22ND ANNUAL

SENIOR SYMPOSIUM

CISE
COLLEGE OF INTEGRATED SCIENCE & ENGINEERING
JAMES MADISON UNIVERSITY

THE SCHOOL OF INTEGRATED SCIENCES

Integrated Science and Technology

Intelligence Analysis

Geographic Science

Biotechnology

CONTENTS

The Integrated Science and Technology degree program prepares students to tackle a wide range of real-world problems. Students gain a broad foundation in various science and technology areas, learn to think holistically to address complex problems, and dive more deeply into one or more problem areas including Applied Biotechnology, Energy, Environment, Information and Knowledge Management, Production System, and Telecommunications, Networking, and Security. Exceptional versatility, an ability to see the big picture, and a strong grounding in the social context of problems distinguishes ISAT students from other technically focused majors.

A SUSTAINABILITY ASSESSMENT METHOD OF 3D PRINTING WITH BIO-INSPIRED DESIGN

Presenters

Abdulrahman Al-Qas, Evan Gibbons, Jenifer Lee

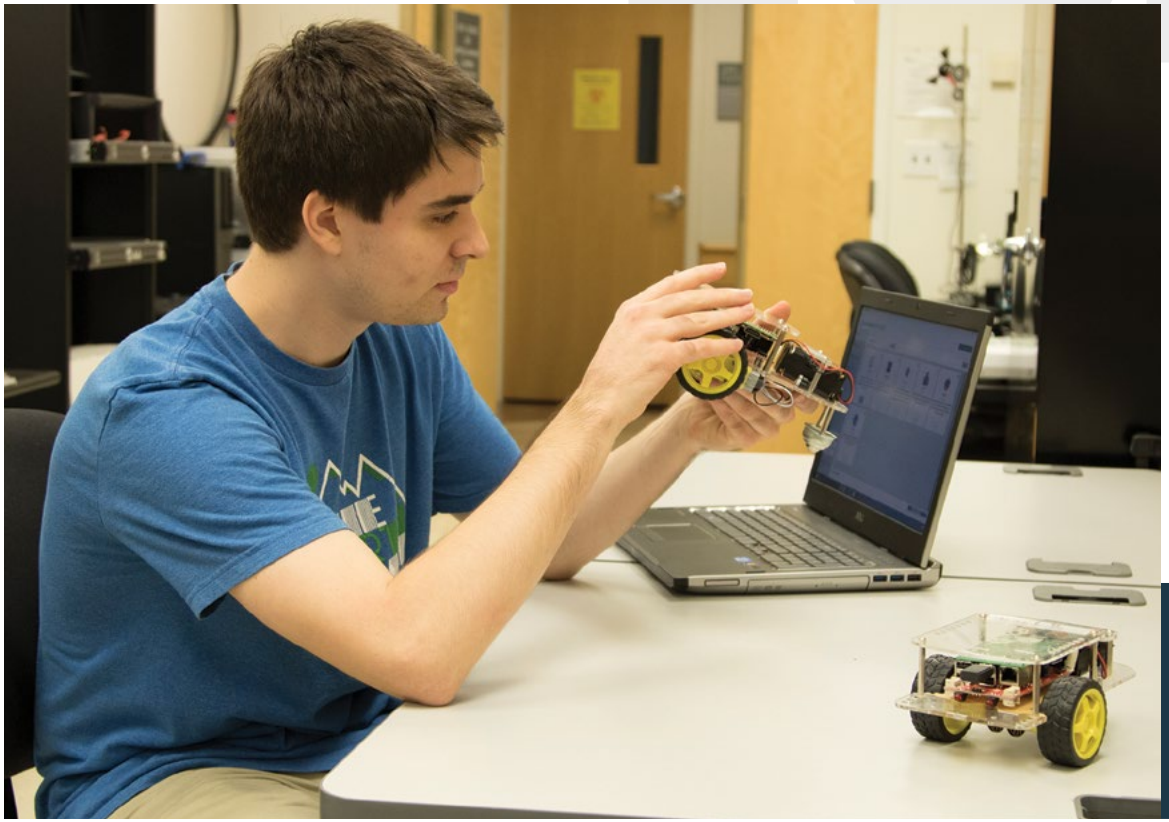
Advisor

Hao Zhang

The team is creating different biomimicry structures on a systems modeling and computer engineering program. This program was used to run the static, fracture, and fatigue tests to analyze each structure and material.

High value material products (e.g. stainless steel, titanium, copper) suffer from high raw material cost and expensive end-of-life management plans. One solution for reducing cost and environmental impact is designing high value parts with complex structure (i.e. biomimicry structures) to reduce material use and meanwhile support the functionality of the part. Additive manufacturing provides a unique way to create such complex geometries. The objective of this research is to present a system method for economic, environmental, and social impact assessment of using biomimicry geometries for additive manufacturing product design. The method integrates concurrent considerations of multiple additive manufacturing design and bioinspired design factors including raw material quality (e.g. size, shape, internal porosity), processing parameters (e.g., laser power, roller speed), and functionality of the product (e.g., stress, strain, displacement). Sustainability assessment methods (e.g. life cycle costing, life cycle assessment) have been used for evaluating cost and environmental impact for processing different geometries. Finite element analysis is used for product functionality testing. A case study is conducted on making a unit Titanium spine implant product with selective laser sintering process. Three structures were examined: diamond structure, honey comb structure, and lattice structure. This study reveals that the method can be applied in additive manufacturing early product design and it assists researchers and engineers explore new bioinspired geometries that could be used in manufacturing.

APPLIED MACHINE LEARNING: AUTONOMOUS NAVIGATION



Presenter

James Cooper

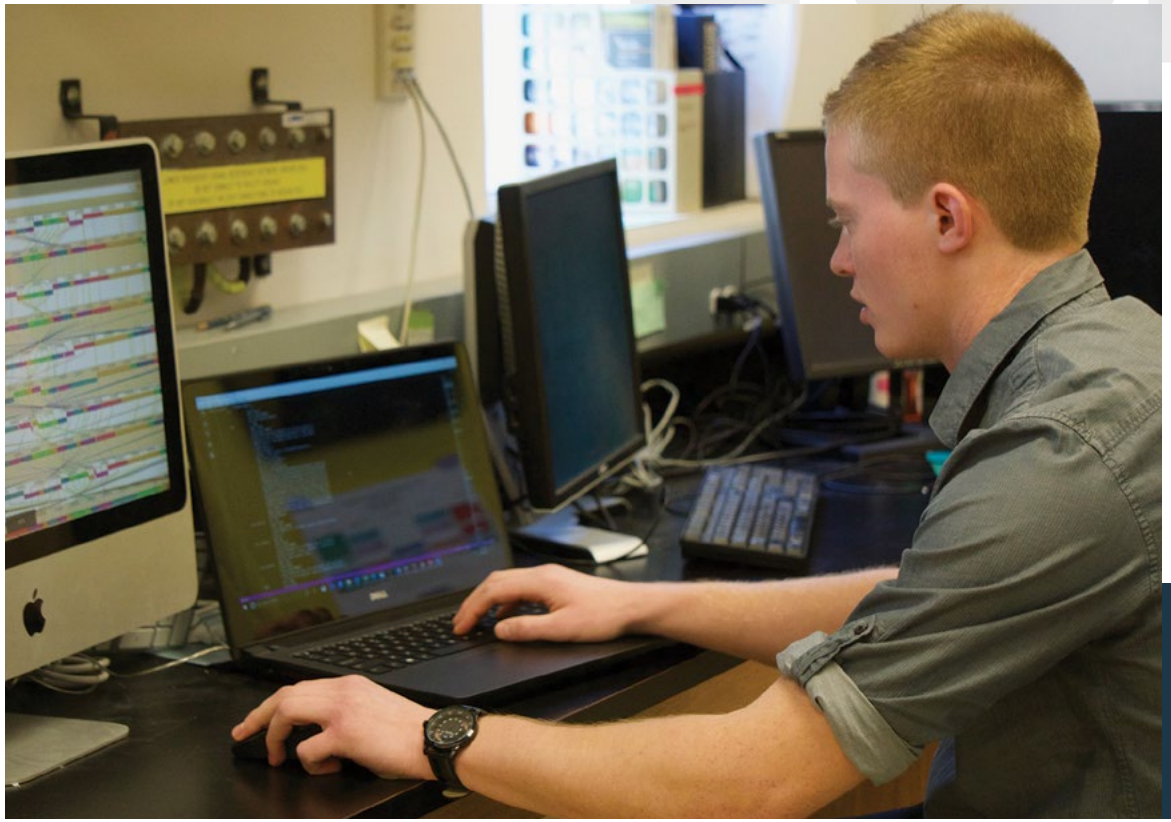
Advisor

Anthony Teate

James is planning to embed machine learning algorithms into a Raspberry Pi GoPiGo car to turn it into a small autonomous vehicle. He is inspecting the Raspberry PI GoPiGo robots before a round of testing.

Although humans have been driving vehicles for over 100 years, driving remains one of the most dangerous activities we perform on a daily basis, resulting in the second highest cause of injury among all age groups worldwide. However, with recent advancements in artificial intelligence and software engineering, tech giants such as Google, Tesla, and others are developing and testing autonomous driving capabilities to begin phasing out the most dangerous aspect of modern-day driving, the drivers. Autonomous capabilities are revolutionizing the automotive industry by limiting the prevalence of dangerous driving, such as drunk and distracted driving, making the roads a safer place for everyone. This project was designed to replicate recent autonomous driving advances, at a much smaller scale, by building and developing our own intelligent navigational software using various machine learning techniques within Google's TensorFlow software. Our robotic car will be equipped with open-source computer vision, OpenCV, along with various other sensors to help quickly identify obstacles and safely navigate the car's path in real-time. Later, we hope to upload this serialized software onto the cloud using Amazon Web Services so our cars can communicate beyond the limits of our localized servers. This project was not meant to duplicate full-scale autonomous navigation, but rather to serve as a miniaturized demonstration of the applicable power of machine learning and Google's TensorFlow software package.

BORDETELLA PERTUSSIS GENOME EVOLUTION CAUSING WHOOPING COUGH RESURGENCE



Presenter

Kevin Loftus

Advisor

Louise Temple

Kevin is analyzing Bordetella pertussis genome alignments using Mauve.

Bordetella pertussis is the bacterium responsible for pertussis, a disease commonly referred to as whooping cough. Recently, pertussis has made a resurgence in the U.S. despite high-vaccination coverage. Possible causes of the increased number of pertussis cases include genetic evolution of B. pertussis, increased awareness of the disease, better laboratory diagnostics, and the switch from a whole-cellular vaccine to an acellular vaccine in the 1990s. Fortunately, just as B. pertussis is evolving, so is the arsenal of technologies used to understand and combat the pathogenic bacteria. Whole genome sequencing is one technology that helps researchers better understand B. pertussis. This project utilizes bioinformatics to analyze data obtained from genome sequence of twelve B. pertussis isolates that were cultured from whooping cough patients in Virginia. Specifically, multilocus sequence typing (MLST) was performed and alleles of several critical virulence factors such as pertactin, pertussis toxin, adenylate cyclase toxin, fimbria, and BipA were analyzed and compared to reference strains and globally circulating strains. The strains used to produce U.S. vaccines are no longer representative of circulating strains. For example, Tohama 1, a strain used to produce vaccines in the U.S., carries a ptxP1 allele, whereas most circulating strains, including all of the 12 strains analyzed in this paper, carry a ptxP3 allele. Analysis of additional significant genes is ongoing. This project builds on information gathered from previous studies and contributes to the growing knowledge of the evolution of the B. pertussis genome as related to whooping cough.

COMPARATIVE LIFE-CYCLE ASSESSMENT: INTERNAL COMBUSTION ENGINE VS ELECTRIC

Presenter

Gabrielle Massoud

Advisor

Steven Frysinger

Gabrielle is taking a closer look at the internal combustion engine (ICE) in a BMW 328 ix.

The purpose of this research is to determine if it is more economically and environmentally sound to purchase an internal combustion engine (ICE) vehicle versus an electric-hybrid.
In order to determine this, two cars are analyzed in a Comparative Life-cycle Assessment (CLCA): the 2017 BMW 330i, an ICE, vs the electric-hybrid 2017 BMW 330e. Both vehicles are the same size, have the same body style, and come equipped with a 4-cylinder engine. Through the CLCA, the materials that go into these cars, but which differentiate them, are analyzed from raw materials, the products they become, where they end up once they are no longer operable as a vehicle, and all the components that are involved throughout their life-cycle. Fuel economy, total costs of owning each car, the fuel itself, and other factors are researched to determine which car is the best choice for the environmentally conscious consumer. A major factor in determining which vehicle is best depends on where the consumer lives and how they choose to drive it. There are different incentive programs around the world that give tax breaks and other perks to those who opt to invest in an electric hybrid, and these incentives and breaks make up for the extra costs that go along with purchasing and maintaining an electric vehicle. The electric-hybrid, 330e appears to have the best package and capabilities.

COMPARITIVE ANALYSIS BY STATE OF TAXATION OF UTILITY-SCALE WIND PROJECTS

Presenter

Christopher Kent

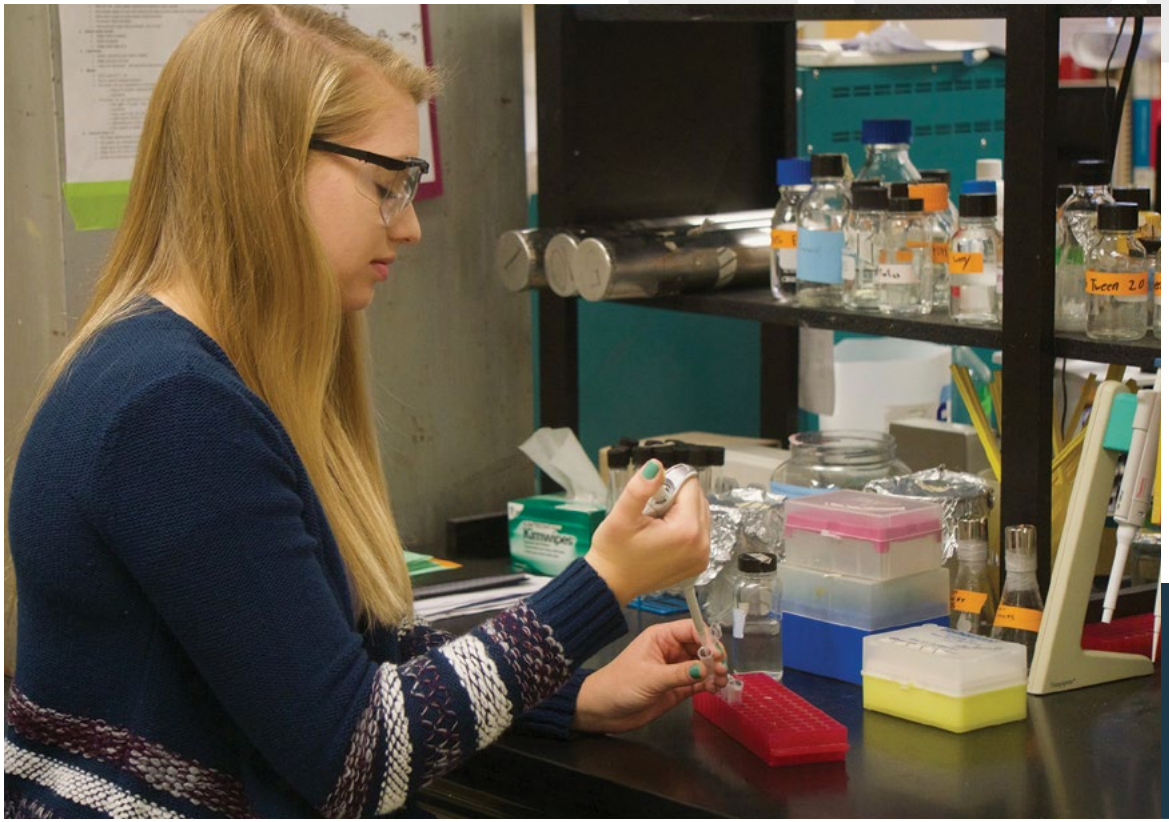
Advisor

Jonathan Miles

Chris is working to find policy tools from states with large amounts of wind power, which could be applicable to future wind efforts in Virginia.

This project analyzes various existing tax structures for utility-scale wind power projects in the United States and presents options for the Rocky Forge wind power plant in Botetourt County, Virginia – which may become the first utility-scale wind project in the Commonwealth. In order to complete this analysis, three states were studied and used as reference – Texas, Iowa and North Carolina. These states have set structures for wind project taxation that may be applicable to the Rocky Forge project. In this study, wind projects that have a generating capacity ranging between 60 and 100 megawatts were considered, as this is comparable to the capacity of the Rocky Forge Wind project. The means by which selected wind power projects are taxed in each of the states considered was examined. An analysis informed by the current state of taxation will be utilized as a taxation scheme in Botetourt County is developed. This analysis will also be useful as future wind power plants are developed in Virginia.

CONFIRMATION AND GENOTYPING OF NATIVE BRADYRHIZOBIUM JAPONICUM STRAINS



Presenter

Brenna Artman

Advisor

Stephanie Stockwell

Brenna extracts DNA from several of the Bradyrhizobium japonicum isolates. This DNA will be quantified, then used in a Southern blot to detect genes associated with the symbiosis with soybean.

