JAMES MADISON UNIVERSITY

# 2022 | SENIOR SYMPOSIUM

SCHOOL OF INTEGRATED SCIENCES

MAKING THE **CONNECTIONS**

Integrated Science and Technology

Intelligence Analysis

Geography

# Acknowledgements

Our annual event would not be possible without the generous support of our donors and project sponsors:

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Shenandoah Valley Organic-Farmer Focus
Trout Unlimited
Venture Well
Vine & Fig's Jubilee Climate Farm
Virginia Department of Environmental Quality
Virginia Department of Forestry

To the family and friends of the School of Integrated Sciences community of learning. Although their names and activities are not described in the pages that follow, they played an important role in the success of these projects. We thank them for their encouragement, patience, and support along the way.


JMU® School of Integrated Sciences


Throughout this book, you will discover an enormous breadth of scholarship accomplished by undergraduate students. Teams have worked many hours over two academic years to develop creative approaches to define and address a wide range of complex and important problems. These projects showcase a skillset that is so needed in an increasingly specialized world—the difficult integration of science, technology, systems thinking, and domain-specific methodologies to arrive at new insights and solutions. Capstones are inspired by student interests, commissioned by external sponsors, and guided by faculty advisers. Ideas are crafted into achievable projects through the development of stated goals, activities, timelines, and benchmarks. Along the way, undergraduates develop their independence and confidence as they work, struggle, explore, and succeed.

...and this is just the beginning for our School of Integrated Sciences Class of 2022!

ISAT

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## Integrated Science and Technology





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# INTEGRATED SCIENCE AND TECHNOLOGY

The Integrated Science and Technology B.S. degree program teaches students to be holistic problem solvers. Systems thinking methodologies are used to define and find leverage points within complex problems. A broad and integrated STEM skillset—with focus areas in biotechnology, computation, energy, environment and sustainability, and manufacturing—is then applied. Training in responsible innovation and anticipatory governance helps to ensure that today's solutions don't become tomorrow's problems. This strategic integrated approach delivers graduates that are uniquely versatile, confident, innovative, and collaborative.

# A DYNAMIC SIMULATION MODEL FOR OPTIMIZING TOOL LIFE IN SUSTAINABLE MACHINING

## Presenter
Tess Moran

## Advisers
Hao Zhang, Ph.D., Rod MacDonald, Ph.D.

The environmental impact of machining operations is often treated as a conflicting interest when compared to other machining factors. In actuality, it is more beneficial in the long term to adjust practices to be environmentally conscious. The objective of this study is to create a systems model to examine the linkages of environmental impact with machining technical settings, tool life, cost, quality, and efficiency. The model aims to replicate the machining behaviors at the unit process level and generate the long-term implications of their techniques and impacts for engineering decision making. Using Stella Architect software, this study created a systems model that quantifies and better depicts the linkages and trade-offs between environmental impact and decisions surrounding machining operation parameters and technologies, and provides quantified relations and further understanding of the dynamics of machining sustainability.



# A WEB-BASED TOOL FOR HIGH SCHOOL SENIORS IN SEARCH OF COLLEGE MAJORS

## Presenters
Maya Pavan, Hafiz Bhuyan, Brendan Lawlor

## Adviser
Steven P. Frysinger, Ph.D.

The team brainstorms ideas about the conceptual design and physical design of the website.

Entering college is a key milestone in a student's life. In fact, 70% of recent high-school graduates enroll in college. This project targets high-school and first-year college students who find it difficult to choose majors because they are undecided about potential career paths. The project aims to alleviate this problem by developing a website that will help inform the students about their options. We conducted research into the needs of the target user population in support of a user-centered design process. Based on these needs, we created both the backend and front end of our user interface resulting in our final product, which is a website in which students can learn about different majors and extract useful information about them.

# ALERT SYSTEM AND ADAPTIVE HEARING PROTECTION FOR SHENANDOAH VALLEY FARMERS

## Presenters
Christian Bowman, Zayne Luker, Will Sinn

## Adviser
Chris Bachmann, Ph.D.

Will Sinn works remotely to develop the noise alert App (inset) while Zayne Luker (left) and Christian Bowman (right) build a prototype of the adaptive hearing protection system.

According to OSHA any person working in a noise environment of 85dB is at risk of noise-induced hearing loss. Employees in the Agricultural Industry are often subject to excessive noise exposure that eventually leads to irreversible hearing damage. Harrisonburg is located in the center of Virginia's top-producing agricultural region. Team members who grew up here observed that the older demographic of Shenandoah Valley farmers is often hearing impaired. To address this local problem and take action against a preventable injury, our team developed an excessive-noise detection App. It alerts the user whenever they are in the presence of sounds that could cause hearing damage.

A haptic signal alerts the user by issuing strong vibrations through their phone, while a flashing alert screen advises hearing protection measures to be implemented. The system records both the level of noise and exposure time to catalog long-term risks. Additionally, the team developed a novel, adaptive Hearing Protective Device that protects the user from excessive noise while still allowing direct communication with co-workers (for on-farm and in-factory applications). When used together, farmers and agricultural workers will be more aware of noise exposure and better prepared to protect themselves and those around them.



# ANALYZING AND TESTING NEW MATERIALS FOR FOOTBALL HELMETS

## Presenters
Joshua Jones, Alvin Mills, Preston Shealy

## Advisers
Shannon Conley, Ph.D., Jonathan H. Spindel, Ph.D.

Due to the rise of concussions that occur within the game of American football, we wanted to further examine why this is occurring at such a high number. In this project, we analyzed the history of concussions, traumatic brain injuries, and brain development across all ages to see what factors were consistent and different that attributed to the rise of concussions. Through extensive research the group wanted to further test football helmets to take a glimpse into what could be done to better improve the football helmet. Through trials of testing, the group gathered information that would be useful to reduce the number of concussions in the game of American football.

# ANALYZING THE EFFECTS OF TOTAL DISSOLVED SOLIDS IN SAND BRANCH, VA

## Presenters
Zachary Tomek, Jared Kunkel, Dalton Buchardt

## Adviser
Robert N. Brent, Ph.D.

## Sponsor
Virginia Department of Environmental Quality

The team is using a net to collect benthic macro invertebrates from the stream.

Waterways across the nation are experiencing the harmful effects of total dissolved solids (TDS) from sources such as mining, urban runoff, and roadway deicing salts. Most states within the country currently do not have a water quality standard for TDS, because the toxic effects differ based on ion composition. Our project focused on developing a site-specific TDS standard to protect aquatic life in Sand Branch, an urban stream in Loudoun and Fairfax Counties, VA.

Laboratory toxicity testing was conducted on field-collected mayflies and snails exposed to samples created to mimic the conditions in Sand Branch. These tests helped us find the safe level of TDS for Sand Branch that will restore and sustain the health of aquatic life. This site-specific standard is being used by the Virginia Department of Environmental Quality to set limits for discharges into Sand Branch and to prepare a cleanup plan for the stream.





# ANTIBIOTIC RESISTANCE AND BIOFILM FORMATION IN CLINICAL ISOLATES OF PSEUDOMONAS AERUGINOSA

## Presenters
Lauren Knabe, Jack Richardson

## Adviser
Louise Temple, Ph.D.

Multi-drug resistant bacteria, Pseudomonas aeruginosa, is a threat to public health, according to the CDC. These bacteria form biofilms, slimy layers that increase its resistance to antibiotics and pose great challenges to treating hospital acquired infections. We have explored the significant societal impacts that arise from increasing numbers of untreatable infections caused by antibiotic resistant bacteria. In our laboratory research, we examined the relationship between biofilms and antibiotic resistance. We worked with uncharacterized clinical isolates obtained from patients at University of Virginia in 2019, and a lab strain, P. aeruginosa PAO1. We determined the minimum inhibitory concentration (MIC) of amikacin and gentamicin, two antibiotics that P. aeruginosa is known to be resistant to, using the Sensititre system. The MIC for P. aeruginosa PAO1 and the clinical strains ranged from between 8-16 ug/mL for amikacin, and 2-16 ug/mL for gentamicin. Results varied between clinical isolates and the lab strain. Biofilm formation also varied among these strains. We are testing the biofilm formation versus planktonic growth in the presence and absence of antibiotics to determine whether antibiotics that do not kill the bacteria inhibit the growth of biofilms, or whether addition of antibiotics after biofilm formation breaks up the biofilms.

# BIO-INSPIRED LAYOUT DESIGN OF MANUFACTURING SYSTEMS

## Presenters
Jonathan Holstein, Dean Jinks, Chandler Branton

## Adviser
Hao Zhang, Ph.D.

Increasing competition between manufacturers has led many to rethink the traditional manufacturing system design and begin to adopt new methodologies or practices in hopes of increasing productivity and sustainability. This research project focuses on analyzing the applicability of implementing bio-inspired designs in manufacturing systems through study of various structures and their functionality. Some of the biological structures analyzed include: a honeycomb, spiderweb, leaf structure, and ant colony, which was compared to a traditional layout. Analysis of production efficiency and transportation distances was conducted through a simulation software. This exploration intends to create new manufacturing system layout ideas for future production characteristics such as high automation, flexible, resilient, and environment friendly.



