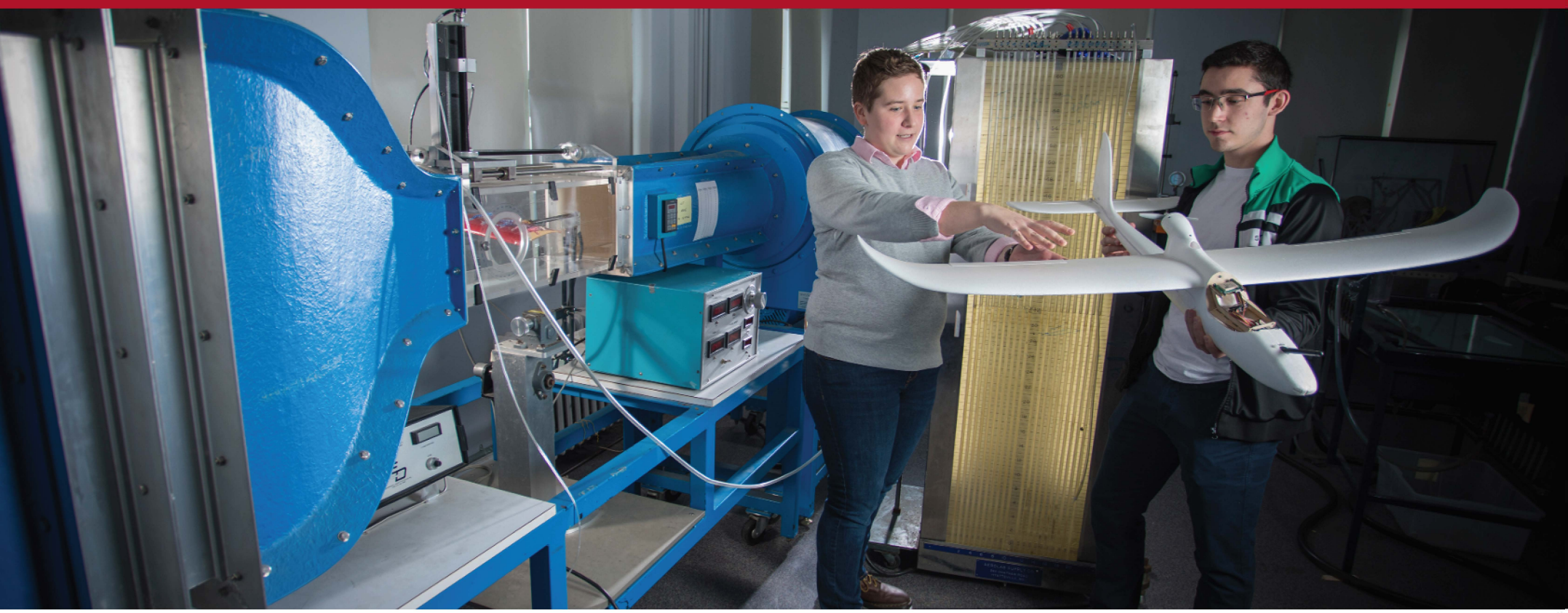
Worcester Polytechnic Institute

Works In Progress
Undergraduate Research Symposium



Monday, November 25, 2019
Rubin Campus Center Odeum

ABSTRACT BOOK

The Works in Progress Undergraduate Research Symposium is an opportunity for our undergraduate researchers to showcase their ongoing major qualifying projects and other extended research and design endeavors.

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1. Lionfish Phase 3

Students: *Michael Abadjiev, Qingyuan Chen, Nicholas Johnson, Orion Strickland, Clark Ewen, Chris Whimpenny, Nicholas Olgado*

Advisor(s): *Craig Putnam, Bradley Miller, William Michalson*

The goal of this project is to develop a fully autonomous Lionfish hunting robot in order to address the issue of Lionfish as an invasive species in the Caribbean. Lionfish are natives of the Indo-Pacific, introduced into the Caribbean in the late 1900's, most likely by aquarium owners setting free pet fish. They have voracious appetites, and breed very quickly. When combined with a lack of natural predators, the Lionfish are contributing to the degradation of a massive ecosystem. This project proposes a fully autonomous robot, to be launched from a support boat, that can track, kill and collect Lionfish. These can then be disposed of, or even eaten, as they are considered a delicacy at many restaurants.

2. Wearable Planar Haptics for the Deaf & Hard of Hearing

Students: *Colin Ancalmo, Yifan Liu, Amani Campbell, James Van Tronk, Emily Wood*

Advisor(s): *Joseph Stabile*

The Deaf and Hard of Hearing community faces challenges identifying audio-based safety and social alerts. Existing options for assistive devices for the Deaf are limited, often costly, and can involve invasive procedures. The goal of this project is to develop an assistive wearable device that enables audio-sensing for the Deaf through wearable planar haptics. Through research, we aim to adapt existing smart-material actuation technology to capture audio alerts in an array of discrete flexible planar actuators, providing haptic spatial sound awareness. Consumer products such as smartphones utilize traditional haptics; by integrating this technology in clothing fabrics, we aim to increase accessibility of assistive audio sensing technology.

3. Conducting Humanitarian UAV Search Missions through Optimal Path Planning and Triangulation of Signal Data

Students: *Isaac Beeman, Sarah Elice, Michael MacCormac, Griffen Spincken*

Advisor(s): *Donald Brown, Matthew Amissah*

We will design a system utilizing an Unmanned Aerial Vehicle (UAV) and two Software Defined Radios (SDR) to efficiently search for a missing person carrying a cell phone. Currently, UAV search and rescue missions rely mainly on the use of the UAV's aerial perspective. However, by leveraging the maneuverability of UAV technology and the modularity of an SDR, together they can be used to measure signals emitted by cell phones and locate a missing person. One SDR will be used to model the signals emitted by a cell phone while another will monitor the frequencies associated with the transmission. Meanwhile, the UAV's position and orientation will be varied to experimentally search for the location of the transmitter emitting the signal.

4. Modular Peripherals for Virtual Reality

Students: *Dominic Cascino, Paulo Chow*

Advisor(s): *Xinming Huang*

We are developing a wireless peripheral system to enhance Virtual Reality (VR) experiences. This is motivated by the limitations of VR controllers and of interactions with virtual objects. Our system makes use of modularity, containing all electronics in a core module that is transferable between different peripherals. The peripherals are intentionally simple in design so that VR application developers and users can create peripherals of their own.

5. Spontaneous Circulatory Flows of Microtubule-Based Active Fluid in a Water-in-Oil Droplet

Students: *Yen-Chen Chen*

Advisor(s): *Kun-Ta Wu*

Active fluid is differed from passive fluid by its ability of consuming internal fuels to generate mechanical work. Here we explored the self-organization of the active fluid confined in a water-in-oil droplet. We found that the fluid developed intra-droplet circulatory flows when the droplet was compressed into a cylinder-like shape. When the droplet was compressed further into pancake-like shape, the circulatory flow was suppressed. Inspired by this result, we invented a device that controlled the compression magnitude, enabling us to turn on and off the circulatory flow in real time. This work paves the path to developing an active fluid-powered machine whose power is manually tuned like a gas pedal of a car.

