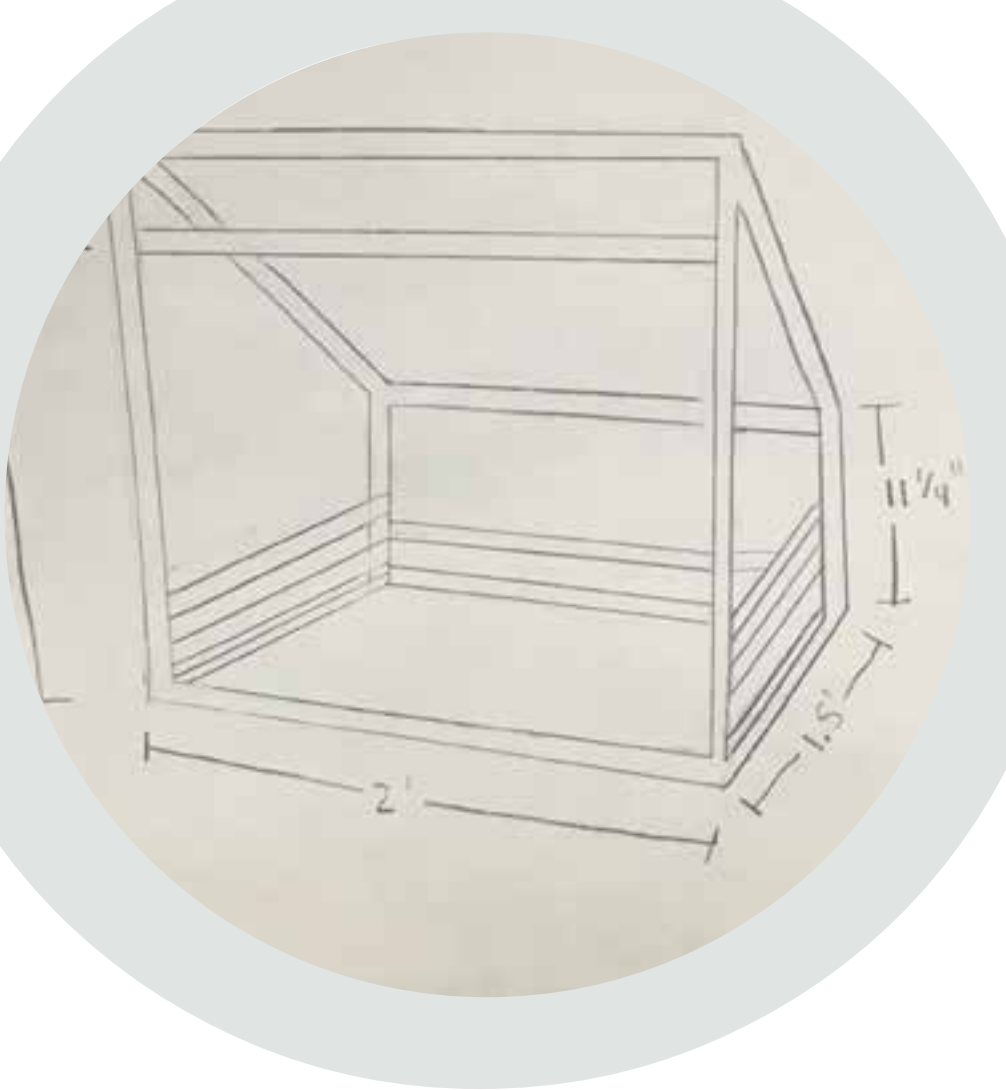
Development of a Research Scale Solar Drier System for Drying Algae

Team
Casey O'Brien
Matthew Pizzico
Sarah Thomas

Advisor
Dr. Samuel Morton

Photo Caption: Team Solar Dryer works diligently to construct their first prototype.

As society develops more alternative sources of energy, there is a growing interest in using microalgae to create biodiesel. Due to its high lipid content, microalgae can yield anywhere between 5,000 - 15,000 gallons of oil per acre which is significantly higher than corn, for example, which yields about 18 gallons per acre. A crucial step in producing biodiesel from microalgae is efficiently removing the water from a harvested biomass. Current methods for removing the excess water, such as electrically-heated single drum dryers, are very inefficient and expensive due to the amount of the non-renewable energy used. This is why the Solar Dryer Team has 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. Under the supervision of Dr. Morton of the Engineering Department, the team is currently gathering baseline drying data from their alpha prototype; a mixed-mode dryer that is heated simultaneously by the greenhouse effect and heated, atmospheric air that flows through the drying chamber. There are no current, external stakeholders for this project, but University of Kentucky's Center for Applied Energy Research has capabilities and resources that they are possibly willing to share in collaborative settings. Potential end users of the final product would be entities such as biodiesel producers, energy companies, and farmers. The project will conclude in April of 2017 with the development of a research scale dryer, readily available to be implemented in large, biodiesel production systems such as biodiesel companies, farmers, and research facilities.



An engineering sketch generated by the team to guide prototype construction.

Energy Reduction at the Kawneer Customer Operations Center

Team
Zach Bartemy
Alex Kroll
Jessica Roberts
Javal Swift

Advisors
Dr. Keith Holland
Dr. Adebayo Ogundipe

Client
Kawneer Customer Operations Center

Photo Caption: MadeEnergy revisiting building subsystems in need of renovations.

Recognizing the importance for sustainable development has never been more crucial than it is today, as natural resources become more scarce and international pollution regulations become more strict, coupled with the constant growth of human development. By recognizing this problem, the need for creating and updating infrastructure to more sustainable systems can be acknowledged. The context of the project falls in the area of updating the Kawneer Customer Operations Center infrastructure to a more sustainable, energy efficient system. Over the two-year span of the project's lifetime, the team will analyze the current state of the Kawneer building, propose methods for increasing the energy efficiency of the building, and lastly measure results after renovation implementation. To begin, a visual inspection, energy audit, and thermal imaging provided the baseline condition for the building. Building off of that data, recommendations were suggested for the 2016 summer renovation. These recommendations have already been approved in part, through the approval process is still ongoing. A budget for the team has been offered as well, helping narrow down the project scope. This fast progress means the capstone team will be able to measure the effected change caused by the team's recommendations this coming year.

Kawneer Customer Operation Center, located on 2013 Deyerle Avenue in Harrisonburg, Virginia, will be renovated based on team's recommendations.