# CAER APP: ANTICIPATORY REASONING THROUGH CREATIVE PROCESSES

## Presenters
Nolan Harrington, Nnaemeka Obidinma

## Advisers
Morgan Benton, Ph.D., Emily York, Ph.D.

The team is working on the user interface design and functionality of the CAER App. This promotes principles of accessibility and usability throughout the development process.

What if we could anticipate the 'unanticipated consequences' of new technologies? The Creative Anticipatory Ethical Reasoning process, otherwise known as CAER, is a process that theorizes future hypothetical scenarios, and evaluates the ethical dimensions that arise from these ideas. This process blends scenario analysis, design fiction, and JMU's 8-key questions to help students, scientists, and technologists apply critical and ethical reasoning skills to new technologies in order to understand and ensure that they are developed and distributed responsibly. The CAER application is designed to be a progressive web application that supports PCs and mobile devices. This application makes the process of investigating different topics more intuitive and interactive while allowing for increased data analysis to support research and education purposes. Furthermore, the app expands upon the current physical mediums used for the CAER process such as paper and whiteboards to make the process more accessible. The application also presents new ways for distributed and remote engagement with the CAER process and allows for a more interactive way for students to participate.

Integrated Science and Technology

# CISE COSTA RICA ABROAD PROJECT: CORAL REEF STRUCTURES

## Presenters
Annie Williams, Connor O'Brien, Ethan Leming, Evan Mason

## Adviser
Karim Altaii, P.E., Ph.D.

## Sponsor
Punta Leona Hotel and Club, Costa Rica

Under the supervision of Mr. Fabio Brenes, students are sculpturing the concrete version of an "Indio Garabito" – a Native Indian of Garabito, Costa Rica.

Efforts regarding coral reef restoration begin with education and awareness. A more aware society leads to better choices made for all. This includes education and participation in ongoing coral reef restoration projects. There are a multitude of ways individuals interested in restoration efforts to become involved. This capstone group did just that, following the guidance of experts in the field. Four structures were built to start an underwater museum, a museum in which tourists, as well as local inhabitants of the area, may appreciate their presence and to enhance coral reef growth. The objective of creating an underwater museum was met as four International articles were written on the project regarding its purpose in aiding coral reef restoration.



# COMPUTER VISION, EDGE COMPUTING AND AUTOMATION

## Presenters
Claire Timmins, Noah Munis

## Adviser
Anthony A. Teate, Ph.D.

Our project involves building and training deep machine learning models to classify images of small items. Each image detected by the model will generate an electrical signal to trigger different color LEDs on a GPIO connected board as well as control different movements of a servo motor. The machine learning models will be embedded in several small edge computing devices, each configured as: a Raspberry Pi + a Google Coral USB Accelerator with a Raspberry Pi Camera attached. The camera will "see" different objects and the Accelerator will run fast inferencing, causing the Pi to trigger the signals. There are several use cases for these edge devices and the final product of this project will implement a prototype of a small computer-vision enabled automated mobile sorter which can be used to enhance throughput, modernize operations, and increase safety in businesses that use these machines.

# CONCEPTUAL DESIGN FOR SOLAR INSTALLER TRAINING CAPACITY ON THE JMU CAMPUS

## Presenters
Owen Cleary, Luke Fay, Tyler Raniszewski, Josh Romero

## Adviser
Jonathan Miles, Ph.D.

The capstone team is taking measurements of the existing solar panel outside the SWTTF to estimate the dimensions of future solar PV arrays for distributed energy lab courses.

The installation of solar photovoltaics (PV) has grown exponentially in Virginia during the past decade, and there is a critical need to increase the workforce to maintain the increasing pace of solar deployment. The Small Wind Testing and Training Facility (SWTTF) on the JMU campus features a 10-kW wind turbine, a rack of photovoltaic (PV) panels, and balance of systems. Our team developed a conceptual design to expand and upgrade the SWTTF to provide the capacity needed to train the future workforce in Virginia that will be responsible for growing the PV industry. An upgraded facility will feature new office and classroom space in a new building that adheres to principles of sustainability, dedicated solar installer training modules, and multiple parking spaces with chargers covered by a solar canopy to charge EVs and enhance training on clean transportation. Our effort also included the development of a conceptual business plan and market study to inform the cost-effectiveness of and demand for such a project.



# DESIGN AND CONSTRUCTION OF AN ERGONOMIC GUITAR FOR REHABILITATION

## Presenter
Robert Aguillen

## Adviser
Chris Bachmann, Ph.D.

Robert Aguillen used computer-aided design to create a more ergonomic guitar for musicians suffering from repetitive motion injuries.

Repetitive motion injuries, such as tendonitis and carpal tunnel syndrome, can be problematic for guitarists whose livelihood depends on their ability to perform. Several treatment options exist, including physical therapy and pharmaceutical strategies, but these often require an extended rest period to promote healing. This may not be possible for a musician whose income is dependent on their ability to perform. The goal of this project was to employ computer-aided design (CAD) to create a more ergonomic guitar that augments existing treatment options by alleviating key stressors, mitigating pain, and allowing the musician to play despite his/her condition. A prototype of the guitar was constructed and tested by several musicians to investigate whether ergonomics can be the key to the prevention and/or rehabilitation of repetitive motion injuries in the guitar-playing community.

# DESIGNING AN ENERGY CONSERVATION OUTREACH PROGRAM FOR OFF-CAMPUS STUDENTS


## Presenters
Alex Biegel, Bryan Menjivar

## Adviser
Maria Papadakis, Ph.D.

The capstone team is spending time reviewing existing research in order to find a solution for the split incentive problem and other conservation disincentives students face.

Energy conservation in rental properties is challenging because neither landlords nor renters have much incentive to buy and install energy-saving equipment or devices. Known as the "split incentive" problem, this situation discourages energy-saving measures that could lower utility bills and improve tenant comfort. Our project explores the split incentive problem as it relates to local college students living in off-campus housing. It identifies the obstacles and opportunities that students face for lowering their energy costs and reducing greenhouse gases. Insights are used to propose design guidelines for an outreach program that includes education and awareness activities and an energy conservation kit. Our tentative conclusion is that the disincentive for energy conservation by off-campus students is strong. Bundled utility allowances, low electricity rates, the need for behavioral change and roommate cooperation, and limited options for reinforcing student motivation are significant barriers to conservation.



# DEVELOPING GREEKS' SUSTAINABILITY KNOWLEDGE AND PRO-ENVIRONMENTAL BEHAVIORS

## Presenter
Kalin Cormack

## Adviser
Christie-Joy Hartman, Ph.D.

The team is interviewing sorority members about environmental sustainability in the Greek community.

Universities are incorporating sustainability in research, teaching, operations, and outreach. However, progress toward members of the university community behaving in sustainable ways and committing to sustainable lifestyles is lagging. Fraternity and sorority members (i.e., Greek community members) are a promising group for universities to engage in the pursuit of sustainability because these students are highly active in extracurricular activities, participate within established organizational structures, and often make up a significant percentage of the student population. This capstone project identified opportunities for JMU to assist in the development of sustainability knowledge and pro-environmental behaviors among the Greek community members, who represent approximately 20% of the undergraduate population. I studied Greek sustainability programs at JMU and other US universities; analyzed JMU Greek students' behavior, attitudes, and knowledge using responses to the Continuing Student Survey and Environmental Stewardship Reasoning and Knowledge Assessment; and reviewed the scholarly literature about fostering behavior change. Based on the results, I developed a year-long programming and assessment plan. It contains four main components and corresponding knowledge and behavior learning outcomes that support the United Nation's Sustainable Development Goal #12: Ensure sustainable consumption and production patterns.

# DEVELOPMENT OF ArcGIS TOOL TO ADVANCE WIND POWER IN VIRGINIA

## Presenters

Ryan Messinger, Jack Schiesl

## Adviser

Jonathan Miles, Ph.D.

The team is working to create a comprehensive mapping tool within the software, ArcGIS. This tool will be used by developers to construct future wind projects within the Shenandoah Valley.

As the United States transitions toward a future clean power, the need for wind power project development continues to increase. However, development of wind power projects is time-consuming, costly, and risky. It requires advanced software, mapping, and data analysis to be conducted effectively and efficiently. Using ArcGIS software and other software resources, we created a comprehensive mapping tool to inform local wind power development by enabling increased access to and understanding of the physical attributes of the Appalachian ridges that extend along the state boundary between Rockingham County, Virginia and West Virginia. Our tool considers features such as geology, wetlands, transmission lines, wind resources, and others including imagery collected during a drone study that will inform future interconnection options. This tool will help to advance the development of clean, sustainable energy as mandated by the Virginia Clean Economy Act of 2020.



# HUMAN GENOME EDITING & THE FUTURE OF WARFARE: AN ETHICAL ANALYSIS

## Presenter

Riley Volk

## Adviser

Amanda Sanson, Ph.D.