Bradyrhizobium japonicum is a nitrogen fixing soil bacterium that forms a symbiotic relationship with soybean plants. The symbiosis allows plants to grow without the need of additional nitrogen fertilizers. Farmers benefit from this relationship because their agricultural yields are improving, while nitrogen runoff and pollution are diminishing. In order to enhance symbiosis, the signaling pathways between soybean plant and B. japonicum must first be understood. Of the two lab strains currently identified, the fhuA/ecfS pathway is present in strain USDA110, and the fegA pathway is present in strain 61A152. This project aimed to confirm that local soil samples collected in previous years were in fact B. japonicum. The B. japonicum isolates were genotyped to determine the gene preference of wild strains, using Polymerase Chain Reaction and Southern blot. The strains were then sorted as USDA110 or 61A152-like based on the presence of key symbiosis genes.

CONNECTING STAKEHOLDERS WITHIN A COLLABORATIVE BIOTECHNOLOGY PROJECT

Presenter

Jordyn Eastman

Advisor

Stephanie Stockwell

Jordyn is using bacterial growth to biochemically confirm the identity of Bradyrhizobium japonicum isolates obtained using a soybean plant trap system.

Bradyrhizobium japonicum is a soil bacterium that fixes nitrogen for soybeans in the context of a symbiotic relationship. The aim of this project was to enhance the collection of new bacterial isolates through a Citizen Science approach with Harrisonburg High School (HHS). Citizen Science is the collaboration of scientists and nonscientists to achieve common goals. This project specifically aimed to develop materials to strengthen relationships and communication between the three primary stakeholders--JMU researchers, HHS students, and farmers who donate soil samples. More specifically, a website with resources and a newsletter were created. The website contains scientific resources such as a downloadable lab manual and video tutorials of key protocols. The newsletter summarizes key findings and creates a feedback loop between the previously overlooked farmers and the researchers. Methods to create the newsletter included administering a survey to collect farmer interests, consulting with HHS teachers, developing a learning module for HHS students, and creating a sample. These materials will be used in future years to support the ongoing collaboration between stakeholders involved in B. japonicum research.

DEGRADATION AND MARGINALIZATION IN TANZANIAN MARINE ENVIRONMENTS

Presenter

Alyssa Withrow

Advisor

Jennifer Coffman

Alyssa is surveying and collecting data for a coral health assessment at Chumbe Island Coral Park Ltd. in Zanzibar.

Coral reefs are among the most biologically diverse and productive of the world's habitats. Reefs are home to a wide variety of marine flora and fauna, protect coastal areas from storms, and generate tourism and thus domestic and foreign revenue. About half of the world's human population lives within the coastal zone, or 100 kilometers from the coast, and billions of dollars of revenue are generated annually through ocean-related businesses. Yet, over 90% of coral reefs along the continental shores of the Indian Ocean are threatened by degradation and climate change. Using the guiding framework of political ecology, this project focuses on Tanzania to explore how blast fishing and seaweed harvesting contribute to coral reef degradation, economic marginalization of the people most directly involved in these practices, and the establishment of Marine Protected Areas as a possible solution to such degradation and marginalization. This project is based on direct research in Tanzania, including personal accounts of current marine health in Tanzania, case studies from the Zanzibar archipelago, and educational lectures by faculty at the University of Dar Es Saalam and Institute of Marine Sciences in Zanzibar. In outlining recommendations for environmental governance of Tanzanian marine environments, I apply a strengths, weaknesses, opportunities, and threats (SWOT) analysis to the specific case study of Chumbe Island Coral Park Ltd., a Marine Protected Area (MPA).

DESIGN AND IMPLEMENTATION OF A PLANT PROPAGATION STRUCTURE AT VINE & FIG

Presenters

Derek Gordon, Elena Konstant, Owen Palmer

Advisors

Jennifer Coffman, Wayne Teel

Sponsor

Tom Benevento, Cornelius Frantz - Vine & Fig

The team is surveying the site and recording the necessary data that will aid in both the modeling and design of the plant propagation structure.

Our team has been working with Vine & Fig in downtown Harrisonburg, Virginia, to help them improve several aspects of their overall productivity. We designed and began implementing an innovative greenhouse growing space for plant propagation, with the intent of increasing edible landscaping throughout the neighborhood. We are also developing means by which to analyze agricultural yields to establish a baseline of the propagation productivity, drafting a plan to increase production on the current site, and designing methods for monitoring and evaluating food yields based on variety, weight, and calories. Despite ample food production globally, the problems of food scarcity and undernourishment persist today. Reliance on industrial agriculture, coupled with inequality within the distribution systems, contribute to these issues. Local, sustainable food production systems could significantly alleviate these stressors. This project focuses on enhancing urban food production through the case study of Vine & Fig, a program of the nonprofit organization New Community Project (NCP). Vine & Fig promotes backyard garden spaces for locally produced organic foods and educates residents in permaculture design. Permaculture can be described as the art and science of creating healthy and resilient human environments abundant in food, water, shelter, energy, and community. On a lot size of less than half an acre, Vine & Fig has grown a variety of crops and produced a documented yield of over 1,800 pounds of food in 2015. Our goal is to increase production while also providing ongoing means for monitoring and evaluation.

DEVELOPMENT OF HETEROLOGOUS VACCINES AGAINST POULTRY AND HUMAN DISEASES

Presenter

Noelle Luis

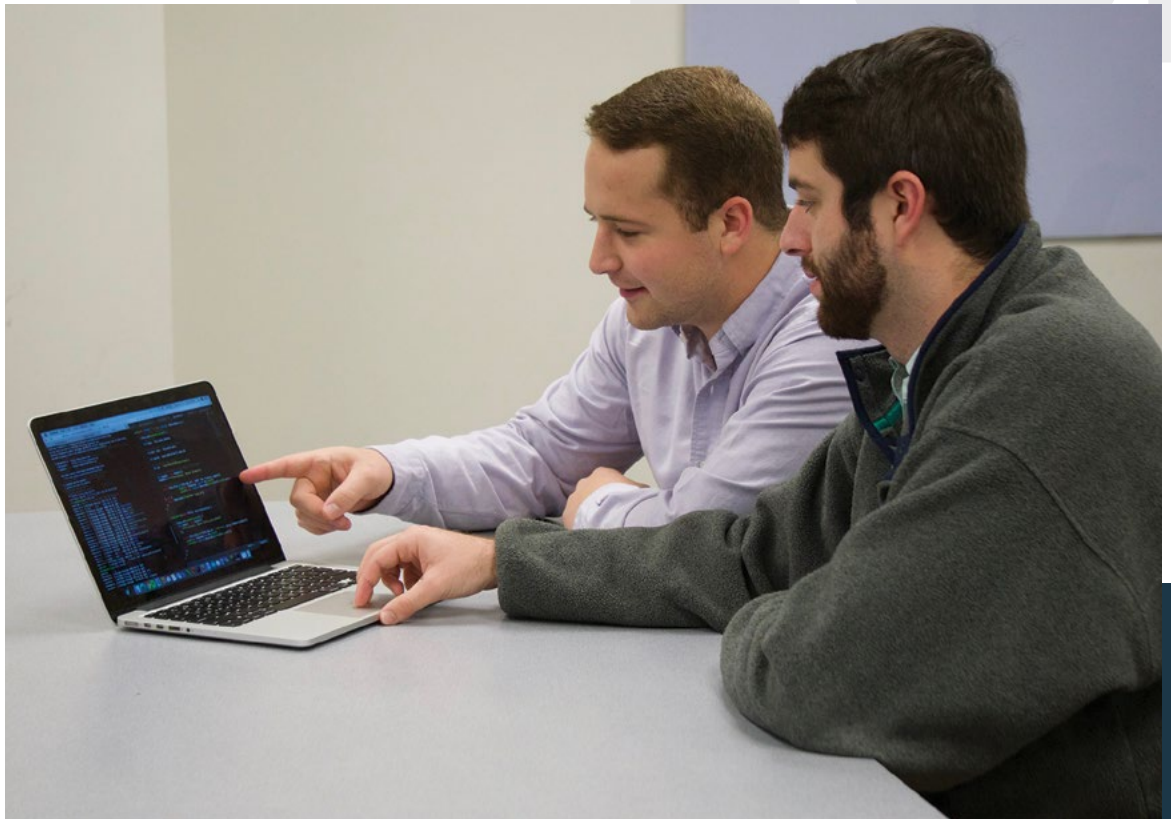
Advisor

Louise Temple

Noelle is pipetting a secondary antibody into a blocking buffer to prepare for the imaging of a western blot.

Bordetella avium is a gram-negative bacterium that colonizes in the tracheas of young poults. This bacteria has been proven to cause bordetellosis, a highly contagious disease that affects the upper respiratory tract causing loss of voice, reduction of appetite, sneezing "snicking", and mucus build up in the trachea. Poultry is also colonized by Campylobacter jejuni, another gram-negative bacterial species that causes food poisoning in humans through contaminated meat but is nonpathogenic in the birds. There is a strong interest in controlling these pathogens to prevent economic loses in the poultry industry as well as human disease. Therefore, a dual vaccine platform has been proposed that will combat both B. avium and C. jejuni. One vaccine strain was created by exchanging the DNA of the B. avium autotransporter, baa1, with the gene for a surface protein of C. jejuni, Cja1. We expected this protein to be expressed in turkeys and to elicit antibodies that will lower the colonization of turkeys with C.jejuni and B, avium. In the current project, the goal is to confirm this expression through western blots using antibodies that will detect the histidine tags on the recombinant protein. In two experiments, signals were detected indicating that the protein is present in the membrane and cytoplasmic fractions of the bacterial culture. Once this is confirmed, the vaccine strain will be tested in turkeys at Va. Tech. Future work will include creating a second recombinant B. avium expressing a flagellar protein, Fla, from C.jejuni.

DIALOGGR 3: TRACKING PHYSICAL ACTIVITY AND MODELING BGL



Presenters

Ryan Nangle, Austin Purritano

Advisor

Morgan Benton

The team is adding the ability to track and collect information on physical activity and exercise to Dialoggr, the mobile app, and create a function that alerts users if their blood glucose levels leave normal limits.

Type 1 diabetes is a chronic, life-threatening illness affecting many children globally. The bodies of type 1 diabetics cannot produce insulin and hence regulate blood sugar levels. Managing diabetes requires constantly monitoring one's blood glucose level (BGL), being careful with food, and administering synthetic insulin, as well as keeping food and activity logs, and seeing a doctor regularly. Dialoggr aims to help type 1 diabetics manage their condition by collecting, organizing, and presenting information about the user's condition efficiently and effectively. The prototype of this mobile app, completed in Spring 2017 by another group of ISAT students, collected information about BGL, carbohydrates, and sleep. Our project extends Dialoggr by adding physical activity to the list of statistics it collects. Physical activity makes it easier for the body to control BGL, increases sensitivity to insulin, and helps prevent long-term complications that sometimes come with type 1 diabetes. Our team also created a predictive model that can alert the user when BGL is in danger of getting too low or too high. Dialoggr will not only improve the lives of people with type 1 diabetes but will also give physicians and researchers access to more and better data that could improve management or even cure this chronic disease.

ELECTRONIC WASTE DUMPING IN AFRICA

Presenter

Lauren Johnson

Advisor

Steven Frysinger

Lauren is exploring how electronics make their way from consumers in Western countries to dumps in African countries.

European countries such as Germany, Norway, and the UK along with the United States, China and Japan are creating more electronic waste than ever before. When electronics break or are replaced with a newer model, they are shipped by E-waste recycling companies to Africa and resold in markets at a discounted price. Unfortunately, many of the products arrive broken beyond repair and must be discarded. The electronics end up in countries like Agbogbloshie in Accra, Ghana where huge dumps of e-waste accumulate. The e-waste dumps are then scavenged by locals who hope to make money from the precious metals contained within the electronics. Sadly, this electronic waste is accompanied by a number of health and environmental problems due to the toxic chemicals present in many of the devices. The research conducted regarding electronic waste dumping in Africa involves analyzing current legislation dealing with the import and export of electronic waste as well as a life cycle analysis of electronics. It will be used to determine what steps can be taken to remediate electronic waste sites and prevent future electronic waste dumps.

ENERGY MODELING AND DESIGN OF PROTOTYPE HYDROPONIC GROW SYSTEM

Team members at the project site, collecting data to support their energy model.

Presenters

Alexander Martin, William Stinson, Emily Trawick

Advisor

Jonathan Miles

Sponsor

Fidelis Farm

Energy and food security relies on innovations that spur sustainable ideologies. This project considers a novel approach to grow microgreens within a controlled environment in a manner that conserves water, minimizes environmental impacts from agriculture runoff, and enables successful agriculture in virtually any environment. The eQUEST® software package, an energy simulator, has been used to create a model of the "grow box" considered in this study. The dimensions were specified, and heating, cooling, and other loads were incorporated into the model which was used to estimate energy consumption. Real-time data were collected from sensors installed in the container, analyzed in Excel and used to validate model performance. The modeling approach allowed for multiple locations to be selected in eQUEST® in order to simulate energy consumption within different climates, and simulations are used to size renewable energy systems and storage in future iterations of the grow box. Potential future applications include military deployments, disaster relief, and urban developments. Grow boxes that completely utilize renewable sources and battery storage will bring these applications to fruition.

ENERGY MONITORING AND CONTROL USING IOT AT PUNTA LEONA HOTEL Y CLUB

Presenters

Alexander Hansen, Tyler Hartman, Erik Vasquez

Advisors

Karim Altaii, Shannon Conley, Samy El-Tawab

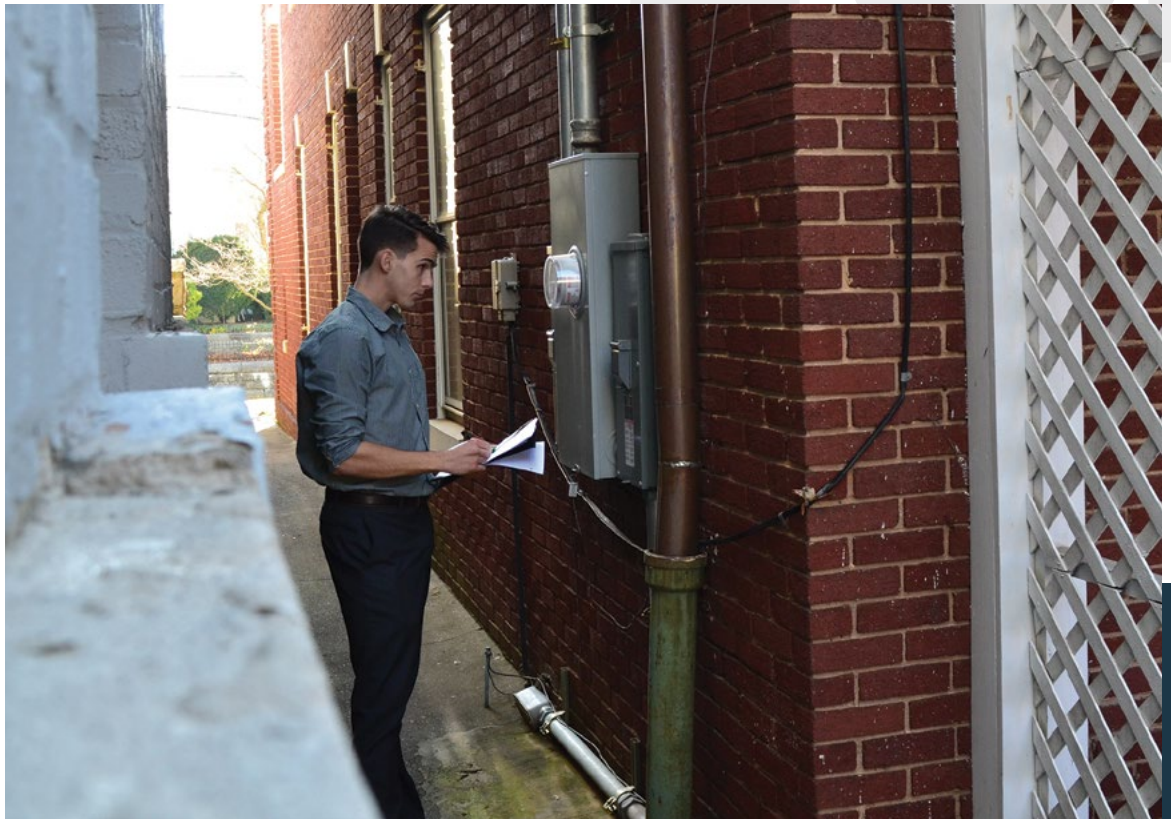
Sponsor

Jose Calderon - Punta Leona Hotel y Club, Costa Rica

Tyler, Alex and Erik research various aspects of the project specifications. Alex makes critical advancements on the iOS applicant while Tyler and Erik focus on testing and implementation of the energy controlling and monitoring wireless node.

The aim of this project is to implement a system in which electrical devices can be monitored and controlled using IoT technology with an international client. This project deals with complete front-to-back aspects including a mobile application, database services, the creation of a private API server, and hardware development. The end goal was to observe its efficacy against energy waste using air conditioning units and standard lighting units. These units were connected to Apple devices set up with iOS applications to control the unit's electrical status and monitor energy consumption, which are recorded onto a database for analysis. This consists of usage reports on the air conditioning units along with trends in consumption.

GHG EMISSIONS ANALYSIS FOR HARRISONBURG ENVIRONMENTAL PERFORMANCE STANDARDS



Presenter

Levi Bane

Advisors

Christie-Joy Brodrick-Hartman, Jennifer Coffman

Sponsor

Vine & Fig

Levi gains experience in sustainability monitoring by recording energy use.

Vine & Fig is a community center and non-profit organization that serves as a support network to members of the Harrisonburg, Virginia, community. A large proponent of progressive environmental work and a part of the Harrisonburg Environmental Performance Standards Advisory Committee, Vine & Fig is now developing an Environmental Performance Standards Action Plan for the city of Harrisonburg.

