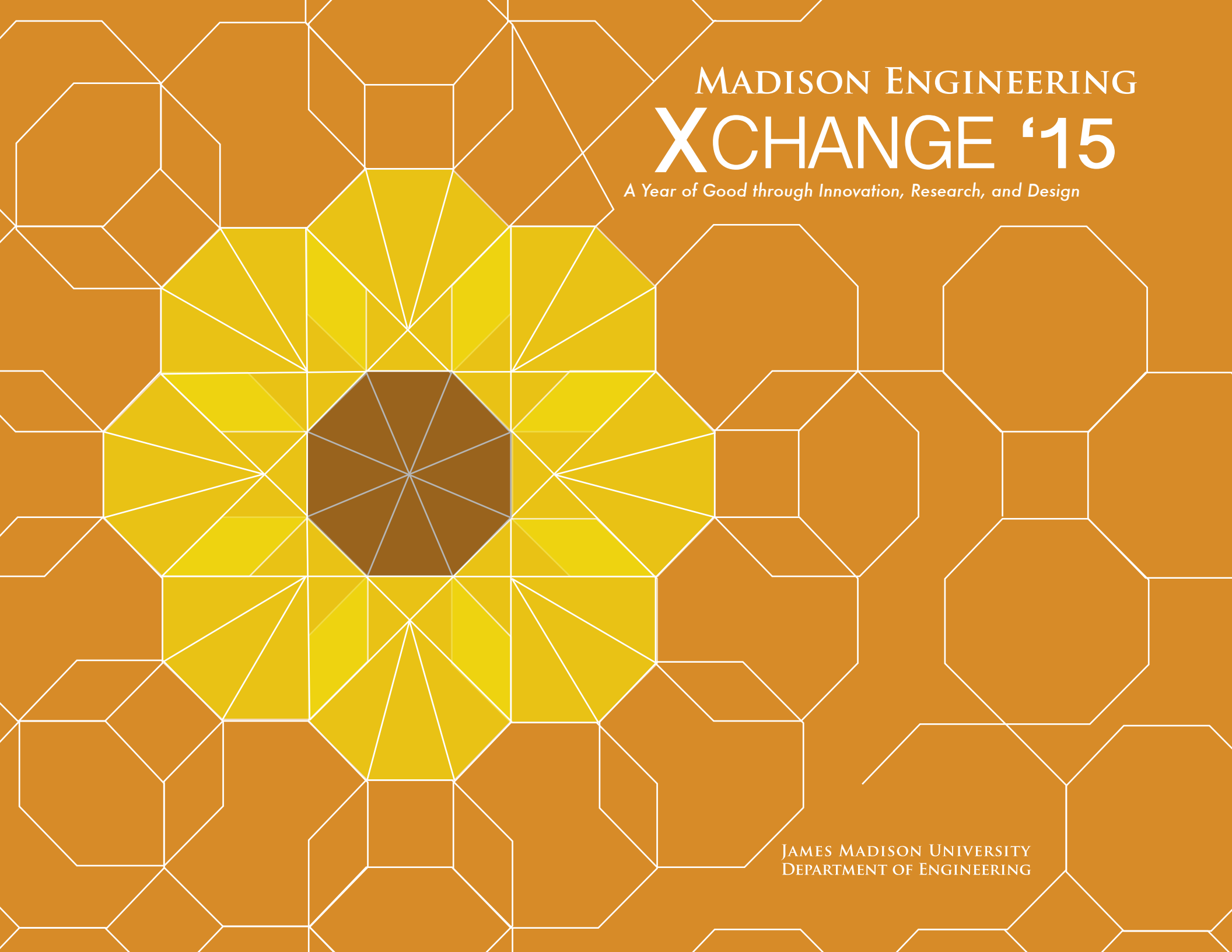
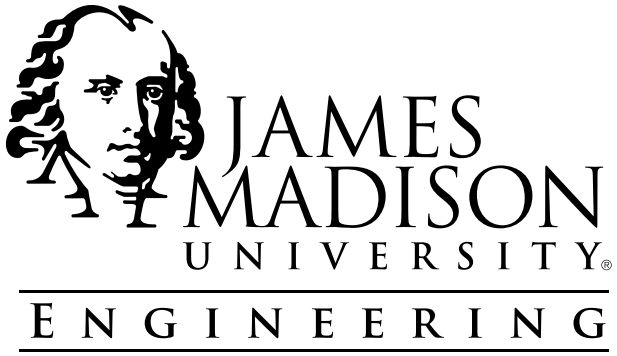
Madison Engineering XCHANGE '15

A Year of Good through Innovation, Research, and Design



James Madison University
Department of Engineering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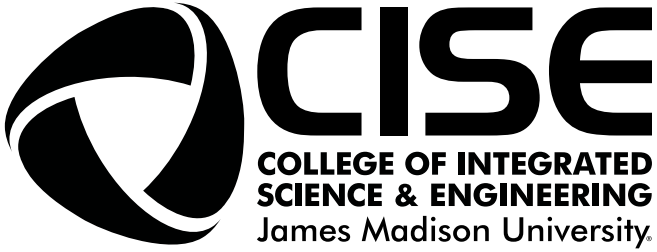

CISE
COLLEGE OF INTEGRATED
SCIENCE & ENGINEERING
James Madison University

Acknowledgements

I'd like to acknowledge our students, faculty, staff and partners who wake up daily with a spirit of generosity, excellence, respect, learning, and collaboration — in the end, these are the qualities that make the real difference depicted by the projects in these pages.

I'd like to especially acknowledge engineering professors Elise Barrella, Robert Nagel, Keith Holland, Justin Henriques and Kyle Gipson for not being able to settle for average, and helping redesign all aspects of xChange 2015. I'd also like to acknowledge the incredible work of Prof. Barrella and Caitlin Boyer for their heroic efforts at orchestrating a massive flow of information for this book, and the xChange event.

A sincere thanks goes out to our families and friends who support us during the long hours needed to bring this all together; they make it all worthwhile.

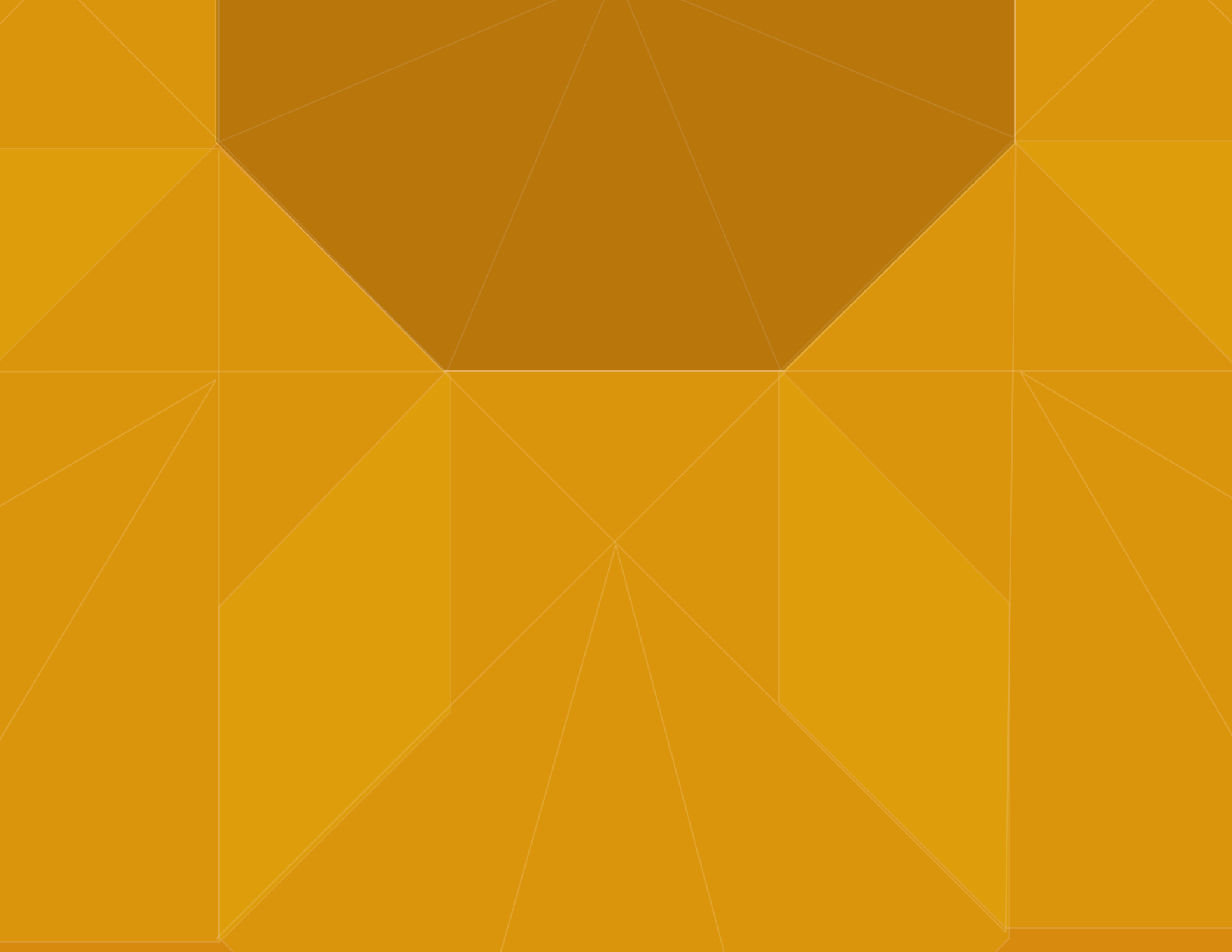
Lastly, the beautiful book you are looking at would not be possible without the vision and artistry of graphic designer Rebekah Bonds, photographers Justin Falls, Julie Stern, Jeffrey Thelin and Henry Zhou, and the staff at Creative Services.

Together, we are blooming.

— KGP

Engineering

Good



Welcome to the 2015 Madison Engineering xChange! It's our annual celebration of the past year's works from our engineering students and their many partners.

We are often asked why the Madison Engineering program is project-based. Part of the answer is that we know experiential learning is one of the most powerful ways to learn, and it's important to us, and employers, to offer an authentic learning environment. The less obvious reason is that the four years of our project-based curriculum connects our students to the project-driven engineering profession; belonging to the engineering community is critical to our students' and alumni's successes.

However, project-based experiences only reach their full potential when two important features are present: engaged learning and ownership of work. As you will see throughout the event today, Madison Engineering students engage with the local community, industry, and others, beginning their first year and continuing through their senior year. The xChange itself is our fullest expression of ownership; all Madison Engineers have worked on a major project this past year, and all are here to put their names and reputations on their efforts in a public forum. Each year, I'm immensely proud of our students who show up, make a difference, and get their work out into the world.

It's your participation in our day, though, that helps complete this virtuous cycle of belonging, engagement and ownership; together we are not only creating some of the best engineers in the world, but also doing our best for the world.

Enjoy the xChange.

Dr. Kurt Paterson
Head, Department of Engineering

April, 2015

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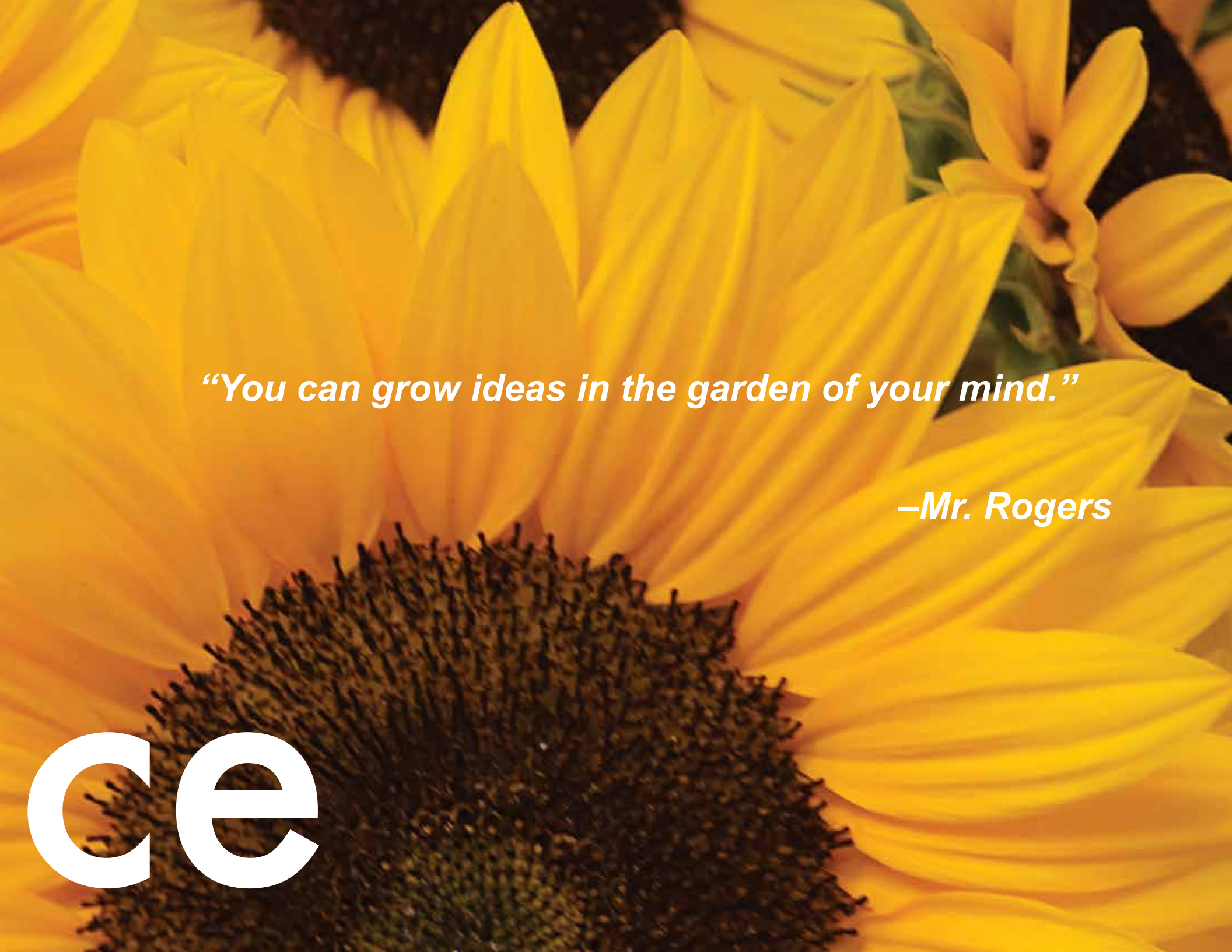
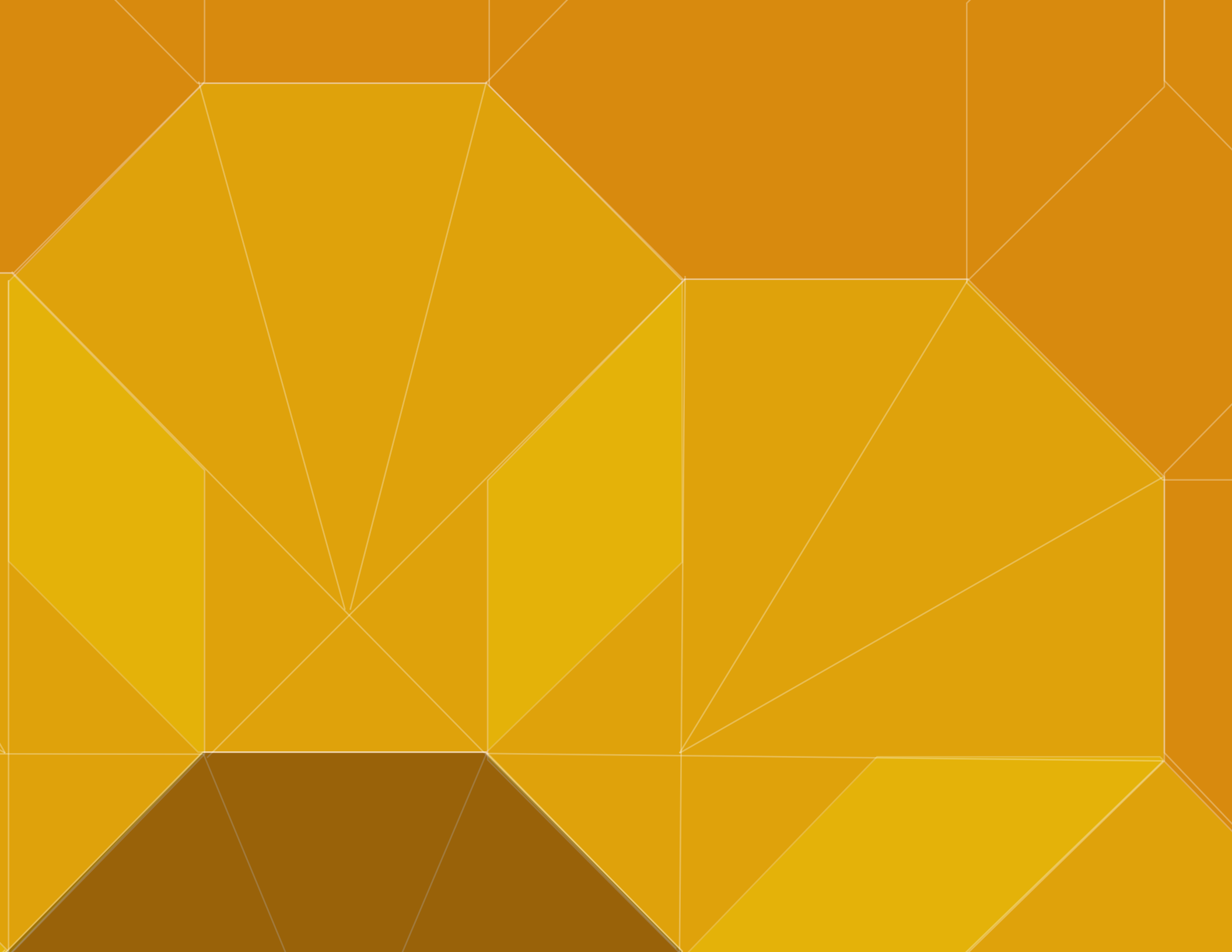