Riley is working on his capstone project where he is seeking guidance from the great stoic philosophers Plato and Socrates.

Human genome editing has progressed rapidly over the last decade. The Nobel Prize-winning technology CRISPR-Cas9 has made gene editing less expensive and more readily accessible than ever before. This analysis explores the current use of human genome editing in militaries across the globe and what ethical considerations guide countries' military decision-making processes.

There exist few legitimate authorities who could impose and, more importantly, enforce global guidelines for the practice of human genome editing. Rather than international regulation, research and implementations are guided by the norms of the international scientific community and the ethical practices within the individual countries. However, relying on current norms could ultimately endanger the autonomy and well-being of service members. The countries examined in the study, China, France, the United Kingdom, and the United States, have varying cultural and ethical boundaries around non-therapeutic adult human genome editing. The variation of different military implementations in these countries may lead to national security concerns for the United States. This project focuses on the ethics that guide the United States military and its supporting systems, how those ethics compare to foreign powers' ethical guidelines, and how our current guidelines may impact the future of biotechnology in the US military.

## IMPACTS OF CLIMATE CHANGE ON STREAM HYDROLOGY IN THE SHENANDOAH VALLEY

### Presenter
Anthony DiCanio

### Adviser
Robert N. Brent, Ph.D.

Anthony is accessing discharge rates using the United States Geological Survey website.

Throughout the past century, climate change has impacted temperatures, precipitation patterns, and sea level around the globe. This project explored the effects of climate change on ten rivers in the Shenandoah Valley. Using long-term flow gauge data from the U.S. Geological Survey, we explored trends in discharge from the 1930s to the present.

The analysis revealed that all ten Shenandoah Valley streams increased in flow by approximately 3% per decade. These findings are consistent with climate models that predict an increase in precipitation in the Mid-Atlantic region, and this project documents the effects that climate change has already had on hydrology in the Shenandoah Valley.



## INCREASING PRODUCTIVITY, DECREASING IMPACTS: CARBON FARMING IN MT. CLINTON, VA

### Presenters
Derric W. Bayne, Hlitshab "Josey" Txakeeyang, Patrick M. Wolstenholme

### Advisers
Jennifer Coffman, Ph.D., Wayne Teel, Ph.D.

### Sponsor
Vine & Fig's Jubilee Climate Farm

In the top two photos, the team is visiting the recent garden beds and using a WTW meter to collect water quality data. The bottom two photos show the team preparing soil samples for testing and a productive community garden.

Vine & Fig's Jubilee Climate Farm, a 6-acre plot of land in Mt. Clinton, VA, serves as our capstone project site. Extensively used throughout the years, the site suffers from soil depletion, streambank erosion, and worsening water quality for Muddy Creek, the tributary that cuts through it. The new landowners, along with other key stakeholders, wish to improve soil and water quality, sequester carbon, produce food, and serve as a model for neighboring properties. The project also aims to develop a metric for tracking carbon with the goal of continuous improvement. Our research provides baseline data for soil quality through soil sampling via three separate methods to assess soil organic matter and thus soil carbon, as well as cross-compare the methods to assess validity. An experiment with three different types of cover crops and control treatments was conducted across 16 beds, and then soil quality was tested again to assess changes in organic matter and thus carbon sequestration. We also tracked water quality over three semesters through the use of YSI and WTW meters to provide baseline data for future comparisons. Community gardens and a food forest are underway, as are plans to improve the riparian buffer at the site.

# INTEGRATING MACHINE LEARNING IN MACHINING CONTROL

## Presenters

Sam Frye, Shawn McManus

## Adviser

Hao Zhang, Ph.D.

Shawn McManus and Sam Frye are working to integrate a machine learning algorithm with a CNC mill.

Subtractive manufacturing, specifically computer numerically controlled (CNC) mills, are common sources of damaged stock material, expensive repair or replacement bills, and long work hours from employees. This project pursued the concept of integrating machine learning with the workflow at CNC mills by implementing sensing instruments within the mill to collect data and predict failure states before they occurred. Using a suite of sensors, including vibration, acoustic, and thermal, we gathered baseline data to create a predictive machine learning algorithm. The system can be reinforced with accumulated dataset from in situ experiment and become a useful augmentation to a human operator for smart machining.



# JMU DUKESAT: HIGH ALTITUDE BALLOON EXPERIMENTS (HiSAT)


## Presenters

Nico Bour, Emilio Cortina, Kent Garland, Tanner Katsarelis, Frank Kelly, Eric Sander

## Adviser

Jonathan H. Spindel, Ph.D.

## Sponsors

Madison Trust, VentureWell

A view from the top of the world. This picture was captured during a balloon launch from an altitude of over 100,000 feet.

The JMU DukeSAT project focuses on designing, developing, and testing a space-based small satellite (CubeSAT) network to provide customer satellites in low earth orbit (LEO) more efficient, regular, and reliable access to the ground. Following up on work to develop the concept and explore wireless networking from prior capstone teams, the 2022 DukeSAT team focused efforts on flight tests of the concept using high altitude balloon (HAB) tests. The first flight test, HiSAT 1, involved the launch, tracking and recovery of a single HAB to an altitude of approximately 60,000 feet. HiSAT 1 demonstrated the team's ability to successfully launch and recover a 4-pound payload containing tracking radios and camera equipment. For the second flight test, HiSAT 2, two balloons were launched simultaneously with prototype radio networking equipment to test and demonstrate the ability for ground-to-air, air-to-air, and air-to-ground communication of flight data including altitude and location for ground stations and balloons reported at approximately 2-minute intervals. During their 2½ hour flight, HiSAT 2A and HiSAT 2B traveled more than 150 miles at speeds over 120 miles per hour reaching altitudes of 101,281 feet and 96,435 feet respectively.

# MECHANICAL PERFORMANCE OF ROCK CLIMBING HOLDS MADE FROM RECYCLED PLASTICS

The team is ensuring that the silicone mold for plastic injecting will fit properly into the injection molding machine.

## Presenters
Paddy McKechnie, Rei Silva

## Advisers
Hao Zhang, Ph.D., Jared Stoltzfus, Ph.D.

Within the United States, 380 million tons of plastic are produced every year, with only about 9% of that plastic being recycled. The other 91% of that plastic can be found in landfills, streets, and our oceans. Recreationally, this municipal plastic build-up can be reduced by replacing polyurethane resins and plastics that are used for items such as rock climbing holds and other climbing equipment. A challenge in achieving this goal is the quality uncertainty of products made from recycled plastics as the performance of reprocessed polymers will be comprised to a certain extent. The objective of this study is to understand the mechanical performance of rock climbing holds made from two plastic processing operations, injection molding and 3D printing. Mechanical performance such as compressive strength of the holds was tested and compared with products made from raw plastic materials.



# PLASTIC PAVERS: A PROOF OF CONCEPT TO INCREASE PLASTIC RECYCLING

The Plastic Pavers team is shredding plastic containers collected from the community, and those shredded pieces are being fed into a single screw plastic extruder which flows into a paver mold.

## Presenters
Alex Lightner, Allison Foster, Robert Quinones, Ryan Farrel, Steven Podrasky

## Adviser
Jared Stoltzfus, Ph.D.

Plastic manufacturers produce over 380 million tons of plastic per year; 190 million tons are single-use plastics and only 9% of all plastic is recycled. The rest is burned for energy, buried in landfills, or littered across our landscape and oceans. This capstone aimed to provide a proof of concept for small-scale recycling of undesirable and dirty plastics into pavers for sidewalks, patios, and potentially even parking lots. We tested different blends of plastics, the impact of contaminants, and the addition of sand on the structural integrity of the plastic bricks we created. By following the "Precious Plastics" approach for small-scale recycling, we hoped to avoid barriers to plastics recycling present in the existing recycling markets. While the bricks were structurally comparable to concrete, questions remain about their performance and impacts of long-term use under natural conditions, and the costs and environmental impact of scaling up production.