"Good" Stove

Team
Daisy Becerra
Kevin Dawson
Ryan Voss

Advisor
Dr. Adebayo Ogundipe

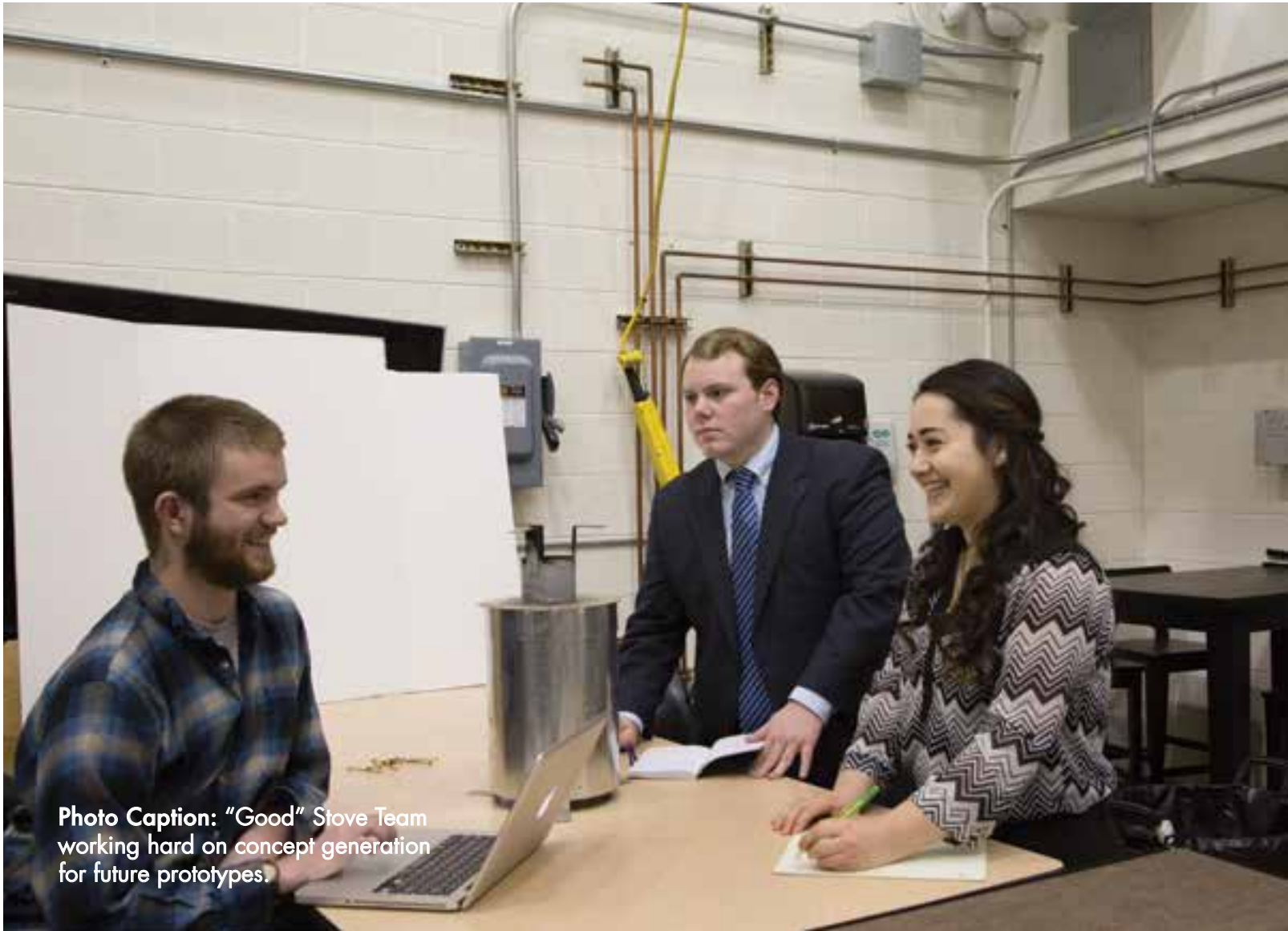


Photo Caption: "Good" Stove Team working hard on concept generation for future prototypes.

Pyrolysis Proof of Concept
Stove Prototype
(Provided by Dr. Teel)

Many rural communities around the world still rely on locally sourced biomass to burn for their energy needs. The World Health Organization (WHO) reports that approximately 3 billion people cook and heat their homes with open fires or leaky stoves that burn biomass. It has also been reported that every year, about 2 million people die prematurely from illnesses related to indoor air pollution from solid fuel use. In this project, we are designing a "good" stove appropriate for use by the Maasai in Longido, Tanzania, a rural African community who use such a stove. We are considering all aspects of this design including fuel type, combustion and conversion mechanisms, cooking conditions, capacity and size, materials, and heat transfer requirements. More importantly, we are focusing on how these requirements can best benefit the Maasai. The goal is to have a working biomass stove that will prevent the user from inhaling particulates, but can also be integrated into the community in Longido. In order for the design to be a "good" stove, it not only needs to be able to fulfill the technical functions, but needs to be accepted into the Maasai community in Longido. There are other similar programs have developed technology that fulfills the technical functions, but many fail because they do not focus on a specific group of people. It is necessary to use testing protocols and develop appropriate concepts that can fulfill the project requirements.

It is also important to create a way to empirically support design decisions. Through employing such a process, each aspect of the design can be justified, so that not only the technical requirements will be fulfilled, but also the social and economic requirements. Currently, we are developing potential concepts and creating a method to test and evaluate the designs.

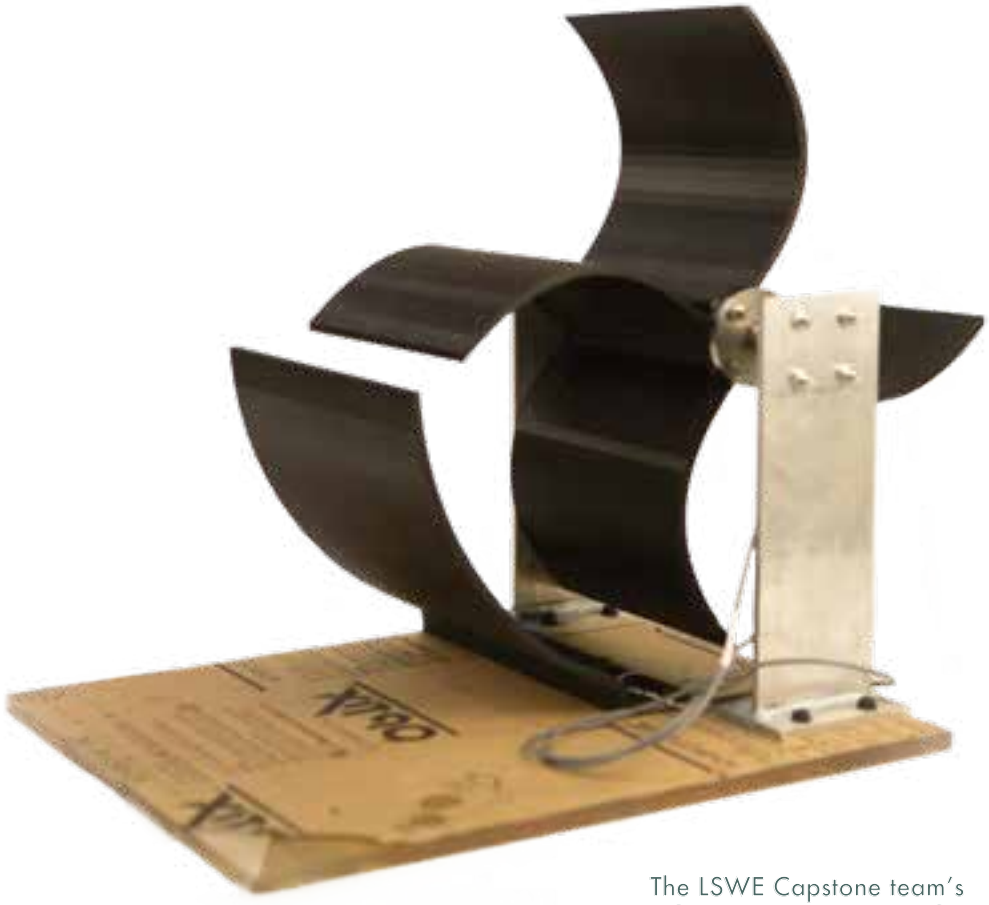
Harvesting Low Speed Wind Energy

Team
Michael Heller
Jamar Johnson
Matt Mason
John Walton

Advisor
Dr. Keith Holland

Photo Caption: LWSE Capstone team members debate the best course of action regarding wind tunnel testing of their prototypes.

Renewable energy is a growing sector of the energy industry because society is concerned about extensive fossil fuel usage. Traditional wind turbines utilize high speed winds (over 20 miles per hour) to generate power; however few areas have consistent high speed wind. In contrast, low speed wind areas, which experience winds between 5 and 20 miles per hour at ground level, are much more prevalent. The design of a low speed wind turbine is challenging because of the required torque to speed ratio. The purpose of this Capstone Project is to design a portable low speed wind turbine that efficiently captures low speed wind energy in order to generate at least five Watts of power and charge small electronics for use by outdoor recreationalists, renewable energy enthusiasts, and those needing emergency power. Five Watts was set as the power goal because it is what most cell phones require and is the output of USB charging ports. For this project, the campus of James Madison University in Harrisonburg, Virginia will be used as a testing area because existing wind speed data collected from anemometers on the campus' wind turbine indicate relatively constant low speed winds. Potential wind speed and theoretical maximum power output are combined through the Betz limit equation to calculate the needed cross-sectional area for the turbine. Using this information, a wind turbine will be designed that will efficiently achieve the desired power output. Currently, the Capstone Team is prototyping different turbine concepts and performing tests to validate the preliminary calculations.