“You can grow ideas in the garden of your mind.”
–Mr. Rogers



Honors

Honors

Honors

Lauren Distler

Feasibility Study:

The Evaluation of Polymer Coatings to Prevent Weathering of Weak Rocks

Lauren Distler is a senior engineering major, graduating in May of 2015. Originally from upstate New York, Lauren and her family have now lived in a small town in Maryland for 15 years. Lauren is an aspiring globe-trotter with interests in philosophy, acoustic guitar, and experiencing the outdoors. In the summer of 2013, she obtained an environmental engineering internship with O'Brien & Gere in Syracuse, NY. The following summer led her to a student research position at the University of Colorado, Boulder. During the last four years at JMU, she discovered passions for the preservation of the environment and for helping those less fortunate through engineering design and management. She co-founded the JMU student chapter of Engineers without Borders, and is a leader in the engineering department. Recently, she has been accepted to the University of New Mexico with a research assistantship to complete a Dual Master's Degree in Community and Regional Planning and Water Resources.

A. Slake durability device used to measure the durability of rock samples.

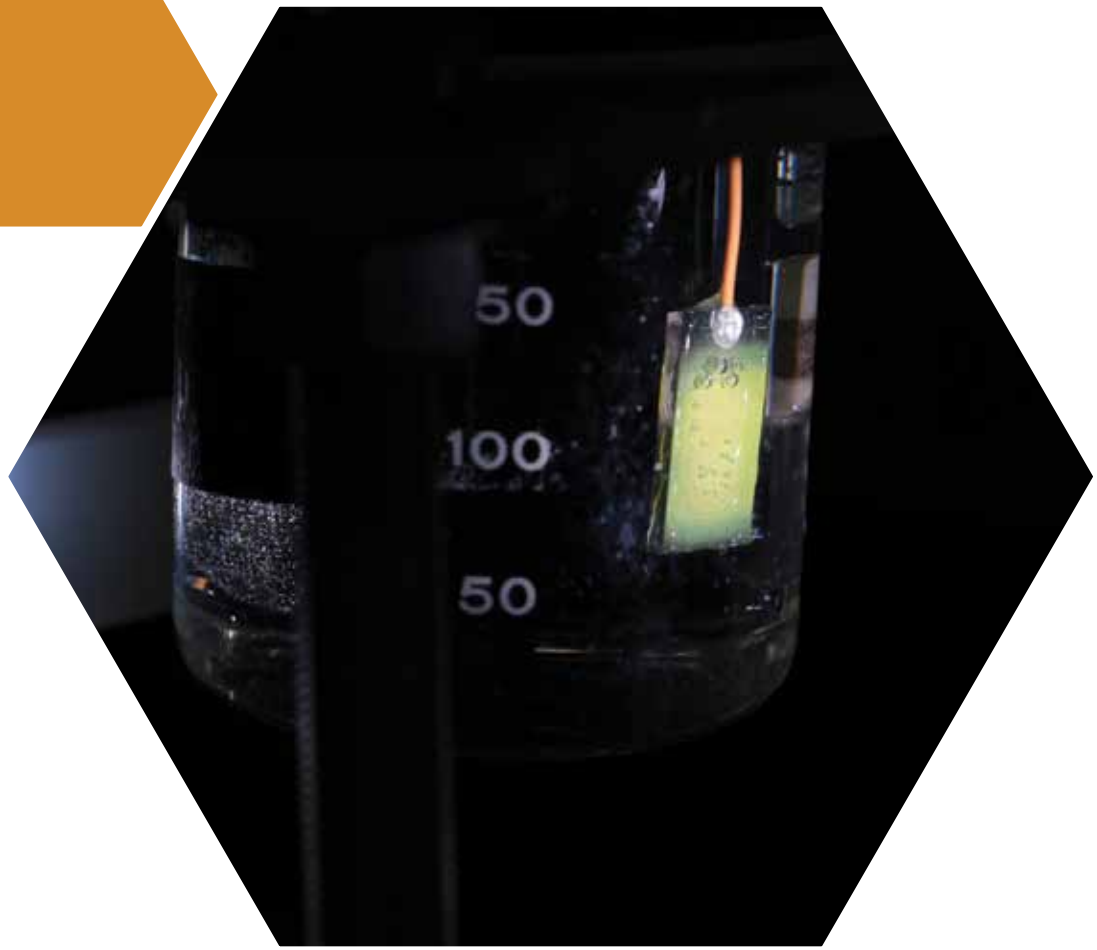
B. Uncoated rock samples after second cycle of slake durability testing

The weathering and erosion of weak rocks along roadways can cause dangerous and potentially fatal rockfalls. Various slope stabilization methods exist, but each presents a set of challenges and trade-offs. The focus of the project is to understand the feasibility of utilizing of a polymer-based slope stabilization technique. Rock samples were collected along US Route 33 in Virginia and West Virginia, and preliminary tests were conducted to evaluate the absorption of water (% mass) and durability. The study evaluates three polymer options in regard to the following criteria: adhesion to rock, layer thickness, semi-permeability, insolubility, and non-toxicity. The polymer selection process yielded that a water-based polyurethane would present the benefits of creating a waterproof and lightweight coating when applied to the rock analyzed as part of this study. Polymer coated rock samples were tested in same manner as the uncoated rock samples from the preliminary tests; where the results indicate a slight decrease in water absorption and an increase in erosion durability. Intended future work will investigate the impact of application technique on the durability and absorptive properties of coated rock samples.

Lauren Phillips

Lauren Phillips will be graduating in May 2015 with a Bachelor's of Science in Engineering and a minor in mathematics. She attended Chantilly High School, in Chantilly, VA. Lauren started research in the summer of 2013 with Dr. Holland and Dr. Lawrence. After graduation, she plans on pursuing a career in mechanical engineering.

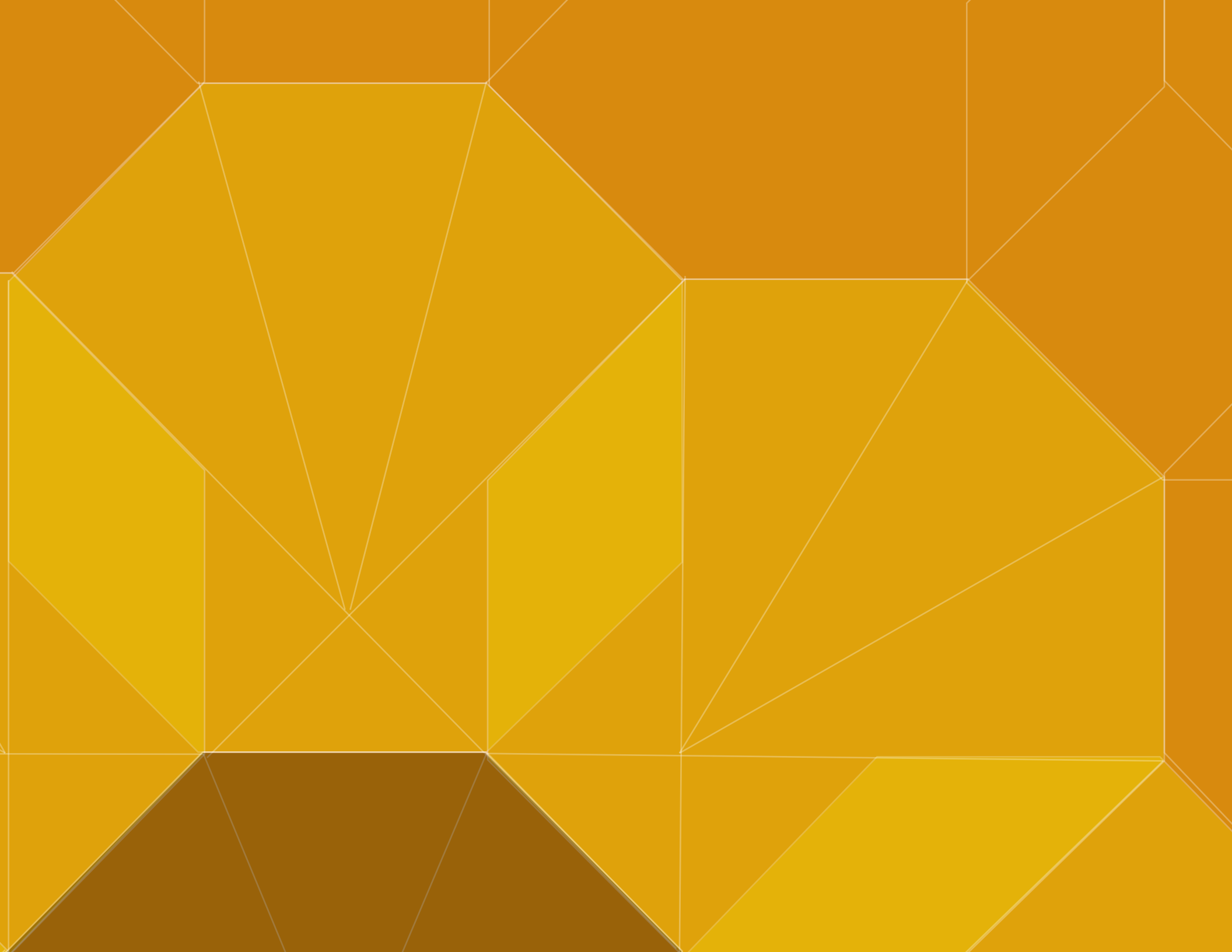
Variability in the Fabrication Process of $BiVO_4$ Photoanodes



Hydrogen gas produced from the photoelectrochemical (PEC) decomposition of water, using sunlight as an energy source, is a promising approach for sustainable fuel production. This decomposition of water is also called artificial photosynthesis. A device that accomplished this process is sometimes call an artificial leaf, which mimics nature inasmuch as it stores solar energy as a chemical fuel (e.g., hydrogen) by splitting water, in this way imitating natural photosynthesis. In 2009, Dr. Keith Holland and Dr. David Lawrence of James Madison University (JMU) initiated a research program to investigate materials for the photoelectrochemical decomposition of water into hydrogen and oxygen, which is a critical component of the artificial leaf concept for the production of solar derived fuels. Significant research is still required to develop the efficient and low-cost semiconducting photocatalyst materials required for PEC water decomposition. Recently, bismuth vanadate, $BiVO_4$, has been identified as a potential low-cost and stable semiconducting oxide for the photooxidation of water. While numerous studies regarding the PEC performance of $BiVO_4$ have been reported in existing literature, few studies about manufacturing variability have been reported. Variability in the performance of the photoanodes has been observed during previous studies at James Madison University. This study looks at one potential cause of variability in the manufacturing process-stoichiometric ratios in precursor solutions. Small and controlled variations in the precursor solutions during the manufacturing process produced no effect on the PEC performance.


"The fragrance of flowers spreads only in the direction of the wind. But the goodness of a person spreads in all directions."
—Chanakya
Gener


osity



Seniors

Seniors

Seniors

Team

Corey Allison

Blake Chapman

Genevieve D'Antonio

Alexander Donley

Dixon Drumheller

Advisors

Dr. Olga Pierrakos

Dr. Heather Watson

Aerodynamics and Rotors Team preparing to test the newest turbine model in the wind tunnel

Aerodynamics & Rotors Turbine Design

Wind Turbine Blade Prototypes designed for implementation on campus.

While wind energy is being increasingly used across the world, the field of micro-wind technology has largely been overlooked. Micro-wind technology is described as small scale energy production typically for personal use. Last year the Aerodynamics and Rotors team created a wind turbine to compete in a national Department of Energy competition, taking 4th place in turbine design, and then spent this past year improving the design. Three new models were created with the intent of implementing the turbines across JMU's campus. These new models were optimized using a software program called QBlade which maximizes the performance of the blades based on a chosen airfoil shape and ideal operating wind speeds. The blade prototypes were tested using the wind tunnel on campus to ensure that they generated the desired 10 watts of energy at low wind speeds, similar to the wind speeds at JMU. The blades and the support structure were designed to be easily interchangeable so different blades can be used depending on the environment the turbine is being used in. Detailed designs and plans for implementation are being left with facilities management at JMU so that one day the turbines can be implemented on campus.

Team

Mary Grimm

Johnny Stein

Mark Titcomb

James Waugh

Advisor

Dr. Samuel Morton III

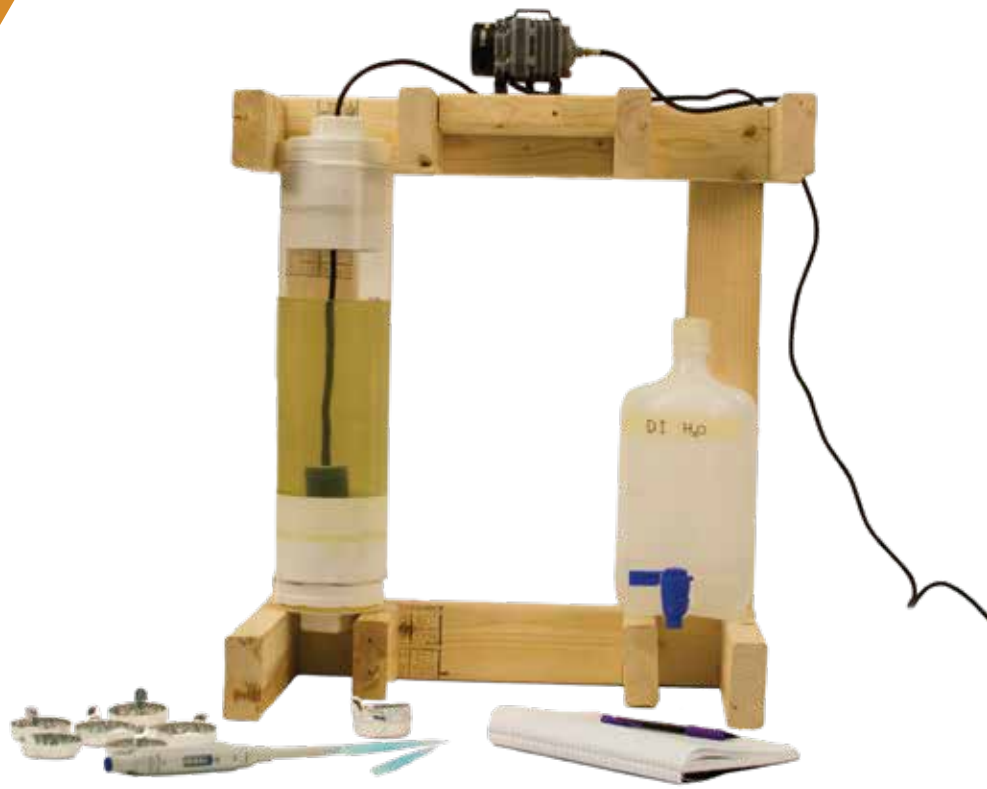
Sponsor

University of Kentucky

The Algae Capstone Team samples batch cultures of Scenedesmus quadricauda to determine growth rate.