Integrated Science and Technology

# RAISING AWARENESS OF THE PLASTIC WASTE CRISIS AT A GLOBAL AND LOCAL SCALE


## Presenter
Mason Lee

## Adviser
Stephanie Stockwell, Ph.D.

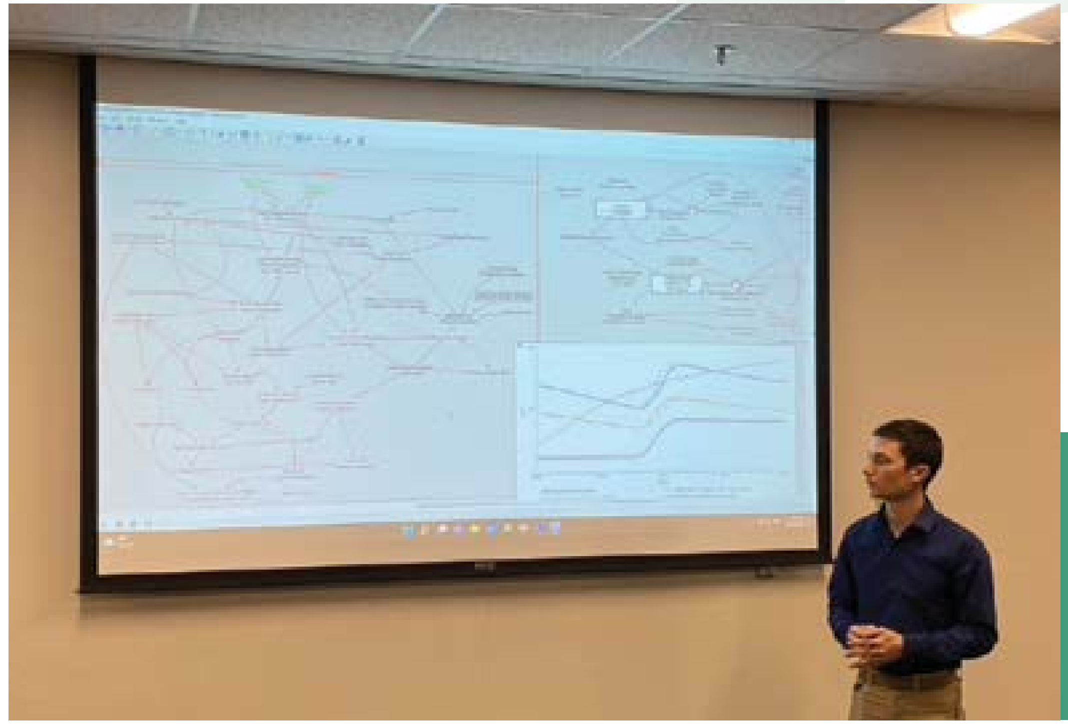
Mason is helping to raise awareness about the benefits of informed choices on the plastic waste crisis to a Harrisonburg community member at the local recycling center.

Sixty-four billion pounds of plastic enter our environment annually; every year more plastic is littered globally than the weight of every American combined. Plastics can take thousands of years to decompose. Byproducts have been found in every animal tested, even unborn children. In living creatures, plastic toxins and microplastics have been linked to cancers, cardiovascular diseases, and neurodegenerative diseases. A 2020 study from the journal of Science states that immediate action may reduce plastic waste by nearly 80%. And yet, if trends continue, 117 billion pounds of plastic waste will enter the environment in 2030. This capstone was inspired by projections like these, coupled with the negative impacts of plastic waste accumulation. This project encompasses a literary review of past and proposed solutions to this crisis. Additionally, field experiments were conducted for analysis and media content creation. Helping to spread crucial facts like 82% of plastics in the environment came from individuals and only 9% of plastics are recycled, may promote social change. These statistics should not despair, but inspire, as it means together through informed choices, we can diminish plastic waste in nature and protect ecosystems and humanity.





# SIMULATION MODELING TO INFORM THE VIRGINIA ENERGY TRANSITION



## Presenter
Ryan Welsh

## Advisers
Rod MacDonald, Ph.D., Jonathan Miles, Ph.D.

Ryan Welsh discusses the behavior produced by his simulation model for the Virginia energy transition based on constraints within the system and how manipulating different energy policies and variables within the model can change.

The Virginia Clean Energy Act (VCEA) was enacted in 2020 with the aim that 100% of our electricity would be procured from non-carbon emitting sources by 2050. For my project, I developed two computer simulation models to consider how such a transition could occur. The first model (VEETS) examines the mix of wind and solar generating capacity required to meet the peak demand for electricity on a typical day in each season. A user interface was also developed and members of the Virginia Sierra Club tested the model prior to publication on the Internet. The second model (Virginia Electricity Sim or VES) considers electricity generation capacity in Virginia over a 50-year period. Results from the VES model suggest that the transition of power-generating capacity from fossil fuels to non-carbon emitting sources will require decades, and that the rate of retirement of coal- and gas-generated electricity must be increased and the deployment of wind and solar power must also increase in order to reach the goal of 100% clean power by 2050.

# STREAM RESTORATION OF BOONE RUN THROUGH REMOTE MONITORING SYSTEMS

## Presenters
Elizabeth Emch, Erin Janiga, Kelly Hayes

## Advisers
Thomas R. Benzing, Ph.D., Ahmad Salman, Ph.D.

## Sponsor
Virginia Department of Forestry, Trout Unlimited

The team is working with representatives from Trout Unlimited and Kyle Snow from JMU on the process of fish shocking.

Boone Run, a forested mountain stream flowing to the South Fork of the Shenandoah River in Virginia, is managed by the Virginia Department of Forestry. In the two previous capstone projects, mapping and water quality monitoring suggest that this stream could be restored to support a healthier aquatic community, including brook trout. We tested the stream water monthly and are designing and implementing a system to collect data more continuously and autonomously, using remote water sensors and unmanned aerial vehicle technology. With the data collected from these methods, we have further analyzed the stream to determine if brook trout can safely inhabit the stream under its current conditions.



# THE DUKE BOARD: SMALL SCALE ELECTRIC TRANSPORTATION FOR COLLEGE STUDENTS


## Presenters
Diego Loving, Cooper Pflug

## Adviser
Chris Bachmann, Ph.D.

Diego Loving and Cooper Pflug believe small-scale electric vehicles present an attractive opportunity for students to reduce their transportation emissions as they commute to and from campus.

Emissions produced from transportation generate 30 percent of greenhouse gases. Although most students are very concerned about Climate Change and live within a mile of campus, an increasingly auto centric lifestyle has led most of them to use single-passenger vehicles for their short commute. Our project examines this paradox by surveying transportation options for the students in the JMU community and providing an assessment of why students make the transportation choices that they do. Our study also examines the potential to expand lower emission transportation options such as electric scooters and longboards. Following the assessment, we designed and built an electric longboard that is superior in performance and easier to use than those currently on the market. It incorporates a removable handle for novice riders and a built-in locking mechanism to secure the board to bicycle racks while in class. In conclusion, we believe small-scale electric vehicles, such as scooters and longboards, provide an attractive alternative for the younger generation to reduce their transportation emissions while in college.

# TRASH TO TREASURE: SUSTAINABLE CONSTRUCTION BLOCKS FROM STYROFOAM WASTE

## Presenters

Kayleigh Baxter-Gagen, Tanner Brunelle, Anthony Bill, Tim Golden

## Adviser

Jared Stoltzfus, Ph.D.

Styrofoam is a ubiquitous material because it's cheap, lightweight, and provides excellent insulation. However, those same properties make it difficult and uneconomical to recycle. This capstone continued the development of a lightweight construction block that can utilize the beneficial properties of Styrofoam, promote recycling, and contribute to energy-efficient housing. Throughout this capstone, we developed molds, designed and operated a small-scale production facility, tested our samples for thermal conductivity and compression strength, and built a retaining wall and raised garden beds with our prototype blocks. Our thermal and structural testing results indicate a wall constructed with our blocks would be stronger than a stick-framing and exceed R-value code requirements. Similar products on the market also claim to withstand natural disasters and be impervious to rodents, termites, and mold; however, we did not test those claims. While the 'recipe' and production process have the potential for continuous improvements, scaling up production and developing additional products represents the best potential for creating a viable business.



# UNDERSTANDING SOCIAL DYNAMICS IN MANUFACTURING SHOP FLOOR ENVIRONMENTS

## Presenter

Andrew Webb

## Advisers

Hao Zhang, Ph.D., Rod MacDonald, Ph.D.

Production systems are increasingly pursuing practices that promote sustainability within their organization. Assessments of these sustainable manufacturing practices have traditionally prioritized examining the economic and environmental impacts of organizational activities over their applicable social impacts. This omission of analysis pertaining to the social pillar of sustainability prohibits informed decision-making regarding sustainable manufacturing practices in an organization. Currently, there is very limited research on manufacturing social sustainability due to difficulty in quantifying social data, which has led to a significant gap of knowledge within sustainability assessments. This study aims to understand the linkages between organizational activities on the shopfloor level with their respective social impacts in order to promote a more fully informed decision-making standard. These linkages will then be further explored through the use of dynamic systems modeling, which acts as a tool in assessing social performance by mapping out the behavior of a given manufacturing system. A case study was examined on a pharmaceutical manufacturing system which aims to enhance corporate social responsibility at the shopfloor level. The resulting model enables decision-makers to consider the impacts of potential human resource usage strategies, contributing to the perpetuation of sustainable thinking in production systems.

# USING BIOCHAR TO REDUCE AMMONIA AND IMPROVE POULTRY HEALTH

## Presenter
Nick Sapio

## Adviser
Wayne S. Teel, Ph.D.

## Sponsor
Shenandoah Valley Organic - Farmer Focus

Pyrolyzing woody biomass using an open flame cap kiln to produce biochar. Biochar like this was ground and transported to a local poultry house where it was dispersed amongst the bedding to observe its effect on reducing ammonia levels.