6. MBSR App Development

Students: *Bryce Corbitt*

Advisor(s): *Eleanor Loiacono*

The goal of this project is to design and implement a prototype platform for "DoYouMindful", a mobile application for practicing evidence-based mindfulness activities to aid young adults suffering from anxiety and depression. In Major Qualifying Projects from 2015 and 2017, mock-ups and features for the app were created. This project's research focuses on discovering methods for designing a data-driven solution that will get the envisioned app in the hands of teenagers and college students. Versions of the prototype are currently in development for iOS and Android. Additionally, a back-end has been designed and is being implemented for managing dynamic content and serving it to the app.

Name of External Sponsor Collaboration: Feedback on app features has been provided by UMass Medical staff.

7. Prosthetic Device

Students: *Nathanial Grunbeck, Kristen McCrea, Emily Schneider, Matthew Mulligan*

Advisor(s): *Pradeep Radhakrishnan, Joseph Stabile*

This project aims to develop a transtibial prosthetic that, can accurately mimic the natural gait and locomotion of a user, be quickly customized based on user requirements, has a lower production and installation lead time and has interchangeable components. Transtibial amputations are among the most common amputation types, which creates a need for an affordable prosthetic that satisfies various daily activities. The most affordable prosthetics for these amputations typically cost around $5,000-7,000 but only allow movement for the most basic daily activities. This high price makes it extremely difficult for people in developing countries to gain access to these prosthetics.

8. Firefighting Application Drone

Students: *Claire Long, Nick Janco, Elizabeth Walling*

Advisor(s): *Maqsood Mughal*

The purpose of our project is to design a drone that will detect and suppress fires with an aerial filming system and automatic spraying system.

9. Desktop at Fingertip

Students: *Aung Khant Min, Ziheng Li*

Advisor(s): *Kaveh Pahlavan, Erin Solovey*

We present "ThuMouse", a novel interaction paradigm aimed to create a gesture-based and touch-free cursor interaction that accurately tracks the motion of fingers in real-time. ThuMouse allows users to experience the truly mouse-less monitoring of the cursor using frequency-modulated continuous-wave (FMCW) radar. While previous work with FMCW radar in human-computer-interfaces (HCI) has focused on classifying a set of predefined hand gestures, ThuMouse regressively tracks the position of a finger, allowing a finer-grained interaction. This paper presents the gesture sensing pipeline we built, with regressive tracking through deep neural networks, data augmentation for robustness, and computer vision as a training base.

10. SNAPP: Mobile SNAP Application

Students: *Ken Morton, Dimitri Berardi, Nick Delli Carpini*

Advisor(s): *George Heineman*

We are developing a cross platform mobile application using industry standard software technologies to bring the SNAP transportation service up to par with the capabilities and convenience of modern technology. We are working with the campus police, SGA, and IT to develop the app, and modeling its design similar to Lyft. By digitizing data collection, we hope this project can serve as a gateway for future research and development. We believe this data will help the police department organize and streamline the SNAP process. Additionally, notifying students about their SNAP ride will increase efficiency and safety by making students aware of their ride's status.

11. Developing a Modular Self Driving Rover

Students: *Zack Orbach, Julia Davenport , Richard Mohabir, Alexander Boggess, Michael DeFrancesco, Michael Pierce*

Advisor(s): *Pradeep Radhakrishnan*

The goal of this project is to develop a modular self driving rover that integrates the use of a control moment gyroscope for self-righting capabilities. This will be completed through extensive research and development (R&D), prototype iteration, and testing. Our work will be applied to the future curriculum of two courses at WPI; Advanced Engineering Design and Engineering Experimentation. The development of modular components allows students to apply focus to the design of different components, and mix and match elements to find their optimal set up. All of our designs will be based on mathematical analysis and experimental data.

12. Application for Understanding Fatigue in LAM

Students: *Ilana Zeldin, Olivia Gulezian, Ken Snoddy, Evan LeBeau*

Advisor(s): *Bengisu Tulu*

The goal of this project is to create a mobile health application to aid doctors at Brigham and Women's Hospital in Boston, Massachusetts in understanding patient daily living factors and how they may contribute to fatigue. Lymphangioleiomyomatosis (LAM) is a rare disease caused by mutations in two genes affecting women of child-bearing age. Currently, little is known about the causes of fatigue and how it correlates with LAM. Specialists at Brigham and Women's Hospital work with LAM patient groups and conduct clinical studies to further understand the correlation between LAM and fatigue. Our work involves collecting user data to help researchers in understanding the causes of fatigue and determining appropriate clinical research studies.

Name of External Sponsor Collaboration: Dr. Souheil El-Chemaly

13. Sub-Algebras of Matrix Algebras

Students: *Kwabena Adwetewa-Badu*

Advisor(s): *Padraig O Cathain*

In this MQP, we will work on computing the dimensions of nilpotent matrices in order to find not only the lower constraints but the upper constraints that matrix can be while still maintaining the properties of a nilpotent matrix

14. Liquid Gallium Air Batteries

Students: *Ari Athair, Tristan Arnold*

Advisor(s): *Andrew Teixeira, Pratap Rao, Ravindra Datta*

This project expands upon the work of past research, to develop a rechargeable liquid Gallium-Air battery. Gallium is nontoxic, sufficiently reactive, and liquid at low temperatures, ~30 degrees Celsius, making it ideal for this use. Liquid-Metal and Metal-Air batteries have some of the highest theoretical energy densities of any current battery technology; Liquid-Metal-Air batteries are predicted to have the benefits of each while counteracting the drawbacks. Theoretical calculation of a Liquid-Gallium-Air battery produces an energy density value 11 times higher than commercially available lithium ion batteries. A battery with such high energy density would help shift energy dependence away from fossil fuels and towards renewable energy.

15. The role of Cavin-1 in Stress Granule Formation through the GPCR Pathway

Students: *Shravani Balaji*

Advisor(s): *Suzanne Scarlata*

The goal of this project is to study the role of the adapter protein Cavin-1 in the formation of stress granules through the Gaq signaling pathway in cell culture. Premature stress granule formation is a phenomena linked to many diseases, including cancer and neurodegenerative diseases. Cavin-1 is an important membrane protein that regulates the structure of pits in the membrane called caveolae. We will use biophysical analysis to characterize stress granules in the presence and absence of Cavin-1, to see if there is a connection and to determine protein interactions.