Algae Phytoremediation of Selenium

Four batch cultures and a photo-bioreactor prototype are used to test growth and adsorption rates.



Selenium contamination poses a risk to human and wildlife health. As coal continues to power the increasing energy demands of the United States, selenium pollution continues to increase. Although selenium is an essential nutrient for life, elevated concentrations in ground and surface water can cause acute selenium poisoning for humans at the Upper Tolerable Limit (UTL) of 0.4 mg/day. Levels above the UTL can cause diarrhea, nausea, skin rashes, discolored teeth, loss of hair and nails, irritability, nervous system problems, and selenosis. For these reasons, the EPA requires that selenium levels in surface water remain below 0.05 mg/L. The objective of this project is to develop a phytoremediation system that utilizes an algae based photo-bioreactor to reduce the amount of selenium in contaminated groundwater to less than 0.05 mg/L. This project consists of creating a prototype photo-bioreactor system and determining the algae growth rate and adsorption rate of selenium. The growth rate will be determined by conducting a dry mass estimation experiment with four cultures of Scenedesmus quadricauda. The adsorption rate will be determined by ICP-MS analysis after selenium in concentration of 0.2 mg/L is introduced to the algae culture at peak concentration. The conclusion of these experiments is significant for determining the cost of an up-scaled photo-bioreactor design for application at sites with selenium contaminated groundwater. The cost of the photo-bioreactor system can be compared to alternative forms of remediation to verify feasibility of the proposed system.

Team

Brandon Coyne

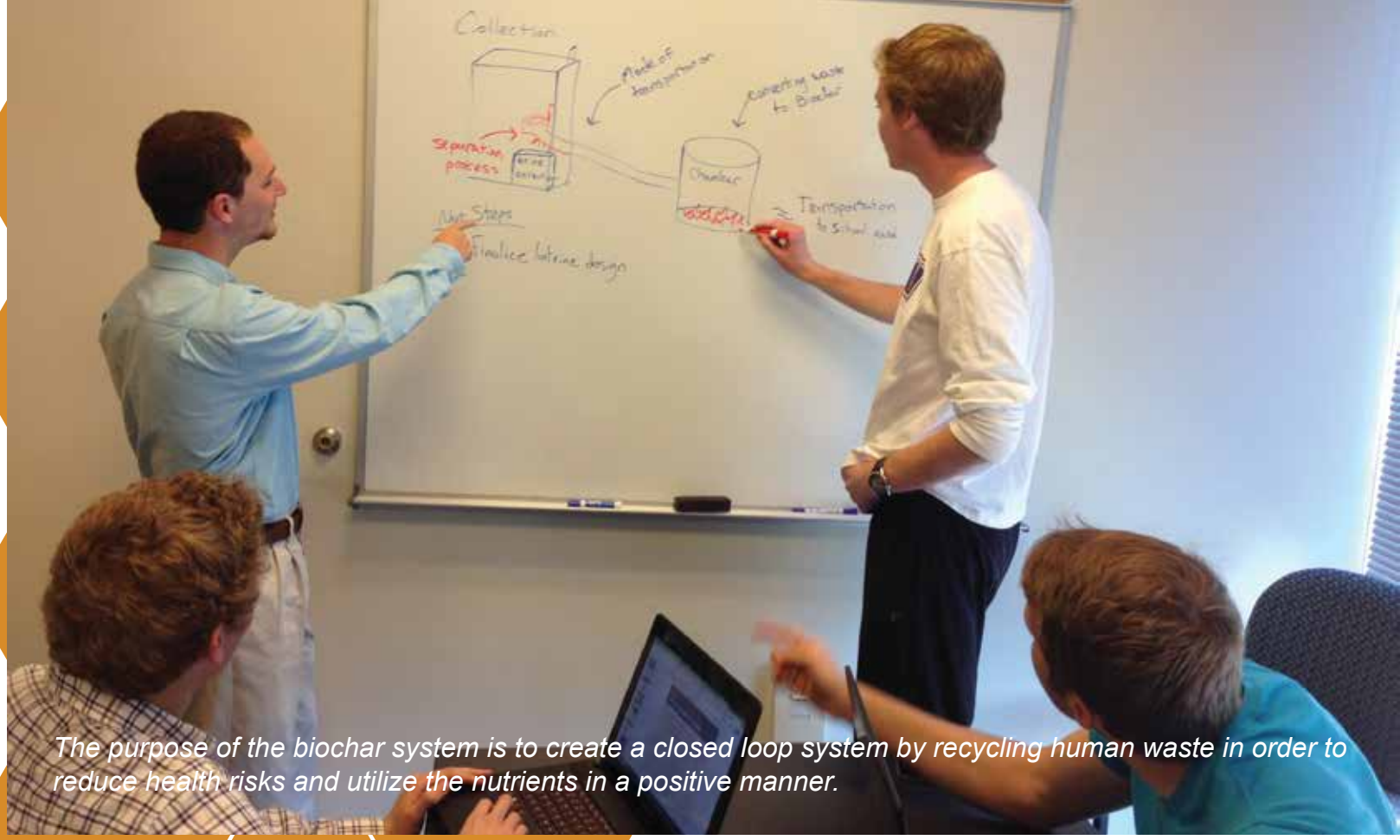
Greg Kitchin

Brenton Lester

Alex Schmitz

Advisor

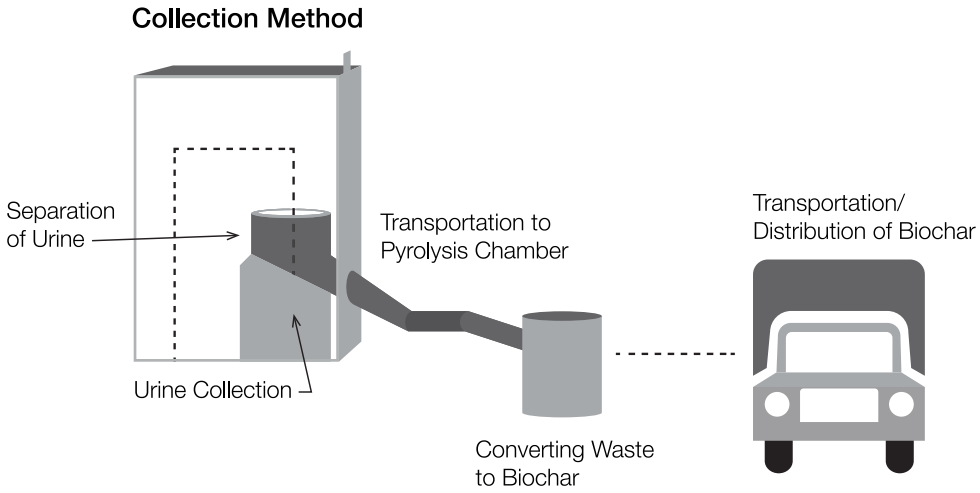
Dr. Justin Henriques



The purpose of the biochar system is to create a closed loop system by recycling human waste in order to reduce health risks and utilize the nutrients in a positive manner.

Biochar

The team's project includes a means for the collection of human waste, the transportation of waste to the pyrolysis chamber, and a pyrolysis process producing biochar to be used as fertilizer.



The purpose of this research is to investigate the feasibility of a small scale and low tech system capable of converting human waste into a biochar fertilizer through pyrolysis. The primary focus is to ascertain if the resulting output from pyrolyzing human waste will have adequate properties to be considered biochar while also classified as an acceptable biosolid for land application usage. The motivation for this experiment stems from the United Nations Millennium Development Goal, to ensure environmental sustainability. With the world population ever increasing the proper disposal of human excrement remains a major problem, especially in developing nations that lack the infrastructure of fully industrialized nations. Current small scale and low tech solutions, such as composting, are time consuming processes that may take several months to complete and produce a fertilizer that has a short useful lifespan. Pyrolysis is a process that can be completed in a matter of hours and produces biochar which, when applied as a fertilizer, may provide long lasting benefits in the soil. Using an existing system, multiple experiments were conducted by pyrolyzing a feedstock under varying conditions. The resulting products were further analyzed to determine if they meet the standards to be considered both biochar and safe for land application. The result of this research will be a feasibility indication as to whether this type system will be able to meet the desired requirements. Based on the results a recommendation will be made indicating if this type of system is applicable for real world application/use.

Team

Bartlett Jones

Christopher Davis

Joseph Gossen

Tim Wilson

Advisor

Dr. Brad Striebig

Team testing chlorine concentrations from MSR Miox, AquaTabs, and Chlorine Generator

Chlorination Device for Water Treament

Prototype of Chlorination device.

According to the World Health Organization there are 3-5 million cholera cases and 100,000 -120,000 deaths due to cholera every year. In this project, we develop a chlorination generation device to be used in rural communities in Sub-Saharan Africa which have open water sources used for drinking, that have been contaminated due to flooding disaster scenarios. The team uses the assumption that fecal matter found in pond water form as a substitute for testing chlorination treatment of coliform, which is the primary water-borne bacteria causing cholera. The chlorine generator creates upwards of 6.05 mg/L of chlorine, with stainless steel electrodes and a contact time of 30 minutes, with the amount of free chlorine was between 2.26 and 4.11 mg/L, which falls well below the CDC and WHO regulation of 5 mg/L. The tests performed in this study will show the effects of chlorination treatment on fecal matter in waste water, as well as a feasibility study of a developed emergency response chlorine water treatment device to alternative devices primarily MSR MIOX and AquaTabs. The feasibility study will entail testing the other chlorination alternatives, comparing the results to the chlorine generator, and quantifying the results.

Team

Kyle Groves

Ciara Middleton

Cairo Sherrell

Will Steinhilber

Advisor

Dr. Adebayo A. Ogundipe

Measuring and recording height changes due to gas production in anaerobic digestion test reactors

Design of an Anaerobic Digestion System

Four Use as an Alternative Food Waste Disposal Method by JMU Campus Dining Facilities

Proof of concept that replicates the anaerobic digestion reactor for the full scale design

The majority of food waste that is generated by JMU dining facilities across campus is disposed in landfills where it decomposes and produces biogas that may release into the atmosphere. Biogas is a mixture of various gases but consists mainly of methane, which has a 21 times greater global warming potential than carbon dioxide, over 100 years. A system is being designed to decompose a controlled amount of food waste via anaerobic digestion, preventing this waste from going to landfills. The subsequent biogas will be captured and can be used as a renewable energy source, keeping it from entering the atmosphere and contributing to the Greenhouse Effect. This project is limited to the design of an alternative food waste disposal system for implementation at East Campus Dining Hall. Food waste characterization was conducted to identify parameters necessary to optimize biogas production. Once these parameters were identified, a proof-of-concept prototype of the system was fabricated to verify that anaerobic digestion of the food waste will yield biogas. With biogas production verified, a bill of materials and user manual for the food waste disposal system were created. These detail the necessary components and instructions for operation of the system if it were to be installed by East Campus Dining Hall to reduce the greenhouse gas footprint of campus dining halls.

Team

Meghan Daly

Fletcher Grow

Mackenzie Peterson

Jeremy Rhodes

Advisor

Dr. Robert Nagel

Sponsor

Mr. Joseph Donndelinger

Courtesy of General Motors Company

Development of an Automated Ontology Generator for Analyzing Customer Concerns

The team of students is currently working with the Research & Development and Product Quality staff at General Motors to develop and implement a system for managing and applying product failure knowledge in the FMEA process.

General Motors Company (GM) service representatives and service technicians generate large volumes of information related to customer concerns. These records are then stored for further analysis by GM Quality engineers. The challenge faced by quality engineers is efficiently processing this data to provide actionable insights to the Product Development staff in a timely manner. The overarching goal of this project is to save the quality engineers time and effort by automating the process of identifying and categorizing trends in product issues and customer concerns. Toward reaching this goal, this James Madison University capstone design team has developed the tool, OnGen, to assist quality engineers with analyzing this data to provide meaningful information with minimal time and labor. OnGen is built using Microsoft Excel and contains embedded macro features in order to run with minimal input from GM Quality engineers. Validation of this system was completed through testing with four functionally dissimilar systems. When comparing the GM-current process to the team's automated process, the required preprocessing time has been reduced from days to minutes. GM Quality engineers will evaluate a prototype of the system prior to implementation.

Team

David Dwyier

Brandon Gulledge

Nicholas Guscott

William Hays

Zachery Mraz

Patrick Nadolny

Advisor

Dr. Rob Prins

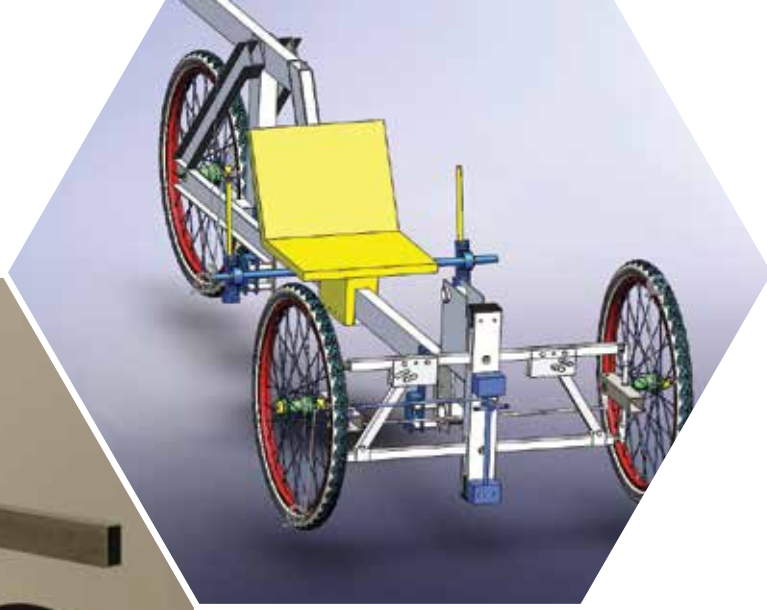
Sponsor

Ed Thurnau

The team works on their electric bicycle prototype.

Electric Bike Capstone

The team challenged themselves to design an electric bike that can be operated in most weather conditions that is specifically tailored to the topographies of Harrisonburg and Charlottesville.



In the past decade there has been a substantial growth in numbers of commuters who are bicycling to and from work. Despite this fact, the most popular method of transportation in present-day society is the use of automobiles. One possible explanation for the fact that most commuters prefer automobiles to bicycles is that automobiles provide a level of comfort and protection from weather that is not typical of current bicycle technologies. With a growing market of commuter bicycles, however, there is an opportunity to improve existing technologies in order to attract potential automobile users to adopt this alternate means of transportation. This capstone project aims to develop a human-powered, electric-assisted commuter vehicle for an interested client that will meet the collective needs of automobile and bicycle commuters. Six engineering students were tasked with designing, constructing, and testing an Electric Commuter Bicycle (ECB). The design and analytical methods used to develop the ECB include: information gathering and benchmarking, conceptual development, prototype fabrication, and both sub-system and full-scale modeling and testing. The final deliverables for this project include a final report, a beta prototype, and a set of detailed engineering drawings.