The purpose of this project aims to spread awareness for the potential use of biochar to create an innovative and sustainable method of using it in poultry litter management. Throughout the 230,000+ poultry farms in the United States, the presence of ammonia from the decomposition of manure poses detrimental health hazards to the immune system of birds resulting in a variety of diseases. Biochar, a carbon rich substance from pyrolyzed woody biomass, was manually produced, ground, and placed in the bedding of a poultry house to observe its effect on reducing ammonia levels within the house. Subsequently, the biochar mixed with the poultry litter will be transported to surrounding crop fields to enhance its use as a soil fertilizer to provide a more marketable product. I found that the ground biochar dispersed amongst the poultry house prior to the bird's arrival eventually got buried underneath a manure cap that formed as the birds grew. This finding signals the need to rework the delivery strategy of biochar in the poultry house to improve its performance.



# VEGAN DIETS: FINANCIAL CONSIDERATIONS, BODY COMPOSITION, AND PHYSICAL PERFORMANCE


## Presenter
Alek Lebedev

## Adviser
Chris Bachmann, Ph.D.

The team is utilizing a bio-electrical impedance analysis device to asses the measurement of lean body mass in relation to body fat. This method helps determine body composition changes throughout the project.

Obesity has been associated with a wide range of long-term health complications, including cardiovascular disease, diabetes, and kidney failure. Nearly 40% of Americans aged 20 years and older are obese and more than 70% are considered overweight. Despite a desire to lose weight, many people struggle to eat healthy due to cultural influences and perceived financial limitations. The goal of this study was to examine the feasibility of implementing a vegan/vegetarian diet on a budget and investigate the impact of vegan/vegetarian diet on body composition and physical performance. A Biological Impedence Analysis was done on healthy volunteers to determine body fat percentage prior to initiating a vegan/vegetarian diet. Where appropriate, physical fitness metrics were also obtained. Participants were provided with a vegan/vegetarian cookbook to help with meal preparations. Local supermarkets were used to determine meal costs and evaluate economic feasibility compared to typical fast-food meals. After two months, results from the vegan/vegetarian participants were compared to a control group. Evidence indicates that a vegan/vegetarian diet is not out of reach for low-income families and is very likely to help in reducing obesity.

# VIDEO GAMES FOR VESTIBULAR REHABILITATION THERAPY (VG-VRT)


## Presenters

Veronica Bargerstock, Carter Elliott, Steven Nguyen

## Adviser

Jonathan H. Spindel, Ph.D.

The team is exploring the potential of video game-based therapy for treating vestibular (inner ear) balance disorders. The team designed, developed, and tested custom Oculus Quest 2 games to mimic traditional vestibular rehabilitation exercises within a virtual reality environment.

One in three people experience dizziness or balance dysfunction during their lifetime. Our project explores virtual reality, game-based vestibular rehabilitation therapy (VG-VRT) as an alternative to traditional vestibular rehabilitation therapy (VRT). VRT employs repetitive eye and head exercises to help retrain the central nervous system and improve how the brain uses input from the vestibular system. Over time, this aids in the recovery of function. While effective, VRT exercises are often perceived by patients as monotonous, and because they are specifically designed to provoke symptoms, patients often stop the exercises too early. In this study, we developed a gamified version of VRT that functions within the Oculus Quest VR environment. Our VG-VRT game brings the patient into an immersive world where they can play games that parallel head and eye movements similar to those in traditional VRT. We developed three VG-VRT games including eye-tracking, following moving objects from one hand to another, and bending over to pick up objects. Data from our game can then be processed and used to predict increases or decreases in difficulty levels for the patient; therefore, increasing the use and effectiveness of this type of therapy over time.





# WASTE TO WALLS: CREATING BUILDING MATERIALS FROM LOW-VALUE PLASTICS

## Presenters

Katherine Wheeler, Quinn Williams

## Adviser

Jared Stoltzfus, Ph.D.

Katherine Wheeler is pouring shredded plastic into the top of the extruder. The extruder pushes the plastic through the tube through a screw, and simultaneously melts the plastic at a very high temperature. The molten plastic is then collected at the end by Quinn Williams.

Plastics are versatile, durable, lightweight, and affordable but only 9% are being recycled. This project explored the potential for recycling contaminated, mixed plastics into blocks suitable for construction. This approach would be especially beneficial in developing countries where plastic waste and inadequate housing are joint issues connected to poverty. We tested several methods for melting and reforming plastics and measured the structural integrity of the products with an Instron machine. We also modeled and created two different styles of molds for creating the building blocks using Fusion 360 software, 3D printers, and a CNC machine. We found that our mixed plastic blocks have a compression strength similar to concrete, and recommend further investigation into potential long-term effects of their exposure to various environmental conditions. We believe that cost-effective, distributed production would also maximize the economic, social, and environmental benefits of recycling plastic waste in lower-income communities around the world.

# WATER OUT OF THIN AIR: IMPLEMENTATION AND MONITORING OF AN ATMOSPHERIC WATER GENERATOR

## Presenters
Brian Tang, David Nick Long, Maria Liu

## Adviser
Karim Altaii, P.E., Ph.D.

## Sponsor
Punta Leona Hotel and Club, Costa Rica

The team is working on building a system to extract water from the atmosphere that relies on geothermal piping to achieve this goal. The system will include an integrated monitoring device that collects temperature and humidity readings for further analysis.

Water scarcity is a continuous problem affecting people all over the world today despite revolutionary accomplishments in the area of clean water generation. It is estimated that 4 billion people experience water scarcity at least one month per year. At any given time, there are nearly 12,900 cubic kilometers of water present in the atmosphere. In an attempt to develop a technical solution to water scarcity, our capstone team conducted research into designing a system that extracts water from the air. Using our research, we fabricated a prototype in which we implemented the system in Costa Rica during a winter session study abroad program in 2021. Prior to designing the system, we calculated the estimated amount of water that we would collect based on the research conducted from the past two capstone project teams working on this multi-year project. The design involves condensing water vapor from humid air using a cold surface heat exchanger. This heat exchanger is cooled by pumping a water-based coolant into the ground using geothermal piping to transfer the heat into the soil. This closed loop system of geothermal piping is configured in a helical arrangement underground at the lowest point of 9 feet deep.



# JUNIOR PROJECTS

The Capstone Project is the culmination of the ISAT Degree. Students begin their capstone work in their Junior year by identifying a Capstone Project in their area of interest and working with their faculty advisor to develop a comprehensive project proposal. These project proposals are presented in poster format during the student's Junior year and will be featured as presentations at next year's SIS Symposium.

**Advanced Tracking of Unidentified Aerial Phenomena in the New Digital Age**
Bethany Biggi, Devon Embry, Paris Beaver

**Analysis of Antibiotic Resistant Bioterrorism**
Jarad Pelczynski

**Automated Monitoring Systems for Pharmaceutical Production**
Charlie Salette

**Bioinspired Design of Material Architecture for Additive Manufacturing**
Connor Gavin, William Redden, Dairon Pleasant

**Bioremediation of Plastics**
Courtney Forberg, Archer Peacock, Rebecca Romero, Zach Yelich

**CAER (Creative Anticipatory Ethical Reasoning) App**
Danica Tran, Zachary Shin, Kaniya Whiting

**Continuing Development of Video Game Rehabilitation for Vestibular Therapy (VG-VRT)**
Karina Howard, RJ Look, Lyle Rodgers, Braeden O'Quinn

**CubeSat: Mesh Network**
Jordan Johnson, Alexa Houck, Ryan Buellesbach, Mufasa Hafeez, Adam Fisher

**Detecting Dark Ships in the South China Sea**
Mason Shockley, Spencer Shilling, Charles MacCabe, Valerie Chenault

**Development of an Orbital Wrist Unit for Body-Powered Prosthetics**
Jennifer Nuckolls

**Early Policy Setting for Assisted Reproductive Biotechnology in Malta**
Jessica McMasters

**Evaluating the Supply Chain of the COVID-19 Vaccine in the United States**
Abby Robinson, Meghan Gellerman, Ava Carr

**Foodtrac App**
Hiroki Mayabayashi

**Horizontal Gaze Nystagmus Interlock Systems for Passenger Cars and Trucks**
Matthew Jenkins, Charlie Thomas

**Lake Management Tool Development and Sediment Monitoring**
Sean Wertheim, Jackson Barnett

**Management of Lake Shenandoah for Multiple Stakeholders**
Joe Dunnigan

**Nation-State Stability Modelling**
Corgan Jasper

**Outcomes of the Application of Biochar on Traditional Farm Transitioning to Organic Regenerative Farm**
Andy Logan, Liam Palmer, Cole Holland, Alyssa Geary, Blake Griscom

**Prevention/Remediation of Nitrogen in Stormwater at a Fertilizer Storage Facility**
Sydney Forman, Nic Peters, Jon Maye, Jordan Wagemann

**Renewable Energy on the progression of the development of the blockchain**
Myles Patterson

**Site Analysis of Rockingham County Wind Farm**
Nathan Brent, Chelsea Lang, Nick Finguerra

**Solar Charging Stations for Electric Vehicles**
Joshua Crawford

**Sustainable and Scalable Biomanufacturing of Algae-Based Biofuels: Investigating the heterotrophic capacity of microalga *Picochlorum renovo***
Zack Woods

**Testing Erosion Mitigation Strategies at Muddy Creek**
Nick Bower

**The Effect of Carbon Farming Practices on Plant Yield and Soil Health**
Anna Sortore, Tyler Ashton

**Virginia Organic Waste Management Practices**
Hayden Abbott

# INTELLIGENCE ANALYSIS

In a world of uncertainty and unpredictability, unbiased and thoughtful analysis is invaluable. The Intelligence Analysis B.S. 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 and critical thinkers capable of bringing increased clarity to uncertain situations in areas ranging from national security to business to law enforcement and beyond.