The goal of this capstone project is to analyze existing datasets for greenhouse gas emissions of the two higher education entities in Harrisonburg — James Madison University and Eastern Mennonite University — with particular attention to categories of emissions within scopes one (direct emissions), two (indirect emissions), and, less heavily, three (other unintentional indirect emissions).

This analysis will enable the consultation of Vine & Fig Community Center and Non-Profit during the formation and completion of their Environmental Performance Standards Action Plan by identifying sources of high greenhouse gas output, as well as applicable mitigation methods. This summary will in tandem provide information by which to identify possible sustainability incentive programs.

EXAMINING TUBERCULOSIS GENES TO FURTHER UNDERSTAND ITS PATHOGENESIS

Presenter

Abigail Andrews

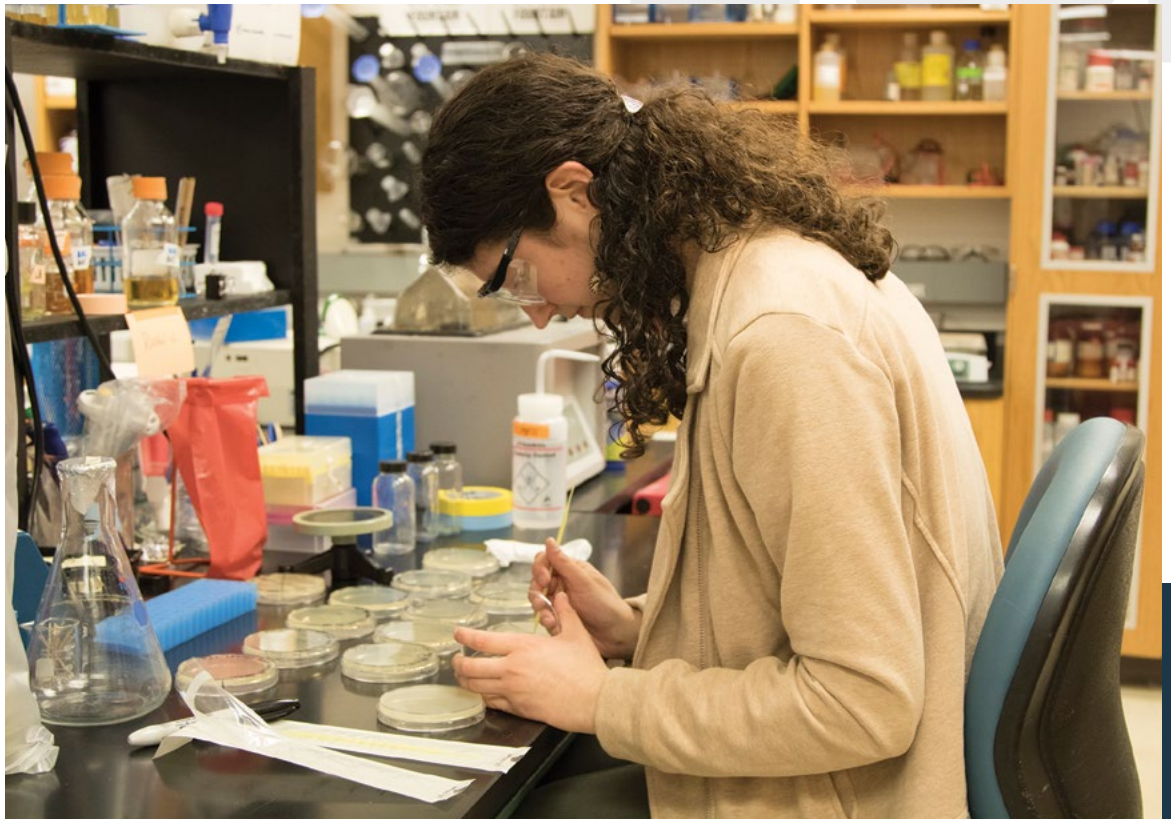
Advisor

Ron Raab

Abby is furthering her understanding of tuberculosis based on the function of the selected genes she is studying.

Tuberculosis may seem like an outdated disease that no longer affects many people, but it is still extremely relevant in third world nations, where it is unable to be treated due to a lack of adequate sanitation, knowledge about the disease and prevention, and antibiotics for treatment. To date, tuberculosis accounts for 2.2% of total deaths in the world. In 2015, The World Health Organization (WHO) reported that tuberculosis was the 9th leading cause of death at 1.37 million deaths, more than HIV/AIDS. In addition, Tb has mutated to a multidrug resistant strain (MDR-TB), which requires an aggressive 6-month drug regimen to treat. Approximately 580,000 cases of MDR-TB were reported worldwide in 2015. An extremely drug resistant strain (XDR-TB) has been found in 117 countries, and nearly 10% of the reported 580,000 cases of MDR-TB were XDR-TB. Even less drugs are able to combat this strain and it poses a larger problem than MDR-TB. Many people simply do not have the resources or money to be able to keep up with the drugs that are required for the treatments. Two genes, IpqM and Rv0420, from Tb have been cloned, expressed and purified. Being able to understand these genes better will help researchers to gain a better understanding of the pathogenesis of Tb and may lead to new, and novel cures based on the function of proteins such as IpqM and Rv0420.

IDENTIFYING A B. THURINGIENSIS RECEPTOR BINDING PROTEIN FOR PHAGE RILEY



Presenter

Rachel Carson

Advisor

Louise Temple

Rachel is working on identifying bacterial cells that were mutagenized by transposons so that bacteriophage resistance testing can be done.

With the number of antibiotic resistant bacteria increasing at an exponential rate, research into new therapies using bacteriophages (phages) is increasing. Phages are viruses that infect only bacteria and are able to co-evolve alongside the bacteria they infect. Researchers' ability to mutate phage DNA makes them a candidate to help fight antibiotic-resistant bacterial infections in humans. Since it takes time for phages to naturally mutate after a bacterium becomes resistant, research into how phage proteins interact with bacterial receptor binding proteins could artificially speed up the process of co-evolution. To study this interaction, the receptor binding protein on the surface of the bacterial cell wall for the phage needs to be identified. Transposon mutagenesis was used in our study to find the receptor binding protein of Bacillus thuringiensis Kurstaki (BtK). BtK was chosen for this study because it is a naturally occurring soil bacterium commonly used as an insecticide in agriculture, but is nonpathogenic to humans. Using the EZ-Tn5TM transposon kit and the Gene Pulser XcellTM electroporation system, 134 individual mutant colonies were isolated and propagated on LB agar plates containing kanamycin. These mutants are being tested for resistant to phage Riley, one of a large number of BtK phages isolated at JMU. The bacteria that are resistant to infection by Riley will have the transposon and adjacent DNA amplified and sequenced. The sequences will then be compared to the chromosomal sequence of Btk to identify the receptor proteins.

IDENTIFYING STORMWATER MANAGEMENT TOOLS FOR NONPROFIT ORGANIZATIONS

Presenter

Victoria Ciavarra

Advisor

Mary Handley

Sponsor

Beth El Synagogue

Victoria is examining a downspout to evaluate where runoff from the roof would enter and the path it will take before either being absorbed into the ground or entering a storm drain.

As the number of people moving to urban areas continues to increase over the next few decades, the amount of impervious surfaces will also increase. Impervious surfaces such as roads, parking lots, and buildings, inhibit stormwater from being absorbed into the ground and result in runoff carrying contaminants. Examples of contaminants may be nutrients such as nitrogen or phosphorus, sediments, or chemicals such as motor oil and other car fluids. Contaminants make their way across those impervious surfaces until they enter storm drains where they flow directly into local waters and ultimately find their way into major waterways. For the Chesapeake Bay watershed, excess nutrients have caused many ecological impacts such as algal blooms and dead zones. The Environmental Protection Agency created the Total Maximum Daily Load (TMDL) program to reduce pollutant loading into waterways. This new requirement has led some cities to implement policies such as Stormwater Utility Fees. Harrisonburg, which has one of these fees, currently charges all land owners $6.00 per 500 square feet of impervious surface. This can put a financial burden on organizations like nonprofits and religious congregations. The objective of this project is to evaluate the property of the Beth El synagogue in Harrisonburg, Virginia which has 22,000 square feet of impervious surface, and to recommend ways to reduce the amount of stormwater runoff from the property in order to reduce the Stormwater Utility Fee.

INDOOR LOCALIZATION FOR HEALTHCARE FACILITIES VIA WIFI & IOT EDGE NODES

Presenters

Nicholas Benedetto, Brendan Colton, Nicholas Reist

Advisor

Samy El-Tawab

The team is testing their edge nodes to collect location data to be displayed on a mobile application. The indoor tracking system will locate the node using the existing WiFi infrastructure within healthcare facilities.

In today's world technology is advancing faster each year and is able to aid us in finding solutions in critical areas of our lives. One of these critical areas is health-care facilities. The doctors and staff working within these facilities are in an environment where they often need to know at a moments notice the location of a patient or other health specialist. One solution to this need is the LoCATE system which uses the improvements in technology to track people in near real time. LoCATE makes use of the current 802.11 wireless networks within a health-care facility and edge node technology as its tracking solution. The edge nodes constantly communicate with the current network in an non-intrusive manner. The data collected from the network with the edge nodes is able to locate the carrier of the edge node within a reasonable range of variability. The data is then pushed and stored on a cloud storage system where it waits to be accessed by our mobile application. The mobile application will display the near real time location of any patient or staff member. The small size of the edge nodes allows for anyone to easily carry the node on a lanyard around their neck. This simple and small solution known as LoCATE is cost effective due to the use of the current 802.11 wireless network infrastructure. Overall LoCATE is the solution that the health-care facilities need and in a short time will be tested and implemented.

ISAT VR 360°

Presenter

Paolo Garcia

Advisor

Anthony Teate

Paolo Garcia testing and debugging the ISAT VR 360Â° application.

Virtual Reality (VR) has become a hot topic in the technology world, allowing people to be simulated in a realistic and immersive three-dimensional 360-degree environment. However, as it is becomes more and more popular, there has been a lot of criticism on the use of VR. The objective of this capstone project is to 1. develop a VR iOS, android, and web application that will allow users to view the ISAT/CS building, visit professor's office to visually see who that professor is, their office hours, and their contact information and 2. kick-start this project so that users can visit more than just the ISAT/CS building and view the whole campus in virtual reality anywhere around the world.

JUNOVR: IMPROVING A BREATH SENSOR FOR VIRTUAL REALITY (VR) APPLICATIONS

Presenters

Thomas Driver, Brandon Perry

Advisor

Morgan Benton

Sponsor

Chris Smith - JunoVR

The team is testing their prototype to validate that their breathing sensor is operational and that the data can be transmitted to display an action in a given virtual experience through an environment created to implement their sensor.

Virtual Reality (VR), a rapidly growing technology, provides a fully immersive visual and auditory experience. While VR's early applications were predominantly games and entertainment, recent applications have expanded to education and therapy. VR has been used to treat PTSD, chronic anxiety, provide portable "sensory rooms" for people with autism spectrum characteristics, and to help people learn to meditate and cultivate mindfulness. JunoVR, the sponsor of this project, developed a novel input/output device, a breath sensor, that allows VR users to visualize and control their breath while meditating. The goal of this project was to take the JunoVR breath sensor prototype and develop the design to make it more durable, easy to manufacture and assemble, and affordable to produce. The team also explored making the product wireless and able to support multiple different VR platforms.

LITHIUM-ION BATTERY-POWERED MOTORBIKE

Presenters

Ben Gilliam, Will Kemmerer

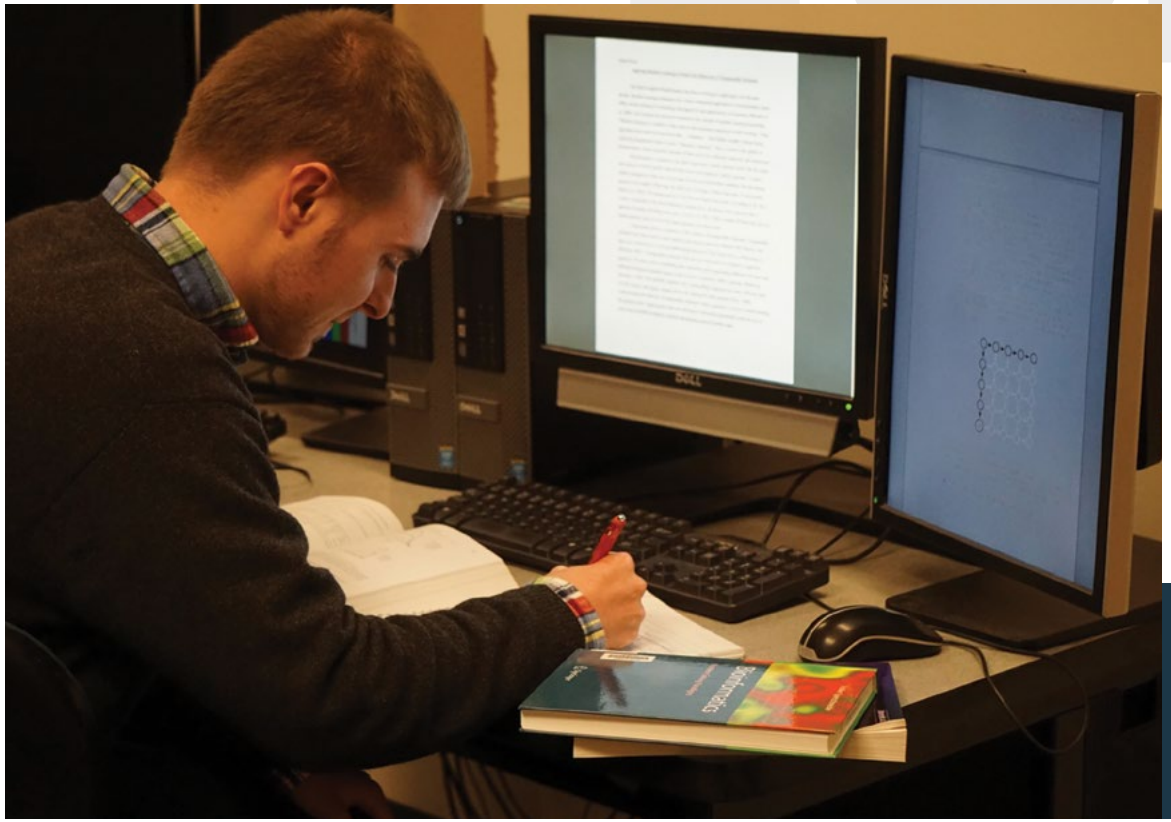
Advisor

Tony Chen

The team maps out where they will place battery cells and an induction motor to power the motorbike.

As electric vehicles (EV) become more commonplace in the US, innovation is only making their batteries smaller and more efficient. Charging stations are becoming more ubiquitous making EV's a more viable option. EV's reduce carbon emissions and, with an increasing number of nuclear power plants, reduce the dependency on chemical energy. The objective of this capstone project is to: build a functioning electric motorcycle, and optimize the range by utilizing high energy density battery pack. This pack will be comprised of Lithium-Ion cells.

MACHINE LEARNING IN BIOINFORMATICS: UNDERSTANDING TRANSPOSABLE ELEMENTS



Presenter

Julius Nevin

Advisor

Nicole Radziwill

Julius gathers genomic data to manipulate using Bioconductor and create a neural network in Tensorflow to automatically identify transposons and predict their behavior.

Transposable elements are believed to be integral in organism genomes. TEs play a role in regulating gene expression and in generating different cell types and different biological structures based on the location of insertion within a genome. Understanding the behavior of transposable elements is crucial to understanding genomes.

The challenge is how to situate these elements relative to those already known. The accuracy of the links between TEs is particularly important for understanding their fate in genomes, and to understand the dynamics of the genome itself. This project explores creating a machine learning algorithm that allows a program to detect TEs and predict behavior to situate elements intelligently and automatically. The Bioconductor R package was used for genomic data manipulation, and Tensorflow was used to train the algorithm. Parts of maize genome data containing multiple TEs was used as test data to gauge the performance of the algorithm.

MADISON CONSERVATION CORPS: AUDITING THE WORLD ONE HOME AT A TIME

Presenters

Steven Campbell, Curtis Cox

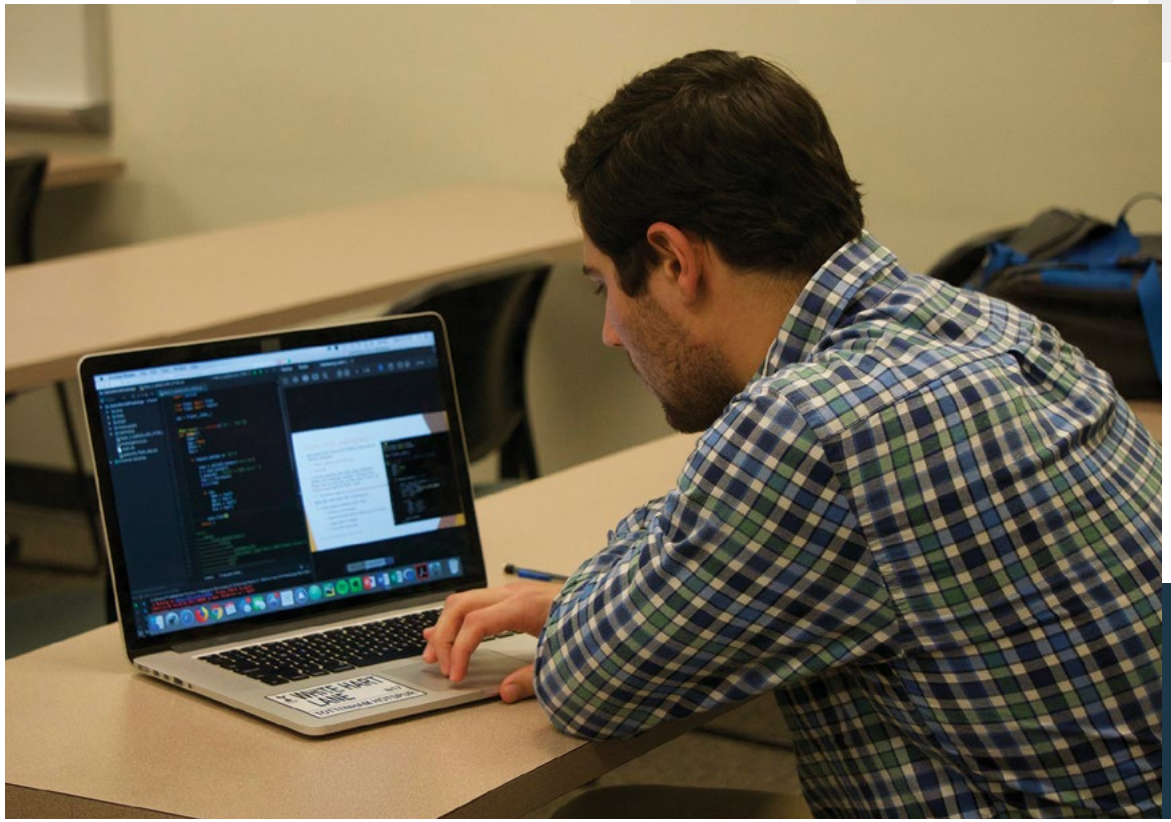
Advisor

Morgan Benton

The team uses a 3D sensor for mobile devices to measure the dimensions of rooms in order to perform an in-home energy audit.