16. Predicting Fantasy Football Scores

Students: *Jake Barefoot, Akash Shaji, Minh Pham, Yanniode Peri-okonny*

Advisor(s): *Donald Brown, Randy Paffenroth, Ziming Zhang*

In this Major Qualifying Project, we are working with DraftKings, an online daily fantasy sports company, to build a model that would predict the number of fantasy points an NFL player would earn in a given week. We combine numerical and categorical data from DraftKings with data gathered from third-party sources to create a data set detailed enough to feed into various machine learning algorithms; these algorithms are able to identify key features for accurate prediction and outperform the baseline model used by DraftKings. This allows us to predict a player's fantasy points given their performance in prior games and supports DraftKings' business model of providing meaningful and compelling competitions for their customers.

Name of External Sponsor Collaboration: DraftKings

17. Identifying Mind Wandering and Cognitive Control With fNIRS

Students: *Hannah Borges, Sylvia Lin, Chau Do*

Advisor(s): *Erin Solovey*

Functional near-infrared spectroscopy, also called fNIRS, is a portable brain sensor that is well-suited for human computer interaction (HCI) studies. It provides information indictive of brain activity since it measures blood oxygen concentration. The objective of this project is to find, with assistance of the fNIRS equipment, patterns in brain data that allows to determine periods of mind wandering and cognitive control. The motivation of this project is to find these cognitive processes because they are common during learning and identifying them in real-time would enable creating more effective personalized learning experiences.

Name of External Sponsor Collaboration: National Science Foundation

18. Applying HCI Design Practices to the Design of BCI User-Interfaces to Facilitate fNIRS Research

Students: *Kyra Bresnahan, Margaret Goodwin, Vandana Anand, Sylvia Lin*

Advisor(s): *Erin Solovey, Rodica Neamtu*

Most fNIRS-based brain computer interfaces are not developed with user-centered design. This project aims to develop a user-interface for the application BrainEx using HCI practices to facilitate fNIRS research. The target users were identified through interviews with lab staff and developing user personas. Then, through iterative design, prototypes of increasing complexity and detail will be designed, evaluated, and refined to satisfy user needs while fulfilling system requirements. The team will then implemented the user-interface using React, perform final user evaluations, and suggest any future development recommendations.

19. Encapsulation of Photodetector for SpO2 Sensing Patch

Students: *Nathan Charles, Carmine Stabile, Daniel Matthews, Andrew Duncan*

Advisor(s): *Pratap Rao, Ulkuhan Guler*

The goal of this project is to develop a photodetector, specifically to be used in a wearable SpO2 sensing patch which is being developed by a partnering MQP team. In addition to developing the photodetector, various encapsulation methods will be research and tested to improve the life-span, reliability, and responsivity of the photodetectors. Current SpO2 sensing machines are bulky and uncomfortable for the patient and often inhibit their range of motion. This wearable patch will be able to gather the necessary data to keep the patient safe without the need for large and uncomfortable devices. The photodetector is a crucial component of this patch as it senses the light used to calculate the oxygen levels in the blood.

Name of External Sponsor Collaboration: NextFlex

20. On the Areal Expansion of the Cell Wall During Polarized Growth

Students: *Danush Chelladurai*

Advisor(s): *Min Wu*

This project studies how tip cells form their shapes during polarized growth, at the early developmental stage of mosses. A cell wall increases surface area when new materials are deposited, and turgor pressure further stretches the cell-wall surface. Our goal is to develop a mathematical method that decomposes growth and stretching based on imaging data of cell outlines with and without turgor pressure. The decomposition will help elucidate how cell shapes are formed by employing the two mechanisms.

21. Flexible Wearable Sensor: Wireless Reflective Pulse Oximetry

Students: *Bill Chieng, Franco Baudino, Fivos Kavassalis*

Advisor(s): *Ulkuhan Guler, Pratap Rao*

Our project aims to design a flexible and wearable device to measure and estimate the peripheral oxygen saturation of patients. Through optical sensors, the device measures the ratio of the percentage of oxygenated hemoglobin to the total amount of hemoglobin. In conjunction, we will also detect the photoplethysmogram of the user to extract additional vital information. In the end, the sensor will wirelessly present the data to the user's phone gathered from the device. This project explores an emerging technology of flexible wearable devices with the addition of the internet of things element. One possible application is in a wireless monitoring system to allow health providers to monitor outpatient vital signs.

Name of External Sponsor Collaboration: NECAMSID

22. Studying the Role of Grain Size on the Performance of Cold Sprayed Parts

Students: *Andrea Claudio Palacios*

Advisor(s): *Danielle Cote*

The properties of feedstock materials for additive manufacturing processes can affect the properties and performance of the final product. This is particularly important in cold spray, since the feedstock's microstructure is maintained in the processed part. One microstructural feature that greatly impacts the material's behavior is grain size. Grain size is directly correlated to a material's strength, hence we aim to study the grain size of aluminum alloy powders for cold spray as a function of heat treatment and particle size. Subsequently, we will evaluate the properties of the processed part and correlate them to our initial findings.

23. Medical Animatronic Head

Students: *Gillian Cohen, James Maxwell, Chris Rene, Ethan Lauer*

Advisor(s): *Pradeep Radhakrishnan*

The goal of this project is to design and develop an autonomous, modular, and easily operable animatronic head to enhance realism in medical training and simulations. Current medical simulation technology is unaffordable for many programs and has limited functionality. This project aims to address these gaps by producing a multi-functional, affordable head and neck model to be used for medical assessment training. A functioning animatronic head prototype was created as a proof of concept by a previous MQP team. Our main goal is to identify and address areas of improvement for this prototype, as well as adapt it for medical use. We hope to produce a final product with improved functionality and wide applicability for the medical field.

24. Investigating the Cleavage Specificity of RNase E in Mycobacteria

Students: *Alexa Davis, Joseph Dainis*

Advisor(s): *Scarlet Shell, Louis Robert, Jose Arguello*

Mycobacterium tuberculosis, the causative agent of tuberculosis disease, uses several strategies to survive physiologically stressful conditions within the lungs, often making infections difficult to treat. One of these strategies is tight regulation of mRNA degradation, which allows the bacteria to conserve energy when necessary, while still synthesizing proteins needed for survival. For most bacteria, mRNA degradation is regulated through endonucleolytic cleavage by RNase E, a critical component of an enzyme complex called the degradosome. The purpose of this project is to investigate the cleavage specificity of Mycobacterial RNase E, whose activity, though well described in several other bacterial species, remains relatively unknown.