Team

Garrett Cashman

Stefan Haas

Jon Nagy

Tyler Wade

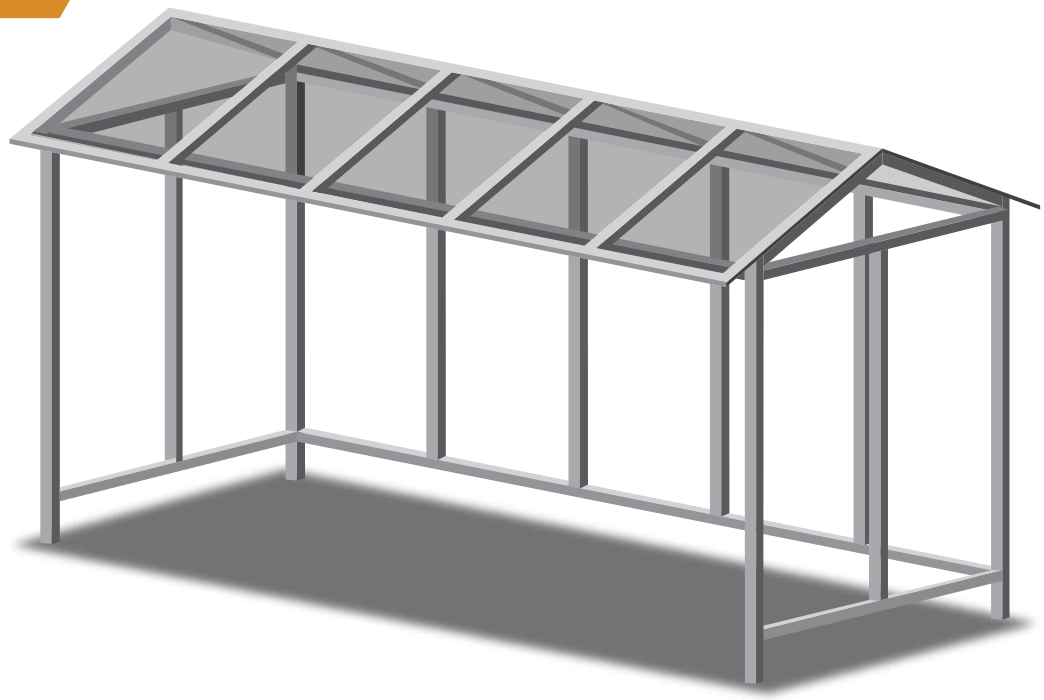
Advisor

Dr. Elise Barrella

The team works on building a rapid prototype of a bike rack they designed to test on JMU's campus.

Four Seasons
Bike Parking Solution
for JMU

The fully assembled 3D model of the Four Seasons Bike Parking Shelter.



The lack of proper bike parking and weather conditions are two huge barriers when it comes to students, faculty, and staff biking on campus. The need for improved bike parking has been identified using several different means. The Four Seasons Bicycle Parking Solution Team is working with bicycle advocates and potential users to help improve the bicycle parking system for JMU. By looking at ways to put bicycle parking where it is most needed and helping to protect bicycles from outside influences such as the weather and theft, they plan on increasing the number of bikers on campus. Through many concept generation methods, the team arrived at a final design that they then refined. They performed many mechanical analyses and computer model tests on the shelter. This assured them that with the selected material, the shelter would withstand all the forces it would face. As the shelter was refined, the team was able to perform an accurate cost analysis to determine exactly how much it would cost to purchase and install it on campus. These analyses proved to the team that the shelter's performance is comparable to other options on the market, while also being the least expensive alternative. The team is also trying to have the design accepted by JMU and implemented on campus for future classes. In hopes to continue with the study, a forthcoming capstone group could continue in-depth testing and find other ways to accommodate biker's needs.

Team

Joey Abla

Mick Blackwell

Benjamin Condro

Kyle Kingsborough

Advisor

Dr. Keith Holland

The team, with assistance from Mr. John Wild, uses a non-traditional trial and error design approach and conceived many feasible designs

Madison Wind Solutions

A modular, inexpensive, robust, portable, and small scale turbine (MIRPST) would be an ideal alternative for expanding wind energy applications.

The need for alternate forms of energy production is directly related to the increase in demand for petroleum based products. Wind energy is a proven alternative to the traditionally used non-renewable resources extracted to meet energy needs. Furthermore, recent advances in wind energy technology have given rise to larger implementations of wind energy systems. Such systems range from industry sized turbines to micro-turbines. An area for improvement within the turbine spectrum is within the small-class, modular turbines. A modular, inexpensive, robust, portable, and small scale turbine (MIRPST) would be an ideal alternative for expanding wind energy applications. MIRPST addresses the need for an individually deployable energy generation system which does not rely on fossil fuels. Being operational in low wind speeds, MIRPST is a suitable alternative for anyone in need of a device to power small electronic devices, such as a cell phone. The increase in efficiency from the novel windshield component has been proven to be substantial by wind tunnel testing. An intellectual property rights disclosure form is being filed for the wind shield component in preparation for potential commercialization.

Team

Dylan Scofield

Marley Taylor

Thomas Ware

Advisor

Dr. Olga Pierrakos

Sponsor

Laconiko

The team tests olive dispensing mechanism

Olive Packaging

Stainless steel mesh is used to filter olives and brine within the system

Laconiko is an award-winning extra virgin olive oil and kalamata olive company whose olives are grown in the Southern Peloponnese, located outside of Sparta, Greece. Laconiko's sorting and distribution center is located in Gainesville, Virginia. Laconiko is known for their outstanding olive oil products and would like to begin to expand the production and distribution of their kalamata olives. Laconiko needs a packaging system developed to replace their current method for packaging, which is archaic and entirely manual. The stakeholders involved in this project consist of the owners of Laconiko, the retailers of their product, and the consumers purchasing their products. The scope of the project is to design and implement a new packaging system to increase the rate of packaging and decrease the amount of manual labor input. The end deliverable of this project is a new packaging system that increases Lakoniko's production and decreases the overall input of manual labor, while ensuring the olive quality/shelf-life is maintained, in order to help Laconiko increase their profitability as an olive distributor.

Team

Jeremy Boone

Brandon Cobb

Christian Conover

Andrew Demers

Matthew Lewis

Andrew Voorhis

Advisor

Dr. Steven Harper

Sponsor

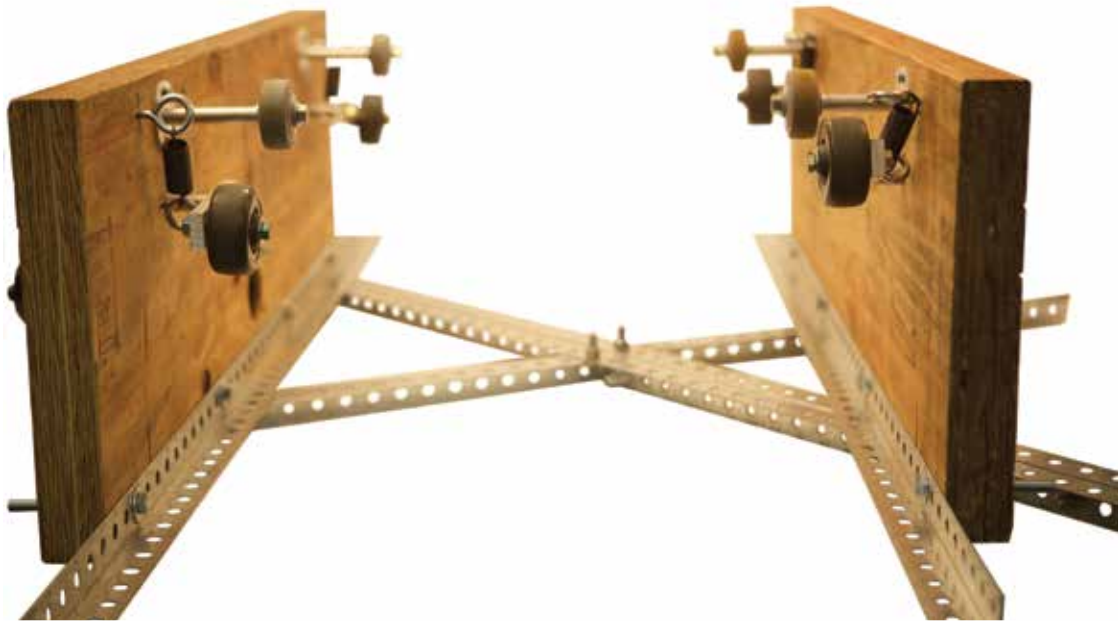
Virginia Department of Transportation

The team working on mounting the motor to the traveler device

P.A.T.S.

Portable Autonomous Traveler System

The Alpha prototype of the traveler system not including the drive chain system, battery, mounted motor, or measurement device mounts.



There are thousands of vehicles traveling on our highways on a daily basis. The energy generated by these vehicles is essentially wasted energy. These vehicles may also impact the integrity of the bridges in which they travel on/under. The project objective is to construct a traveler that can move autonomously along an I-beam under an interstate overpass. The traveler should be able to support multiple measurement devices in order to collect data.

The potentially collected data may then be used to the support the broader impacts of this project. The broader impacts for the traveler system may include, but are not limited to: salinity measurements, wind data collection that can lead to the possible feasibility for a wind capturing device, and bridge inspections.

The team has constructed an alpha prototype of the traveler system over the duration of the capstone process. The team has completed motor speed, wheel axel integrity, and transmitter/receiver testing to date. The goal by the end of the Spring 2015 semester is to have a fully functioning prototype so that the predecessors to the project will have the tools necessary to collect the desired data.

Team

Mark Dufresne

Lauren Phillips

William Patrick

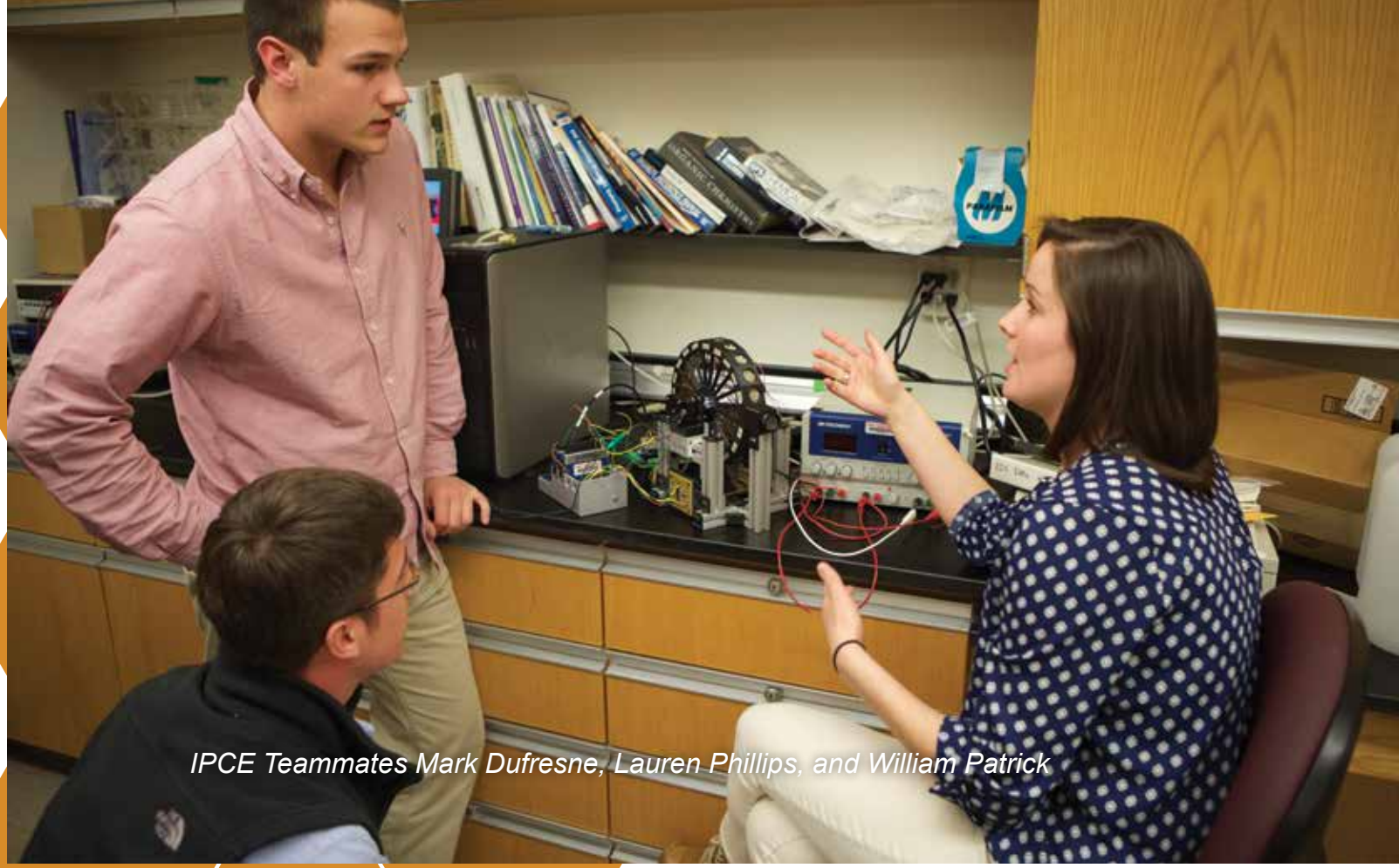
Advisors

Dr. Keith Holland

Dr. David Lawrence

Sponsor

JMU Center for Materials Science

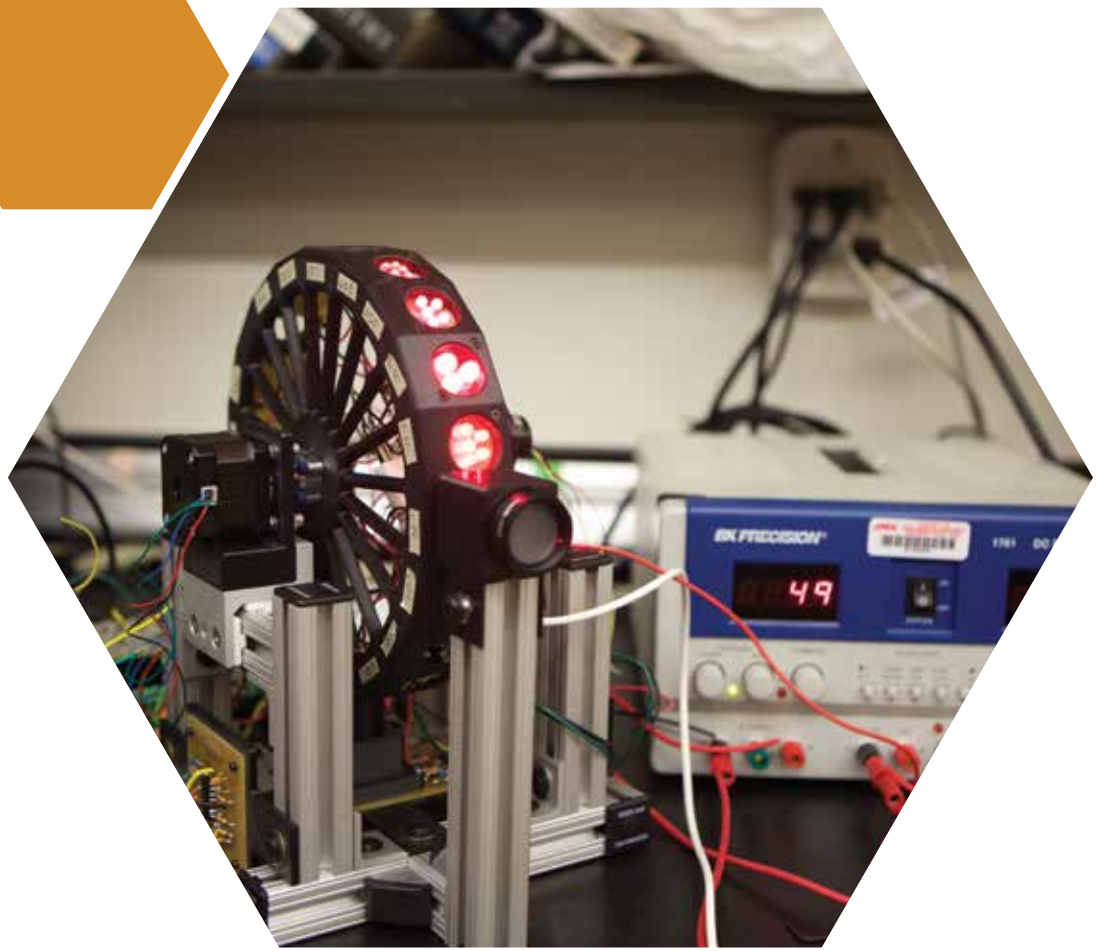


IPCE Teammates Mark Dufresne, Lauren Phillips, and William Patrick

IPCE/QE

Quantum Efficiency Measurement Apparatus

Working prototype to measure the quantum efficiency of a photosensitive material.