Two paths exist to mitigate the dangers of climate change caused when humans burn fossil fuels to produce electricity: conservation, and alternative energy. This project focuses on conservation. By tapping a vastly underutilized resource--college students' boundless idealism and inexhaustible energy--the Madison Conservation Corps aims to provide a home energy audit to every residence in Harrisonburg. In building a mobile app to manage their student organization and conduct audits, this project seeks to produce a blueprint that can be copied by student groups at colleges and universities throughout the world. This team picked up where the 2016-2017 team left off, completed the MCC iPad app, and will demonstrate how their app performed in an actual audit.

MISINFORMATION IN THE AGE OF TECHNOLOGY: COGNITIVE, LEGAL, AND TECHNOLOGICA



Presenter

Christopher Collins

Advisor

Steven Frysinger

Chris is researching relevant literature associated with the history of fake news and its impacts over time.

The use of misinformation to defame and discredit opponents, confuse and persuade the public, and exacerbate social division is not a novel tactic. However, just as the development and proliferation of the Internet revolutionized the way humans communicate with one another, so too has it invigorated and transformed the effectiveness of misinformation campaigns (Burkhardt, 2017). Under the umbrella of misinformation, one finds fake news and its side effects. In the wake of the 2016 election, the influence of "fake news" was discussed ad nauseam; its prevalence and apparent impacts have invoked a wave of concern regarding misinformation. In addition to a historical synopsis of fake news and misinformation in general, this paper seeks to explore the social, legal, and technological implications of the phenomenon; the connections between the aforementioned aspects were made clear in the process. In pursuit of the cognitive impact and correlates of fake news and misinformation, a study was conducted to assess the cognitive load on individuals reading fake and real news articles. The results of this study were analyzed using R statistical analysis, and discussed in section (3.4) of the thesis. Finally, the prevalence and availability of misinformation on the Internet, and its consequent effect on the growing distrust of expertise was evaluated.

PENETRATION TESTING PLATFORM FOR AUTOMOTIVE EMBEDDED SYSTEMS

Presenters

Daniel Aramayo, Joseph Barone, Kevin Lin, Kevin Olsen

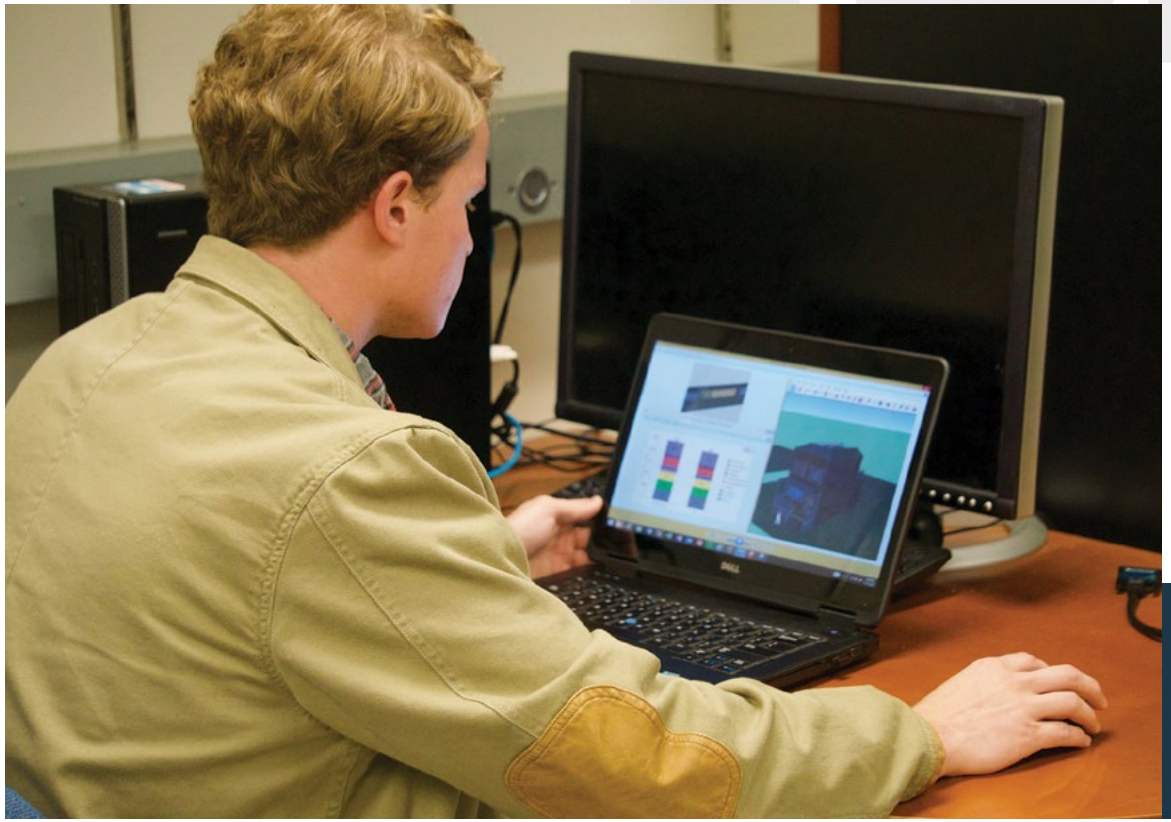
Advisor

Emil Salib

The team is working to exploit vulnerabilities in the vehicle's Controller Area Network (CAN) bus by injecting packets to control cyber physical systems.

Modern vehicles are becoming more connected through ubiquitous wireless and mobile cellular networks. Such a connectivity is currently used for communications, in-vehicle security, emergency services, hands-free calling, turn-by-turn navigation, and remote diagnostics through the like of OnStar subscription. OnStar, for example, takes advantage and makes use of the electronic control units (ECUs) implemented into an on-board network known as the CAN (Controller Area Network) bus. The CAN bus protocol design and implementation have been proven to be vulnerable to security and safety attacks using the service diagnostics port (also known as OBD II), giving access to virtually all of the vehicles electronic controls including engine management and braking control, potentially producing devastating effects when in the hands of an attacker. Although these attacks can be executed through an on-board hardwired connection, the capability of executing them wirelessly presents a far more significant safety threat. In this project, we focus on the identification of the CAN bus vulnerabilities through wired and wireless access (such as Bluetooth, Wi-Fi and Cellular). The major goal of this project is to deliver a penetration test environment including numerous successfully tested security and safety attacks on a number of modern vehicles that are accessed through wired and wireless CAN bus connections. The pen test environment will be designed and implemented to enable teachers and students to include additional security and safety attacks through development tools such as APIs, scripts and libraries.

PERSPECTIVES ON SUSTAINABLE RESIDENTIAL DESIGN IN MODERN AMERICA



Presenter

Meade Wayland

Advisor

Chris Bachmann

Several modeling software packages were used to investigate the environmental impacts associated with urban development with the goal of inspiring sustainable design.

Residential and transportation related energy consumption contributes to the production of greenhouse gasses and problems associated with climate change. The current U.S. residential model is heavily dependent on suburban homes (43% of the population); these space intensive layouts require more transportation, energy, and land than urban areas. Research data from the US Energy Information Administration indicates that the residential and transportation sectors contributed 998 and 1,883 metric tons of CO2 in 2016, respectively. To better understand how urban development and land-use planning strategies influence environmental impact, housing trends in the United States were analyzed in parallel with nations of comparable climates. A thermodynamic analysis was performed on a typical stand-alone suburban home in the Virginia climate in comparison to urban-style row homes of comparable square footage. Additionally, transportation requirements for the two residential environments were compared. Preliminary results indicate significantly higher heat transfer rates with suburban homes in addition to increased transportation needs.

Residential development is a complex issue; stakeholders are varied from policy makers to home builders and buyers, energy producers, and future generations. Positive environmental impacts will be noticeable with a cultural shift towards live, work, play residential models. Factors such as cultural expectations, economic status, and stage of life were considered in the design to provide the opportunity for a sustainable life for the largest number of Americans. Sustainable living in the United States is not only a viable option but also enhances community and reduces environmental impact.

PROJECT MANAGEMENT AND SUPPORT FOR JMU COLLEGIATE WIND COMPETITION TEAM

Presenters

William Blanchard, Ryan Goerl, Sydney Mace, Nicholas Vaisa

Advisor

Jonathan Miles

Sponsor

U.S. Department of Energy

Projection Management Officers reviewing the team assignments prior to weekly town hall meeting.

The 2018 JMU Collegiate Wind Competition team comprises 31 students representing five majors, all working together to develop a novel wind turbine design with corresponding business plan, and to perform a siting exercise for a hypothetical 100-MW wind power plant in Rockingham County. This work will be presented at the third biennial Collegiate Wind Competition to be held at the American Wind Energy Association WINDPOWER conference in Chicago, Illinois in May 2018.

At the event, students from JMU and eleven other universities will see their turbines tested in a wind tunnel, participate in a wind power project planning exercise, give a private pitch to a board of judges, and present an open floor public pitch. Our capstone team supports five sub-teams each responsible for one main deliverable and six other support sub-teams, as we serve as Project Management Officers (PMO). We are responsible to communicate between the Department of Energy and National Renewable Energy Laboratory about the deliverables and, to run weekly town meetings, to document the entire process and to participate individually on sub-team efforts. Our goals during this capstone experience is to perform successfully at competition and to acquire managerial skills and gain leadership experience that will be applicable within the renewable energy industry.

QUANTIFYING VARIABLES INFLUENCING OSTOMY BARRIER ADHESION TO PATIENT SKIN

Presenter

Sara Kraeutler

Advisor

Rebecca Simmons

Sponsor

Confidential External Sponsor

Sara conducts research on potential factors that may influence ostomy barrier adhesion to patient skin.

Imagine this: you are out in public and all of a sudden, fecal matter started leaking out from the side of your abdomen. How embarrassed would you be? The ability to go to the bathroom when we choose is something that most humans take for granted. For a variety of reasons, some individuals lose normal bowel or bladder function and undergo a surgical procedure which results in the need to collect bodily waste in an ostomy bag. These individuals, referred to as ostomates, are left with a stoma, a small opening on the surface of the abdomen which diverts the flow of feces and/or urine. For the past 25 years, a global manufacturer of ostomy products has reported over 18% of customer complaints relate to ostomy barrier adhesion issues. The goal of this project was to determine if the customer complaints are a result of a patient characteristic, a manufacturing process defect, or some combination of the two. After extensive scholarly research on the ostomy industry, an Institutional Review Board survey was designed for our target audience, ostomy support group members, to look for trends among human factors (such as age, weight, medical conditions, humidity, etc.) that could potentially influence ostomy barrier adhesion. Data was collected from around the United States, analyzed and findings were then reported to company executives so that they could continue to improve the lives of ostomates around the world.

REPOWERING THE CISE SOLAR ENERGY PLANT

Presenter

Mark Kerby

Advisor

Jonathan Miles

Mark Kerby taking an inventory of materials of the current CISE Solar Energy Plant.

The purpose of this project is to review the original design of the CISE solar energy plant, located on the hillside in front of the Integrated Science and Technology building, modifications to the facility, and develop a plan to re-power the facility with an assortment of state-of-the-art photovoltaic panels. An initial inspection of the current facility revealed that the original panels still in place are old and present a very low generating capacity thus suggesting that the generating capacity of the plant can be increased by as much as five-fold by replacing the original panels with new ones. The new design also considers the benefits of upgrading the inverter and other components. A re-powered CISE solar plant will also provide a more effective teaching tool as students will be then be able to measure the performance of different panels types as they perform under identical conditions. A renewed and refreshed CISE solar energy plant will continue to provide an on-site clean energy source for the campus and a unique teaching tool for many years to come.

RESPONSIBLE INTEGRATION OF AUTONOMOUS VEHICLES IN AN AUTO-CENTRIC SOCIETY

Presenters

Charlie Boyd, Chase Collins, Claire Fulk, Kiva Gayle, Grant Hobar, Nick Jarrow, Troy Stephens

Advisors

Chris Bachmann, Emily York, Samy El Tawab, Shannon Conley

Sponsor

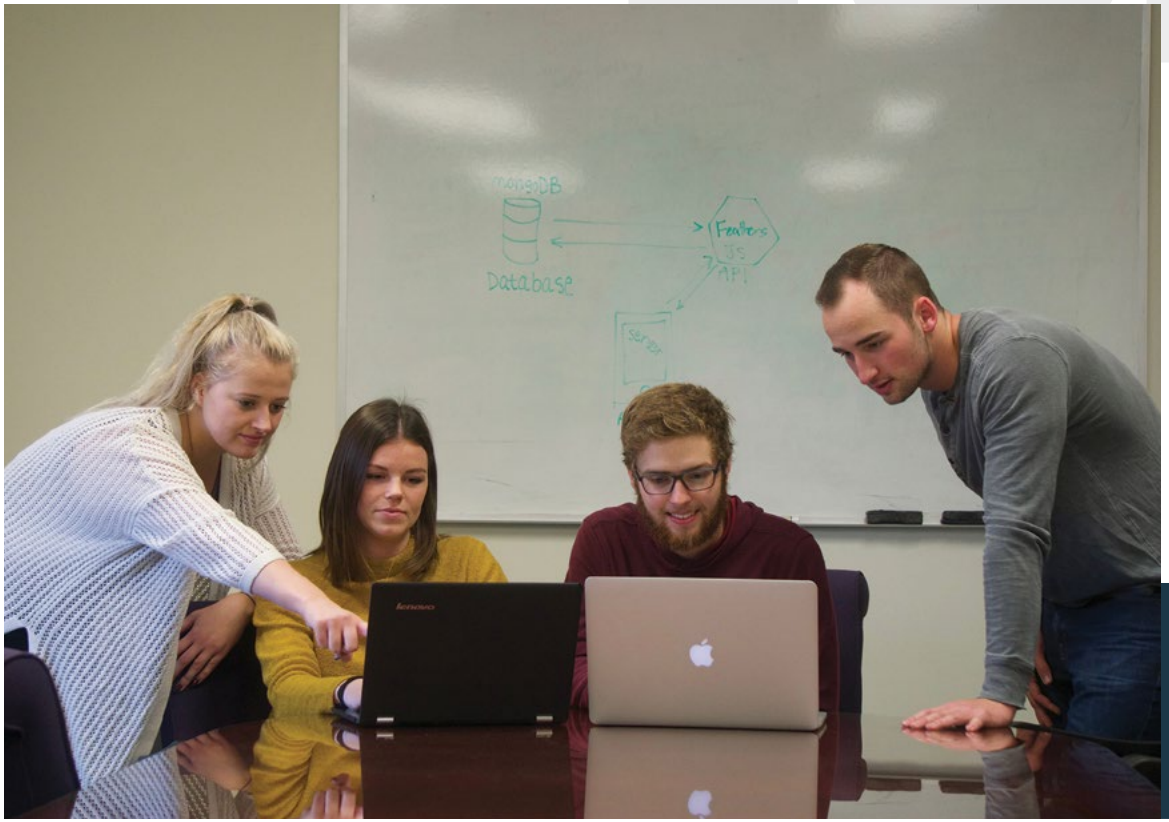
Ryan Luckay, JP Kelley - ISAT Alumni, Deloitte

The team is connecting sensors to the vehicle's central computing system and building the infrastructure allow for informed decision making and fully autonomous operation.

According to U.S. Department of Transportation data from 2015, 94% of all traffic accidents are caused by human error. To address this safety concern and improve the overall operating efficiency of the transportation sector, many automakers have spent significant effort developing autonomous vehicles (AV's). Recent technological advances and price drops in computing power, sensor technology, and wireless communication have resulted in AV's that can sense their surroundings and make intelligent decisions by communicating with neighboring vehicles and surrounding infrastructure. This has greatly accelerated the transition from test-track prototypes to mass production efforts, with many manufacturers claiming large-scale deployment of AV's over the next five years. But how will autonomous vehicles be safely and responsibly integrated into society? Although it is believed that autonomous vehicles will be safer than human driving, the first few years of deployment will involve a mix of traditional and driverless vehicles on the road at the same time. Among the many issues yet to be resolved is how these new autonomous vehicles will respond to unpredictable behaviors of human controlled automobiles.