25. Determining Cognitive Controls with the Use of fNIRS

Students: *Chau Do, Gabi Tessier*

Advisor(s): *Erin Solovey*

This study uses data collected from fNIRS machine and computer log data taken from participants of the study to predict the mind wondering and cognitive control in the brain. The tests performed by participants are O-Span and AX-CPT that cause stimuli to appear on the screen. An fNIRS machine is also used during the experiment to measures the oxygenated and de-oxygenated blood in the brain. The data taken from the fNIRS machine is used to find a relationship between the oxygenated and de-oxygenated data with the data from tests performed by the participants. We predict that by connecting the fNIRS data with the computer log data, we will be able to define the phases of mind-wandering, phases of focus, and patterns associated between the t

26. Fibrin and Hyaluronic Acid Based Microtissues for Tissue Engineered Heart Valves

Students: *Zhijie Dong*

Advisor(s): *Kristen Billiar, Ying Lei*

The goal of this project is to create and assess a tissue engineered heart valve created from fibrin and hyaluronic based hydrogels. Heart valve disease often requires a replacement surgery of the diseased valve. Current tissue engineered replacements have the issue of retraction, where the valve won't close all the way and there is back-flow of blood. A past study in this lab showed that hyaluronic acid, a compound found in high abundance in developing hearts, when combined with fibrin, a blood component that forms clots, can create a a viable tissue engineered alternative that reduces retraction over time. This project continues that work by working to further improve the tissue constructs and quantify the results.

Name of External Sponsor Collaboration: National Institutes of Health (NIH)

27. Tree Cover in Union Hill

Students: *Kirsten Doyle*

Advisor(s): *Laureen Elgert*

The goal of this project is to examine the current urban landscape in the Union Hill neighborhood of Worcester, MA, particularly in reference to tree cover, and compare those results to the current urban landscape in other Worcester neighborhoods. Urban trees provide social, economic, and environmental benefits to those communities that have access to them. Researchers aim to understand the conditions that created the current urban landscape in Union Hill and the conditions that are in place to improve tree cover and access to it.

Name of External Sponsor Collaboration: Worcester Tree Initiative

28. Habitat Selection by the Eastern Whip-poor-will

Students: *Joshua Driscoll, Alli Ross*

Advisor(s): *Marja Bakermans*

Using the latest GPS data logger technology, this study seeks to characterize nesting and wintering habitat used by the Eastern Whip-poor-will. Specifically, we will quantify land cover data to compare habitat for whip-poor-wills on the breeding ground versus the non-breeding ground. We hypothesize that 1) habitat features on breeding and non-breeding grounds do not differ and 2) habitat used by whip-poor-wills differs from random sites available to birds. In particular, we will examine habitat features (e.g. forest type, etc.) at the local (e.g., 1 km) and landscape (e.g., 5 km) scales. This species is of particular interest in Massachusetts where it was listed as a Species of Special Concern under the Massachusetts endangered Species Act.

Name of External Sponsor Collaboration: Massachusetts Division of Fisheries and Wildlife

29. Modular Socially Assistive Robot Framework

Students: *Tyler Dubuke, Jacob Bader, Jonathan Sanchez, Raymond Schade*

Advisor(s): *Greg Fischer, Carlo Pinciroli*

The goal of this project is to design a framework for a socially assistive robot that can be used to aid in therapy and learning of an individual. This will then be used to design a Penguin for Autism Behavior Intervention (PABI) as a case study to prove the functionality of the framework.

30. Characterization of the Bond Interface between a Biologically Induced Repair and Concrete

Students: *Emma Edwardson*

Advisor(s): *Nima Rahbar, Jessica Rosewitz*

The goal of this project is to study the bond between concrete and a biologically induced concrete repair. Concrete is the most common building material in the world, but it has a number of problems relating to its durability. It is susceptible to cracking and degradation, and the United States is already billions of dollars behind on repairing and replacing concrete infrastructure. The repair uses enzymes, carbon dioxide, and calcium to precipitate calcium carbonate, healing cracks by returning strength and reducing permeability. The bond between the repair and the concrete is not well studied, so the goal of the project is to study the visual and mechanical properties of the repair so it can be used on a greater scale in the future.

31. Waste Oils to Sustainable Plastics: Supercritical Catalytic Hydrocracking of Palmitic Acid

Students: *Joseph Esposito, Jeffrey Page, Philip Smolitsky, Douglas Theberge*

Advisor(s): *Michael Timko*

As the need for alternative energy sources grow due to burgeoning implications of climate change and diminishing reserves of fossil fuels, many chemical precursors such as valuable aromatics used to create plastics which are currently sourced from petroleum will require more sustainable alternatives. Our MQP is researching the reaction pathway of palmitic acid cracking: a process which converts a naturally occurring fatty acid into these valuable products. With this information, we hope to better understand the reactions taking place in the process. Catalyst stability is also being investigated to provide a basis for future economic analysis of scale-up for the process.

32. Understanding the Interactions of FXR1 and 2 with PLCb1

Students: *Gabriella Fiorentino*

Advisor(s): *Suzanne Scarlata*

The goal of this project is to understand the Interactions of FXR1 and 2 with PLCb1. It is known that FXR1 is a stress granule protein that PLCb1 will potentially bind to when a cell is under stress. Different techniques of gene overexpression and fluorescent imaging will be used to observe the protein's activity and localization.

33. Understanding Multi-Sensory Integration through Serotonin Signaling in Caenorhabditis elegans

Students: *Emily Flavin*

Advisor(s): *Jagan Srinivasan*

The goal of this project is to gain a greater understanding of neuronal communication through serotonin, and how this communication is impacted by drugs commonly used to treat mood disorders such as depression and anxiety. Serotonin is a neurotransmitter used by the nervous system to transmit signals that allow behavioral changes and movement of an organism. Selective Serotonin Reuptake Inhibitors (SSRIs), which are used to treat mood disorders, limit the removal of serotonin from the gap between two neurons. This project aims to elucidate the impact of these drugs on avoidance behaviors in C. elegans, which will allow a deeper understanding of how SSRIs change neuronal communication in humans.

34. Design of New F-State AL Alloy

Students: *Patrick Flinn, Adam Rodeen, Michael Cullen*

Advisor(s): *Yu Zhong*

Our project is looking into a new commercially viable aluminum alloy that meets a range of desired mechanical properties. Specifically in search of an alloy for use in large scale automotive applications that can be used as cast. Thereby foregoing the need to heat treat the metal parts lowering the manufacturing time and overall cost of the part. There are some alloys that do meet the mechanical requirements but use materials too expensive to make them viable commercially.

Name of External Sponsor Collaboration: Eck Industries, Rheinfelden, Shiloh, and Harley Davidson

35. RNase E Autoregulation

Students: *Karina Franca*

Advisor(s): *Scarlet Shell*

The goal of this project is to observe if the enzyme Ribonuclease E (RNase E) autoregulates its expression in mycobacteria by observing changes in gene expression. RNase E has been observed to autoregulate its synthesis in E. coli. However, it has yet to be shown if RNase E is also able to autoregulate its synthesis in mycobacteria. Gene expression will be observed in Mycobacterium smegmatis as a safe model for Mycobacterium tuberculosis (Mtb), the pathogen that causes tuberculosis and is responsible for millions of deaths worldwide. Regulation of gene expression may influence the ability of Mtb to adapt and survive within human hosts, so research on the biological functions of Mtb may provide insight into new ways to combat tuberculosis.