## 21ST CENTURY AUTHORITARIANISM AND THE THREAT TO U.S. DEMOCRACY

### Presenters

Zachary Ratcliffe, Kali Slate, Chloe Thompson, Chris Larounis

### Advisers

John Robinson, Ph.D., Stephen Marrin, Ph.D., Noel Hendrickson, Ph.D.

### Sponsor

The MITRE Corporation

The team is identifying key trends and underlying patterns from an indicator matrix to incorporate into their analysis.

Across the U.S., there is concern about the decline of democratic values and expansion of authoritarian ideologies. This project explores the political stability and strength of U.S. democracy under the pressure of anti-government violent extremists and authoritarian movements. Using Economic Stability Analysis and SWOT Analysis, we determined the U.S. is returning to a state of political stability after being in a volatile state throughout 2020. Additionally, we used Indicator Analysis to assess the trend of authoritarian behavior over the past seven years. Our conclusion is that anti-government violent extremists are unlikely to successfully influence the U.S. government to reject or weaken its commitment to democratic values within the next two years.

# ADVERSARIES AND EMERGING TECHNOLOGIES IN THE SPACE DOMAIN

## Presenters
Matthew Mathes, Alyssa Cartee, William Shaw, Declan McKeown, Caroline Hamilton, Topher Saclolo

## Adviser
Orlandrew Danzell, Ph.D.

## Sponsor
Altamira Technologies Corporation

The space domain is re-emerging as a point of interest for many nations around the globe. The 2020s mark the resurgence of the previously dubbed "space race" of the 20th century. However, the space race is no longer solely centered around launch capabilities and extraterrestrial landing. The nations participating in the "modern space race" are now researching and developing new technologies for commercial, military, and national security. The environment of the space domain is likely to evolve as many of these new technologies significantly increase space capabilities.

This product aimed to assist Altamira Technologies Corporation with its mission by exploring the current space environment, identifying emerging technologies that may significantly impact the battlespace, and forecasting how the space race will evolve in the next five years. Altamira Technologies Corporation is a leading partner to the Department of Defense and the U.S. intelligence community. Altamira provides advanced engineering and analytics to innovate the missions of Space Superiority, Cyberspace Dominance, and Battlespace Awareness. Altamira directly supports the United States Air Force and the newly established United States Space Force with conducting global space operations.





# ANALYZING INSURGENT ACTIVITY IN MOZAMBIQUE

The team is looking at a map of insurgency attacks within the Cabo Delgado.

## Presenters
Amanda Brotemarkle, Virginia McDaniel, Alayna Stormer

## Adviser
John Robinson, Ph.D.

## Sponsor
Federal Bureau of Investigation

Al-Sunnar wa Jama'a (ASWJ) is an active insurgency group within the Cabo Delgado province of Mozambique. This project analyzes the activity of ASWJ and explores the continued significance of the group with regards to U.S. foreign policy and strategy. The ideological nature of ASWJ is also considered, and connections to known terrorist groups are also explored. Using analytic and critical thinking techniques, we have identified that it is likely for ASWJ to continue to use violent tactics and will exercise influence over the region's natural resources.

# CHINESE INVESTMENT IN TRANSPORTATION INFRASTRUCTURE IN LATIN AMERICA

## Presenters
Alex Branick, Emily Cannon, Makenna Robinson, Chloe Tarbell

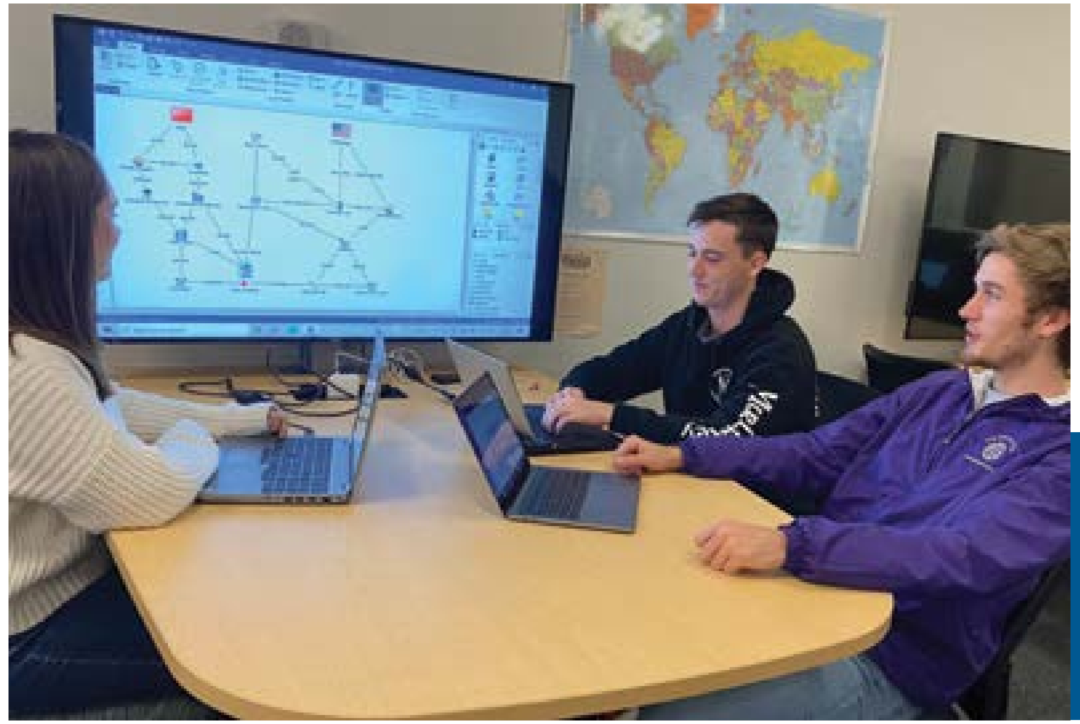
## Adviser
Orlandrew Danzell, Ph.D.

## Sponsor
National Geospatial-Intelligence Agency

China's global investment has increased significantly in recent years with Latin America and the Caribbean (LAC) as their newest ventures. Most investment occurs through the Belt and Road Initiative, though Brazil, Colombia, and Honduras are not signed on to the program. However, China continues to invest in transportation infrastructure projects in these nations. This project assessed why these three countries have not joined BRI, and whether they are likely to commit to the venture in the near future. Additionally, the team evaluated what each country needs, if China has the resources to meet those needs, and what China's goals are in the region. Using structured analytic techniques and analytic methodologies, the team developed key judgements for the different countries in an effort to better understand the current and likely future state of affairs between China and LAC, as well as what that means for the United States.



# COUNTERING CHINESE INFLUENCE IN AFRICA: THE U.S. SOFT POWER APPROACH



## Presenters
Casey Baker, Lauren Eisenhuth, John Meteyer

## Adviser
John Robinson, Ph.D.

## Sponsor
Mines Advisory Group

The team is creating a link chart with the software i2 Analyst Notebook to examine the connections between the United States and China as they compete for global influence.

China is likely to become a more dominate global actor and viable partner than the U.S. due to their growth in hard power tactics and the weakening of U.S. strategy. China's hard power approach to achieving global influence through economic investment and military power outpaces the United States' soft power approach of relationship building and humanitarian missions, like conventional weapons destruction. Hard power is a more effective method present day because of the tangible and visible benefit that financial investment and military presence provide. The strategic power competition between the U.S. and China is comprised of these competing approaches.

## LAND USE CLASSIFICATION TRENDS RELATING TO CLIMATE CHANGE IN CHINA


### Presenters
Ben Carroll, Cecilia Clark, Lorelei Legg, Alexis Mays, Savannah Mitchell

### Adviser
Orlandrew Danzell, Ph.D.

### Sponsor
National Geospatial-Intelligence Agency

Over the past decade, climate change has drastically impacted China's geographic and economic landscape. This project explored the root causes and implications of climate change on four case study regions in the country. The team analyzed climatic and farming/industry related environmental impacts in China starting 2010 to the present. Our estimate provides strategic analysis for the next five-to-ten years. Through the use of Geospatial Intelligence, Strategic Analytic Techniques and Data Analysis, the team analyzed the region's main climate issues to forecast future implications for our sponsor. Our tentative estimate suggests that unless drastic measures are taken by the Chinese Government to reverse the effects of climate change, it is highly likely the country will experience food insecurity and further destruction of arable land.