The goal of this project is to develop two 1/8 scale autonomous vehicle prototypes that can detect and respond to erratic driving, as well as investigate the technical, cultural, political, and ethical dimensions associated with establishing how autonomous vehicles can be responsibly integrated into our existing auto-centric society.

SIMULATING THE SUCCESS OF JMUSCOOP: A PWA TO PROMOTE RIDESHARING AT JMU



Presenters

Brenna Ellison, Cole Gerhart, Hannah Walsh, Luke Wilbur

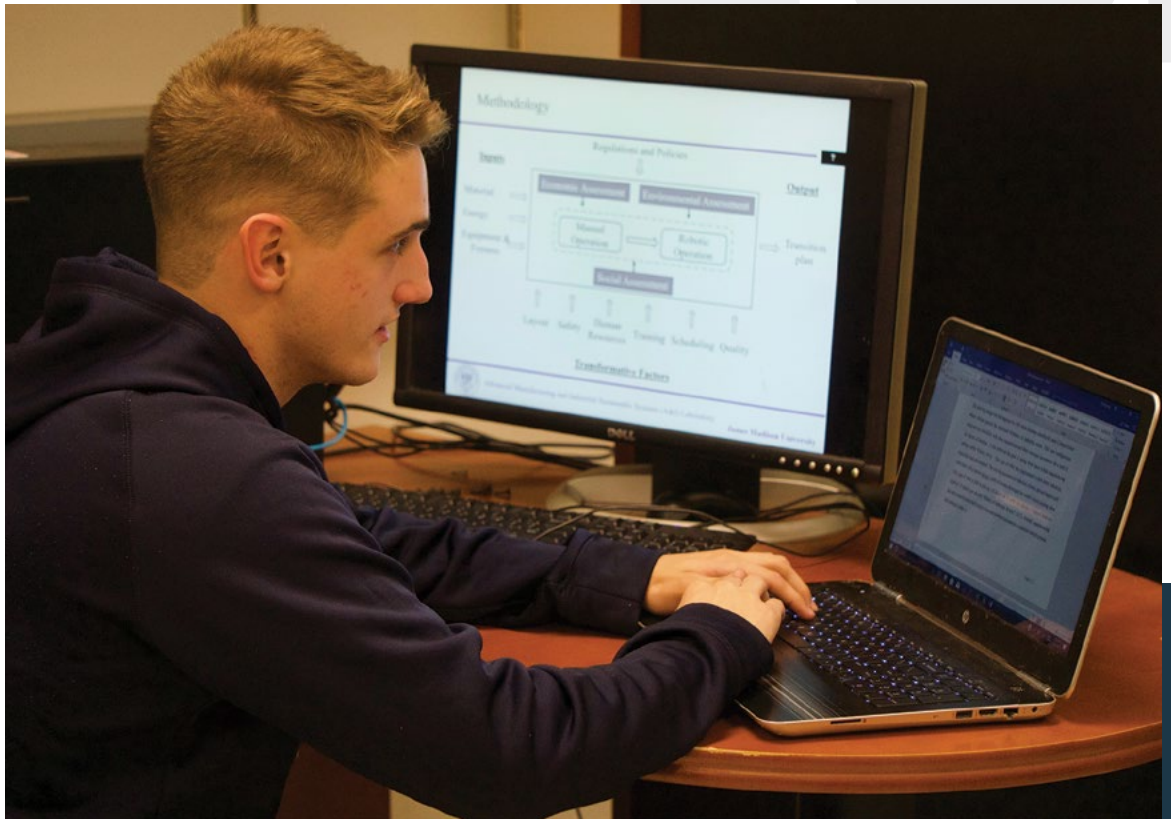
Advisor

Morgan Benton

The team is coding additional pages to add to their application.

At JMU, too many cars and too few spaces leads to traffic congestion, air pollution, fender-benders, endless idling and circling the lots, as well as tardiness, missed classes, stress, unhappiness, and missed learning opportunities. Alternatives to driving like biking, walking, Über, taxis, or the bus each have their disadvantages. An unfilled niche in the JMU transportation ecology is carpooling or ridesharing. JMUScoop is a progressive web app (PWA) designed to connect JMU students to promote ridesharing. This year's project builds upon the prototype built by last year's team and augments it by generating a computer simulation of Harrisonburg traffic for the purpose of developing key performance indicators (KPIs) for the JMUScoop app. With a model, the team hopes to be able to determine if their app has been successful at reducing the number of cars being driven to campus.

SUSTAINABILITY ASSESSMENT OF INDUSTRIAL ROBOTICS TRANSITION IN SMES



Presenter

Kyle Epping

Advisor

Hao Zhang

Kyle is researching and developing a comprehensive sustainability decision-making tool for adopting industrial robotics for small and medium-sized enterprises.

Small and Medium Enterprises (SMEs) face challenges of implementing industrial robotics in their manufacturing due to limited resource and expertise. The economic potential of using industrial robotics, however, remains to be large due to manufacturers leaning towards newer technology and automated processes. Industrial robotics within SMES is vital to keep US manufacturing competitive as production systems moves into Industry 4.0. The research for a comprehensive sustainability decision making of adopting industrial robotics is limited for SMEs.

This study presents a system methodology of evaluating sustainability of implementing robotic techniques in key processes that would benefit the SMEs. The methodology identifies the vital factors (i.e. economic, technology, management) for decision making of implementation a robotic technique. Economy tradeoffs are evaluated using life cycle costing method that assesses and compares two alternatives' operational costs discounted over a specific time period. Environmental impact is evaluated using life cycle assessment that analyzes material use, energy consumption throughout the stages (manufacturing, implementation, and maintenance) of adopting robotics. Finally, a social life cycle assessment will be conducted to evaluate the impacts industrial robotics have within human psychology, workplace relations, and public policy. In order to demonstrate the application of the proposed methodology, a case study with SMEs manufacturing characteristics is presented. This research will benefit the engineering management community by providing SMEs an analytical tool for industrial robotics implementation decision making.

SUSTAINABILITY ASSESSMENT OF SINGLE STREAM AND MULTI-STREAM RECYCLING

Presenters

Costantino Berradocco, Hannah Delawter, Thomas Putzu

Advisor

Hao Zhang

Sponsor

Harrisonburg Public Works Department, James Madison University Facilities Management

The team is evaluating the economic, environmental, and social impacts of both Single and Multi-Stream recycling collection systems in Harrisonburg, Virginia.

There is an increasing trend by municipalities to move towards single stream systems for reducing material management costs, increasing recycling convenience and participation, and processing greater quantities of material. Research on evaluating sustainability of the two streams is very limited. In order to gain an in-depth understanding, this study intends to evaluate economic, environmental impact, and social impact of single waste recycling stream and the usual multi-stream collection system. The methodology follows the life cycle assessment method including (1) goal and scope definition: defining the goal, functional unit, and the system boundary of the two management streams, (2) life cycle inventory: collect material and energy data at the stages of collection, transport to transfer station, treatment at material recovery facilities, and end fates of wastes; (3) impact assessment: metrics are developed and quantified to assess economic, environmental and social impact; and (4) interpretation: result is examined using sensitivity analysis. As a case study, this research uses an American town as a case study. The study result contributes to the current knowledge on sustainability understanding of the two streams and is able to assist governmental decision making at all levels.

SUSTAINABLE AGRICULTURE: INTEGRATION OF AQUAPONICS AT PUNTA LEONA RESORT

Presenters

Cailin Dyer, Jack Lipsky, Paris Smith

Advisors

Karim Altaii, Shannon Conley

Sponsor

Punta Leona Hotel and Club, Costa Rica

Team members are pictured inside the hoop house which is home to the finished product of an aquaponics system comprised of two media beds and two fish tanks to provide a local food source for the Hotel's restaurants.

Sustainable agriculture is becoming an increasingly important method of food production. The field of sustainable agriculture came about with an increasing population, causing increased food demand. The increased implementation of factory farming and agribusiness has led to exploitation of land and a decrease in resource availability. The objective of this project is to implement a system that mimics a naturally occurring cycle that is all organic using an integration of fish and plants. The system was designed four months prior to the implementation to construct a bill of materials with regular communication with the management at Punta Leona Hotel and Club (PL H&C) in Costa Rica. The system was constructed over a three-week period at the site of the hotel. First, the ground was cleared and leveled so that the supporting legs could be installed and cemented. The holes for the fish tanks were dug out of the ground and the fiberglass tanks were installed in the holes. Once the legs were completed, the separately constructed media bed was set up on the supporting legs, lined, and filled with lava rock. The system was completed by installing the piping system and filling the system with water, plants, and fish. This system provides PLH&C in Costa Rica a self-sufficient food supply to feed guests. An analysis was completed to compare the food miles and life cycle of the food currently served at the resort and the change in food miles and food life cycle with the implementation of the aquaponics system.

THE ARTIFICIAL LEAF

Presenters

Keyton Elliott, Cameron Collard, Jeffery Mangold

Advisor

David Lawrence

The team is preparing for the deposition of thin nickel and aluminum films in the electron beam evaporation system. These metal coatings are used as an electrode on the PV (solar) cells.

Hydrogen is an ideal "clean" fuel because when combusted it produces pure water and no carbon dioxide. Currently hydrogen is made from natural gas, a fossil fuel; and in the hydrogen production process CO2 is an undesirable by-product. An interest in creating pure, clean hydrogen fuel from the photo electrolysis of water powered by sunlight has been around for years. To make this practical, we must develop an efficient and cost effective artificial leaf. In our project, we are creating an artificial leaf by fabricating a GaAsP photovoltaic cell and adding a photo-catalyst layer to the top surface. The complete structure is complex and is made by depositing multiple thin films on a GaAsP substrate. The top layer of the structure is a $BiVO_4$ photo-catalyst coating. This material is a good candidate because it promotes the water splitting reaction and also generates additional voltage to enhance the hydrogen production. Our team's focus has been to improve on the prototype made by last year's team. The prototype devices generally have poor photovoltaic cell performance. We are studying the electrical contacts between the various layers of the device and by improving those contacts we hope to achieve an increase in electric current flow through the device, which will result in improved efficiency of water splitting.

THE ATLANTIC COAST PIPELINE AND A STUDY OF ITS IMPACTS ON TROUT STREAMS

Presenter

Erik Raser

Advisor

Thomas Benzing

Sponsor

Jake Lemon - Trout Unlimited

Erik is monitoring water quality in Hodges Draft, a trout stream to be crossed by the Atlantic Coast Pipeline, to establish baseline conditions.

The Atlantic Coast Pipeline is designed to transport natural gas through Virginia. Along its proposed route, this pipeline will cross mountainous terrain that includes streams with native brook trout. Partnering with Trout Unlimited, this study monitored water quality on Hodges Draft, a small trout stream in Augusta County. Trout Unlimited is committed to the preservation of trout habitat but recognizes that natural gas has become the energy of choice for meeting current demand. However, constructing pipelines can cause environmental impacts such as increased erosion to create water quality issues in rivers and streams. During this study, water quality was monitored monthly in the impacted stream (Hodges Draft) and a nearby control stream (Ramseys Draft) to establish baseline conditions before pipeline construction. Both streams have water quality and conditions that are characteristic of high mountain streams. Seasonal changes were observed in streamflow, water temperature, and conductivity. Specific conductivity is very low, less than 100 microSiemens, peaking during periods of low streamflow and input from decaying leaves. In addition to monitoring the streams, this study also monitored the regulatory progress of the pipeline proposal. The Federal Energy Regulatory Commission (FERC) approved an environmental impact statement prohibiting construction of stream crossings during October 1 to March 31 when brook trout are present. Additionally, their approval allows only isolated cut methods, such as dam-and-pump or flume, for crossing Hodges Draft. While approved by FERC, the project is still awaiting final approval pending state permits and the resolution of court proceedings.

THE IMPACTS OF SOILING ON SOLAR PHOTOVOLTAIC PANEL EFFICIENCY

Presenters

Andrew Schweser, Bradley Smith

Advisor

Jonathan Miles

Sponsor

WGL Energy

The team analyzes the effects of soiling on solar PV efficiency and whether cleaning the solar panels increases their performance.

Soiling is the collection of dust and other debris on PV modules that plays a significant role in reducing the efficiency of photovoltaic (PV) systems. Its effects vary by location, yet left unattended it can be detrimental to a system's overall power production.

Currently, system analysis has not matured to a point where the optimal time to clean PV modules is easily identified based on cost-benefit analysis. The objective of this study is to develop a better understanding of the effects of soiling in various U.S. climate regions and to develop a method to easily identify the optimal time to clean PV modules based on cost-benefit analysis. Data collected on WGL Energy's solar facilities will be used to assist with this study.

VOICE OF THE CUSTOMER (VOC) FOR SMALL FARM INDUSTRIAL HEMP PRODUCTION IN VA

Presenter

Blake Sutterfield

Advisor

Nicole Radziwill

Blake uses his networking and outreach skills in to set up interviews with those he met at the Small Farm Family Conference in Charlottesville, Virginia.

Cannabis was one of the world's first agricultural crops, used for ropes, textiles, and medicines by many cultures as early as 8000 BCE. As a result of the Marihuana Act of 1937, the United States banned the commercialization and recreational uses of cannabis because it contains variable levels of a psychoactive component, tetrahydrocannabinol (THC).

This project explores the viability of industrial hemp, a strain of cannabis with low THC levels, as an agricultural resource for Virginia and its farmers. Two-way interviews with professionals in the agricultural field at VSU as well as farmers who own and manage small farms, ie. farms operating with less than 300 acres, were conducted to assess the Voice of the Customer (VoC) for potential crop growers in Virginia while educating them about the benefits of industrial hemp farming in Virginia. Barriers to entry, and ways to mitigate them, were identified.

WATER SUSTAINABILITY IN HARRISONBURG: GREYWATER IRRIGATION AT VINE & FIG

Presenters

Daniel Figueroa, Seth Herbst

Advisor

Jennifer Coffman

Sponsor

Tom Benevento - Vine & Fig

The team surveys the location of the proposed greywater irrigation system.

Humans and our complex societies are not only water-dependent but, in many cases, rather extravagant in our water usage. From industrial processes, agricultural irrigation, and municipal supply, to creating suburbs and water parks, mainstream U.S. culture has a great deal of embodied water, and that comes at significant ecological costs. While our world is nearly 70 percent water, only approximately 3 percent of it is freshwater and only 0.5 percent is available for human use. As the population of Harrisonburg, Virginia, continues to grow, elevated residential water demands will increase the stresses on local water sources. Residential water reuse can help reduce overall water consumption and may decrease operating costs for local wastewater treatment plants. Greywater is wastewater from sinks, showers, and laundry machines that can be put to good use in the Shenandoah Valley, the driest region in Virginia. This capstone project has partnered with Vine & Fig to design and implement a greywater system to irrigate an urban food garden and to serve as a model for Harrisonburg residents. Greywater is subject to a variety of permits and inspection processes. Legal research, water quality testing, and analyses of lettuce biomass and quality were conducted to determine effective approaches for a residential greywater irrigation system. Greywater irrigation systems show promise for mitigating water scarcity and food insecurity around the world.

IA

In a world full of uncertainty and unpredictability, unbiased and thoughtful analysis is invaluable. The Intelligence Analysis degree program educates students in a range of structured thinking techniques and an array of technology tools, combined with an understanding of broader contextual issues. IA graduates are flexible critical thinkers capable of bringing increased clarity to uncertain situations in areas ranging from national security to business to law enforcement and beyond.

ANALYSIS OF RUSSIAN CYBER INFLUENCE IN THE UNITED STATES POLITICAL SYSTEM

Presenters

Paige Herter, Leif Markee, Holly Schnader

Advisor

Tim Walton

Sponsor

Ken Knight

The team works on developing a causal loop diagram to highlight the different variables involved in the system and identify how they are related.

Russia's role in the 2016 U.S. Election is uncertain and complex in nature. Our preliminary assessment shows that the actions taken by Russia in the cyber domain will likely continue and increase into the year 2037, resulting in an increase of Russian influence into the Western world, playing on divisiveness in the U.S. The goal of this analysis is to recognize key factors involved in Russian cyber actions in order to prevent future interference and compromises of U.S. elections. We hope, through our analysis, to identify trends in Russia's goals, actions, and results of their actions in order to gain insight into when actions against U.S. elections could occur, as well as the scope of the involvement, and the capabilities of the adversary. One aspect of our analysis is to gain knowledge on Russia's perspective of the situation using red team analysis. Another is using scenarios generation and futures analysis to identify probable future events and identify potential courses of action. By analyzing Russia's released statements, as well as their actions and media portrayal of the involvement, we hope to gain a deeper understanding of the potential for future involvement and the degree to which this could affect the democratic process. During data collection we used academic and news sources in addition to working with our sponsor, the United States Cyber Command J2X Division. Overall, we hope to provide decisions makers with information that enables enhanced decision advantage.

ANALYZING THE RELATIONSHIP BETWEEN HATE GROUPS, MESSAGING, AND VIOLENCE

Presenters

Sophie Cienski, Kimmy Murphy,
Kim Rodean, Abhis Sedhai

Advisor

Kathleen Moore

Sponsor

Anonymous

The team reviews the statistical report of the correlated tweets with the maps of instances of violence across the United States.