36. Mapping Internet Connectivity

Students: *Samuel Goldman, Christopher Myers, David Vollum, Evan Goldstein*

Advisor(s): *Craig Wills*

This project aims to provide answers to the question, how well connected to the internet are Americans? Using pre-existing data and collecting new data, we are analyzing geographic and other factors impacting network infrastructure and overall internet usability across the United States. Pre-existing data sources include traceroutes from numerous distributed nodes. Data collection methods include distributing a measurement website to volunteers throughout the country and using DNS cache manipulation to measure DNS infrastructure. With these techniques we will map internet connectivity across the United States, providing valuable information to network architects, everyday users of the internet, and many others.

37. Tradução Técnica de Métodos de Segurança em Pesquisa

Students: *Katherine Gomes*

Advisor(s): *Kevin Lewis, Esther Boucher-Yip*

The goal of this project is to create a laboratory safety manual for a research laboratory of the University of Campinas in Brazil and then to translate and localize the manual into Brazilian Portuguese. In Brazil, I will conduct observations and interviews to create documentation of the laboratory's most common practices. After writing the manual in English, I will then use the professional art of translation and localization of language to product a Portuguese version. I plan to user-test both manuals and compare my own translation to software. This project aims to investigate the issues of the lack of safety documentation in laboratory environments and the need for effective translation in a globalized world.

Name of External Sponsor Collaboration: University of Campinas, Brazil

38. Analyzing the Cellular Stress Response of Human Osteosarcoma Epithelial Cells through Exposure to Polycyclic Aromatic Hydrocarbons (PAHs)

Students: *Amanda Grossi, Aimee Bell, Victoria Loosigian*

Advisor(s): *Natalie Farny, Louis Roberts*

This project is intended to study the cellular stress response through exposure of human osteosarcoma epithelial cells to polycyclic aromatic hydrocarbons (PAHs). The cellular stress response may be triggered by changes in temperature, DNA damage, pH changes, reactive oxygen species, and other toxic conditions affecting the cellular microenvironment. Different stressors yield different cellular stress responses including the initiation programmed cell death, DNA repair pathways, and the formation of membraneless assemblies known as stress granules. This research project utilizes benzopyrenes, a class of polycyclic aromatic hydrocarbons, to induce the formation of stress granules in the osteosarcoma cells of the U2OS cell line.

39. SCREAM: Superelastic Continuum Robot for Endoscopic Articulation and Manipulation

Students: *Andrew Gulotta, Joseph Bartone, Jesse d'Almeida, Nicholas Pacheco*

Advisor(s): *Loris Fichera, Gregory Fischer, Haichong Zhang*

Tumors of the larynx affect 1 in 40 people worldwide at any time. Treatment traditionally involves surgical excision under general anesthesia in the operating room, but a simpler alternative exists: office-based endoscopic laser treatment. However, office-based procedures are still underutilized; the laser fibers used in these procedures do not possess distal articulation, making it impossible to treat patients with tumors in locations that cannot be reached with a linear path. We are developing a steerable continuum robotic manipulator to allow surgeons to articulate a laser fiber in the larynx to enable more effective treatment of tumors.

Name of External Sponsor Collaboration: Dr. Thomas Carroll

40. Analysis of Time Evolution Algorithms to be Utilized in Modeling Classical and Quantum Mechanical Systems

Students: *Katherine Hudek*

Advisor(s): *L. Ramdas Ram-Mohan*

Time evolution in classical and quantum mechanical systems has been the focus of research because the behavior of physical systems with time are determined by their initial conditions. Calculation methods for the system values as it changes throughout time have to be very accurate in order to have predictions that we can rely on. This is the challenge of time evolution and its modeling. In this project several time evolution algorithms were implemented and evaluated according to criteria of accuracy, stability, and consistency. Several scalar algorithms were examined as well as a technique for matrix exponentiation.

Name of External Sponsor Collaboration: Clare Boothe Luce

41. Exploring the Use of Sktime to Classify fNIRS Data

Students: *Fareya Ikram*

Advisor(s): *Erin Solovey, Rodica Neamtu*

This project aims to explore the use of sktime toolbox for the classification of fNIRS data by developing a testing infrastructure that will allow researchers to specify an fNIRS dataset and run sktime models on the specified data set. This tool will be accompanied by a manual that presents information on how to use the tool and how to set up sktime. The tool and the manual were tested against potential users and recommendations were recorded for potential future improvements.

42. Bioinformatics Approach to Mental Illness

Students: *Junbong Jang*

Advisor(s): *Dmitry Korkin*

The goal of this project is to develop a machine learning approach to further understand the mechanism of mental illness such as depression, dissociative disorder, post-traumatic stress disorder (PTSD), and suicidal ideation. Suicide was the 2nd leading cause of death for age group 10-24 in 2016 and the suicide rate increased 56% between 2007 and 2017. Researchers aim to understand the mental illness to improve diagnosis, treatment, and prevention of mental illness and ultimately reduce the number of suicides. Clinical and MRI data from two types of subjects, patient and control, that were collected by clinicians at McLean were analyzed to discover the most significant indicators of mental illness.

Name of External Sponsor Collaboration: McLean Hospital

43. 3D Printing Automation

Students: *Alex Johnson, Owen Smallcomb, Andrew Kacherski, Dante Mauriello, Noah Donald, Nicholas Colucci*

Advisor(s): *Pradeep Radhakkrishnan, Joseph Stabile*

The goal of this project is to develop a system which will facilitate 3d printing with continuous throughput. Successful research in this project will result in the development of a system which can continuously produce 3d printed parts with minimal intervention by human operators. Additionally the system will be modular and scalable so that it can be customized to be useful in various environments such as offices, universities, maker spaces, and manufacturing facilities.

44. SHEILA: A Sensitive Hardware Information Leakage Analysis Tool

Students: *Edward Krawczyk, Jacob Grycel*

Advisor(s): *Berk Sunar*

Hardware that is performing operations on sensitive data can inadvertently leak information about that data. These leakages may be hidden in the power draw of the hardware, data dependent timing of operations, or many other side-channels. Detecting these leakages is the first step in preventing malicious actors from recovering this sensitive information.
This project takes an information theoretic approach to detecting information leakage in hardware designs. By performing analysis at the netlist level, SHEILA can be applied to an arbitrary hardware platform. Furthermore, SHEILA is not limited in the attacks it can detect, due to its generalized approach to leakage detection, and incorporation of an active attacker model.