The objective of this project is to create a low cost, accurate, and reliable Incident Photon to Charge Efficiency (IPCE) measurement system, also referred to as a Quantum Efficiency (QE) measurement system. Quantum Efficiency or Incident Photon to Charge Efficiency is a measure of the electrical current generated by a photosensitive material relative to the intensity of the light incident on the material. The efficiency is measured through the spectral response of the sample. These measurements are collected via the use of expensive laboratory equipment. Accordingly, research opportunities are limited and therefore highly selective to institutions capable of providing funding necessary for these measurement systems (e.g., well funded colleges and universities). Such IPCE/QE measurement systems are crucial for the research and development of novel photonic materials and systems for next generation photovoltaics, photocatalysts, biological reactors, and optical sensors. The project stakeholders have identified an opportunity to design an IPCE/QE measurement system that is less than 1/3 the benchmarked price of currently available research grade systems. To reduce design costs, alternative solar simulation forms and light filtering methods were pursued and utilized. Additionally, cost-effective components were included within a modular system that provides comparably accurate efficiency measurements to those previously benchmarked. The resulting low-cost system is intended to reduce barriers of research of novel photonic materials and provide an alternative method for preliminary evaluation of photonic material performance.

Team

Nicholas Henriksen

Sean Micucci

Rachny Soun

Advisors

Dr. Jacquelyn Nagel

Dr. Robert Nagel

Sponsor

Friendship Industries

The team hard at work analyzing and refining their prototype

Robotic Assistive Technology

The design went through multiple iterations before being manufactured by the university's machine shop.

The Robotics Assistive Technology Team is tasked with designing a process for assembling a latex cap onto a cardboard tube for medical testing. This process requires that 8000 units are made by 4 personnel over an 8 hour work day. The team is working with an external client, Friendship Industries Inc., who is a community engaged company whose main task is to employ people living in the Rockingham, VA area who are not otherwise readily employable. The team has focused efforts on three subsystems in this project: a latex stretching system, a test counting system, and the layout of the assembly process. The latex stretcher was conceptualized and evaluated based on quantifiable data taken from testing concepts. The design went through multiple iterations before being manufactured by the university's machine shop. The counter system uses an infrared sensor to count the number of tests that have been assembled. The number of counted tests is shown on a digital display. The layout of the assembly process was conceptualized and evaluated through optimization. Finalization of the dimensions for the layout was completed after setting up the layout in the Launch Bay. We hope to supply our client with the digital counter to make the bagging process more efficient. We will also deliver the latex stretcher for the use of the employees of Friendship Industries. The clients will receive the results of the optimized layout, which minimizes the flow time between each process.

Team

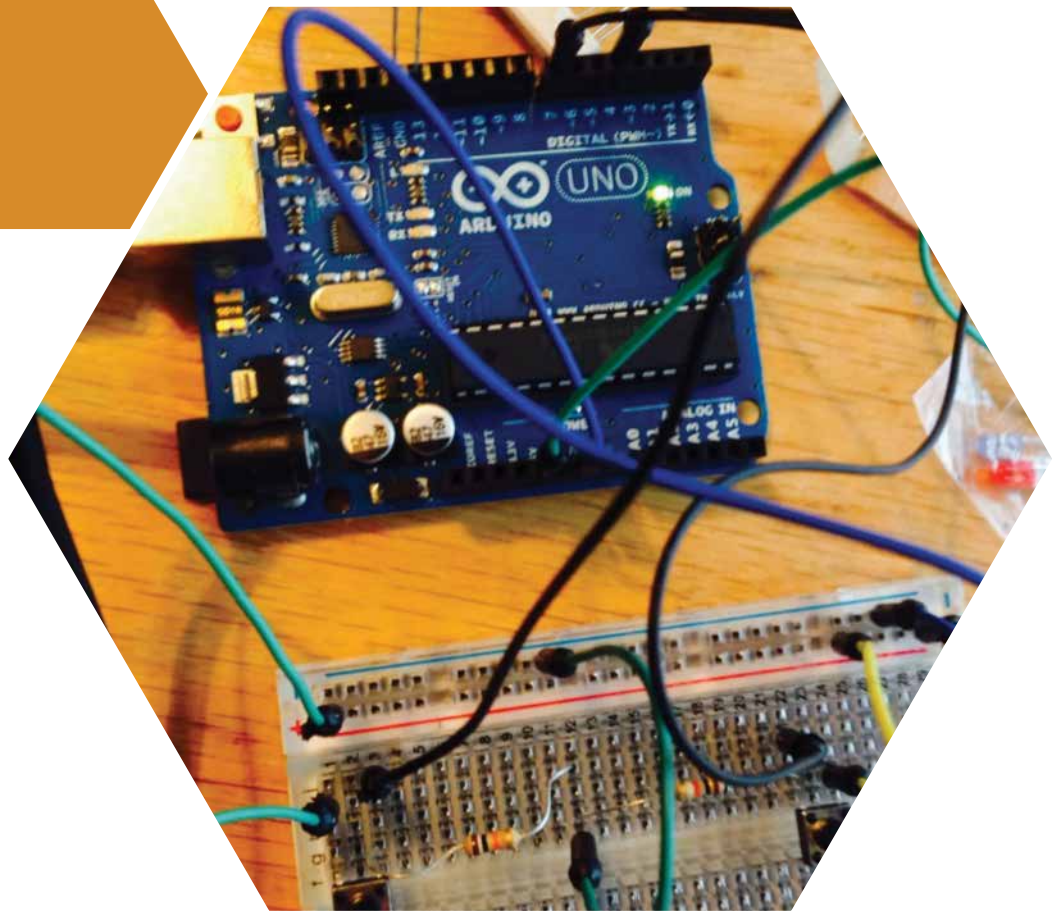
Matthew Boyer

Advisor

Dr. Justin Henriques

Sensors for Sustainable Transport

Counter Sub-System Addition



Public bus routes in Nairobi Kenya are run by busses called Matatus and their routes are unfortunately not very structured. There are bus stops in Nairobi, but the buses don't follow any specific routes between these stops and only pick routes based on experience. To better structure the routes of these busses, officials first need to know where the buses are going and this is solved with the GPS tracking device already built for these busses. Although tracking the busses is useful, city planners need more information to accurately guide busses' routs. One of the most crucial pieces of information is where all the bus riders are and providing a counter to the drivers will help keep track of how many people are on their bus at any given time. Counter information will be used to indicate where bus riders get on and off the bus. GPS routes will then be colored according to the number of riders at a given coordinate. To complete this goal, a counter sub-system will be added to the original GPS tracker system. This counter subsystem consists of two buttons that allow bus drivers to count the passengers going on and coming off of the bus. Finding where passengers are going in the city will help city planners plan bus routes and improve city infrastructure.

Team

Corey Birkel

Travis Carlton

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Lauren Distler

Sameer Saini

Richard Schommer

Advisors

Dr. Elise Barrella

Dr. Joy Ferenbaugh

Dr. Kyle Gipson

Clients

Mr. Abe Kauffman and

Mr. Dale Chestnut

(JMU Facilities Management)

Ms. Thanh Dang

(Harrisonburg Dept. of Public Works)

The stormwater team computing the efficiency of several designs and filtering stormwater samples collected on Grace Street.

Stormwater

Management Design & Hydrologic Analysis

Google Sketchup rendering of the team's parallel bioretention cell design; underground view showing proposed filtration media layers, perforated infiltration pipe, and curb cut.

Blacks Run is a polluted stream in Harrisonburg, Virginia, and is a part of the Chesapeake Bay watershed. The Grace Street Corridor (GSC) is a street northwest of James Madison University campus, and it lies partially in the Blacks Run floodplain. Due to its high percentage of impervious land cover, the GSC is one of many non point sources of pollutants flowing into Blacks Run. Nonpoint source pollutants generally originate from diffuse sources and include sediments, phosphorus, and bacteria. Through water quality testing for Total Suspended Solids (TSS) and mapping of stormwater flow using ArcGIS, the team determined various subsystems of focus. For each subsystem, a TR-55 hydrologic analysis was conducted and analyzed. City and state design codes were assessed for a range of conceptual solutions in order to develop a stormwater design plan for the GSC. The proposed solutions incorporate various stormwater Best Management Practices (BMPs) for implementation on Grace Street. The team used mathematical modeling to predict the effectiveness of the proposed solution in relation to the reduction in contaminant load and flow rate of stormwater to Blacks Run.

Team

Catherine Hess

Terence McKeever

Jonathan Picart

Bernard Stoll

Advisors

Dr. Jacquelyn Nagel

Dr. Mary Tacy

It's incredible to design something in one place and have a positive impact on a complete stranger thousands of miles away

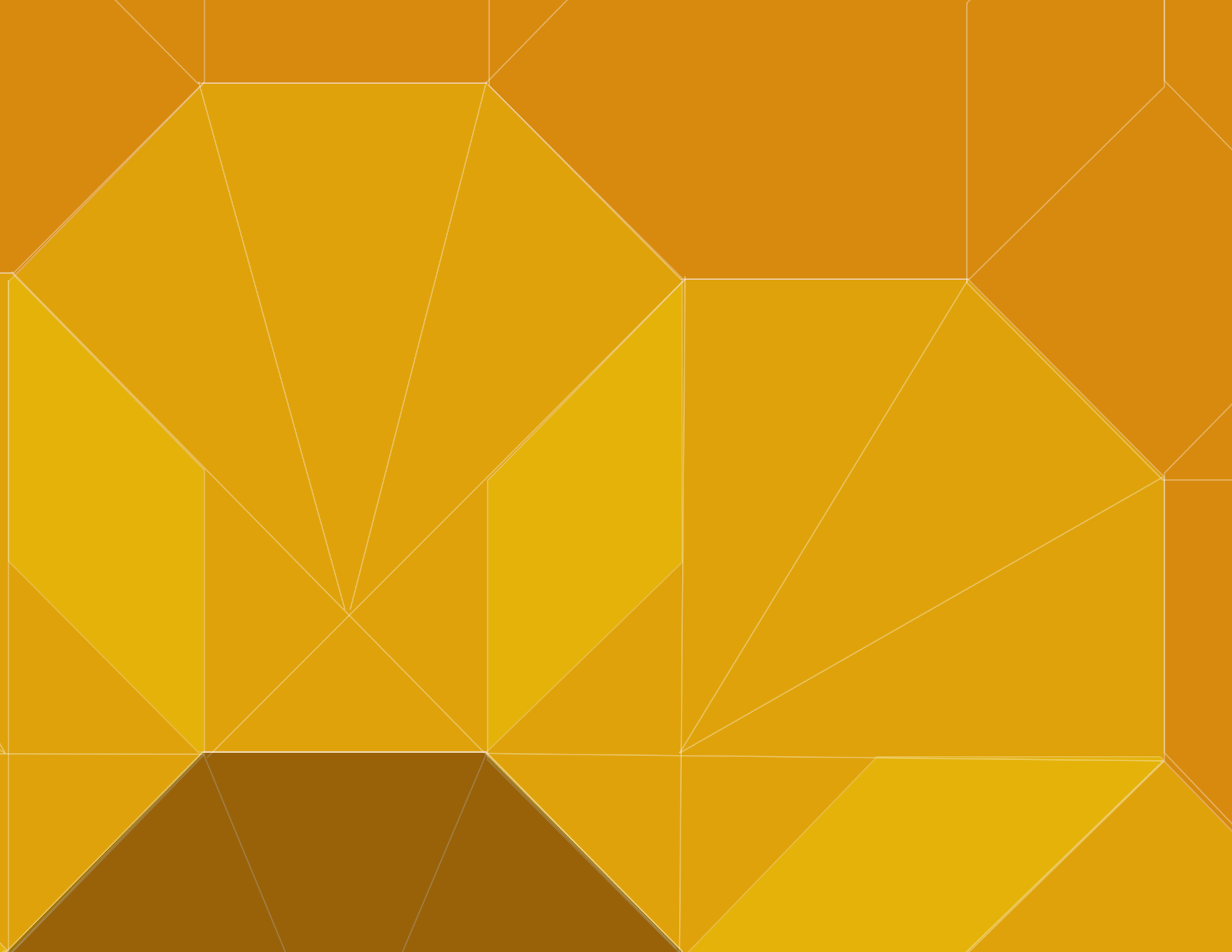
Wheelchairs for Haiti

Wheelchair composed of locally available PVC and recycled bicycle parts; created and vetted for functionality against World Health Organization standards.

Handicapped children in Haiti typically do not have wheelchairs suitable for their environment and cannot afford one designed for the local conditions. The country's terrain is mainly mountainous, rocky, and muddy. Haiti is currently the poorest country in the western hemisphere, with 80% of the population below the poverty line and an average income of $1-$2 per day. This project aims to design and produce a tested and refined wheelchair for the client, a Haitian child. This wheelchair will enable the client to traverse over various terrains, be independently mobile, and engage in activities such as attending school and bathing. It must also be locally maintainable and affordable on an average Haitian income. The design approach for the project began with a list of customer needs, target specifications, and functions created through interviews and preliminary research. Different techniques were implemented for concept generation, evaluation, and selection for each of the subsystems. SolidWorks and mathematical models were used to analyze support forces, propulsion, braking, and failure, and then synthesized to select the wheelchair subsystems. Subsystem prototypes were tested and refined, followed by the integration into a final prototype. The final prototype is composed of a PVC frame and recycled bicycle parts, all of which are abundant and can be obtained locally. The team has produced a comprehensive parts list and assembly guide so that anyone in Haiti can produce the wheelchair without confusion. Because of the wheelchair, the client can participate in village life and become a contributing member of society.


“In the spring, at the end of the day, you should smell like dirt.”
— Margaret Atwood


Respect



Juniors

Juniors

Juniors

Team

Garret Brown

Michael Caple

Nizar Kamel

Rene Najera

Meredith Penney

Andy Perry

Andrew Read

Ryan Taylor

Lisha White

Advisors

Dr. Robert Nagel

Professor Evelyn Tickle

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

3D Printing with Concrete

The team created prototypes in order to test the properties of different mixes of concrete.

Additive manufacturing is a rapidly advancing field that has revolutionized 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 seeks to create a 3D printer that uses a concrete-based material, which can be used by the average consumer. After designs are generated and evaluated, designs move to the prototyping phase. By prototyping ideas, physical and mathematical models were created to help further develop understanding of the system. Currently, a pumping system has been created to test the feasibility of the pumping design. The system found most suitable, through investigation of existing designs for concrete pumping, is a hydraulic or piston style pump. To observe the extrudability of the concrete, a concrete dispensing apparatus was utilized. As a result of testing a standard concrete mix, the team gained insight into the process of printing concrete. This includes learning about different aspects of the concrete such as the cement-to-water ratio, observations on how the concrete can be extruded, nozzle size, and the bonding between each layer. Some other observations were that the concrete material must have a fast setting time and must constantly be agitated while being pumped through the system. This printer will open the door for printing technology for component materials, such as asphalt, and facilitate the artistic creativity of architects, landscapers, and everyday people all over the globe.

Team

Alex Anderson

Trevor Bond

Patrick Clarke

Advisor

Mr. Mark Showalter

Sponsor

Terry Heffield

J.A.A.R.S.

Quest Aircraft

The team is performing wet layup to prepare new specimens for future testing.