The LSWE Capstone team's first prototype model of a drag-based wind turbine, one of several design concepts.

Human Thermoregulation

Team
Diego Jauregui
Hongmyung Lim
James Read

Advisor
Dr. Kyle Gipson

Photo Caption: The team is interested in discovering novel ways to cool human core body temperatures during exercise in hot environments.

A potential testing apparatus to determine variables and parameters for the project.

Humans cannot efficiently nor effectively cool down their body under hot temperatures. Research shows that a person's performance begins to suffer during aerobic exercises, such as running and cycling, when their body core temperature exceeds 104.2°F. Due to these findings, many devices such as cooling vests have entered the current market with the intent of lowering an athlete's core body temperature during exercise in hot conditions (in excess of 80°F). Unfortunately, research studies have found these devices only succeed at decreasing surface and skin temperatures only while leaving body core temperatures largely unchanged. As a result, the human brain incorrectly perceives the person's core temperatures as being lower than what they actually are, leading to feelings of illness after exercise due to physical overexertion. However, research has also indicated another cooling method, cool air inhalation, is much more effective at reducing core body temperatures. In line with these findings, communications have been established with the JMU Department of Kinesiology to develop a prototype for a cool air inhalation device that will more effectively reduce core body temperatures in athletes exercising in hot conditions. A prototype will be developed and tested that effectively cools core body temperature. Potentially, if this human thermoregulation problem is solved, then the solution will be able to help more than just in the area of athletic performance; this solution may be helpful in the advancement of medical, scientific, and military applications.

Infrastructure Sound Walls

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Tucker Firnstahl
Kevin Palmer

Advisors
Dr. Heather McLeod
Dr. Bethany Brinkman

Clients
Virginia Department of Transportation (VDOT)
Smith-Midland Precast Concrete

Photo Caption: Team ISW discusses their first cement mix design before casting.

Team ISW will cast and cure at least four prototype mix designs for comparison against existing sound walls.

Currently implemented sound walls in Virginia are failing after one year of use, but the specified design life by the manufacturer is 50 years. The goal of Team ISW (Infrastructure Sound Walls) is to identify the cause of durability issues and prevent premature degradation of sound walls by pinpointing the initial causes of structural or material failures. Team ISW is currently reviewing sound wall designs, precasting methods, construction methods, absorptive concrete characteristics, and concrete durability to gain a background in concrete design. The Virginia Department of Transportation (VDOT) has a list of suppliers who may participate in the bidding process; however the sole responsibility of VDOT is to select a bidder, most commonly the least expensive. Once a manufacturer is selected, VDOT supervises installation and oversees the project's completion. Team ISW aims to improve the quality of provided products to VDOT by revising standards specified to the approved suppliers. Through a successful project, VDOT will save time and money, which is currently allocated to future projects, rather than maintenance and repair of previous projects. Team ISW is currently developing a concrete mix design to replicate the absorptive mix used by the model manufacturer Smith-Midland. After a mix design is developed, Team ISW will subject concrete samples to ASTM (American Society for Testing and Materials) standardized test procedures, such as freeze--thaw durability, heat of hydration, and air content, to search for failures and potential flaws in the mix. The results of these tests will be used to diagnose problems in the design procedures or mix design used by Faddis manufacturing facility, who has provided inferior sound wall designs. Team ISW is scheduled to visit the Faddis manufacturing facility in late March.

Measuring Highway Wind

Team
Matthew Bors-Koefoed
Taylor Dillingham
Brandon House

Advisor
Dr. Steven Harper

Photo Caption: The team discusses modifications to the design and possible ideas for mounting the data capturing devices to their planned structure.

Shown are the components of the drive assembly to be integrated into the alpha prototype

For a vehicle to move forward, it must first push the air in front of it out of the way. This causes a draft or "artificial wind" which becomes more prominent at higher speeds. With a number of vehicles traveling Interstate 81 North alone that easily reaches 38,000 every day, it is clear that there is a large amount of this "artificial wind" being created. The problem is that little research is available that details these traffic generated wind events. The Highway Wind team's aim is to collect data on and analyze these events. To accomplish this, the team will construct a device that travels along I-beams under highway overpasses while running equipment like pressure sensors and wind anemometers. Simultaneously, video will be taken to compare the recorded data with the type and number of vehicles that pass. The team's goal for the next few months is to finish an alpha prototype of this device to conduct initial testings. VDOT has given the team permission to run tests on a bridge in Glasgow, Virginia that should provide the team with an accurate representation of the structures the device is expected to traverse. By the end of the project the team hopes to collect real-world data from the underside of highway overpasses. With this data, the team will be able to draw conclusions on the kind of wind events created by different vehicles under various circumstances. The team's analysis of this data will provide a better understanding of the effects of wind events caused by traffic and may prove to be useful to other entities and future projects.

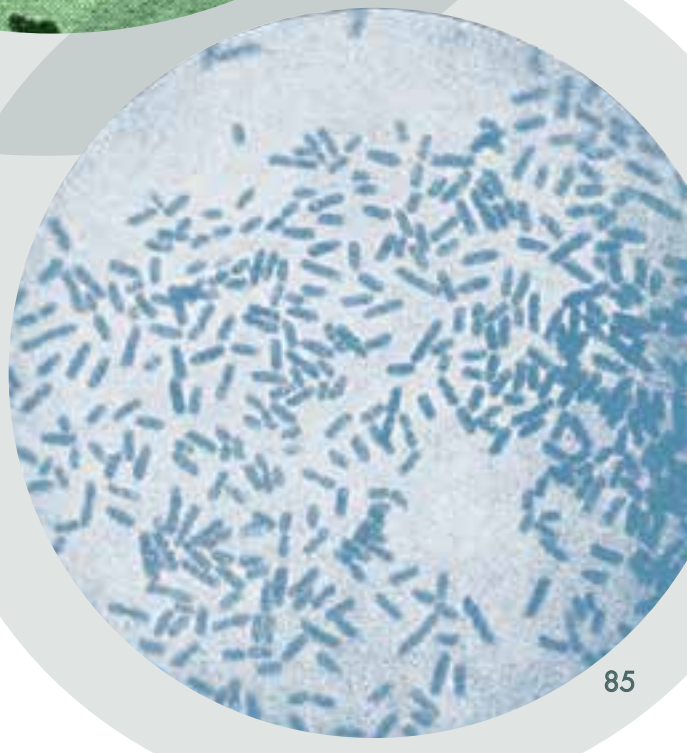
Point of Use Water Treatment

Team
Breanne Martin
Nick Strosnyder

Advisor
Dr. Bradley Striebig

Photo Caption: BAN researches a gravity fed filtration system by working with sieves to separate fine and coarse aggregate.

Across the world, nearly 2.5 billion people, including half of the developing world, lack access to potable water. Natural disasters such as floods or earthquakes can limit access to potable water by destroying existing infrastructure and polluting water sources. Access to potable water is imperative in the aftermath of a disaster because water-borne diseases, such as cholera and giardiasis, spread more easily when large numbers of people are displaced and living in temporary housing without adequate sanitation. The BAN Solutions Capstone Team (BAN) has researched common diarrheal diseases and concluded that biological water treatment by chlorination is the best method for treating water after a natural disaster because it combines the interests of the team members and needs of disaster victims as an innovative design challenge. After extensive investigation, the method of electrolysis chlorination was selected as a sustainable design. Electrolysis uses direct current to initiate an electrochemical reaction that ionizes and recombines any chloride salt in the water to form chlorine gas, which then kills potentially harmful microorganisms through oxidation. In addition to chemically treating the water, the design will also have a gravity fed filtration system to remove particulate matter. BAN strives to develop a sustainable design for the 2017 Madison xChange and hope the design will benefit future disaster relief efforts.