45. Detecting Anomalies in Brain Time Series Data Collected Using fNIRS Technology

Students: *Petra Kumi, Jacob Pardue*

Advisor(s): *Rodica Neamtu, Suzanne Weekes, Erin Solovey*

In our project, we use machine learning methods to detect anomalies in data collected using Functional Near-Infrared Spectroscopy (fNIRS), a new type of brain imaging technology. The portability and accuracy of fNIRS allow researchers to model brain activity of subjects in everyday situations. Many sensors are used to collect fNIRS data, which contributes to its high complexity and makes analysis using statistical methods unreliable. It can also increase the presence of anomalous points. The study of anomaly detection of fNIRS is well sought after, as an accurate anomaly detection algorithm can help distinguish between anomalies caused by hardware or other external factors and those that can lead to further insight into how the brain works.

46. Building a Bacterial Biosensor for the Detection of Synthetic Opioids

Students: *Amanda Maffeo*

Advisor(s): *Natalie Farny*

Amongst the growing opioid crisis, the focus of this project is to design a biosensor for synthetic opioids. Through the use of synthetic biology techniques, an adaptable and quantitative system will be designed in order to detect fentanyl. The practical use of this biosensor will include detection of fentanyl within biological systems, as well as environmental samples.

Name of External Sponsor Collaboration: UMASS Lowell

47. Writing in the Biomedical Engineering Discipline

Students: *Salome Maldonado*

Advisor(s): *Brenton Faber*

As writing in the disciplines advances in the university curriculum, anticipation for students to publish their own research increases. But, there is a stark contrast between the genre of student writing and that of journal articles. This project will evaluate the process of constructing a published research article using a variety of genre analytical strategies. This includes defining the genre, the discourse community, and the social action of the biomedical engineering field to transform what is now a WPI Biomedical Engineering Master's thesis into a published journal article. This project aims to clearly define this process and to provide insight into the question: why can't a graduate student just write their own journal article?

48. Predicting the Short Term Price of a Stock

Students: *Dan Mao, Palawat Busaranuvong*

Advisor(s): *Mayer Humi*

US stock market is often divided into 11 sectors. Among all of them, the Energy Sector and the Consumer Staple sector were selected as the focus of this project. Our prototype model takes the historical stock price, and market indices as input. Using this data construct several models
to make a prediction. Methods include Autocorrelation, Trendline analysis, and Fourier series analysis, etc.

49. Implantable UCL Repair System

Students: *Cullen McCarthy, Giulio Cataldo, Matthew Cannata*

Advisor(s): *George Pins, David Magit*

This project aims to address the treatment of elite throwing athletes, such as pitchers and quarterbacks, with partial tears of their ulnar collateral ligament (UCL). Currently, these injured athletes either need to have an aggressive ligament reconstruction (Tommy John surgery), intended for complete tears, or continue to play injured until the ligament ruptures. The goal of this project is to design an implantable device to aid in the repair of damaged tissue. This device will provide athletes with an additional therapeutic option that better matches the extent of their UCL injury and ultimately allow for shorter recovery periods. Ultimately, the scaffolds developed in this project can be used for other orthopedic soft tissue injuries.

50. Advanced Baseball Analytics

Students: *Leah Mitchell, Elijah Ellis, Matt Boros*

Advisor(s): *Jon Abraham, Barry Posterro*

Through this research we have developed various models using historic baseball data to predict full seasons and individual games for teams in the MLB. Our project consists of two main models: the preseason and the in-season model. These two methods use various regression and statistical methods to create predictions for any given team. Throughout this research we have explored other important topics such quantifying cluster luck and defining garbage time. We used the development of garbage time and cluster luck in attempts to quantify true player talent.

51. Parameter Estimation of Cell Dynamics

Students: *Lynne Moore*

Advisor(s): *Andrea Arnold, Sarah Olson*

The goal of this project is to model the dynamics within a cancerous cell population that has been introduced to cancer treatments, using a variety of differential equation techniques. Cancer cells come in a variety of forms and strengths according to their ability to proliferate. Extensive research and experimentation have been conducted to better understand the interactions between these cancerous cells and potential treatment methods. Our research utilizes a local lab's data for three different drug treatments to justify our model. We also utilize a variety of filtering methods for parameter estimation within the model to find the proper fit for the provided data.

52. Concrete 3D Printing

Students: *Gordon Murray, Oliver Brochu, Paul Rivera, Xavier Hines-Coombs*

Advisor(s): *Nima Rahbar, Cagdas Onal*

Carbon emissions and material waste associated with construction are increasing concerns to the world population. These concerns demand for new technologies capable of producing a more sustainable means of construction. 3D printing with concrete is a new technology that has the potential to reduce the environmental impacts of construction through increased material efficiency. The goal of this project is to advance the field of concrete 3D printing through research on the inter-facial bond between printed layers of concrete which is currently a weakness in printed structures. We aim to enhance the inter-layer bond strength by experimenting with different layer geometries to increase the mechanical interlocking between printed layers.

53. Epidemiological Studies of an Urban Free Medical Service

Students: *Sahil Nawab, Enyonam Edoh, Delainey O'Connor, Sarah Brown*

Advisor(s): *Brenton Faber*

This project is examining patient data from a free urban health system in Worcester. We are studying larger trends associated with patients who use the service. Specifically, we are examining the disease incidence and prevalence within the population, the service's treatment effectiveness, and the financial impact of the service on the larger Worcester health system. These data will enable the development of more effective treatment protocols, specifically towards hypertension, diabetes, and infectious disease management. Data will inform quality and process improvements at the clinic and help us to understand how the clinic influences the quality of life of patients at the population level.

Name of External Sponsor Collaboration: Epworth Free Medical Service, Dimensional Insight

54. Modeling Heterogeneity in the Pancreatic Tumor Microenvironment In Vitro

Students: *Jessica Netto*

Advisor(s): *Catherine Whittington*

The goal of this research project is to recreate features of the microenvironment surrounding pancreatic tumors using a model system that is designed for use outside of the body (in vitro). We model the tumor microenvironment using collagen and hyaluronic acid, which are extracellular matrix (ECM) components of found in the tumor microenvironment. We plan to use collagen hybridizing peptides (CHPs), which bind to collagen, to recreate the heterogeneity that arises in the tumor microenvironment through a process called desmoplasia. By accurately modeling features of desmoplasia, we can design more predictive in vitro preclinical models of pancreatic cancer, which can eventually help meet the clinical needs for better treatments for patients.