Composite Seat

Materials making up the prototype including: unidirectional carbon fiber, high strength polymer epoxy and Nomex honeycomb structure.

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. So far, the team has researched composite material properties, derived relevant criteria from the FAA regulations, brainstormed multiple design concepts, and started material testing to further inform the designs. Design feasibility is assessed using material testing methods such as tensile, impact, and durability. A final assessment will be done by Quest Aircraft to evaluate whether the leg design will pass FAA requirements while being worth the money needed to certify the legs through the FAA. At the present time the project is still ongoing and therefore full results are not available. Preliminary research, however, has shown promising evidence of a successful design. At the end of the project, the new designs, if accepted by Quest, will provide the JAARS airplane with a lighter seat leg to allow them to carry more cargo.

Team

Kyle Byrd

Rachel Hollenbeck

Caleb Kim

Tyler Symons

Joseph Taylor

Brock Warinner

Advisors

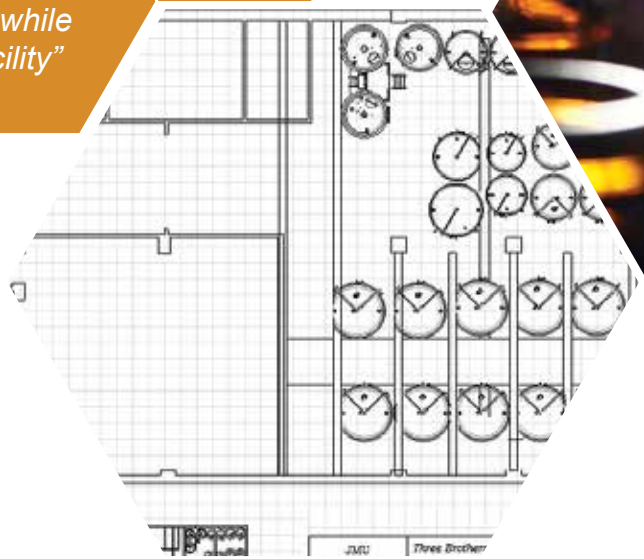
Dr. Steven Harper

Dr. Samuel Morton

"The team researches and analyzes other facilities that resemble Three Brothers' potential layout to get an idea of what a successful brewery consists of and how brewery expansion processes work."

Designing a Beverage Process Facility

“The project team ensures that they keep the tradition and character of Three Brothers’ Harrisonburg brewery layout in mind while developing concepts for their new facility”



Three Brothers Brewing Co. is a company that arose in the year of 2012, and ever since their start, they have acquired a substantial customer base. In light of this success, it has become apparent that expansion is the next step for this organization. Three Brothers Brewing has seen a 370 percent growth over the past two years they’ve been in business. Therefore, in order to meet this customer demand, a new production facility will need to be designed and constructed for their brewing line. The project will consist of three main deliverables; developing a tool based on county incentives to assist our client in the site selection process, designing a layout of the systems within the facility itself, and developing an efficiency plan. The team will analyze different traits of various local counties, mainly focusing on economic incentives and provide our client with a tool for selection. Once a decision assistance tool has been finalized, the next step will be to design the systems within the facility itself. Through methods of benchmarking and feedback from the advisors and stakeholders, the project team will generate various concepts based on the project requirements. These concepts will be further evaluated by criteria developed by benchmarking methods. After observing different systems, models will be created to help the client run the systems and processes at maximum efficiency. The team aims to deliver a final layout plan that will be an essential model to guide Three Brothers in their expansion.

Team

Aaron Andrews

Dan Cracovaner

Maryam Ekbatani

Jillian Leary

Tyler Shannon

Abraham Yoslov

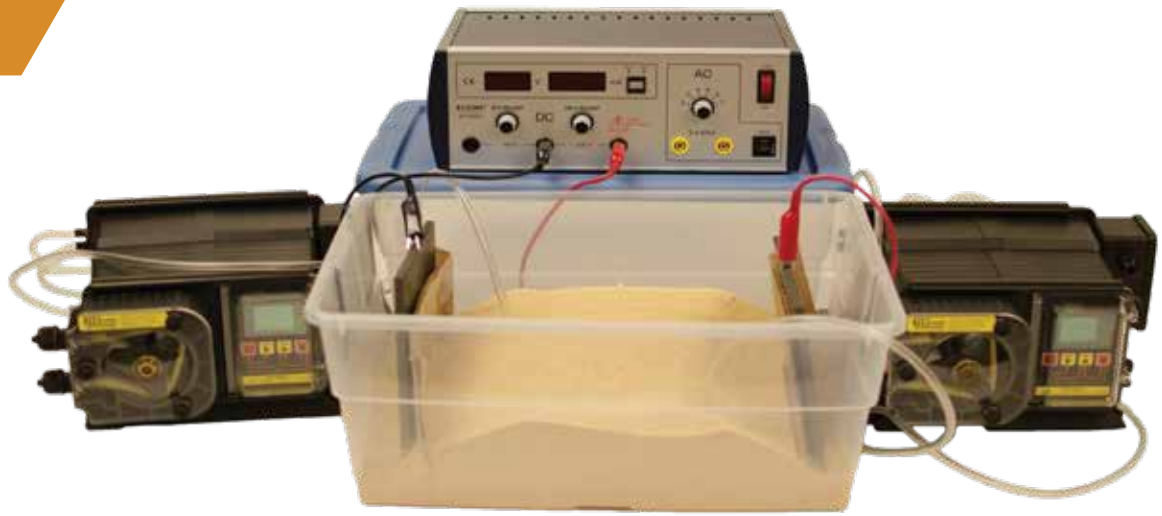
Advisor

Dr. Adebayo Ogundipe

The team is determining initial heavy metal concentrations within a soil specimen using an x-ray fluorescence spectrometry device."

Electrokinetic Soil Remediation

The proof-of-concept prototype shown is being used to prove the legitimacy of the basic science behind electrokinetic technology.



As the Digital Era continues to evolve, the global community is faced with the challenge of dealing with colossal masses of electronic equipment that has been laid to waste. More often than not, this equipment is dumped irresponsibly rather than recycled. The heavy metals and other toxic organic matter in this waste then leach into the soil, eventually contaminating groundwater supplies as well as imposing both fertility and toxicity issues on the soil. The purpose of this research project is to design a low-cost and low-energy intensive electrokinetic soil remediation system capable of removing heavy metals from various soil types, in an effort to restore environments back to their natural state. In short, electrokinetic technology works by applying an electric current to the soil, thus causing the metals within to migrate to a location where they can then be removed. By purposefully contaminating soil samples with electronic waste debris, initial soil analysis has shown the presence of highly toxic Copper, Lead and Nickel to be 104, 2822, and 4978 percent of their EPA allowable limits for concentration within soil. These initial readings serve as baseline concentrations that must be tremendously reduced to safe levels as established by the U.S. EPA during the remediation process. The design team intends to develop a system capable of lowering these concentrations to EPA standards through the use of electrokinetic technology, in combination with nontoxic chemical agents, to enhance the remediation process.

Team

John Boccagna Elder

Daniel Hallinan

Kelsey Lineburg

Kylie Stoup

Cole Turner

Sergio Yabeta

Advisors

Dr. Elise Barrella

Dr. Heather McLeod

Sponsor

Tom Benevento
(New Community Project)

The team works together to organize access points generated from community feedback meetings

Greenway System

Spatial analysis tool used to help the team evaluate potential project designs.

Many residents and visitors of Harrisonburg have limited options for healthy, affordable, and efficient transportation that meet their commuting needs. Multiple neighborhoods are disconnected due to gaps in the transportation network for walking, bicycling, and transit which 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 planning and designing a network of paths to promote community engagement, social equity, environmental sustainability, and multimodal transportation opportunities for Harrisonburg. By designing an integrated transportation network to local amenities, such as schools, parks, and businesses, all members of the Harrisonburg community will have the opportunity to safely travel throughout the city without dependence on vehicular modes. Community feedback meetings and stakeholder interviews have been conducted to gather information regarding desired locations of access. Results from these meetings indicate that the highest priority access points are: downtown Harrisonburg, Valley Mall, JMU, EMU and Hillandale Park. The engineering team is investigating information concerning additional access points and once completed, a team of GIS students will use spatial analysis software to evaluate routes connecting these points of interest. To meet the goals of the project, socioeconomic and demographic information will be analyzed and combined with transportation data to generate and evaluate safe and effective routes between access points. The finalized access points and routes will be displayed on a system map as the project deliverable for the semester.

Team

Collier Apgar

David Hieronymus

Zachary Patterson

Paul Revesman

George Schmidt

Jacob Wild

Advisor

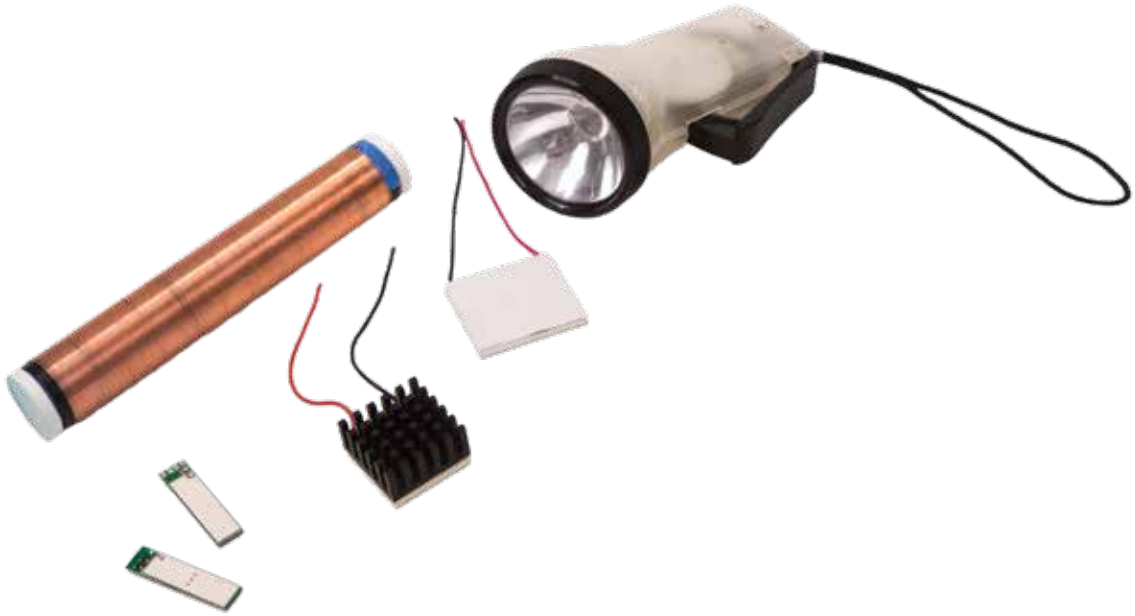
Dr. Jacquelyn Nagel

"The noblest pleasure is the joy of understanding"

- Leonardo Da Vinci

Havesting Energy from Human Movement

From left to right: a prototype for a solenoid energy harvester, a thermoelectric energy harvester, and a piezoelectric energy harvester, respectively.



Electronic devices lose power when they are taken on extended outdoor trips (hiking, snowboarding, rock climbing, etc.) and energy sources are not readily available. While performing these activities, the human body dispenses energy to its environment in the form of mechanical energy and heat. This capstone project focuses around utilizing this otherwise wasted energy to charge electronic devices. Several energy harvesting technologies are being considered, such as piezoelectric material, Peltier devices, solenoids, and mechanical generator systems. These methods could be used to charge a rechargeable battery pack, which could then be used to charge any USB compatible electronic device. The four methods mentioned are currently being tested in a laboratory setting to see if they can generate enough energy to charge a battery pack when actuated by human motion. As a result of these tests, it has been found that piezoelectric materials are not feasible for this application; Peltier devices may be feasible if many are connected in series; and solenoids and mechanical generator systems may be feasible if they are optimized. Further tests will determine which direction the team will go hereafter.

Team

Richard Baier

Luke Haskins

Josh Kay

Roberto Riviere

Mathew Russell

Hunter Sandridge

Advisors

Dr. Keith Holland

Dr. Samuel Morton

Dr. Bradley Striebig

Sponsors

Global Plasma Solutions (GPS)
Building Systems and Services, Inc. (BSS)

"Engineering a solution to validate our client's claims and exceed their expectations."

Ion Generation

The photo provided is a sample of T-Slot extrusion forframing with PVC clamps holding sample Lexan for wall.

Ion-Plasma Air Purification Test Apparatus

With all the different air purification systems on the market, companies are hard pressed to find a way to differentiate themselves from the rest. Global Plasma Solutions (GPS) finds themselves in this exact place. They have just developed a device that incorporates ion-plasma air purification technology to clean the air in ductwork, as well as in commercial and residential settings. The only problem is that they do not have concrete results that prove the validity of their claims of the effectiveness of their device. The purpose of this capstone project has two parts. The first part of this project is to construct an apparatus to test and validate the claims that GPS has made, and the second part is to develop experiments that test the effectiveness of the GPS device. During the first year of this project the group will design and construct a functional testing apparatus for the GPS unit. This apparatus will simulate a commercial building and incorporate a functional HVAC system and GPS unit. During the second part of this project, the team will design and conduct experiments, using the apparatus to inform the clients on how well their product actually works. Ion density, airflow rate, temperature, humidity and particulate matter will all be measured to quantify the results recorded in the apparatus. These results will allow the clients, Global Plasma Solutions, to quantify the success of their device, which will allow them to better market and sell their device.

Team

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Curtis Hendrick

Dan Carrier

Felipe Melivilu

Tyler Shaw

Wheeler Dey

Advisors

Dr. Jacquelyn K. Nagel

Mr. John Wild

Mr. Sam Osterhout

The team prepares the carbon fiber for testing.

Low-Cost Manufacturing of Structural Carbon Fiber

The team designed then machined an aluminum compression mold in the JMU Machine shop, it uses 36 bolts to achieve internal pressure up to 3000psi.

In the world of racing, seconds matter. Teams push their vehicles to the limit reaching for faster and faster times. Teams have been able to reduce the overall weight of vehicles with advances in lightweight composites by creating components out of carbon fiber. However, only recently has carbon fiber made its way into structural components such as wheels. With a possible improvement of 0.256 seconds in a 0-60 mph time for a sports car, developing a low cost solution for manufacturing structural carbon fiber becomes pertinent. Investigations of molding methods to better understand the behavior of carbon fiber composites, which behave differently than metal components, lead to the development of the structural carbon fiber manufacturing process. Using the preliminary research conducted on carbon fiber, a compression mold was designed and machined. The ability to create samples under a wide range of pressures up to 3000 psi, applying different resins, and varying carbon fiber weave orientations allows for the discovery of the optimal molding conditions for manufacturing structural carbon fiber components.

Team

Brian Groener

Nile Knopp

Kent Korgan

Rowen Perry

Jonathan Romero

Kody Smith

Albert Stainback

Austin Strzelczyk

Advisor

Dr. Justin Henriques

Client

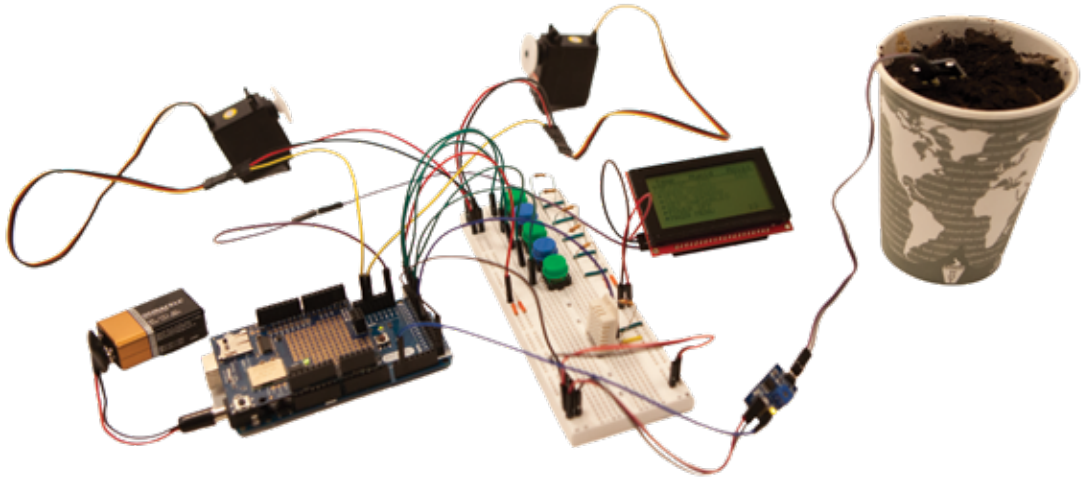
Possibilities Africa

"To plant a garden is to believe in tomorrow"

– Audrey Hepburn

Low-Cost Greenhouse with Integrated Systems

The control system interprets climate conditions to modify the greenhouse microclimate and regulate resources.