Microscopic view of the water borne disease Vibrio cholerae which will be killed with chlorine released from the electrochemical reaction.

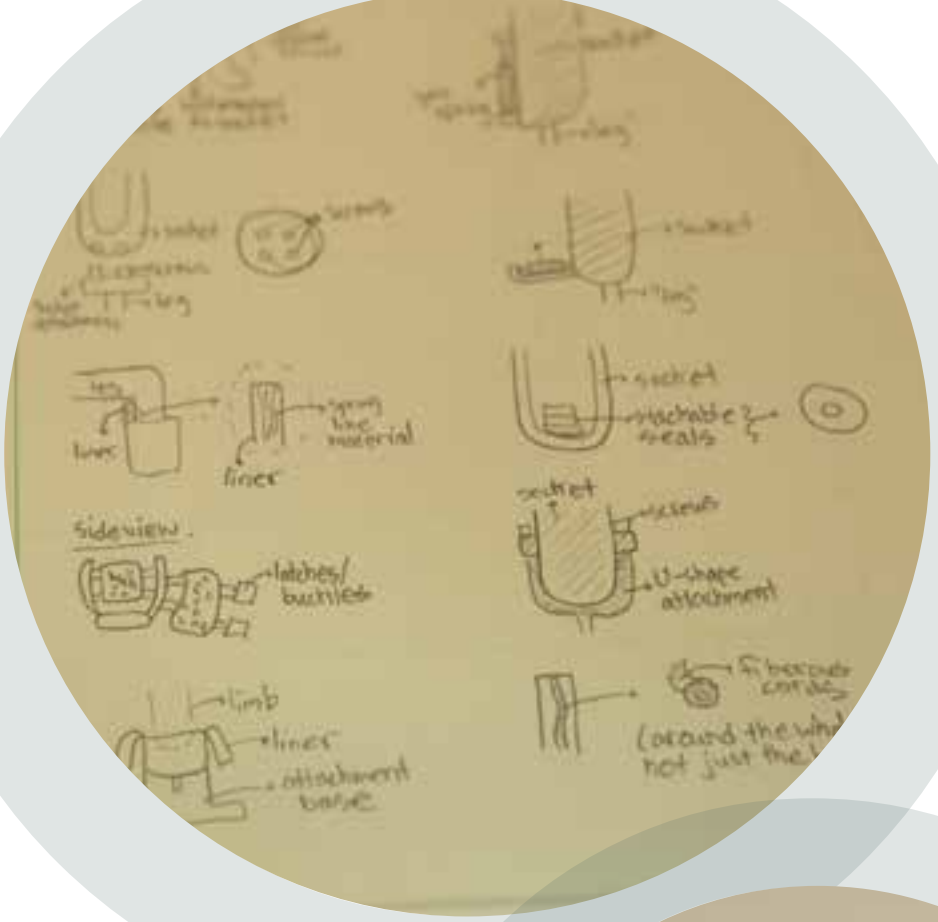
Prosthetic Suspension System

Team
Thomas Barrett
Blaize Majdic
Danielle Wilson

Advisors
Dr. Elise Barrella
Dr. Heather McLeod

Photo Caption: The team creates mathematical models to understand the functions of the prosthetic devices.

Currently there are 1.7 million people affected by limb amputation. Of these amputees, about half of them are below knee. While current designs for prosthetic legs provide amputees with greater levels of mobility, the systems still have their limitations. After doing in-depth background research on the pin lock, elevated vacuum, and suspension sleeve systems, the team observed many users experiencing pain and discomfort with these devices. This pain is a result of the vertical up-and-down motion, called pistoning, experienced by the limb within the socket of the prosthetic leg. This motion results in a greater amount of pressure being applied to the bottom of the residual limb during the walking motion. The goal of this project is to develop a prosthetic system that reduces pressure and alleviates the pain experienced by the user, thus improving their quality of life. To determine the exact cause of pain, which will be modeled as pressure, the team is developing static and dynamic mathematical models of the user's walking cycle. Once these models are completed, the team will collect data on a person's walking cycle to verify the calculations. These mathematical models will aid the team in generating feasible design concepts geared towards reducing the pressure felt by the user. The team's objective is to have a complete prototype by the end of next year that is backed by data that has been gathered and analyzed. If successful, this design could significantly improve an amputee's walking cycle, and provide them with a better prosthetic.



The team begins to visualize their ideas to life through sketching concepts and obtaining real world models of prosthetic components.

Stormwater Management Plan

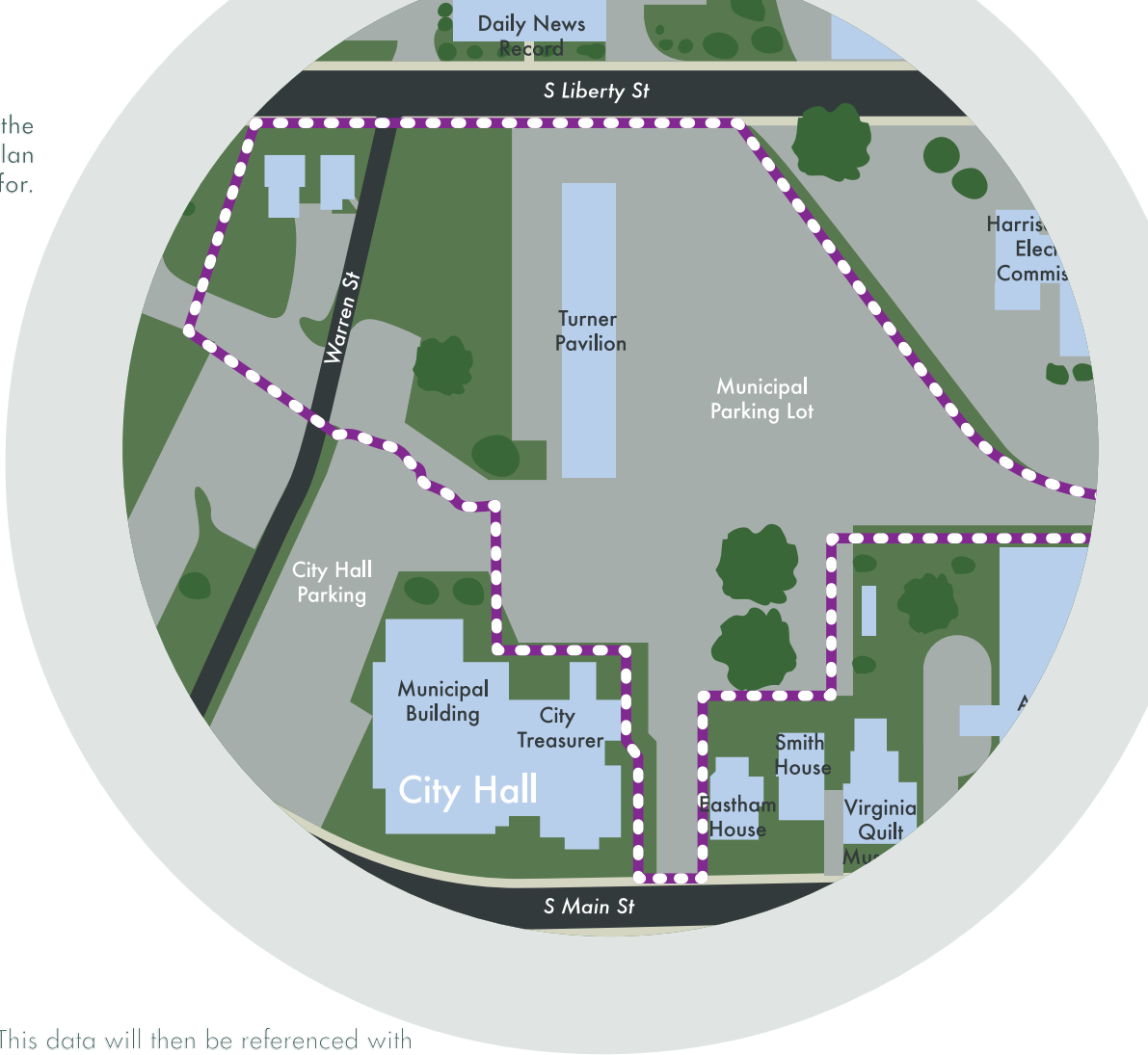
Team
Madeline Baldwin
Jeffrey Culp
Devon Paysour
Andy Rivas

Advisors
Dr. Elise Barrella
Dr. Bethany Brinkman

Client
Build Our Park Committee of Harrisonburg, Virginia

Photo Caption: Team members testing water from project site for contaminates and chemicals, such as phosphate.