Increasing social media use combined with widespread public misinformation and hyper-partisanship are creating a multi-faceted problem for national security and law enforcement. This project aims to uncover to what extent the proliferation of political propaganda and extremist sentiments through social media correlates with specific instances of violence within the United States. By analyzing past, current, and future trends surrounding social media use, propaganda campaigns, and politically-motivated violence, this project quantifies the role of social media in the actualization of ideological violence within the U.S. This project reaches beyond the scope of similar studies by using a larger data set as well as several analytic methodologies to determine which components and underlying factors have the greatest impact. The analysis for this project was based on a collected database of over five thousand geolocated tweets that contain keywords involving a violent or polarizing sentiment. A cross-examination with a database of prominent extremist organization locations and reported violent incidents across the U.S. provides a location-based context to identify instances and areas of possible correlation. ArcGIS was used to support this project visually using the geo-located data to construct visualizations of the collected tweets across the country. Trend Analysis and Alternative Futures Analysis were used to generate plausible future scenarios based on the identified sustainable trends in social media manipulation and political violence. Each scenario includes the indicators and implications that would be of most value in a national security and law enforcement context.

COMPETITIVE CAPABILITIES 2025

Presenters

Joshua Bailey, Quentin Canada, Mary Donovan

Advisor

Qingjiu Tao

Sponsor

Craig Fleisher, Aurora WDC

Through close collaboration with our sponsor, the team is able to give a realistic vision of competitive intelligence competencies needed in the industry by the year 2025.

As a supporting function of the business process, Competitive Intelligence (CI) plays a key role in a multitude of industries throughout the business world. There currently exists no standardized set of skills that a CI professional can be expected to have, therefore decision makers are unable or unwilling to understand the value of the CI Professional and their place within an organization. With this in mind, our sponsor Aurora WDC requested a deep dive into the theoretical competencies that a competitive intelligence practitioner will need by the year 2025. This project does not specifically look at a single industry, but rather at the business environment as a whole as the focus for future CI competencies.

CYBER-ATTACKS POSE THREAT TO NUCLEAR AND ELECTRIC INFRASTRUCTURE SECTORS

Presenters

Tanya Groover, Cody Kessel

Advisor

Steve Marrin

Sponsor

DHS

The team is working on identifying weaknesses within the nuclear and electrical sectors of the United States infrastructure, in order to mitigate against possible cyber attacks within those industries.

This project approaches the analytical research question, "How significant are the risks to critical infrastructure posed by malicious cyber activity?" to help entities such as the Department of Defense so that they may better protect the American people. The answer is that an alarming amount of current infrastructure is poorly maintained and is operated by vastly outdated equipment and software, leaving many sites vulnerable to attack. Throughout this project, we focus on risks presented to the nuclear and electrical sectors of infrastructure. This is due to how any disruption in either can result in loss of life and can tie up a vast amount of resources. In addition, numerous attacks and breaches into these systems have already happened, including a security firm being able to completely take over a major electrical grid. We will be using several analytical techniques to assist us in forming holistic and accurate conclusions, such as a Course of Action matrix, which will help our consumer in deciding which steps to take first.

DEVELOPING FRAMEWORKS FOR A MORE PROACTIVE TSA

Presenters

Todd Duerbeck, Noah Gilhousen

Advisor

Tim Walton

Sponsor

Ken Knight

To combat security threats, the TSA has developed a set of security procedures intended to protect the nation. As rapidly evolving threats emerge, TSA would benefit from relying on more proactive structured analytic methods to protect the nation.

The Transportation Security Administration (TSA) faces the dilemma of implementing reactive security policies despite an evolving threat atmosphere. With the introduction of structured analytic methodologies using a grassroots approach within TSA's hierarchal structure, TSA would be presented with the ability to establish a proactive security culture to predict and counter relevant security threats in a cost effective manner. The implementation of structured methodologies to help identify security vulnerabilities would add an additional layer of vetted information for TSA analytic and decision making components. The aforementioned methodologies are broadly applicable within TSA's various areas of responsibility, notably the aviation industry. Based on known trends in the TSA, it is highly likely that TSA will continue to address security threats in a reactive manner. Due to this, TSA will remain vulnerable to evolving security concerns despite ongoing efforts to mitigate threats. If implemented, the use of a more structured and inclusive analytic process has the potential to greatly limit the risk of severe terror related incidents.

EXPLOITATION OF VULNERABLE POPULATIONS: A ROHINGYA CASE STUDY

Presenters

Jake Dutton, Rachel King,
Maddie Leavitt, Claire Zakszewski

Advisor

Tim Walton

Sponsor

Freeland

The Rohingya minority in Myanmar is one of the most persecuted and vulnerable populations in the world. Using the Rohingya as a case study, the team will collaborate with Freeland to identify other vulnerable populations.

The Rohingya crisis has caught global attention, revealing extensive intrinsic dynamics of a larger issue. This assessment will be exploring the underlying forces and factors involved in the development and perpetuation of the Rohingya crisis in Myanmar. With nearly one million Rohingya having fled Myanmar, this is currently one of the largest refugee crises in the world, yet it is widely misunderstood and heavily censored. In anticipation of future foreign investment and land development, the Armed Forces of Myanmar are displacing the Rohingya people and other ethnic minorities by using extreme force to discourage these minorities from returning to their resource rich homeland. The military is acting under the guise of historical ethnic and religious tension, concealing the government's true motives and further fueling conflict in the Rakhine State. The government of Myanmar has amended their Constitution and passed legislative acts to support their actions against the Rohingya and other minorities. This project uses Trend Analysis, Systems Analysis, and Geospatial Analysis to develop a framework that allows outside organizations to understand what factors ultimately create populations that are vulnerable to exploitation and trafficking. The student team is working with Freeland to identify the factors and forces that have influenced the exploitation and trafficking of the Rohingya minority with hopes that our analysis could assist Non-Governmental Organizations (NGOs) and government agencies in preventing traffickers from exploiting other vulnerable minority groups in the future.

FINDING A GENDER DIVERSITY FORMULA FOR THE INTELLIGENCE COMMUNITY

Presenters

Lauren Brittigan, Sean Cochran, Ariana Tutko

Advisor

Steve Marrin

The team used analytic methods to assess current gender problems.

This policy analysis seeks to recommend improvements to gender diversity within the Intelligence Community (IC) for the Director of National Intelligence (DNI). This analysis was accomplished by utilizing analytic methods to assess current gender problems, taking a comprehensive assessment of current gender diversity initiatives through comparative benchmarking, and resulted in providing holistic recommendations for a new gender diversity policy that could be implemented by the DNI. Specific structured analytic techniques that were applied include a job analysis, systems dynamics, and a scenario generation with indicators. These methods established a foundation for understanding gender diversity as well as forecasting its possible failures or successes in the future for the IC. A stronger initiative must be implemented as the DNI's current gender diversity initiative through the Office of Intelligence Community Equal Employment Opportunity and Diversity (IC EEOD) is not achieving the desired goal of promoting a diverse workforce. This focus on gender diversity is reflected within corporate and academic research, which finds a greater female involvement in the workforce is an asset regardless of the field. Through our policy analysis and recommendations, opportunities were provided which will assist the Intelligence Community in achieving their gender diversity goals through the guidance of the DNI.

GROWING GLOBALLY THROUGH SHENZHEN, AN NOVEL APPROACH FOR HIGH TECH STARTUPS

Presenters

Pete Renai, Thomas Sullivan

Advisor

Qingjiu Tao

The team makes a conference call to discuss business.

The status quo of small business practice in the west has been to grow domestically before going international. China offers a market for business unlike any other in the world, due to its enormous population and opportunities for new businesses in the realm of technology. When you partner this with hubs of manufacturing and innovation such as Shenzhen, China it provides opportunity for businesses from the west. Specifically, the smaller high-tech business that could utilize the Chinese market to jumpstart their business. This is easier said than done for smaller business due to the cost and culture of Chinese business. However, the upside is huge. So, with the right strategy, it could skyrocket small business from the west leading to a trend that could change the status quo significantly.

MAPPING INNOVATIVE CLUSTERS IN NEW YORK CITY

Presenters

Sunny Butt, Dane Diksa, Jenna Elliott, Cassie Fox

Advisor

Qingjiu Tao

The team is working to develop an interactive map of start-up companies in emerging industries located in New York City to provide an actionable product for venture capitalists.

Our topic aims at providing analysis to venture capitalists aiding them to decide what to invest in based on the emerging markets and technologies that impact both large financial institutions as well as start up companies in the city. Financial start up companies in New York City are recognizing the need and money potentially involved in innovative technologies seen in financial technology, artificial intelligence, cyber security, and clean technology clusters. To further the potential for venture capitalists to get a higher return on investment, we chose to focus on the two most lucrative industries of financial technology and artificial intelligence. Using a combination of patent analysis, futures analysis, and SWOT analysis, we created a list of winning and losing startup companies for the financial and artificial intelligence industries. To make our final product actionable for our venture capitalists, we developed an interactive map where they can explore the hierarchy of startup companies and look directly at our findings.

MAPPING THE COUNTERINTELLIGENCE THREAT OF DRUG TRAFFICKING ORGANIZATIONS

Presenters

Christopher Kennelly, Courtney McLaughlin, Kristian Snyder, Nicholar Weber

Advisor

Michael L. Deaton

Sponsor

Ken Knight

The team evaluates how effective US drug interdiction efforts are along the southern border and addresses the current state of these efforts and the capabilities of Drug Trafficking Organizations.

Drug trafficking organizations in Mexico have been highly successful in exporting illegal and dangerous drugs into the U.S., in part because of their increasingly sophisticated methods for gathering intelligence on U.S. drug interdiction efforts. The purpose of this analysis is to identify threats and opportunities with respect to U.S. interests by exploring the dynamic between DTO intelligence and U.S. counterintelligence activities. We use open sources to examine how the drug trafficking organizations in Mexico and elsewhere recruit operatives, plan operations, gather intelligence, and adapt to U.S. interdiction efforts. Because much of what we understand about counterintelligence emerged from state-based adversaries, we also examine how U.S. counterintelligence along the southern border might be reconsidered when facing non-state enemies such as the drug-trafficking organizations.

SCENARIOS FOR THE FUTURE OF AFGHANISTAN

Presenters

Shaan Bhatnagar, Peter Chang,
Joshua Fleetwood, Jaclyn Knapczyk

Advisor

Noel Hendrickson

The team uses alternative futures analysis in southern Afghanistan to help combat global illicit opium production.

With President Trump declaring the opioid epidemic as a nationwide public health emergency, opium cultivated in Afghanistan has become an emerging threat to the United States. Our analysis will give insight into how alternative futures analysis in the southern provinces of Afghanistan can help to target, and effectively decrease the international supply of opium by 2032. The majority of literature on Afghanistan does not focus on the counternarcotics efforts as the big picture, instead they focus primarily on counterterrorism efforts. Our analysis focuses on determining the extent to which developments in Southern Afghanistan, will plausibly be a significant threat to interests of the United States for reasons that are independent of concerns of counterterrorism. Through our analysis, chances for intervention have been developed to give insights into how United States forces can fight the opioid epidemic in Southern Afghanistan.

STRUCTURE AND ORGANIZATION OF WILDLIFE TRAFFICKING GROUPS

Presenters

Joseph Andrews, Joey DeYott, Sam Schaidhammer

Advisor

Tim Walton

Sponsor

Freeland

Elephants are killed every 15 minutes for their ivory tusks, leading to 40,000 deaths every year. Asian Elephants are also trafficked live across the Myanmar/Thailand border.

The illegal animal trafficking business is an estimated 23 billion dollar industry, destroying animal populations across the globe. Many of the animals trafficked come from Africa and Asia, destroying local environments, endangering protected species, and placing law enforcement and civilians in danger from poachers and other criminals engaged in this action. The intended goal of this research is to develop a deeper understanding of the structure and organization of animal trafficking networks in Africa and Asia. This project uses a variety of analytical techniques, including supply chain analysis, network analysis, threat analysis and analysis of competing hypotheses.

This analysis focuses on illegal animal trafficking in Asia and Africa, with the aim of determining the key actors and groups engaged in trafficking in the regions, and the key links of the supply chain of those actors.

THE CFIUS REVIEW TOOLKIT: IMPROVING AN ANALYST'S TRADECRAFT AND TRAINING

Presenters

Alex Barger, Rose Bennett,
Tayler Harper, Jack Osborne

Advisor

Qingjiu Tao

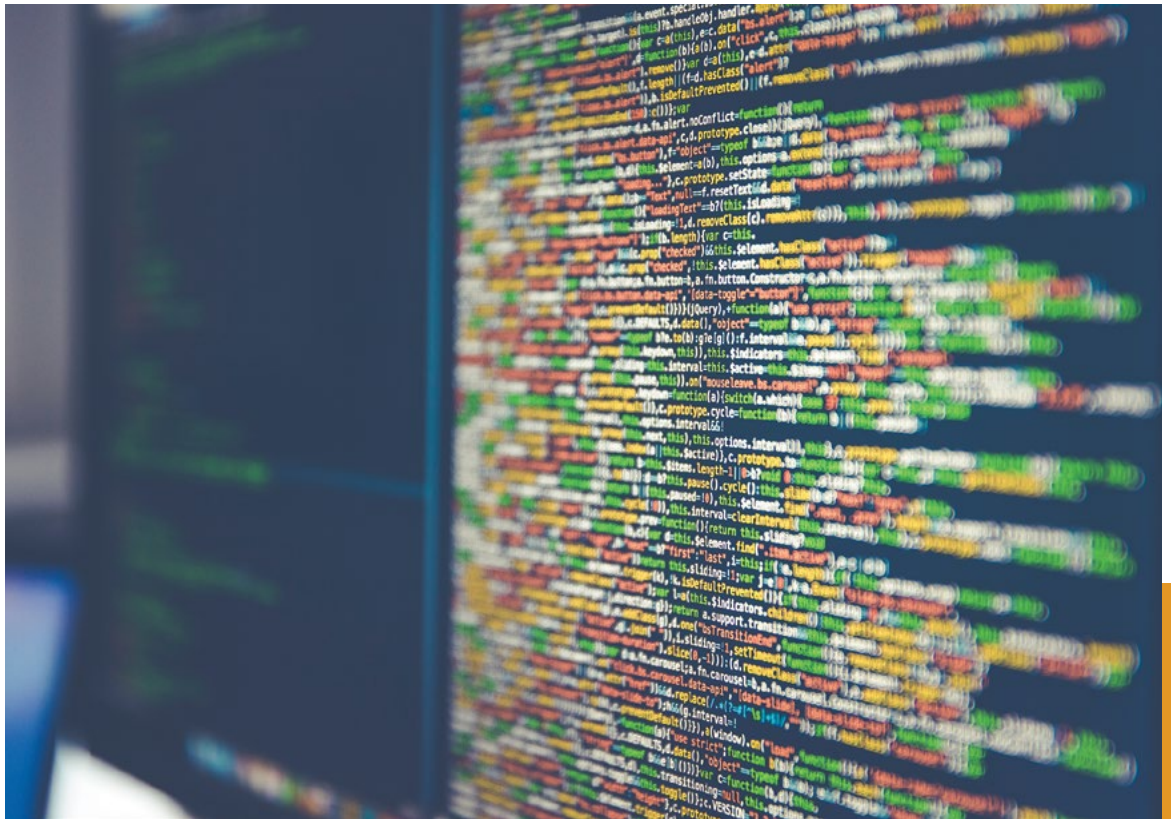
Sponsor

Ken Knight

By combining our computational and analytical skills, we can provide CFIUS with valuable implications and recommendations regarding the large quantity of foreign investment into the United States and guide analysts with their goal of screening national security threats.

The Committee on Foreign Investment in the United States (CFIUS) is an interagency committee that serves the President by assessing the national security implications of FDI. Increasing volumes of work and time constraints have negatively affected CFIUS response capabilities. This project focuses on developing a training guide and curriculum for analysts involved in the CFIUS transaction review process. Due to the confidential, global, and dynamic nature of the process, we have utilized various structured analytic techniques to develop a comprehensive framework for analysts to use and adapt. CFIUS transactions cover a vast number of industries, so we have focused on transactions or acquisition deals regarding semiconductors while developing the framework. This framework includes the development of an extensive annex to aid with navigating the multidisciplinary topics that CFIUS cases encompass including business processes, international practices, litigation, technical language, and more. Our research methodologies include strategy assessment, indicator of change lists, and analysis of competing hypotheses. All information filed in the CFIUS review process is kept confidential so we have utilized diagnostic methodologies to engage these information gaps. The training mechanism was developed using contrarian techniques, which challenge the inefficiencies of the conventional CFIUS process. Using these methodologies, we are developing a CFIUS analyst toolkit that includes risk assessment matrices, comprehensive databases, and instructional flowcharts. Our training program and analyst toolkit are intended help manage uncertainty and decrease knowledge gaps, while increasing the efficiency and accuracy of CFIUS analysts.