Food security remains a global challenge, particularly in low-income regions such as Sub-Saharan Africa. Innovations in low cost greenhouse design and the increased accessibility of electrical components for automation have the potential to raise food security, particularly in areas where climate change is creating additional inconsistency in weather trends. The benefits of having an automated system include the reduction of resource consumption, reduced labor, and increased crop yield. Possibilities Africa, a non-profit in Nairobi, Kenya, has tasked the greenhouse capstone team to develop a semi-automated, low-cost, and self-sustainable greenhouse solution that can compete in price with existing non-automated greenhouses available on the market in Nairobi. The project goal is to determine whether the costs of automation can be justified by its added benefits. The eminent design processes employed thus far include: benchmarking of existing greenhouse solutions, concept generation of system design, and concept evaluation using physical and analytical modeling. The team has succeeded in narrowing concepts and developing preliminary physical demonstrations of the structure and controls; however, further embodiment of an integrated system is required to perform testing. From the results of testing, iterations can be made through data analytics to optimize the growing variables, debug potential flaws, and evaluate whether increases in costs associated with automation result in increases in productivity or efficiency. Pending positive results, the system can be implemented by the client, Possibilities Africa, for the purpose of decreasing the prevalence of undernourishment and hunger.

Team

Jake Boles

Andrew Dates

Bryan Garret

Nima Guerin

Alex Narrow

Kiara Pontious

Sarah Rowe

Brad Weidner

Advisor

Dr. Olga Pierrakos

Mr. Zachary Murter

Mr. CJ Schlager

The team discusses the condensation process required to convert water vapor to liquid water.

Making Water out of Thin Air

Reverse engineering a dehumidifier condensation process educated the team on the system requirements necessary in the design for the formation of liquid water.

Water stress and scarcity affects 1.2 billion people on a global scale, nearly one fifth of the human population. The purpose of this project is to create a device that extracts water vapor from the air and transforms it into a useable liquid form. Background research was conducted on various suitable locations, fluid properties that affect phase change, natural and man-made systems that are capable of transforming water vapor to liquid water, and filtration methods to ensure that water is safe for use for various applications. The device will be implemented within 30 degrees north and south latitude of the equator so that the area has a high relative humidity. A high relative humidity provides a metric for determining the quantity of water vapor in the air that can be extracted for other uses. Currently, the focus is on South America, Africa, the Middle East, Southeast Asia, and Australia. Based off of research, limitations, and need, a passive design, indicating that no external power source will be used for water extraction, was selected as the design goal. The device can help the inhabitants of the chosen region with irrigation, drinking water or daily uses. The addition of the device into either of these areas of need can make a substantial difference environmentally, economically, and socially.

Team

Chris Giambri

Dylan Chapman

Evan Eaves

Hunter Heavner

John Woodward

Karl Braun

Advisors

Dr. Kyle Gipson

Dr. Jaquelyn Nagel

Sponsor

MillerCoors Shenandoah Brewery

Team to experiment and better understand the inefficiencies that are currently affecting MillerCoors' HVAC system.

MillerCoors HVAC Analysis

A programmable logics controller (PLC) used to manipulate the HVAC system.

Heating, ventilation, and air-conditioning (HVAC) systems regulate indoor climate and air quality conditions to create a comfortable environment for occupants. The business administration office of MIllerCoors' Shenandoah Brewery located in Elkton, VA has found their current HVAC system to be economically inefficient. The HVAC analysis team is working with MillerCoors to propose a solution to reduce the heating, cooling, and maintenance costs of the system. The team is focused on the sensors and controls of the system and is working to create a model representation of the building serviced by the HVAC system. A programmable logics controller (PLC) with a formulated algorithm can be implemented to manipulate the HVAC system of the scaled-down model. This allows the team to experiment and better understand the inefficiencies that are currently affecting MillerCoors' HVAC system. The desired model provides information regarding operation costs and energy consumption over a period of time. With the results from the model, the team can manipulate operations to maximize efficiency. The techniques used to optimize the model can be utilized at the client's facility as a means to improve the function of the entire HVAC system. By maximizing the efficiency of the client's system, operation, and maintenance costs in turn are minimized and can result in a more cost efficient HVAC system for MillerCoors.

Team

Lauren Donston

Kendall Effler

Thomas Kaisen

Jesse McWilliams

Willie Woodard

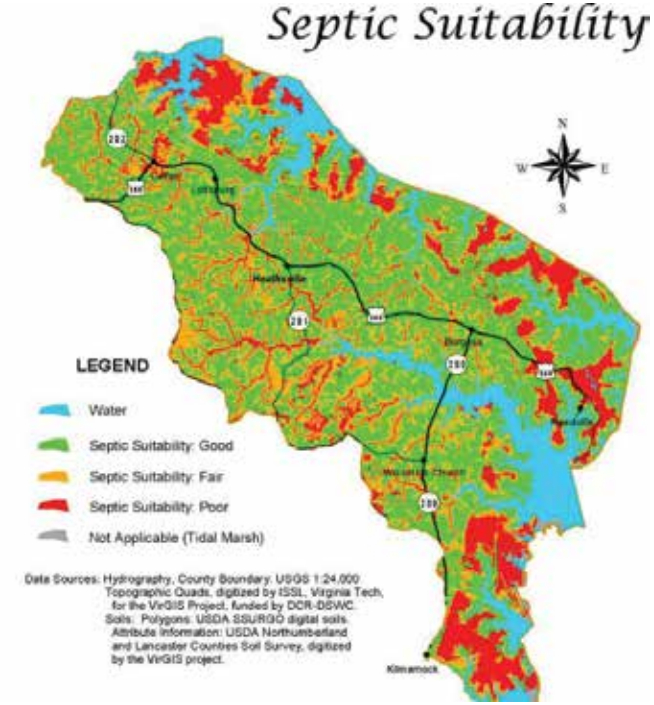
Advisor

Dr. Bradley Striebig

With the environment being a common passion, our goal is to improve water quality in The Chesapeake Bay.

Municipal Wastewater Treatment System

Bluff Point, in the lower part of Northumberland County is not suitable for septic tanks. http://www.co.northumberland.va.us



The dissolved oxygen (DO) concentration in the Chesapeake Bay is affected by nutrient loading, specifically nitrogen and phosphorous. The DO concentration has to increase from current levels to preserve life in and around the Chesapeake Bay. Currently the majority of Northumberland County, which borders the Chesapeake Bay, uses septic tanks for wastewater management. Septic systems do not remove nutrients from wastewater, making septic systems an inappropriate method for decreasing nitrogen and phosphorous levels. Decreasing the loadings of nitrogen and phosphorus in wastewater effluent will increase the DO concentration in the Chesapeake Bay. With an improved DO concentration in the Chesapeake Bay, ecosystems will thrive. The design and introduction of a municipal wastewater treatment system will focus on decreasing nutrient concentrations entering the Chesapeake Bay from municipal wastewater. Treatment selection will be based on anticipated nitrogen and phosphorous removal of each treatment option for Northumberland County. The proposed techniques could positively impact DO levels with implementation in areas surrounding the Chesapeake Bay.

Team

Zachary Booker

Taylor Calder

Kaitlyn Cunningham

Rachel Harvey

Natalie Jones

Jay Naduvilekunnel

Advisor

Dr. Jonathan H. Spindel

"Our goal is to increase the entertainment value of vestibular rehabilitation therapy."

Novel Methods for Vestibular Therapy

Oculus Rift, one of the pre-existing systems the team is benchmarking in order to create a technology-based rehabilitation system.

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 is striving to find a novel method for vestibular rehabilitation 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, patient motivation to follow a prescribed therapy regimen would increase. The team is working with healthcare professionals and conducting internal research to implement an effective approach into a video game system to better address the limitations of current therapy methods. Benchmarking existing video game systems, including the Nintendo Wii, Xbox 360, and Oculus Rift, was completed. The information gathered from benchmarking was evaluated using a decision matrix, which played a role in determining the final concept. Based on these results, the team will develop an initial prototype to showcase what the final deliverable will resemble after testing and refinement. To best meet customer needs, the final deliverable will provide entertainment to encourage patient retention.

Team

Brittany Berni

Jerney Davis

Kathryn McDonald

Advisor

Dr. Robert Prins

The Rehabilitation team studies the abilities and characteristics of the project's defined user.

Rehabiliation Engineering

The end deliverable will be a wheelchair accommodation that aims to be adaptable to manual Sunrise Medical Quickie wheelchairs.

Individuals who have to use a wheelchair, either temporarily or permanently, do not have a wheelchair accommodation that fits their specific needs. As engineers, the Rehabilitation team aims to assess their needs and design an accommodation that can better the individuals' quality of life. Due to the vast difference in the needs and abilities of each wheelchair user, the scope has been 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 Woodrow Wilson 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 gaining independence. Independence includes allowing the user to accomplish tasks they might otherwise have needed assistance with.

The accommodation must allow the user to attach, detach, and utilize the system on their own. Benchmarking has also been done which allowed the team to come up with potential solutions to functions as well as identify additional requirements for the accommodation. Implementing these requirements throughout the design will allow for a satisfied, more independent user. Currently the team is designing proof of concepts for users to interact with and provide feedback for iteration.

Team

Chris Colvin

Arthur Gartner

Sierra Hahn-Ventrell

Donny Pasquarello

Brian Rasbach

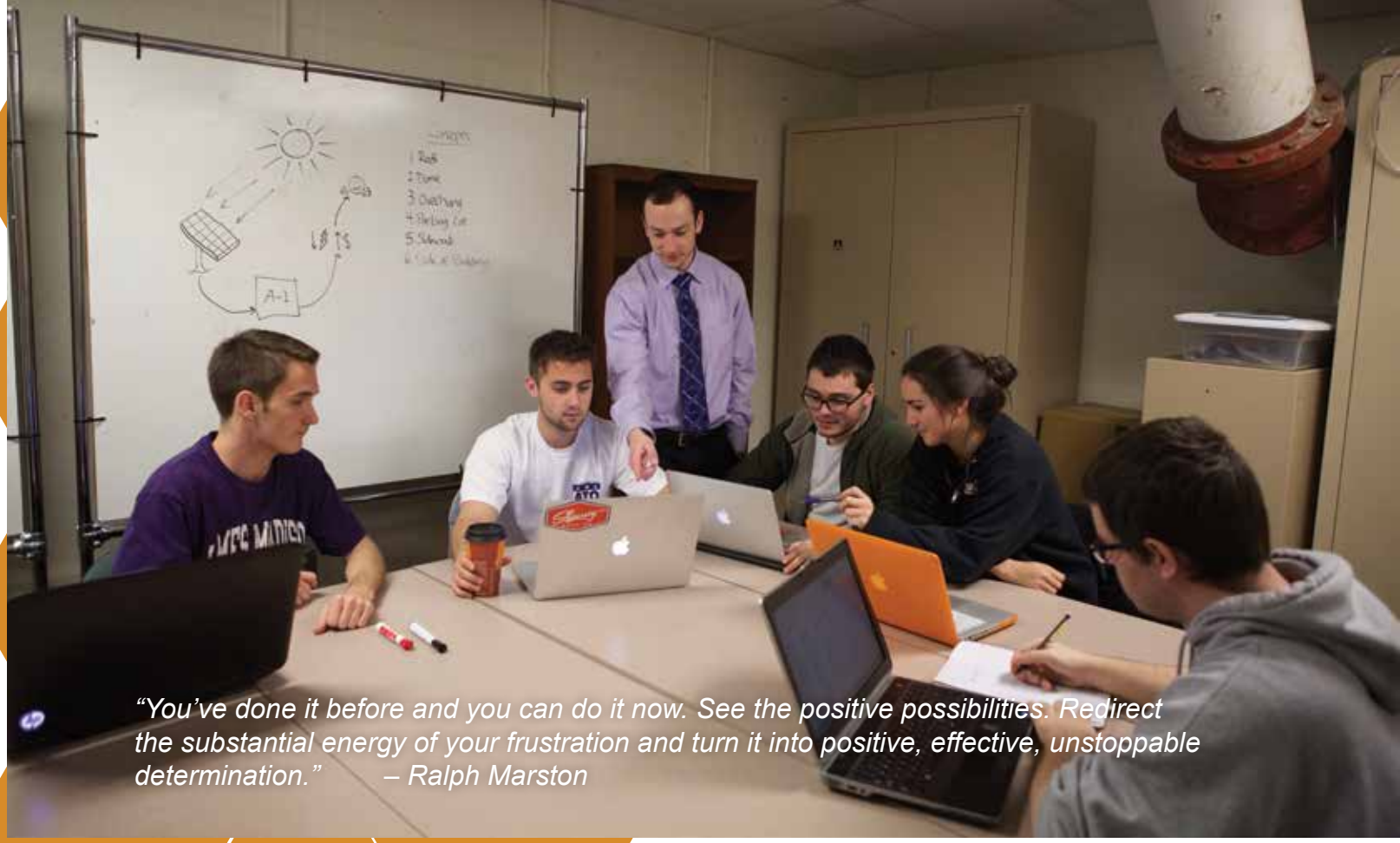
Brett Thomas

Advisor

Dr. Kurt Paterson

Client

ISNW Education &
Research Subcommittee



"You've done it before and you can do it now. See the positive possibilities. Redirect the substantial energy of your frustration and turn it into positive, effective, unstoppable determination." *– Ralph Marston*

Solar U:

JMU Green Energy Systems Analysis & Design

James Madison University solar panels located on ISAT hill.

The Commonwealth of Virginia Executive Order 31 has mandated a 15% reduction in electrical consumption by 2017 for all state facilities. This project is designed to decrease electrical consumption by 15%, by creating a solar system addition to the Health and Human Services at James Madison University. The methods used include extensive research and benchmarking peer institutions such as Eastern Mennonite University and American University through interviews, online research, and on campus tours as well as decision matrices when analyzing solution alternatives, Pugh charts, rapid prototyping and multiple design solutions. The project has been broken down into a three-step process: economic feasibility, including payback and financial analysis, a feasibility generation packet, which includes preliminary designs and capabilities, and final designs which will include three final design solutions including schematics of solar systems for each budget tier. The results from preliminary research and feasibility analysis determined that a medium or small-scale project is possible within budget. From stakeholder analysis the results indicate that the solar system will be primarily solar panels with a strong focus on social requirements, especially public image and promotion, with the use of PV cells and will not contain a storage unit. Based on these results multiple design solutions will be created to determine which meets the stakeholders needs the best and follows the requirements. These results narrow proposed solutions and determine where the budget will be primarily allocated. The project will continue with data and analytical calculations to finalize design alternatives and prepare design solutions.