Map of site in which the stormwater management plan is being designed for.



A capstone team from James Madison University's Engineering Department is tasked with designing a sustainable stormwater management plan for Harrisonburg's new downtown urban park. The Build Our Park Committee of Harrisonburg, VA has been working to install a park that will act as a model for the surrounding areas and includes many environmentally friendly initiatives. Therefore, the stormwater management system for the park must remove contaminants and be feasible for implementation and maintenance. The capstone team's final product will be designs and plans for a stormwater system that will control and reduce the runoff from the 4.5 acre site along with additional flow from adjacent sites. This final system will satisfy stated goals as well as all requirements pertaining to the project. The requirements for this system will be derived from local and state regulations, as well as customer needs acquired from the Plan Our Park Committee. A crucial part of developing these requirements is testing the sites' runoff water for contaminants. The team has developed a detailed testing plan outlining testing methods for each contaminant of concern, including but not limited to nitrogen, phosphate, and suspended solids. Testing will take place throughout the spring 2016 and following fall semester in order for the team to determine average amounts of concentrations of contaminants running off the site area. This data will then be referenced with state and local codes to help determine the levels of contamination that need to be removed. Given this information, a quantitative measure of evaluating specific stormwater solutions will be available. Research will continue to be completed throughout the project on existing stormwater solutions which will aid in the team's brainstorming and concept creation process. Completing these steps by May of 2016 will leave the team prepared to formally begin generating written and drawn stormwater management plans for the park space.

Sustainable, Accessible and Feasible Energy for Mobile Coffee Establishments

Team
Darby Brooke
Aidan Ryan
Michael Scrogham
Travis Weeks

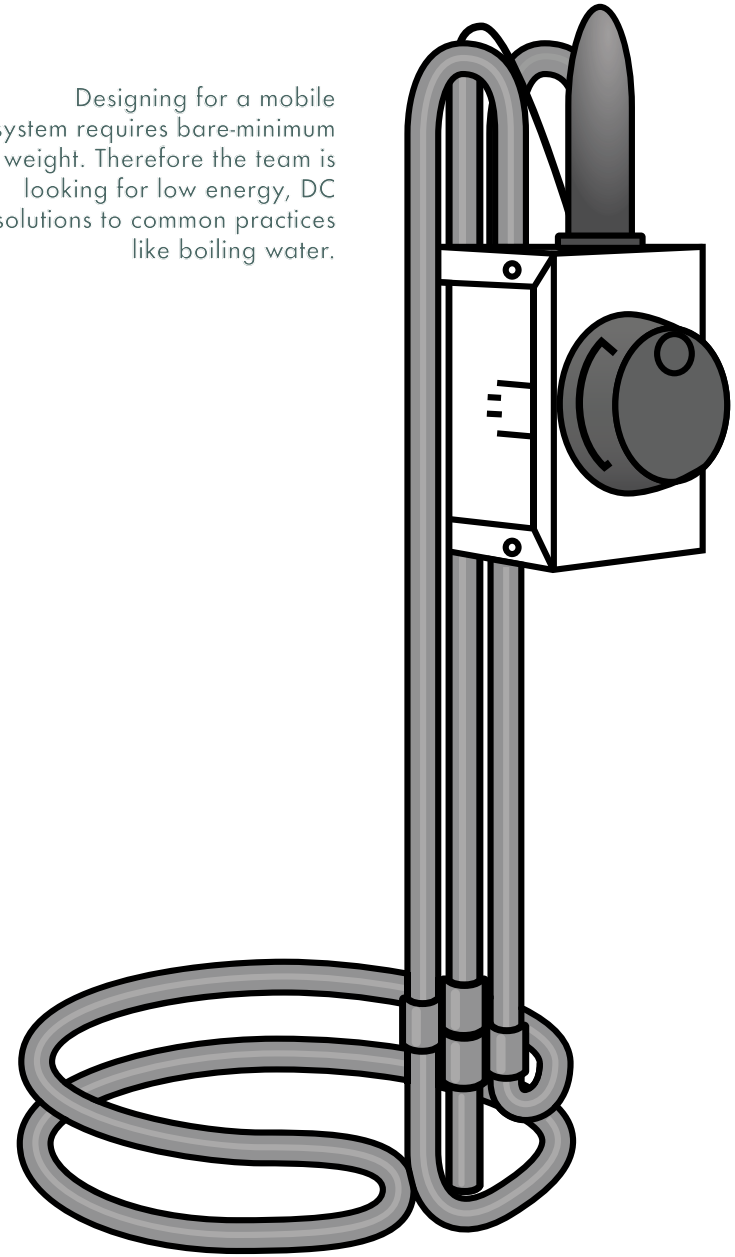
Advisor
Dr. Justin Henriques

Client
JMU Dining Services

Photo Caption: No level of detail is too small for the team, as they strive to bring sustainability to every facet of their project.

Harrisonburg has seen a large increase in its number of food trucks with more than 20 food trucks operating and serving their product regularly. Also increasing in popularity is the specialty coffee industry, which can be seen in Harrisonburg from various cafes opening such as Black Sheep, Shenandoah Joe, multiple Starbucks, Greenberry's and more. However, with this increase in popularity of both mobile foods and specialty coffee, there are little to no efforts towards bringing sustainability into the picture. This capstone project seeks to take something that more than 150 million Americans do every day, and integrate it within the mobile food market. In this way, the thing can go directly out to the people, and tell a story about how important it is to consider the impact that our individual actions have on the planet at large. That thing is coffee consumption. Brewing coffee requires a large amount of electricity. Based on current findings, for a home user to have their espresso machine and coffee brewing device turned on for ten hours is equivalent to the energy needs of a full charge on the 2016 Nissan Leaf! So the amount of energy needed to drive from Washington DC to Richmond, Virginia is roughly the same that a home barista might go through in a day of having their equipment on. This project seeks to set an example for how sustainability can be brought into every facet of daily life, including your morning cup of coffee.

Designing for a mobile system requires bare-minimum weight. Therefore the team is looking for low energy, DC solutions to common practices like boiling water.