THE IMPACT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING ON THE CYBERSECURITY INDUSTRY



Presenters

Campbell Buhrow, Anthony Correia, Jack O'Neill, Will Rickard

Advisor

Tony Teate

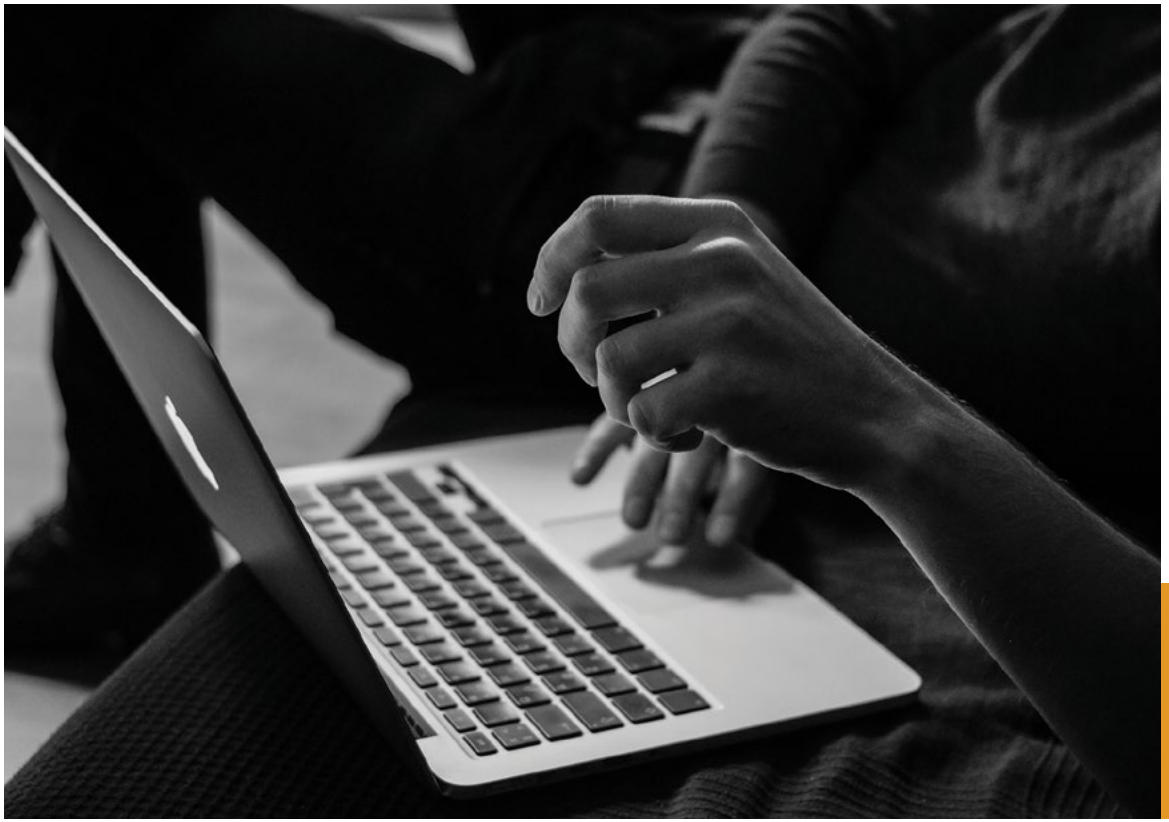
Sponsor

McAfee Corp.

The team is working to get a futures outlook on the impacts of artificial intelligence, blockchain, and quantum computing on cyber security.

This project focuses on the how artificial intelligence (AI) and machine learning (ML) will impact the cybersecurity industry. We will also look at the role of how current technologies, such as blockchain, and emerging technologies, such as quantum computing, will not only impact this industry, but may change the cybersecurity landscape. We have constructed a five to ten year road map outlining which technologies will be adopted fastest and for what purpose, as well as what industries will be mostly likely to adopt them. By creating a futures assessment of AI in cybersecurity, we aim to provide our client, Symantec, a better understanding of their position in the cybersecurity industry and how this may impact them in the future. We utilized various analytical techniques to gain better insight into the industry and the technology. From analyzing the current holistic landscape of AI and ML and how they each are currently being utilized, in tandem with the current state of cybersecurity, we were able to forecast the cybersecurity landscape for the next three to five years. Our analysis also delves into other key technologies that have an integral presence in the way the future of AI and ML is being shaped in this space. This foundation allows us to more confidently depict what role these technologies will have in cybersecurity in ten years. In doing so, we addressed key issues, risks, opportunities and threats pertaining to the cybersecurity industry. Based on our findings we have made recommendations on areas our client should be aware of within this dynamic space. Our analysis aims to provide our client with key information that they can use to gain a competitive advantage in their industry.

TIERED APPROACH TO IMPROVING A DARK WEB ANALYSIS TOOL



Presenters

Alexandra Arvai, Lauren Campbell, Dayna Collins

Advisor

Kathleen Moore

Sponsor

Anonymous

Illegal activities such as human trafficking, drug sales, and stolen personal data exchanges often occur on the Dark Web.

The Internet is divided between the Surface Web, which is accessible through standard web-based practices, the Deep Web, which cannot be accessed with traditional search engines, and the Dark Web, which requires specific software for access and is an environment dependent on anonymity. Illegal activities such as human trafficking, drug sales, and stolen personal data exchanges often occur here. The environment is fluid and at times incongruous. Law enforcement and national security entities can struggle to adapt and often fail to properly utilize the Dark Web as a source for intelligence gathering and analysis. This research examines issues in user design in the beta version of an intuitive Dark Web research program created by a startup security company. The project explores the potential of the Dark Web, and through scenario development will establish appropriate methodologies, standards, and implications for analytical inquiry. The value of this research is refining the tool to be more aligned with how it would be used in analytical contexts such as national security, law enforcement, and competitive intelligence. Our contribution to the sponsor and the field is an improved technology with enormous potential in analytical environments.

USE OF SUBTERRANEAN FORTIFICATIONS BY VIOLENT NON-STATE ACTORS BY 2030

Presenter

Marshall Grimard

Advisor

Steve Marrin

Hours of critical analysis, thorough and in-depth research, and a host of analytical methodologies are the only way to find out what the future may hold for the military applications of exoskeletons: aka power.

This capstone project examines the use of fortifications in general on the modern battlefield by violent non-state actors. It identifies the current trends in VNSA's use of fortifications to accomplish their goals, and outlines various scenarios which may, based on the evidence, plausibly unfold by the year 2030. Further, this project utilizes the background information on the use of fortifications by actors based on historical cases dating back to the Roman era, thus creating a detailed snapshot of the doctrines and strategies which have used fortifications in battles and campaigns. It also makes use of system dynamics modeling in order to further understand the factors which go into using fortifications by both VNSA and nation state actors to show how they play a vital role in the respective actor's achievement of goals. Additionally, this capstone project will provide indicators for decision makers to ascertain which scenario is most plausibly coming to be, along with several other minor analytical methods designed to support the futures analysis assessment of the project.

VIABILITY OF DOMESTIC CBRNE TERRORIST ATTACKS: THE CASE OF LAS VEGAS STRIP

Presenters

Connor Brennan, Eric Lim, Jennifer Smith

Advisor

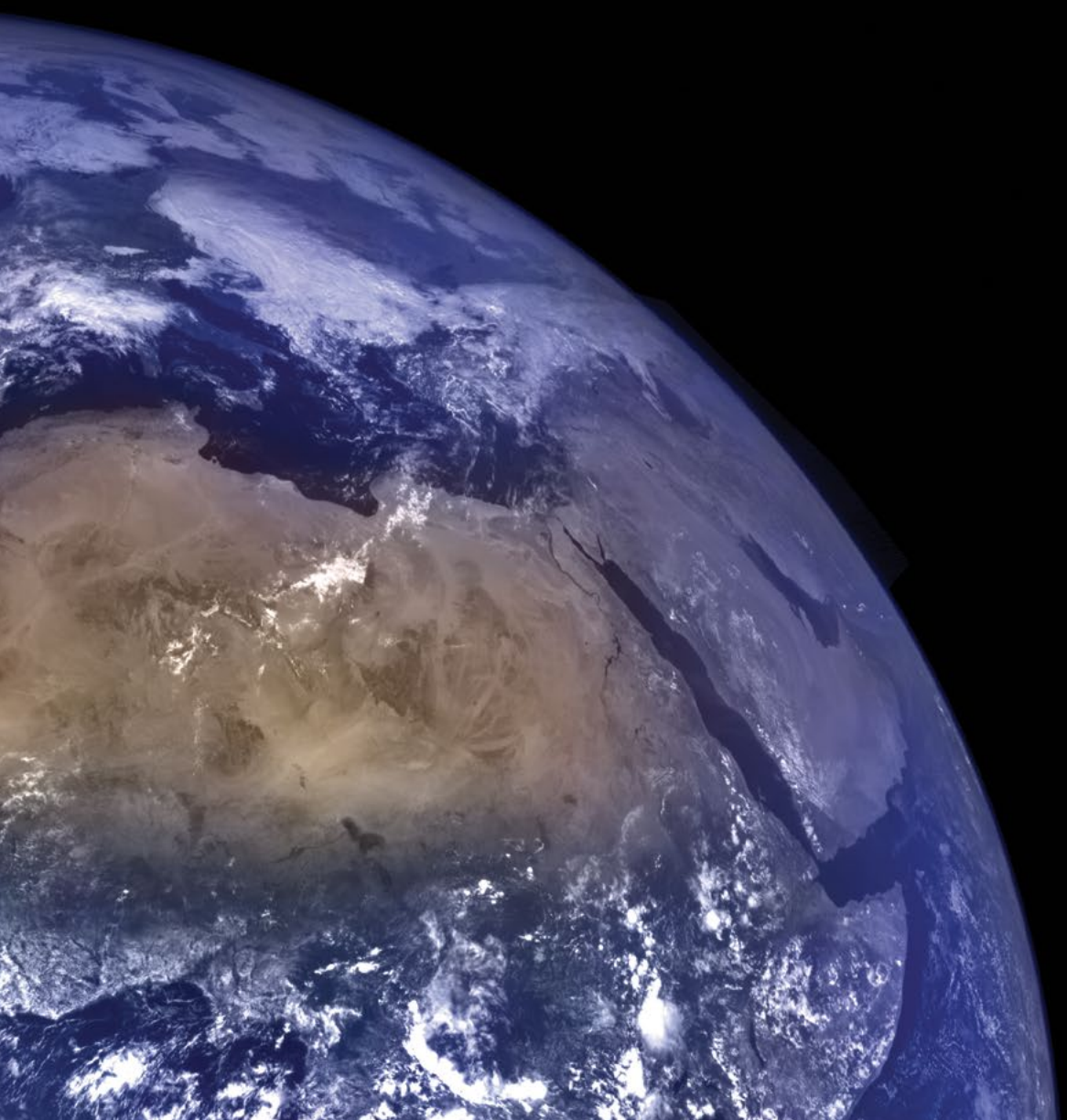
Sami Raab

Eric, Connor, and Jennifer discussing how various CBRNE attacks could take place in Las Vegas.

Chemical, biological, radiological, nuclear, and explosive (CBRNE) threats are a frightening prospect that is not well understood by the general public. It has been debated whether domestic CBRNE terrorism is a rising threat or if it is too difficult and unlikely to warrant any significant preparations. While many have decided that preparing for the worst is better than being surprised by an attack, others believe that terrorists will continue to prefer to carry out attacks using methods that are tried and true, such as vehicles or firearms, which are attractive because they have proven to be lethal and effective. This project explores the reasons why a potential terrorist may try new methods, the financial viability of those methods, our perceived difficulty of how to produce these agents, and the difficulty of disseminating these agents. Then, to provide context, we examine these concepts in a soft target, in this case Las Vegas, to understand what sort of vulnerabilities are present and what response would be required in the case of a mass casualty incident. We use systems dynamics, scenario generation, alternative competing hypotheses, and practical research to determine whether a potential method would be viable for a terrorist attack. We found that, in general, some CBRNE instructions and materials are relatively accessible to small-scale domestic terrorists. The implications of this judgement mean that there are several basic vulnerabilities that have been overlooked for the security of soft targets.

GS

As global connections and competition increasingly characterizes our way of life, understanding the importance of place and space has never been more critical. Geographic Science is a major that pushes students to see the connections between human societies and culture and the natural environment. It provides them with the tools to use and visualize data across spatial dimensions, and the knowledge to employ those tools carefully and appropriately. Our students blend all of these facets of geographic study together to better understand and address the problems facing the world today.



ANALYSIS OF BIOPHILIA AND URBAN DESIGN IN HARRISONBURG

Presenters

Justin Arnold, Drew Berdo, Jackie Lee, Kayla Rini, Maxwell Titus

Advisor

Henry Way

The team is working with GPS coordinates of field sites throughout Harrisonburg to analyze for correlations with U.S. Census data in accordance with their key of Biophillic Design to gather tentative insight on urban design in Harrisonburg.

This project's area of interest was the city of Harrisonburg with focus pertaining to the varying neighborhoods throughout the recorded US Census Block data. Team members collected field information utilizing their own Biophilia Key and recorded GPS coordinates of these areas for geospatial analysis via ArcGIS. The team analyzed fieldwork for patterns relating to demographics including race, college population, education levels, and median income level. The project developed an understanding of urban planning and biophilia hypothesis and worked to create an academic foundation for future analysis of Harrisonburg and its urbanization in the Shenandoah Valley.

EQUITABLE SUSTAINABLE DEVELOPMENT: THE NORTHEND GREENWAY AND PATHS FORWARD

Presenters

Amelia Morrison, Quintin Petersen

Advisor

Henry Way

The team is working to understand how environmental sustainability projects in US cities can reproduce uneven power relations in society, including gentrification, marginalization, and displacement. The project searches for policy and outreach strategies to prevent the continuance of these inequalities.

As global climate change cultivates a demand for "green" development, the rhetoric of sustainable development has been increasingly challenged by social justice advocates as an appropriation of inclusivity discourse to serve the lifestyle tastes of the affluent. This ongoing tension is examined within the context of Harrisonburg, Virginia's Northend Greenway, a 2.5 mile shared use path and stream rehabilitation project that connects a cluster of underserved neighborhoods to key areas of business, education, and recreation in the city.

A key consideration from a critical geographical perspective is whether the Northend Greenway can serve as a model for truly inclusive sustainability projects in other small US cities. GIS mapping is used to identify and visualize communities in Harrisonburg that have been historically underserved and that - we hope - will benefit from this project. Perspectives from policy makers, grassroots organizers, and residents are explored to analyze the risk of gentrification in a key neighborhood. Ultimately, it becomes clear that stronger commitments to affordable housing must be made from the beginning of projects like the Northend Greenway to ensure that well-intentioned sustainability initiatives do not displace vulnerable residents. Furthermore, a community participation structure that employs grassroots organizations as liasons between city policy makers and residents of key neighborhoods should be developed to enhance the quality of community participation and information exchange in under-represented neighborhoods.

GARDENS FOR INCREASING JMU STUDENT ENGAGEMENT WITH PUBLIC SCHOOL STUDENTS

Presenters

Andrew Deluca, Bridget McGregor, Clare Parkinson, Tyler Strong

Advisor

Amy Goodall

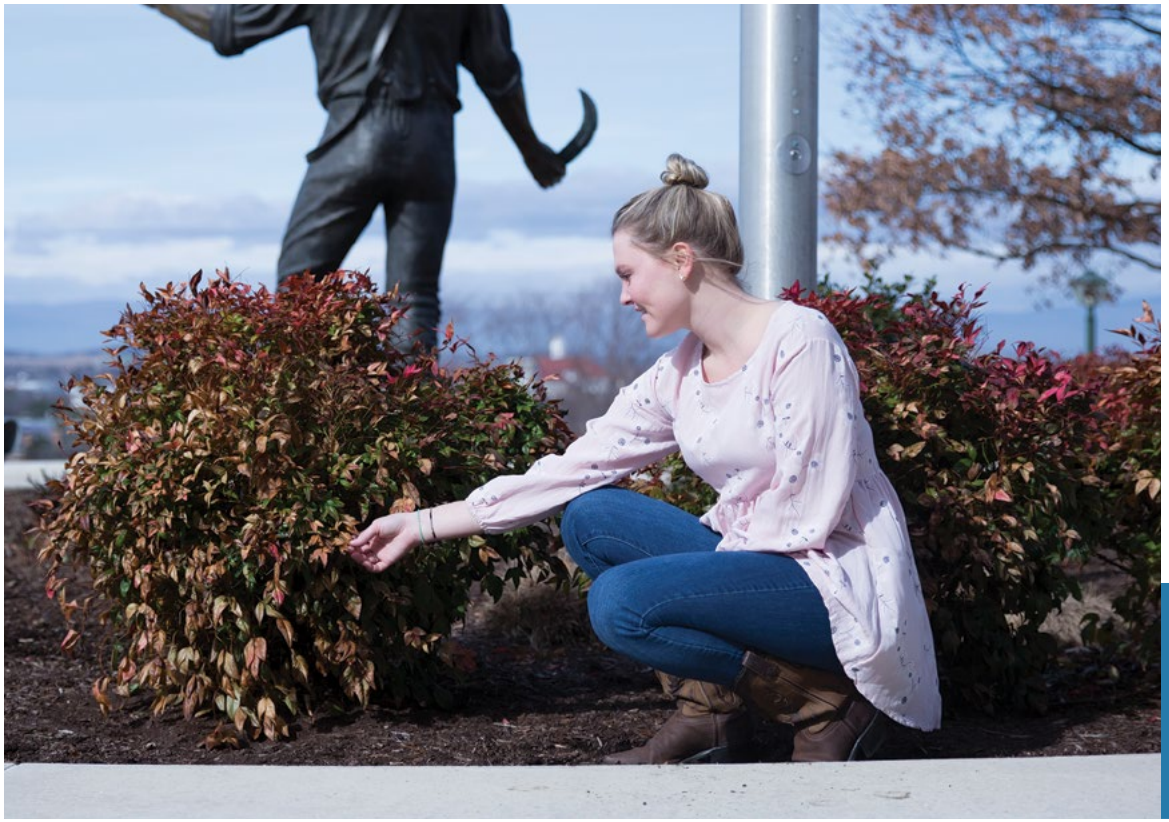
Sponsors

W.H. Keister Elementary School, Smithland Elementary School, Thomas Harrison Middle School Great Oak Academy, Bluestone Elementary School

The team is working with Harrisonburg City Public Schools' students to increase their use of school gardens and knowledge about the garden ecosystem.