Team

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Edward Powell

Mo Katz

Robert Swope

William Smythe

Advisor

Dr. Samuel A. Morton

"Our environment, the world in which we live and work, is a mirror of our attitudes and expectations" *– Earl Nightingale*

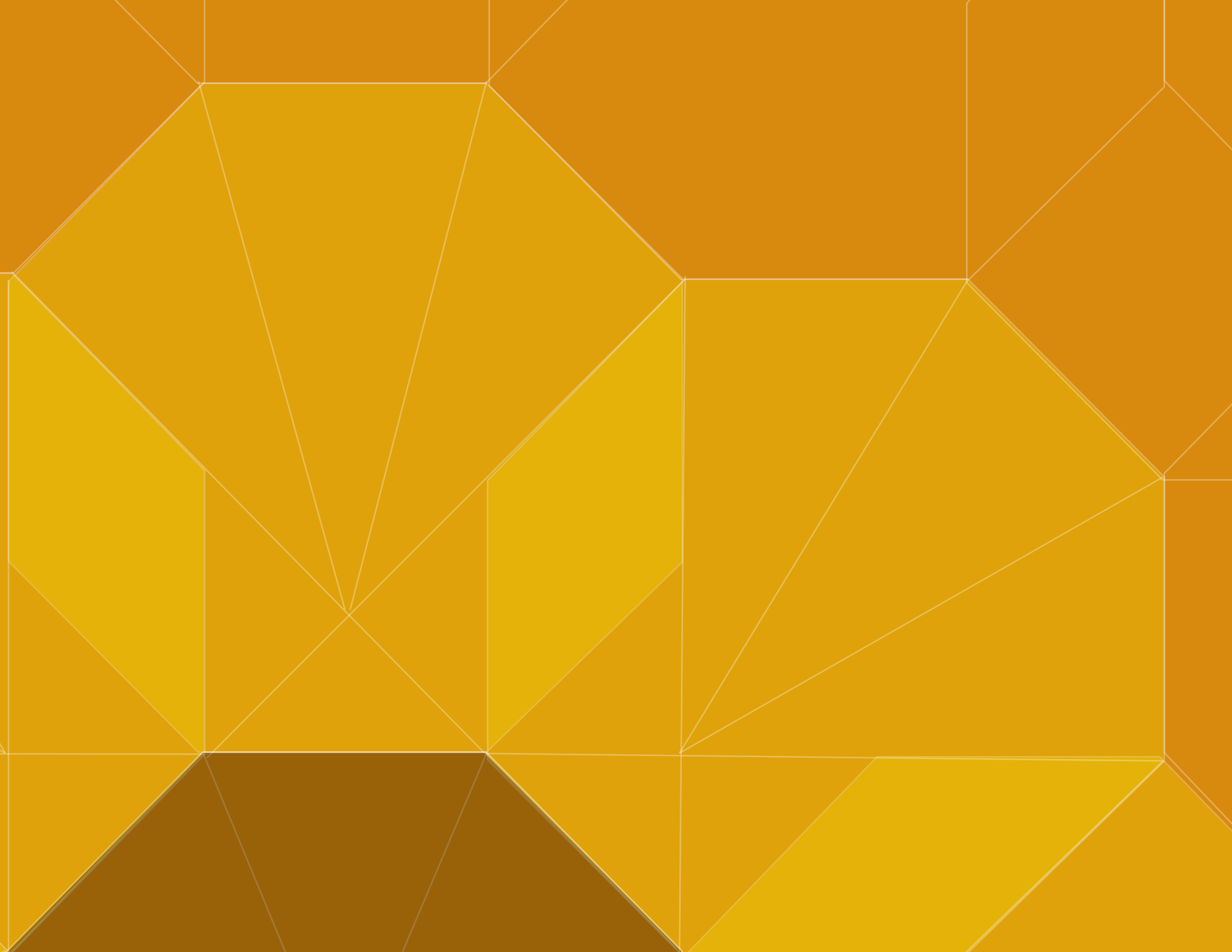
Treatment of Hydraulic Fracturing Wastewater

Testing the effects of various chemicals on algal growth.

The wastewater that is generated as a result of hydraulic fracturing poses serious environmental and health risks and there is currently little oversight of the chemicals used, quantity of such chemicals, as well as the effects of the process on groundwater. The storage of the water underground and the current disposal of wastewater, not only contaminates part of our limited water supply, but directly affects communities across the country causing soil and drinking water to become be unusable. The team's goal is to develop a process that allows the wastewater to be treated and reused for repeated fracturing or cleaned so that it is safe to be returned to the environment. This process is attained by first identifying all the contaminants and their respective concentrations and then determining the best method for removing or diluting said contaminants. Since the composition of the wastewater varies with location, we narrowed our scope to the Marcellus Shale area in order to keep the contaminants present in the flowback consistent. There are current treatment options that can clean the wastewater, but due to the high cost of these methods they are not often implemented by fracking companies. It has been determined that different types of microorganisms and other filtering processes could be combined to provide a cheap and effective alternative to current treatment methods. Currently, the team is researching different types of microorganisms to see which species will be most effective in chemical absorption.


Collabo

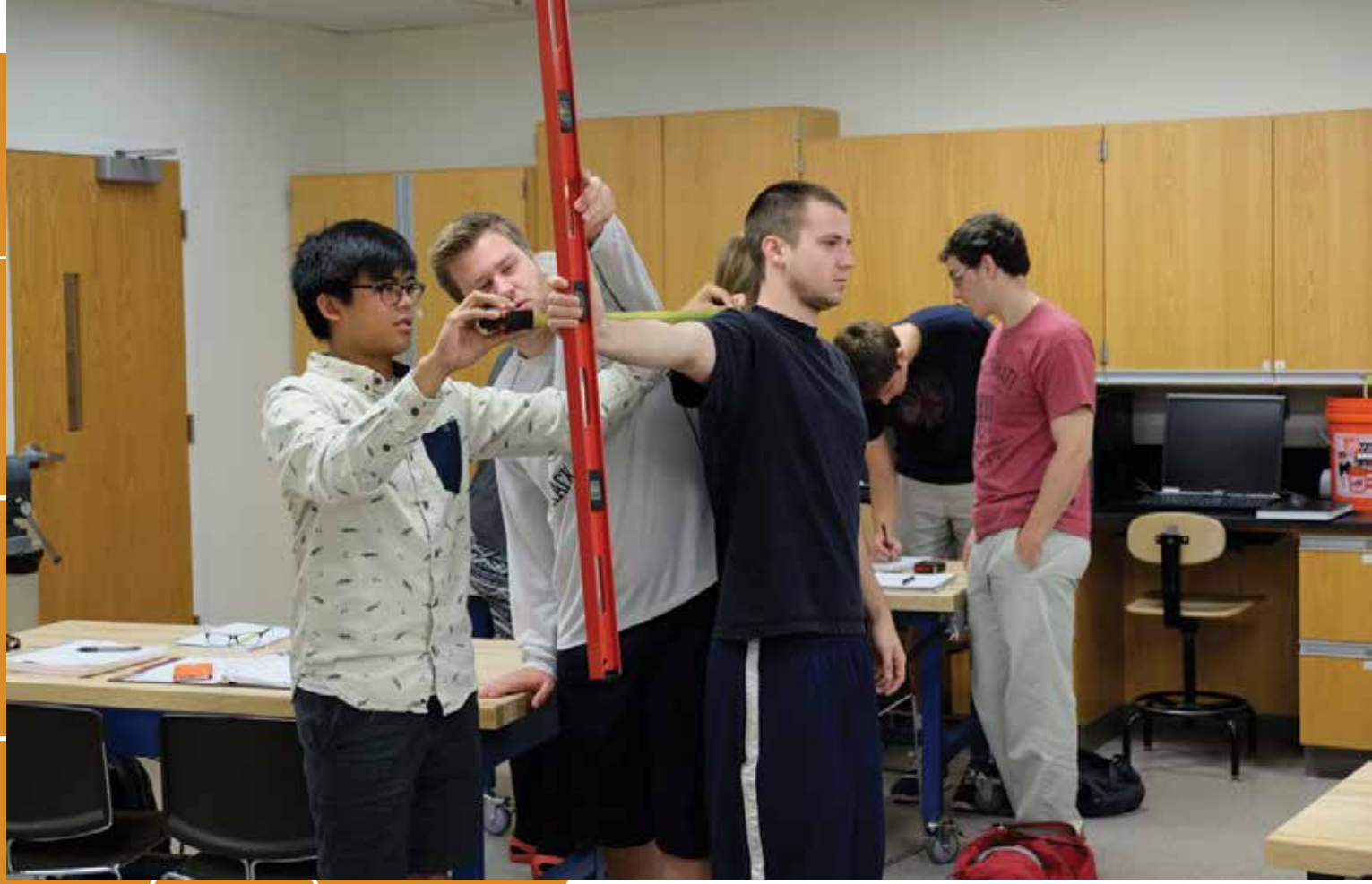

“You can cut all the flowers but you
cannot keep spring from coming.”
— Pablo Neruda
ration



Sophmore

Sophmore

Sophmore



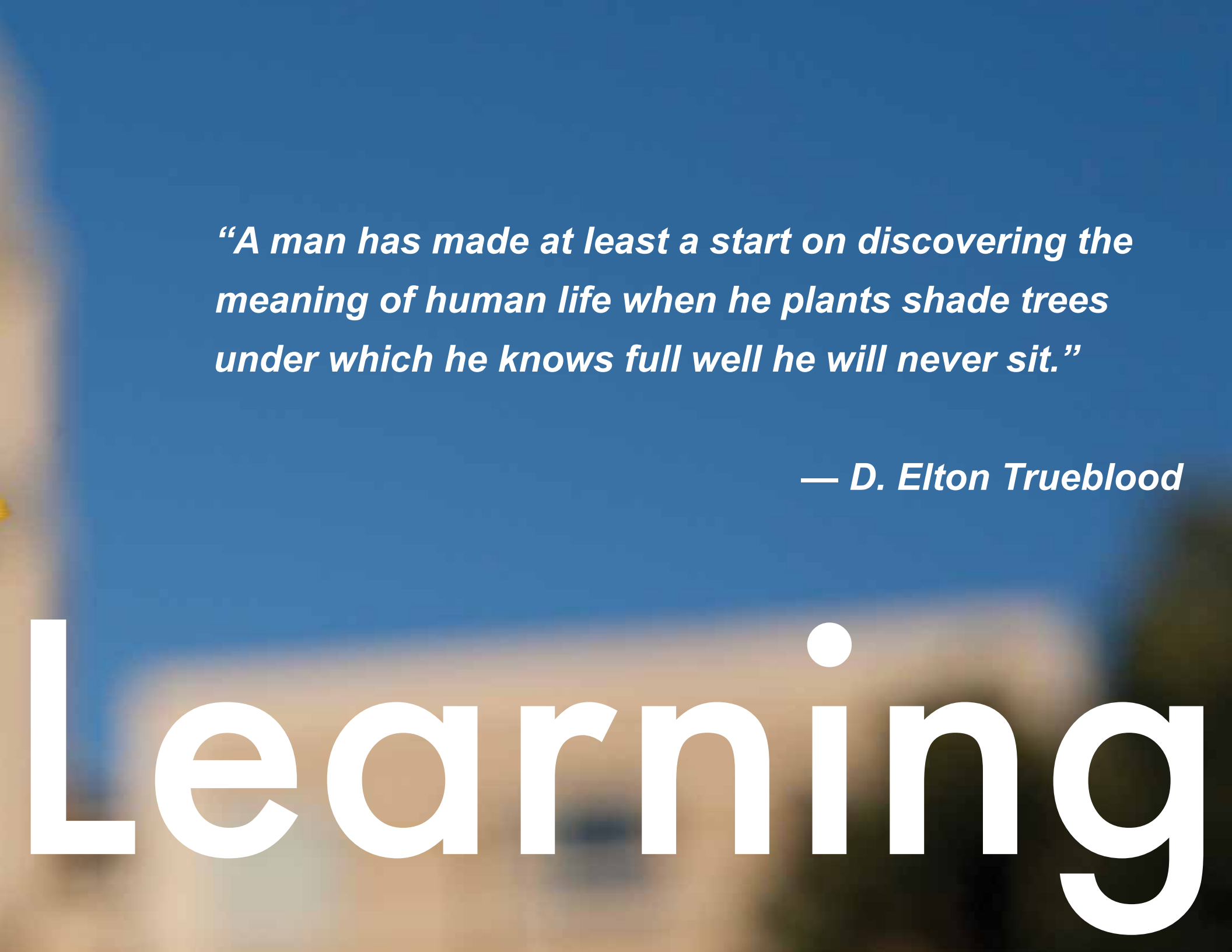
Human Powered Vehicle Design

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

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

Each year, an individual who has not been able to independently ride a bicycle prior to working with our students is given an opportunity to receive a custom-made human-powered vehicle that can provide both independence and exercise. The impact is on the students, the faculty, and the families involved.

Sophomores continued..


“A man has made at least a start on discovering the meaning of human life when he plants shade trees under which he knows full well he will never sit.”
— D. Elton Trueblood
Learning

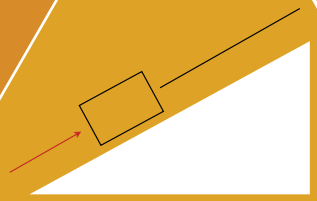

Freshmen
Freshmen
Freshmen

Explore More Museum

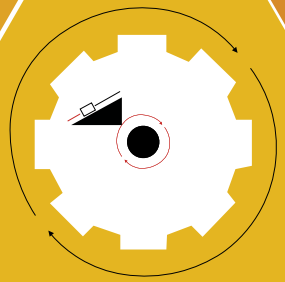
What could spark a child's imagination of and encourage them to learn programming and electronics? First-year engineering students in Dr. Holland's ENGR 112 class were challenged by the Explore More Discovery Museum of Harrisonburg, VA to design and prototype an interactive display for 8 – 12 year olds to demonstrate the limitless possibilities upon learning programming and basic electronics. Such displays can be used by the museum for engagement and enrichment activities and programs related to programming and electronics.

By learning the Arduino microcontroller architecture and programming language, applying skills developed in the ENGR 112 class, and collaborating in project teams of 3-4 students, six unique and creative solutions to this challenge will be presented at the xChange.

Simple Machines



Inclined Plane



Wheel & axle

The ENGR 112 sections taught by Dr. Henriques and Dr. Gipson have a course project in which teams of 4-5 first year engineering students design and construct a system of simple machines for a local client, Woodland Montessori School. The client is interested in using the simple machines to teach children concepts in science and engineering. Each team member has selected a minimum of one simple machine (i.e. a subsystem), which they will be responsible for designing and producing. The simple machines of each member of the group will be place together to create a "system" that is able to complete a task, similar to a Rube Goldberg Machine. The teams have been instructed to apply the Human-Centered Design process which was introduced in ENGR 101 in the fall semester with the engineer fundamental analysis, and analytical and physical prototyping skills learned now in ENGR 112. Students are also instructed that they will have to provide evidence and analysis for the decisions they make through the project. Embedded in the project are engineering decisions that could include but are not limited to safety considerations, educational merit, sustainability, costs, desirability, and scale-up challenges.

Screw

Solving Big Problems for Tiny Houses

The Tiny House movement is gaining attention in developed countries 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. Freshmen teams in Dr. Barrella's and Dr. McLeod's sections 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 a tiny house to reduce their environmental footprint. Over the course of the semester, the teams are using creative and analytic problem-solving process to tackle: space efficiency, heating/cooling of the house, renewable energy, waste management, and innovative materials. All of these challenges involve safety, health, affordability and legal dimensions as well.

We would like to extend a special thanks to the following individuals who have enriched the undergraduate MadE experience this year.

Thank you for your time and unyielding support.

ALUMNI SERVING AS CAPSTONE DESIGN REVIEW PANELISTS

Adib Amini (Ph.D. Student, Civil and Environmental Engineering, University of South Florida)

Sara Bethel (Systems Engineer, Booz Allen Hamilton)

Evan Bowen (Engineer, Kawneer, Harrisonburg VA)

Leslie Bland (Ph.D. Student, Materials Science and Engineering, University of Virginia)

Tim Brooks (Senior Project Engineer, Skanska Building USA, Harrisonburg, Virginia)

Kent Graham (Project Engineer, Construction Division, ColonialWebb Contractors)

Leah Haling (Department of Energy, National Energy Technology Laboratory (NETL))

Connor Heede (Project Engineer, Chartier Group, Hoboken, NJ)

Devin Imholte (Systems Engineer, Battelle Energy Alliance, LLC - Idaho National Lab)

Joey Lang (Engineer, SURVICE Engineering Company, Dumfries, VA)

Jared Price (Ph.D. Student, Electrical Engineering, Penn State University)

Dan Wolfe (Ph.D. Student, Electrical and Computer Engineering, University of Delaware)

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