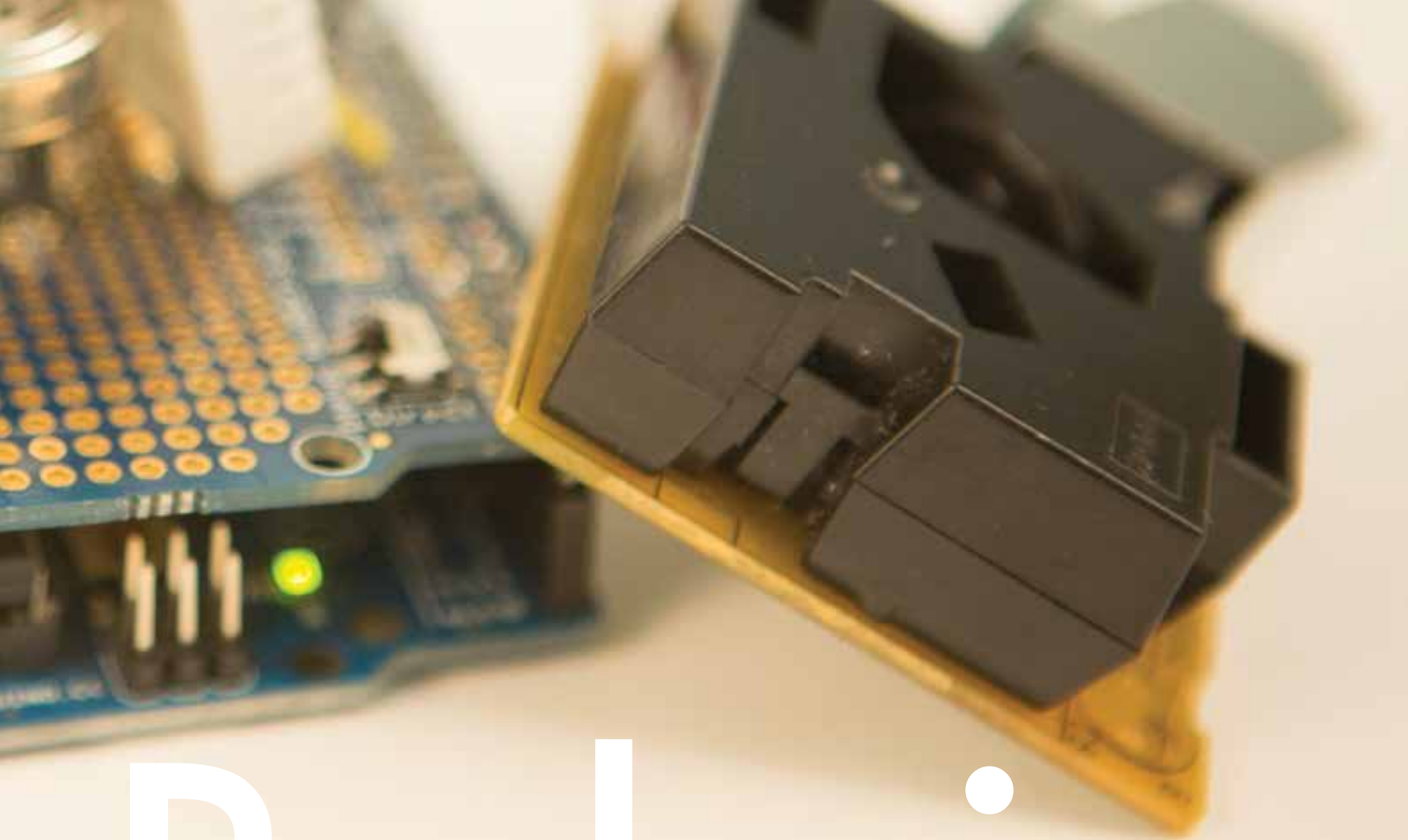


We had some good times in Engineering. We all miss You. Rest Easy Brother Man! RIP
~ Kevin P.

In memory of Austin (Steven) Underhill (1994-2016)

"The best way to complain is to make things."

— James Murphy, LCD Soundsystem



Redesign

Sa

ophomores

Teams

Advisors
Dr. Jacquelyn Nagel
Dr. Robert Nagel

Client
Syerra

Madison Madness Forever
Mark Castro
Jack Boone
John Nevin
Julie Strunk
Jacob Nelson
Dylan Granados
Jeff Redd
Caleb Jones
Mazna Bilal
Grant Arnold

Human Powered Solutions (HPS)
Austen Hendrickson
Billy Metzler
Cameron Dudley
Daniel Pinson
Greg Mayo
Justin Smith
Kaitlyn Barger
Matt Thomas
Michael Zern
Peyton Pittman

JMaddy Industries
Maxwell Adams
Bryan Barns
Joseph DeLuca
Michael Evans
Kyle Jenkins
Marilyn Lehmuller
Cole Potridge
Daniel Rauch
Ashlie Veroni

East Coast Engineers
Lauren Hafer
Anthony Deleon
Chelsea Waldon
Gray Kline
Kathryn Mahach
Martin Melhail
Matt Wolcott
Mitchell Gerdau
Greg Schmidt

Just a Couple of Dudes
Andrew Ward
Austin Marrs
Branden Gross
Connor Scott
Ethan Reeves
Matt Dove
Matt Kerner
Richard Xu
Tyler Leitman
Zach Cummings-Green

Team Rocket
Seemran Patel
Bryan Browne
Clay Bomberger
Michael Heller
Azeem Muffi
David Gwynn
CJ Collins
Zach Leonard
Connor Bell

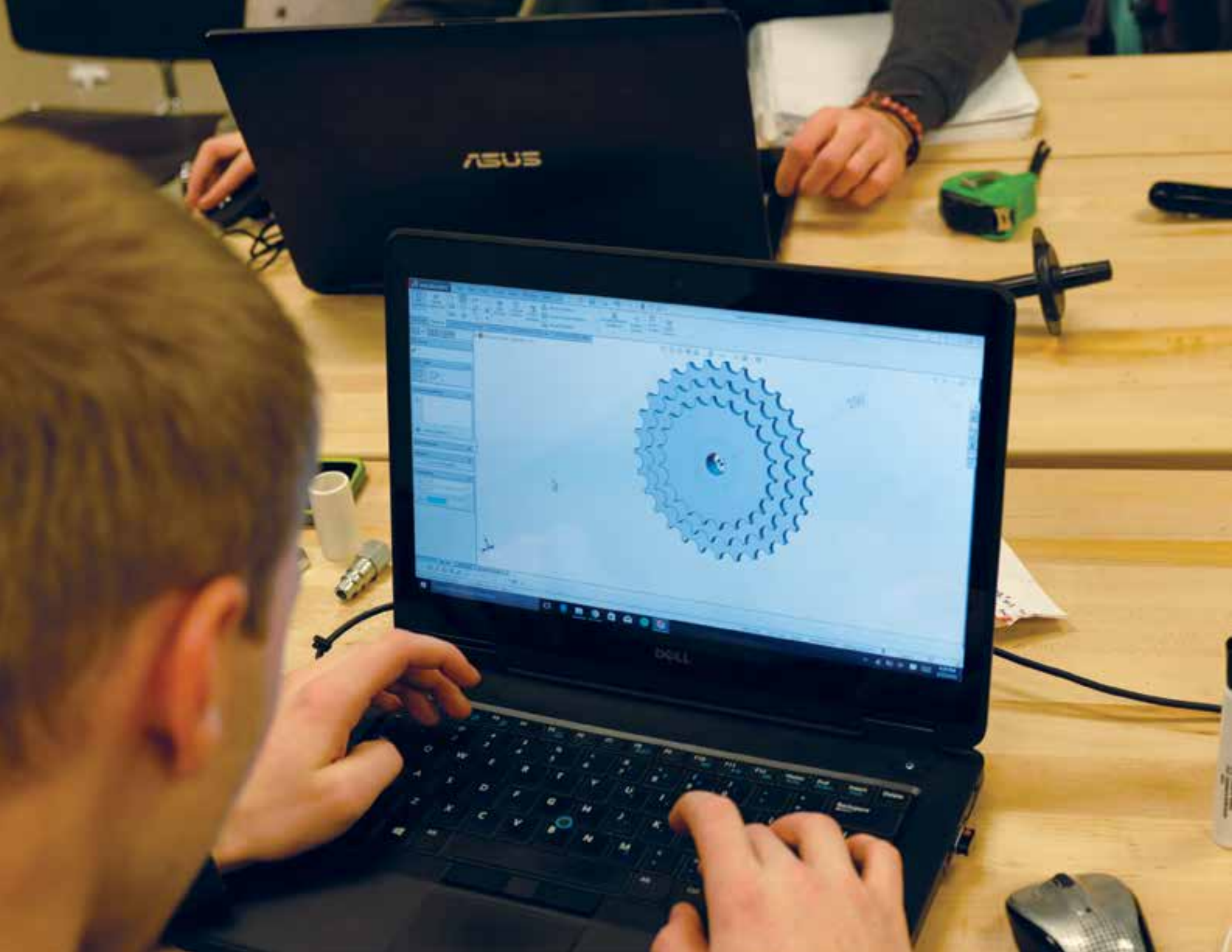
MadE in Madison
Kyle Butt
Mason Clairmont
John Feden
Morgan Felix
Harmon Hawkins
Winifred Opoku
Cameron Robinson
Daniel Utrera
Joseph Winn