55. The Effects of Caveolin on Aging

Students: *Delainey O'Connor*

Advisor(s): *Suzanne Scarlata*

Imagine if Alzheimer's, the most common neurodegenerative disease in humans could be prevented.A study in the University of San Diego has discovered that in mice with an over expression of Caveolin-1 protein, there are no signs of damage typically seen in Alzheimer's affected brains. The mice are showing no neuronal damage due to age. Caveolin are scaffold proteins The goal of this project is to use a PC12 rat neuronal cell model to study the effects of an over expression of caveolin proteins and how it affects neuronal aging. This will be done through live cell imaging and protein analysis. By measuring the rate of retraction of neurons in response to stress, it can be determined if the caveolin is having an affect on cell morphology

56. Using Collagen Fractal-Fiber Bundles to Model Extracellular Matrix Heterogeneity in Pancreatic Tumors In Vitro

Students: *Paige O'Gorman*

Advisor(s): *Catherine Whittington*

The project evaluates the response of pancreatic cancer cell lines to extracellular matrices (ECM) with heterogeneous surface structures. Tumor heterogeneity occurs when the tumor microenvironment is remodeled. Our proposed model is inspired by an in vitro minimal matrix scar model that produces heterogeneous collagen fiber bundles on the surface of polyacrylamide gels. We then overlay the surface with mixtures of collagen type I and hyaluronic acid, which represent the tumor ECM, to alter cell-ECM interactions. Upon substrate characterization and culture of pancreatic tumor cell lines on the surface, we can establish structure-function relationships between pancreatic cancer cells and ECM organization to better predict tumor behavior.

57. Artificial Tongue

Students: *Sarah O'Neil, Benjamin Bridges, Claire Sellen, Renee Dorer, Colin Hiscox*

Advisor(s): *Pradeep Radhakrishnan, Dirk Albrecht*

Our team is continuing the development of a soft robotic tongue prosthesis. This project is oriented towards providing a prosthesis in an area where other prosthetic options are limited. The primary focus of the project itself is to provide oral cancer patients, who have had their tongues removed, with a device to perform the swallowing function of the tongue. The continuation of the project will explore methods of integrating the tongue into the mouth, which includes the development of a retainer to hold the tongue in place as well as miniaturizing the system to fit carefully in the oral cavity.

58. Lift Every Voice: Critiques of Algorithmic Bias

Students: *Michael Osei*

Advisor(s): *Yunus Dofüan Telliel*

Lift Every Voice looks at black technologists' response to algorithmic bias. I am particularly interested in groups such as Data for Black Lives, Algorithmic Justice League, and Black in AI that have advocated for a change in current corporate strategies and government policies concerning big data. While these groups acknowledge the ways in which machine learning and related technologies can perpetuate already-existing racial injustices and discriminations, they also suggest that alternative structures of accountability and ownership can redirect such technologies for social change. I argue that such proposals urge us to think about ways to harness the power of new technologies for positive social reform.

59. Design of an External Foam-water Suppression System to Protect One- and Two-Family Homes From Firebrand Ignitions During Wildfires

Students: *Dylan Parrow, Ariana Rozen, Emily Han*

Advisor(s): *Milosh Puchovsky, Albert Simeoni*

The goal of this project is to use a performance based design approach to design an external automatic foam-water suppression system to protect one- and two-family residential structures against firebrand ignitions. The major threat to structures in wildfires are firebrands, which are embers the have broken off from burning fuels. We aim to define realistic fire scenarios in which firebrands could cause a home ignition, select appropriate system components, develop system discharge criteria, and provide a system design layout. The system will operate automatically and independently from local utilities.

60. Machine Learning Implementation in Educational Technology

Students: *Zonglin Peng, Rui Huang, Alp Piskin, Connor Paisner, John Bulman*

Advisor(s): *Neil Heffernan, Anthony Botelho*

The goal of this project is to use machine learning to provide constructive feedback for student open responses. We are integrating with the ASSISTments platform to help teachers give more helpful and timely feedback to their students. Using a data set of open responses and corresponding grades, we were able to use machine learning to develop a model that can give what the most likely grade for an essay might be. Our model gives 3 suggestions for a given student response, and the teacher can pick the most appropriate one. We will further develop this using user testing with teachers that want to try out new features in ASSISTments.

61. Automated Collection of Speech Samples From Unknown Distinct Speakers

Students: *Minh Pham*

Advisor(s): *Jacob Whitehill*

The accuracy of speaker verification and diarization models depends on the quality of the speaker embeddings used to separate audio samples from different speakers. With the goal of training better embedding models, we devise an automatic pipeline for large-scale collection of speech samples from unique speakers that is significantly more automated than previous approaches.

62. Electron Correlation and Spatial Entanglement in Semiconductor Materials

Students: *Dung Pham*

Advisor(s): *L. Ramdas Ram-Mohan*

The spatial correlation of few electrons confined in semiconductor quantum dots are of great interest for realizing solid state quantum computing devices. The goal of this project is to (a) develop an action integral formalism in coordinate space for solving few-particle wavefunctions in arbitrary confinements, and then (b) use this new method to investigate the spatial entanglement of electrons in a wide variety of systems. We examine the dependence of quantum entanglement on the symmetry of the system, as well as on external electric and magnetic fields. Possibilities of fine-tuning the entanglement values for quantum information processes are also demonstrated.

63. Muscle Density in Spinal Cord Injury

Students: *Megan Pinette*

Advisor(s): *Karen Troy*

The goal of this project was to develop standardized methods to measure muscle density and volume in CT scans. These methods were then used to analyze the CT scans of patients in a spinal cord injury clinical trial. Following a spinal cord injury, people are highly susceptible to muscle atrophy due to the lack of movement and force being placed on their leg muscles. This lack of muscle mass can lead to a decreased metabolic rate and increased fat storage.
During the clinical trial, participants used exoskeleton assisted gait training. CT scans of the legs were taken of the participants at the beginning, middle and end of the 12-month trial. The results of the CT scan analysis will then be compared throughout the 3 time points.

Name of External Sponsor Collaboration: Leslie Morse, University of Minnesota

64. Supplementation in C. elegans

Students: *Eveline Reddington*

Advisor(s): *Carissa Olsen*

The goal of this project is to determine the impact of green coffee bean extract supplementation on the overall fat content in Caenorhabditis elegans. Prior research on green coffee bean extract has shown fat storage decreases in C. elegans. We aim to analyze the impact of the supplementation on fat synthesis, absorption, and accumulation through isotope labeling to trace fat origins. It is suggested that green coffee bean extract also impacts longevity, so we aim to determine the mechanism by green coffee bean extract impacts both longevity and fat storage, as well as understanding the relationship between the two pathways.

65. Streamlined Alternative Communication Using Context Aware AI

Students: *Andrew Robbertz, Cole Winsor, Zachary Emil, Richard Valente*

Advisor(s): *Rodica Neamtu*

For many people with verbal or cognitive impairments, engaging in conversation can be tiresome and time-consuming. LIVOX provides a unique, pictogram-based AAC application to facilitate communication through a simple, yet highly customizable interface that accommodates a wide range of vision and motor impairments. Our goal is to reduce the time and effort required to communicate by leveraging context-aware natural language processing and machine learning algorithms. Currently, users must navigate nested pages to find desired pictograms. Our approach will listen for questions from interlocutors and present relevant responses to users.