## MINIMIZING PROLIFERATION OF DUAL-USE AND CRITICAL TECHNOLOGIES IN HIGHER EDUCATION

### Presenters
Grace Bailey, Alex Buchanan, Tiffany Hung, Najim Murshidi

### Adviser
Orlandrew Danzell, Ph.D.

### Sponsor
Pacific Northwest National Laboratories

The threat of foreign actors obtaining important technologies such as quantum information, AI/machine learning, and microelectronics is an increasingly and significant concern. Using numerous analytic techniques, we examined the individual risk of proliferation of these technologies based on their ease of transport, existing security measures, and importance of the technology. Our tentative conclusion is that microelectronics is more at risk than quantum information and AI/machine learning and requires stricter security measures. Our conclusion is based mainly upon the fact that both quantum information and AI/machine learning are difficult to transport physically or digitally due to the large size of their code and their physical existence spread over many servers.

# ONLINE ANTISEMITIC DISCUSSION UNLIKELY TO INDICATE OFFLINE ANTISEMITIC CRIME


## Presenters

Ariel Decko, Ray Hossain, Byron Gilbreath, Maddie Hince, Spyridon Kaloudelis

## Advisers

John Robinson, Ph.D., Jeffrey Tang, Ph.D.

## Sponsor

Accenture Federal Services

In 2020, the Department of Justice identified a rise in antisemitism and Jewish hate crimes across the United States. Our project attempts to identify indicators of online discussion of antisemitic topics and a correlation between this online discussion and kinetic criminal activity through structured analytic techniques, geospatial analysis, and a sentiment analysis model that evaluates a collection of tweets. This project provides a list of indicators to help the DOJ forecast future criminal activity related to antisemitism. We found that it is unlikely that the DOJ can use the online discussion of antisemitic topics to anticipate the frequency of kinetic criminal activity. However, it is likely that social media usage, salient public events, and political polarization are the most effective indicators for online discussion of antisemitic topics.





# PEOPLE'S REPUBLIC OF CHINA'S TELECOMMUNICATION INVESTMENTS IN SOUTH AMERICA

## Presenters

Sasha Ackerman, Allison Snow, Christina Ward

## Advisers

John Robinson, Ph.D., Timothy Walton, Ph.D.

## Sponsor

National Geospatial-Intelligence Agency

The team utilizes geospatial technology to analyze the current trends of People's Republic of China's investments in Argentina, Brazil, and Venezuela. By tracking the number and location of these investments, we can do more accurate analytic methodologies.

The People's Republic of China (PRC) has continued increased investments in the telecommunication infrastructure of South America, causing concern from American leaders in data security. This project covers the threats posed to the United States by these investments in Argentina, Brazil, and Venezuela. We analyzed these threats through technical knowledge on telecommunication, analytic methodologies, and geospatial data. By utilizing the analytic methods of indicator analysis, link analysis, red team, and Maxar's geospatial technology we can follow the trends and forecast future threats to United States national security through investments made by the PRC in South America. Our conclusion is that the likelihood of an increased threat posed to the United States is moderately high based on the level of control the PRC maintains over the investment companies and, in turn, data security concerns with incoming 5G and small cell technology.

# RADICALIZED INSIDER THREATS WITHIN THE UNITED STATES' CRITICAL INFRASTRUCTURES

## Presenters
Fiorella Levine, Adriana Menjivar, Brianna Nassiri, Vanessa Nkurunziza, Miguel Parada

## Adviser
Orlandrew Danzell, Ph.D.

## Sponsor
Pacific Northwest National Laboratory

Over the years, policymakers and scholars have noticed an increase in government employees becoming radicalized, thus crippling several U.S. industries from within. This project evaluated and analyzed four out of the sixteen critical infrastructure sectors' ability to detect rising insider threats based on their vetting criteria and processing foundations. By using the following structured analytic techniques: Key Assumptions Check, SWOT Analysis (Strengths, Weakness, Opportunities and Threats), ACH (Analysis of Competing Hypotheses), and STEEP Analysis (Socio-Cultural, Technological, Economic, Ecological, and Political), the team analyzed probable threats and opportunities in an effort to educate clients of best-practices to improve the vetting processes within the chosen critical infrastructures. Our tentative conclusion is that 4 out of the 16 sectors evaluated do not adequately detect processing employees that have radicalized ideologies or that may be susceptible to radicalized ideologies.



# SOCIAL MEDIA FOR INCREASING THE ADOPTION RATE OF E-BEAM TECHNOLOGY IN CENTRAL ASIA

The team is analyzing the prevalence of industry leaders in Central Asia through data visualization software.

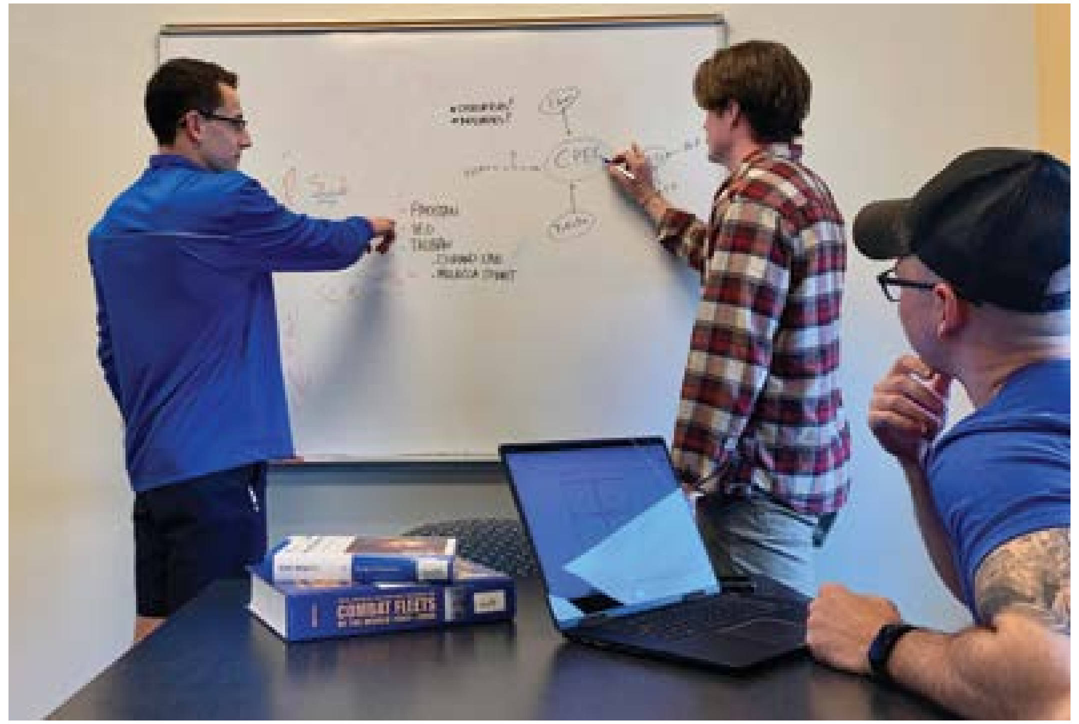
## Presenters
Kelley C. Kropff, Ryan M. Garvey, Travis L. Smith, Ranj H. Sidhu, Felix T. Couniha

## Adviser
Orlandrew Danzell, Ph.D.

## Sponsor
Pacific Northwest National Laboratory

Alternative technologies perform an equivalent or better function than comparable devices while reducing the security risks of devices that contain radioactive materials. Electron Beam (E-Beam) irradiation can be used in the food processing, agriculture, medical, and environmental industries without the environmental and physical security risks of radioactive materials. The team provided a strategic analysis of Central Asia's adoption and utilization of alternative technologies and examined how various social media platforms in selected countries can increase consumer adoption of alternative technologies in the next five years. The countries of focus are Kazakhstan, Kyrgyzstan, and Uzbekistan. These countries were selected due to their demographics, history, and potential for social media marketing campaigns. The target market includes the technical actors in the radiological space, including human and animal health, environment, and industrial manufacturers of agricultural and food products.