Golden Standard
Isabelle Caballero
Myles Fogleman
Kevin Frautschi
Joe Grabowski
Stetson Kniff
Ryan Ku
Matthew Liebl
Maria Parilli Castillo
Jamie Woodall

The Enforcers
Robert Baxley
David Black
Dillon Celinski
Ryan Hartsell
Kyle Hodges
Wyatt Jankauskas
Wade Knaster
Andrew Thoreen

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 Syerra, a young lady with cerebral palsy. Through the year, students worked closely with Syerra, her mom, 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; chose components; and constructed their final design. The one design from the sophomore class best suited for Syerra will be selected and sent home with her following a summer of focused refinement completed during an internship by a Madison Engineering student.

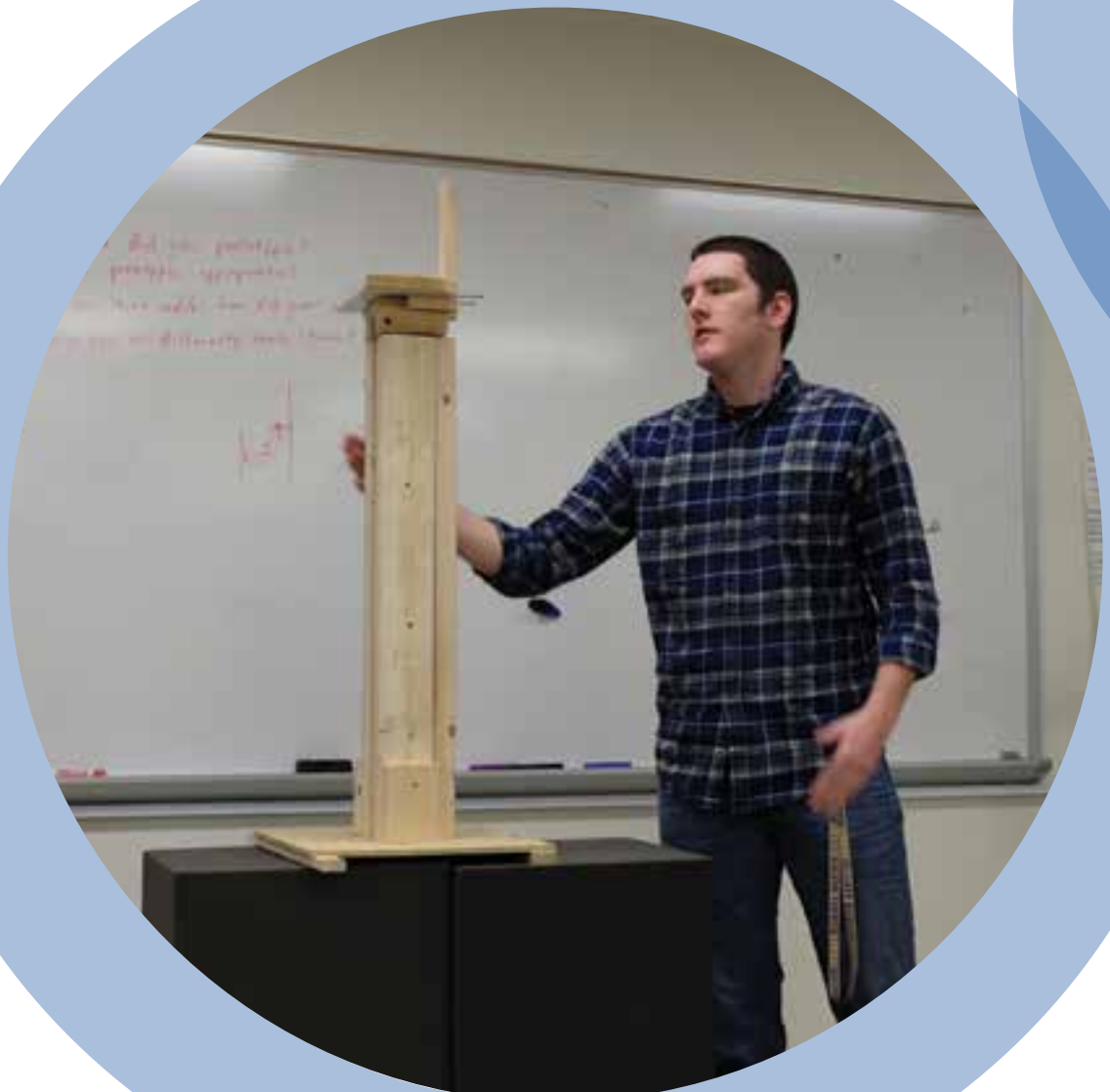

ASUS
DELL


19


PHI MU


(1) What System did you prototype?
(2) Why
adidas


103
AIR FIRC
ACADEM




Campus Cookies


Delight

"Fall in love with the problem, not the solution, and the rest will follow."

– Uri Levine, Co-founder, Waze

First-Year

Teams

Advisors
Dr. Kyle Gipson
Dr. Brent Cunningham

Clients
Dr. Perry Shank
Niki Miragliotta

J-SAGA
Sanarea Ali
Arie Bradley
Ganesha Greenwald
William "Austin" Raines
Jacob Thompson

Miracle Workers
Luc Bailey
Lukas Bergstrom
Grace Carter
Alexander Gellios
Robert Gerber

Peter and the ACBC
Costantino Berard
Peter Condro
Alex Hasty
Christopher Marce
Brian Schieber

Team Blue
Marian Gerlitzki
Sabrina Hammell
Carlee Smith
Tristen Spencer
Savannah Wood

Workaholics
Troy Fries
Julia Hutchens
Austin Pelto
Anni Yang

Cool Coulombs
Dalton Whetzal
Dwyer Bird
Shane Butler
Christine Gatto
Daniel Fouch

Engineering in Rhythm
Dominic Coradazzi
Ernest Benner
James Fasano
Reuben Johnson
Kerry McCullagh

FTM
Jason Renalds
Natalie Peterson
Brogan McCauley
Jeremy Alino
Jared Givan

Team Avalon
Raphael Bellon de Chassy
Preston Liverpool
Michael Bruce
Matthew Hill

The Rolling Stones
Bernard Bair
Joseph Carrico
Jens Byer
Amaas Ilyas
Will Roussel