JMU Geographic Science (GS) students designed and built a vegetable and native flower garden at W.H. Keister Elementary School (KES) in spring 2012. Since that time, GS capstone students have worked to maintain the garden and design activities that can increase student use of the garden. The objective of this project was to expand the garden program and to design methods for further development of a garden culture that contributes to sense of community, student appreciation for healthy eating, and environmental awareness. We participated in garden work with KES students from August – October 2017, listed our observations of successes and suggestions for improvements, researched designs of other grade school gardens, assessed soil health for potential changes over time, and researched literature and lesson plans in order to develop tools to increase teacher interest in using the school garden. Throughout the year, other public schools expressed an interest in expanding or adding vegetable and flower gardens to their programs. Included in this presentation is a summary of our field work and literature research that greatly influenced our designs for expanding or developing new vegetable and flower gardens at four Harrisonburg City Public Schools. We will present field guides, learning activities, and a proposal for a citizen science program. Each of these are designed to increase environmental learning for students of all ages as well as increasing opportunities for engagement between JMU students and public school students and their teachers.

IMPORTANCE OF SCHOOL GARDENS FOR URBAN CHILDREN IN MIDDLE SCHOOL



Presenter

Erin Brennan

Advisor

Amy Goodall

Sponsor

Thomas Harrison Middle School

Erin is focusing on urban gardening in schools and communities. She has been working closely with an alternative school program at Thomas Harrison Middle School in Harrisonburg, VA.

Capstone students in the JMU Geographic Science program built a garden with a local elementary school in 2012. Since then, the garden has been successful in providing a learning environment for elementary and university students. As part of planning the expansion of the garden program, the objectives of this study were to accentuate the importance of school gardens for urban students and, to investigate the importance of a school garden for urban students at a middle school level. Methods for this study include literature review and planning a garden with a local middle school. Based on these research methods, a middle school garden will be redesigned in spring 2018 within Harrisonburg. This presentation emphasizes the importance of urban school gardens as a learning space.

TEMPORAL ANALYSIS OF BUTTERFLY COMMUNITY COMPOSITION IN HARRISONBURG, VA

Presenter

Olivia Saacke

Advisor

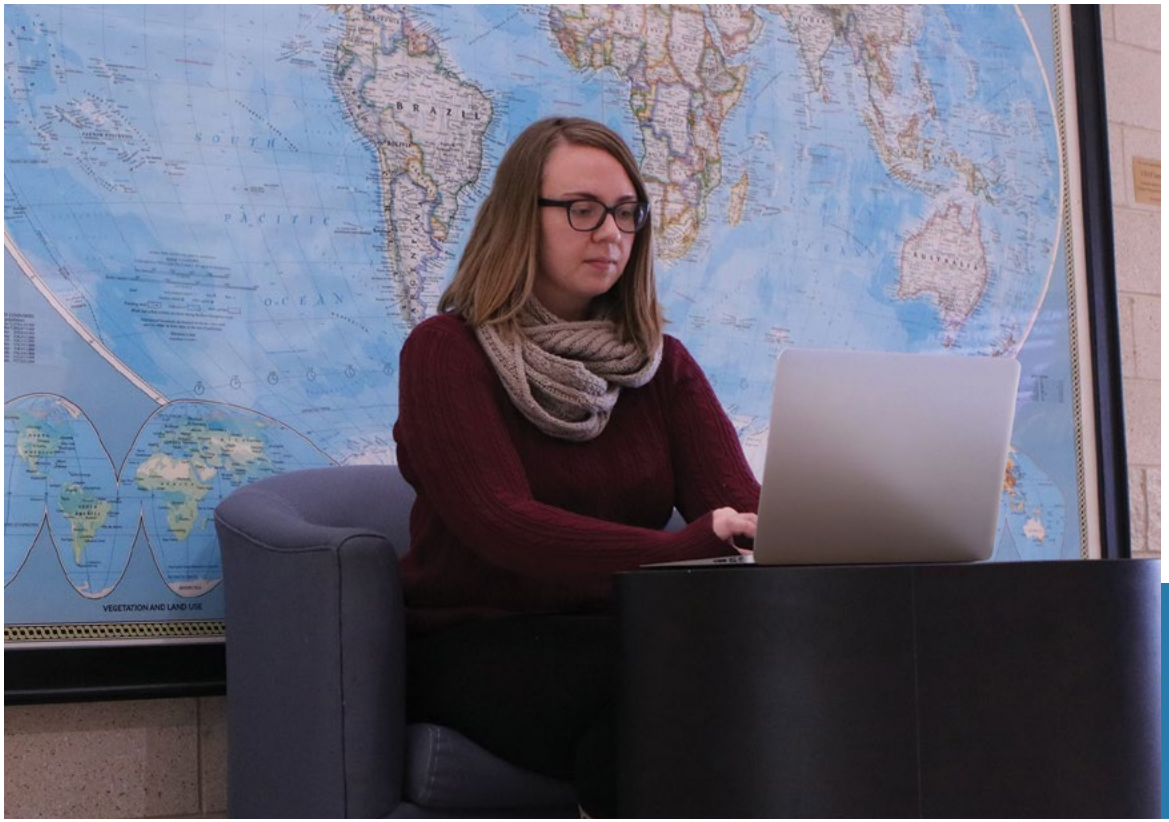
Amy Goodall

This project involved surveys of multiple butterfly habitat patches in Harrisonburg, including the James Madison University Hillside habitat restoration area.

As pollinators, butterflies play a significant role in the function of an ecosystem and therefore can serve as indicators of environmental conditions. The objectives of this study were to assess butterfly species composition in Harrisonburg during the fall 2017 semester, and to compare the findings to surveys conducted by Geographic Science students during the 2013 through 2016 fall semesters.

A modified Pollard Walk survey method was used each year to survey butterfly communities within habitats on the James Madison University campus, a city grade school garden, and two Harrisonburg city parks. Results indicate year-to-year variability in some species and families of butterflies, particularly in the Pieridae (Whites and Sulphurs) and Hesperiidae (Skipper) families. This presentation summarizes the similarities and differences in species composition and abundances among sites surveyed in 2017 and among years 2013 – 2017. It also provides suggestions as to why observed differences exist across time such as changes in habitat, trends in atmospheric conditions, and challenges in identification of cryptic species and species that are potentially hybridizing.

UHIS AND SUSTAINABLE DEVELOPMENT: A SPATIAL ANALYSIS OF EL PASO, TEXAS



Presenter

Whitney Ricker

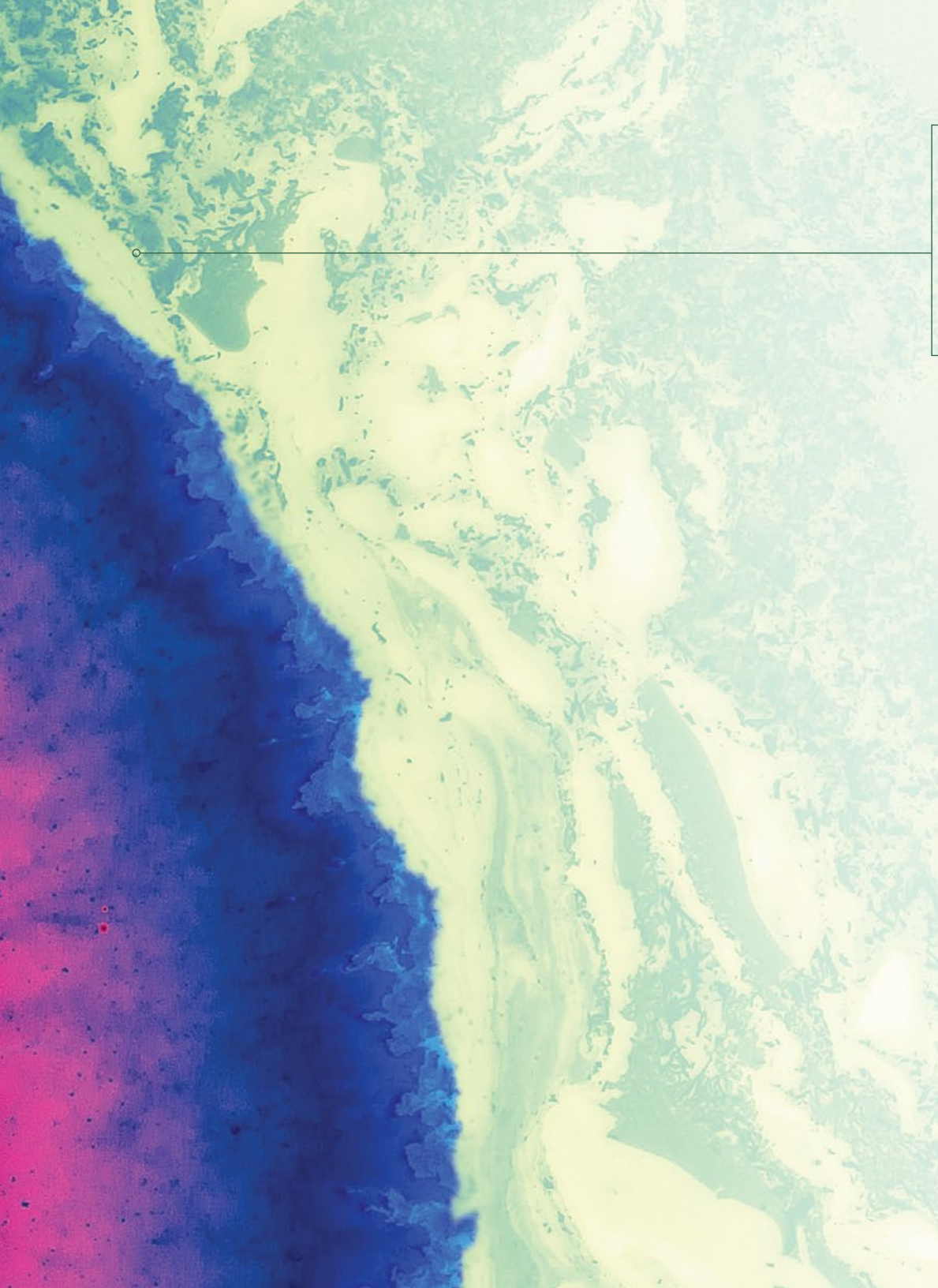
Advisor

Mace Bentley

Whitney is working to analyze MODIS heat data at a 1km resolution in order to ascertain what neighborhoods in El Paso are the hottest on average.

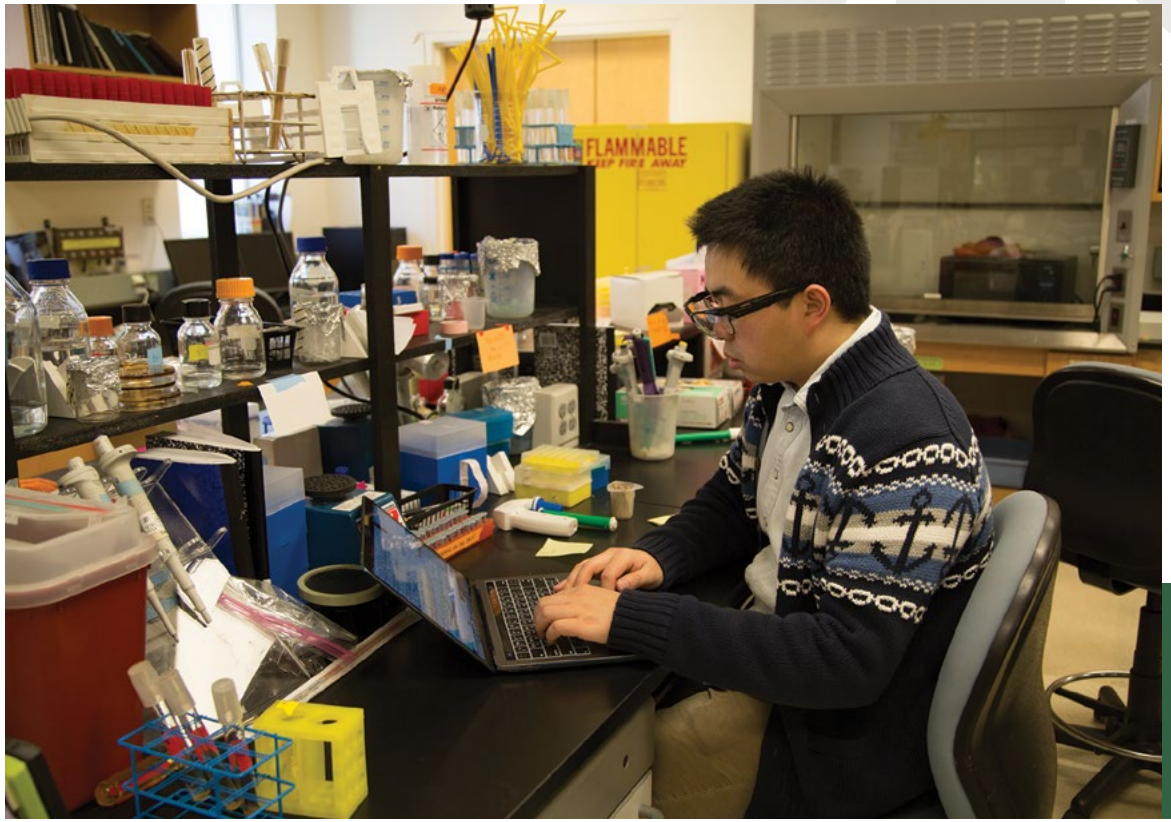
Due to human-induced climate change, cities across the globe will experience increasing extreme heat events. The largest cause is the urban heat island (UHI) effect, as more areas are urbanized and large quantities of land are paved over, leaving little to no natural vegetation. Multiple studies have shown that UHIs correlate with health issues, poverty, low education attainment rates, outmigration of younger residents, and other negative societal impacts. This is the case in El Paso, Texas, where research has shown that some of the most impoverished residents live in some of the hottest neighborhoods. This study will focus on access to healthy and sustainable food sources within impoverished El Paso neighborhoods. While past studies have generally focused on health and societal impacts of extreme heat, I will look at this issue from an environmental justice standpoint, focusing on whether individuals in "hot spots" have equal access to healthy food options, or if they live in "food deserts." Using MODIS heat data from the summers of 2014-2017, I will present findings from a spatial analysis to show if any new hot spots have appeared in the city. Upon overlaying the heat layer with socioeconomic indication layers, I will demonstrate correlations between hotspots and food scarcity with indicators such as: locations of stores that sell organic food, proximity to community gardens, and availability of transport to food sources. As our society continues to urbanize and UHI generates extreme heat, these findings will become increasingly important in our efforts to adapt.


BIO-IT



Students in the Biotechnology degree program explore the growing realm of biotechnology and its applications. The program, which the School of Integrated Sciences jointly operates with the departments of Biology and Chemistry, allows students to take a deep dive into the field, including intensive laboratory experiences and opportunities for groundbreaking research. The projects listed in this book are those that are advised by faculty members in our School.

COMPARISON OF THE COMPLETE GENOME SEQUENCES OF BORDETELLA AVIUM AND B. HINZII ISOLATED FROM TURKEYS OVER A 40 YEAR PERIOD



Presenter

Chih Hao Huang

Advisor

Louise Temple

Sponsor

4VA

Genomics projects utilize previously derived DNA sequences to do further analysis such as this comparative genomics project.

Bordetella avium causes bordellosis, an upper respiratory disease in turkeys, and it was thought until recently to be the only cause. In the last three years, a majority of isolates from turkeys with symptoms of bordetellosis have been identified as B. hinzii using standard biochemical tests. The complete genome sequence of four samples ranging from the 1980's and 2015 was obtained using PacBio sequencing. In addition, the genome sequences of B. avium 197N, B. hinzii F582, and Bordetella pseudohinzii HI4681 were obtained from GenBank. Mauve was used to comparative genome studies. Based on the phylogenetic tree generated by Mauve and R, members of each species group together, and B. pseudohinzii and B. hinzii are closely related. Within the species, the chromosome sequences are highly similar and collinear. The main differences within species were identified as prophages and plasmids with no obvious phenotypic effect. B. hinzii genomes are approximately 1 million bases longer than B. avium. In our initial analysis, the regions of difference include mostly redundant metabolic genes in B hinzii. A unique secretion system was identified in only B. avium, which could potentially indicate a unique secreted protein. More detailed analysis is currently being performed to yield a more complete analysis of differences in these species.

DEVELOPMENT OF THE CRISPR-CAS SYSTEM FOR MUTAGENESIS IN THE GRAM NEGATIVE BACTERIUM, BORDETELLA AVIUM

Presenter

Arissa Gordillo

Advisor

Louise Temple

Sponsor

4VA

In the laboratory, Arissa is creating defined bacterial mutants to understand the pathogenesis of a poultry pathogen.

Since the revelation of clustered regularly interspaced short palindromic repeats (CRISPR) and CRISPR associated (Cas) nucleases as a genome editing tool, the system has been used in numerous ways to alter the genes in organisms of various sizes and complexity. The most well known potential is in gene therapy for cancer. The application of this method has not been commonly used to engineer genomes of bacterial models, even though the system itself originated in bacteria. Bacterial mutagenesis is a difficult challenge, but an important step in understanding the biology of the organism. In this project, we have been developing the methodology to use the CRISPR-Cas system to introduce changes to a bacterial genome, a Gram negative bacterium, Bordetella avium. B. avium is an upper respiratory tract pathogen and the causative agent of bordetellosis in avian species.

To show that the method is successful, we are targeting a known virulence factor that has a testable, phenotypic change. Thus far, we have used bioinformatics to design the DNA sequences needed to prepare the system for use in Bordetella, and we have obtained the required biological materials. The next steps involve polymerase chain reactions, movement of DNA molecules in the bacterium, and selection for the mutant.

Thank You!

On behalf of the ISAT Department, I want to thank the students, faculty, sponsors and especially the staff whose hard work helped to make this book and our event possible.

The incredible amount of dedication, teamwork, time and effort (and occasionally some frustrations) is what makes this event possible year after year.

Jeffrey Tang
The School of Integrated Sciences

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