# THE INFLUENCE OF TALIBAN GOVERNANCE IN AFGHANISTAN ON CPEC DEVELOPMENT




## Presenters

Steven Davic, Sean Doogue, Benjamin Kettler

## Adviser

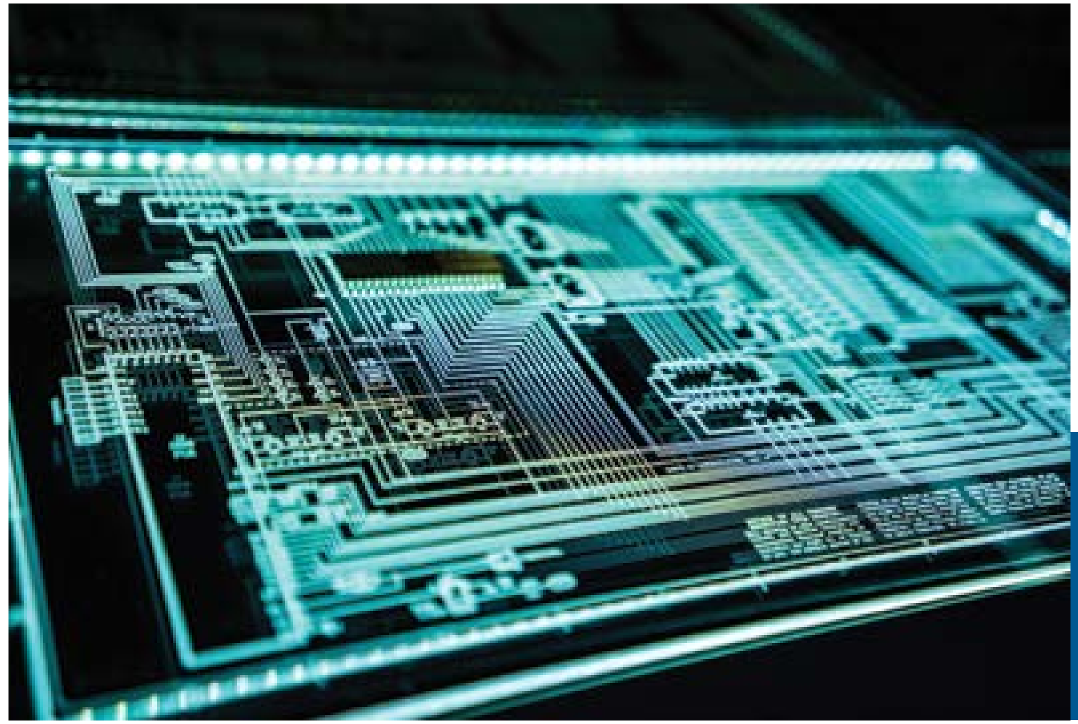
John Robinson, Ph.D.

The China Pakistan Economic Corridor is a multi-billion dollar infrastructure and development plan which will dramatically reduce China's reliance on the Malacca Strait, an important bottleneck for U.S. Naval strategy. This project explores how the recent development of Taliban governance in Afghanistan will affect CPEC's rate of development using causal and futures oriented analytic techniques. Using Vensim software, we modeled the core interactions among actors in CPEC development. We then altered the values of key variables in the system to identify potential futures. Our conclusion is that Taliban governance in Afghanistan is ultimately unlikely to impact CPEC's current rate of development.





# THREATS AND OPPORTUNITIES OF THE PRC'S TECHNOLOGY DEVELOPMENT



## Presenters

Nick Hernandez, Zach Nowfel, Madison Storey, Evan Mungin, Jacob Puterio

## Adviser

John Robinson, Ph.D.

Evaluating China's current use and plans for the 5G network and smart technology.

In recent years, global leaders such as the United States and People's Republic of China (PRC) have increased 5G and smart technology growth at a rate unseen by previous technology advancements. This project explores how the development and use of 5G and smart technology from the PRC will lead to potential threats and opportunities for the U.S., the threat of increased influence in U.S. technology and the opportunity for the U.S. to develop their own technological infrastructure. Using futures exploration and strategy assessment methods, we assessed potential environments for the growth of 5G and smart technology to exist in and how it could affect the PRC and the U.S. Due to the nature of this technology and its constant advancements, a limitation that challenges us is the lack of information on current developments.

## GEOGRAPHY

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.



# MULTIPLE SPATIAL SCALE ANALYSIS OF BUTTERFLY HABITAT

The team is surveying a site in Harrisonburg for butterflies.


## Presenters
Jason Darling, Brooke Solderich

## Advisers
Amy Goodall, Ph.D., Dudley Bonsal, Ph.D.


The spatial scales at which butterflies move across landscapes to meet life cycle requirements are not well understood. This project investigates habitat use by butterflies at local and landscape spatial scales at multiple sites in Harrisonburg, Virginia. To understand butterfly species presence and abundances, we use butterfly observation data collected by JMU students enrolled in the Geography Global Biodiversity course during the fall semesters from 2016 to 2020. We use remote sensing and GIS technology to delineate land cover at the sites surveyed and performed statistical analysis to assess the correlation between land cover classes and butterfly species diversity and abundances. Based on our results, we find that (i) the density of flowering species has a strong influence on butterfly abundances at a local scale, and (ii) connectivity between meadow habitat patches is important for species diversity and abundances at landscape scales.

# VALUES OF AN ELEMENTARY SCHOOL MEADOW

## Presenters
Gracyn Goldstein, Shannon Yerabek

## Adviser
Amy Goodall, Ph.D.

## Sponsor
Harrisonburg City Public Schools

Gigi and Shannon work to assemble a picnic table that students painted for their school garden.

JMU geography students began a vegetable and wildflower garden program with Keister Elementary School, Harrisonburg, Virginia, in spring 2012. The wildflower garden was popular among students of all ages because it brought opportunities to observe pollinators. In 2018, an area of lawn adjacent to the garden was allowed to naturalize and develop into a meadow. Each year, the meadow has a higher diversity of native flowering species. We have volunteered in the garden and meadow since our freshman year at JMU, except for the months of COVID-19 closures. Our experiences inspired us to design activities to enhance the use of the meadow as a learning environment for elementary school students. Our presentation emphasizes the values of a school meadow based on our own experiences and our research of literature. Included are the benefits for undergraduate student learning, examples of pollinator species observed, and the objectives of the learning activities we designed.



Projects are a key element of the Geography curriculum. Below is a list of semester research projects from GEOG 327: Climatology, GEOG/HUMN: 301 Natural Disasters and GEOG 447: Climates Through Time.

## GEOG/HUMN 301: Natural Disaster Response

**The Hunga Tonga Tsunami**
Chase Briles and Alejandro Robles

**Flooding Along the Rhine River Basin**
Katy Christman and Kelley Kropff

**The Dangers of Hurricane Ida**
Anna Dix and Canyon Nuckols

**An Insect Infestation in the Horn of Africa**
Anthony Dodson, Mike McCaffrey and Nick Meek

**Flooding Disaster in South Sudan**
Evan Drake and Anna Merklinger

**Late Season EF4 Tornado Decimates Towns in Western Kentucky**
Miles Desamour and Ellie Hill

**Yemen's Cholera Epidemic**
Emma Devlin and Raylen Jones

**Drought and Food Insecurity in Afghanistan in 2021**
Caitlin Kerr and Jessica Sarmiento

**Climate Change, Glaciers and Mass Wasting in the Himalayas**
Sean Bagdon and Peter Smearman

**The Eruption of Cumbre Vieja Volcano on La Palma**
Sydney Jenkins and Taly Zapanta

**Another Record Year of Wildfires in California**
Evan Butler and Dermot O'Connell

**A Devastating Ice Storm Paralyzes Texas**
Michael Gilbert and Gigi Goldstein

**Catastrophic Super Typhoon Rai Strikes the Philippines**
James Mitchell and Kailie Scott

## GEOG 327: Climatology

**Climate Change and the Impact on the Burmese Python's Habitat**
Ethan Bell and Patrick Cuccias

**Impacts of Sea Level Rise on Tangier Island**
James Etheridge and Marc Magee

**Infrastructure Changes Due to Sea Level Rise in Virginia Beach**
Jessani Collier and Melissa Santjer

**Indications and Impacts of the Tahiti Deep Water Coral Reef**
Charles Childers, Peter Nosal, Robert Southern

**Climate Change and the Bleaching of Coral in the Great Barrier Reef**
Michael Gilbert and Peter Smearman

**Iceland's Climate and Its Geothermal Energy Usage**
Alyssa Cassano and Anna McKee

**Sea Level Rise Affecting Australian Indigenous Communities**
Sydney Jenkins and Landon Rutledge

**Ice Sheet and Permafrost Melt in Greenland**
Harry Callahan and Sean Connolly

**Urban Heat Island in New York City**
Ellie Hill and Maya Salzano

## GEOG 447: Climates Through Time

**Climate Study of San Diego (1939-2021)**
Patrick Blackburn and Peter Smearman

**Climate Analysis of Townsville, Australia (1941-2021)**
Anna McKee, Katie Mozingo and Robby Southern

**Temperature Analysis of Tasiilaq, Greenland**
Names: Michael Gilbert and Matthew Stumpfig

**Climate of Madrid Through Time**
Ryan Donnelly and Evan Drake

**Alta, Norway Climate Analysis**
Reed Boettner and Harry Callahan

**Point Barrow, Alaska's Climate Through Time**
Christopher Dodson and Cory Griffith

As we wrap up another SIS Senior Symposium, it’s important to pause and express our gratitude.

We are truly fortunate to spend our time learning, growing, and doing meaningful work as a community of scholars. This way of life is a tremendous privilege.

It takes a village to pull off an event of this magnitude, and we could not have done it without the unique contributions of so many.

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