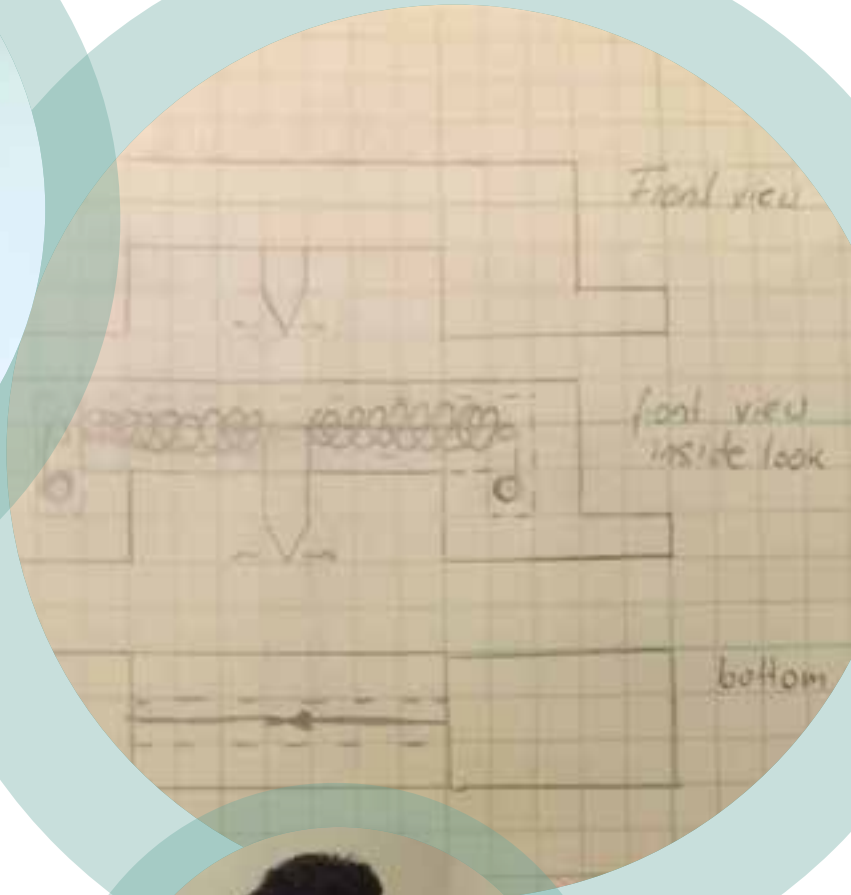
Thunder Mifflin
Sarah Trotter
Sam Drzal
Caleb Hoehner
Oumaima Atraoui
Nicholas Colonna

Adaptable Musical Instrument

Two sections of ENGR 112 have a course project that involves the discovery, design and construction of adaptable musical instruments for three local clients ranging in age 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.


30

G C E A
C - Chord


Front view
front view
inside look
bottom

Teams

Advisor
Dr. Keith Holland

Clients
Harrisonburg Explore
More Museum

#areyoudownwithup#
Kareen Rivera
Delaney Kost
Jaron Martinez
Colin Brechwald
Connor Ray

Fix It or Die Tryin'
Michael Davis
Carlos Cox
Kyle Inocco
William Armstrong
Kareem Ebraham

Its Electric
Christopher Slykhuis
Nicholas Liberati
Harrison Gillock
Kristen Heaton

Optimus Holland's Autobots
Callum Morton
Daniel Clements
George Walter
David Sydnor
Maui Ong Ante

Team NAASA
Faldo Jatmoko
Andrew Payne
Neth Gardner
Ashley D'Angelo
Alex Mironenko

The Notorious ENG
Mark Livingston
Ahmed Elnour
Matthew Dove
Matthew White
Ben Jenkins

Harrisonburg Explore More Museum

What sparks the imagination and curiosity of children? How can we encourage them to become makers, creators, and engineers driven to solve complex problems? First-year engineering students in Dr. Holland's ENGR 112 class partnered with the Explore More Museum of Harrisonburg, VA to address these questions. The Explore More Museum is in the process of expanding their interactive exhibit offerings. After visiting and learning about the museum, the ENGR 112 class was challenged to identify opportunities to engineer potential solutions to benefit the museum. Six student teams developed ideas and solutions to address high priority needs for the Explore More Museum, including the design of interactive kinetic sculptures and ball mazes, maker space challenges, and donor recognition displays.



JMU
CLUB SOCCER



Teams

Advisors
Dr. Elise Barella
Dr. Heather McLeod, P.E.

Clients
Warlick-Burrow Family

D.N.B Homes
Daniel Butler
Braxton Faggert
Nick Pitorri

GreenHomes
Jonny Lizama
Nik Meuschke
Connor Sinn

M.A.T house
Lawrence Marfo
Austin Trimble

More Space, More Problems
Rayshawn Booker
Albert Fung
Trent Orie

Team Bert
Melanie Boyle
Ben Cotton
Andrea MacGregor

Team Big Things (TBT)
Tori DeSpirito
Nathaniel Lucas
Sophia Welch

Tiny Builders
Marie Marshall
Kathryn Nielsen
Lizzy Tafoya

Tiny House BIG LIVING
Rob Branch
Rohan Jung

Design by RJ
Riley Pates
John Hannahs

Downsizers
Roman Cook
Kyle Vickery
Garrett McGurl

Team Blue Ribbon
Matt Lancaster
Justin Starnes

Team Builders
James Kizler
Zaki Samady
Brenden Barcas

Team Design Squad
Ethan Anderson
Nick Butts
Edward Carbaugh

Team Tiny Fix
Zachary Shipman
David Villar
Jake Quercia

Team Tiny People
Joshua Payne
Adam Pinegar
Brian Pluchinsky

Tiny Trio
Brianna Palazzola
Jamie Riley
Sarah Alter

Tiny Works
Aaron Sloss
Jonathan Sarker
Jorge Pena

Living Large in a Tiny House

Did you know that the average house size in the US is approximately 2500 ft^2 and has increased by 50% since the 1970s? The Tiny House Movement is growing in the US as a means to reduce environmental impacts of residential living and make home ownership more economically viable for many individuals and families. Tiny Houses are residential structures of approximately 150-400 square feet that can be either permanent or on wheels. Freshman engineering teams are analyzing challenges and design solutions associated with Tiny Houses to serve the needs of their clients, a local family of four. The family would like to downsize to reduce their environmental footprint while maintaining quality of life. Over the course of the semester, the teams are using creative and analytic problem-solving processes to design and build innovative space-saving solutions. They are also investigating ways to efficiently and cost effectively power the house, ideally using renewable energy. To best serve their clients and represent the engineering profession, the teams need to weigh the feasibility, safety, health, affordability and legal dimensions of all options. How large can you live in a Tiny House?


JAMES MADISON
DUKES

Team

Advisor
Dr. Bethany Brinkman

Madison Anderson
Thea Azzarone
Sean Bartro
Samantha Coriarty
Johannah Daschil
Hunter Davis
Emma Drummond
Andrew Farber
John Hunter
Farris Jarrar
Xavier Johnson
Joshua Jones
Matthew Kennedy
CJ Lilovich
Austin Luke
Jack McGeoghegan
Federico Meersohn
Thomas Milkowski
Matthew Mumford
Ian Nguyen
Tevenia Rodgers
Kristian Tarter
Richard Thrift
Dylan Tracey
Cole Young

Mechatronic Pinball Machine

The field of mechatronics combines elements of mechanical engineering, electrical engineering, and programming to create complex mechanical systems that are controlled by electrical signals. To demonstrate their proficiency in these basic engineering fields, students in Dr. Brinkman's ENGR 112 class designed, modeled, built, tested, and refined small, playable, mechatronic pinball machines. Each machine includes a solenoid spring to set a conducting ball in play, spinning motors to direct the ball around the board, numerous lever switches to initiate lights and buzzers when contacted by the ball, and a rotary solenoid flipper to keep the ball in play. An Arduino Uno board plays programmed music to accompany the game. The base board was also modeled in SolidWorks to assist in construction. During the design and construction process, student teams learned the importance of planning the mechanical and electrical systems side-by-side so as to have room for all of the wires and moving components. Key elements of the final mechatronic pinball machines are workmanship, creativity, and playability.


NOTICE

Magic

by Shel Silverstein

Sandra's seen a **leprechaun,**

Eddie touched a troll,

Laurie

d

a

n

c

e

d

with *witches* once,

Charlie **found** some *goblins'* **gold**.

Donald HEARD a *mermaid sing,*

Susy spied an elf,

But all the *magic* I have known

I've had to *make* **myself.**