Name of External Sponsor Collaboration: Livox

66. Epigenetic Reprogramming Prompts Hereditary Behavioral and Chemical Changes in C. elegans

Students: *Annalise Robidoux*

Advisor(s): *Jagan Srinivasan, Carissa Olsen*

Epigenetic reprograming is the ability of the DNA to reflect experiences by modifications upon the molecule. I was very interested in the number of generations an epigenetic reprograming can be passed down to. To initiate epigenetic reprograming in response to chemical cues, I exposed C. elegans to the aversive chemical osas#9 during different developmental stages and found that worms decrease in avoidance later in future generations due to epigenetic reprogramming. The future directions of this project are to investigate changes in genetic expression associated with the receptor responsible for sensation of osas#9 and an analysis of the overall metabolome of the worms.

67. Gender Effects on Decision to Report Witnessed Crime

Students: *Siearah Robles*

Advisor(s): *Jeanine Skorinko, Angela Rodriguez*

This study will investigate gender effects on the decision to report a witnessed crime. Participants will watch a video under the guise of testing a video coding software, during which a theft will be witnessed. Participants will be given multiple opportunities to report the theft to the experimenter. The gender of the perpetrator will be manipulated to be either male or female and stress will also be measured through cortisol sampling. We predict that people will be more willing to report against male confederates and that stress levels will be heightened when viewing the theft.

68. Design of a High-Powered Rocket

Students: *Jarod Romankiw, Nicolas Amato, Zachary Huaman, Alicea Hyland, Jacob Koslow, Jordan Pickunka, Jack Procaccini, Saiyab Ranjit, William Roe, David Santamaria, Jake Scarponi, Braden St. Jacques, Jake Tappen*

Advisor(s): *John Blandino*

Design, build, and fly a reusable rocket to an altitude of 1500 feet. Provide students with the opportunity to work as a team to design, build and test a moderately complex aerospace system in which the overall vehicle performance is critically tied in with the mass and performance of the individual components and assemblies. Provide students with specialized training in and opportunity to apply software tools: MATLAB, ANSYS Fluent, COMSOL, ANSYS Mechanical, Cantera, others

69. Investigation of Antibiotic Identity Among Bacterial Antibiotic Producers

Students: *Cole Royer, Ronan Ball*

Advisor(s): *Michael Buckholt*

The goal of this project is to expand on undergraduate lab work done in BB2915. This class had students look for antibiotic producing bacteria in the soil, but never investigated what specific antibiotics were being produced. The goal of our MQP is to take the antibiotic producers isolated in BB2915, extract any antibiotics from the preserved bacterial cultures, and determine their identity. At the end of the project, we hope to have a log of what specific antibiotics are produced by different types of bacteria. This will potentially illuminate a new source of clinically effective antibiotics that can be taken advantage of for therapeutic means.

70. Multiscale Characterization of Surfaces Produced by Additive Manufacturing

Students: *Nathaniel Rutkowski, Patrick Bowles*

Advisor(s): *Sneha Narra*

The goal of this research is to apply multiscale area analysis to additive manufacturing to characterize the as-built surfaces and their performance. Additive manufacturing can be used to produce complex shapes which cannot be achieved using conventional manufacturing techniques. In some cases, parts produced by additive manufacturing cannot be machined in a post process and must be used with the as-built surface. In this work, we aim to develop relationships between the manufacturing parameters used in the metal additive manufacturing process and the resultant surface topographies. Then, determine functional relationships between the resultant surface topographies and properties such as heat transfer.

Name of External Sponsor Collaboration: United Technologies Research Center (UTRC) and North Carolina State (NC State) University

71. Designing Multi-Agent Software Systems

Students: *Brandon Sanders*

Advisor(s): *Jennifer deWinter, Curtis Abel, Scott Harris*

The goal of this project is to develop, test, and commercialize a "Data Backbone" technology for Industry 4.0 systems. These systems are comprised of many different devices like sensors, cars, smartphones, and robots. Due to their heterogeneity, these systems are often built using many different kinds of software and data management tools--they have "fragmented" architectures. This fragmentation makes these systems hard to create and maintain, and also exposes them to more cyber security threats. Therefore, I am creating a new Data Backbone technology which will provide a unified foundation to easily build and fortify Industry 4.0 systems.

Name of External Sponsor Collaboration: Alicorn Systems

72. Health Insurance and Its Impact on the Survival Rates of Breast Cancer Patients in Synthea

Students: *Robert Scalfani*

Advisor(s): *Shamsnaz Bhada, Lane Harrison*

The goal of this project was to build policy modules in a synthetic health system to analyze how healthcare policy impacts breast cancer survival rates. To do any inference regarding healthcare policy, researchers need secure and protected health data which is restricted by privacy laws and interoperability issues. Synthetic health systems generates and help investigate health data without concerns of violating legal restrictions (HIPAA). In this research, we programmed health insurance and loss-of-care modules into a synthetic health system simulator (Synthea) to simulate and analyze the impact of health insurance on breast cancer survival rates. We successfully reflected real world insurance and loss-of-care impact statistics in Synthea.

Name of External Sponsor Collaboration: MITRE

73. Driver Rehab Application

Students: *Yosias Seifu, Oliver Rayner, Remy Allegro, Julia D'Agostino, Remy Allegro, Yosias Seifu, Oliver Rayner, Chau Do*

Advisor(s): *Eleanor Loiacono*

The goal of this project is to make a web-based application for the Massachusetts Rehabilitation Center (our sponsor). We are creating an application to digitize and streamline the process that they use to evaluate disabled drivers and figure out what car modifications need to be made to a car for their clients to be able to drive. We are using the MEAN bundle(MongoDB, Express.js, Angluar.js, Node.js) to make the application.

Name of External Sponsor Collaboration: Massachusetts Rehabilitation Center

74. Chitin Elicits a Calcium-Mediated Immune Response in Physcomitrella patens

Students: *Catherine Sherman*

Advisor(s): *Luis Vidali, Elizabeth Ryder*

Plants recognize a variety of different pathogen associated molecules in order to react effectively. In Arabidopsis thaliana, it is known that chitin, a component of the cell walls of fungi, causes oscillations of intracellular calcium; however, it is a intricate system and not much is known beyond the three proteins that make up the receptor complex: Lyk4, Lyk5 and CERK1. The moss Physcomitrella patens, a simpler organism, also displays calcium oscillations in the presence of chitin. The goal of this project is to use P. patens as a model to study the mechanism involved in the plant immune response to chitin. This will be done by identifying and silencing the genes in P. patens thought to be responsible for the chitin immune response.

Name of External Sponsor Collaboration: Funded by National Science Foundation Grant

75. Integration of MT-Based and Bacteria-Based Active Matter

Students: *Samuel Skinner*

Advisor(s): *Kun Ta Wu*

The goal of this project is to investigate the properties of active matter systems that use both MT active matter and bacteria based active matter. Though both of these systems have been studied heavily separately, nobody has yet tried to combine these two systems. This project hopes to observe if one of these systems dominates a integrated active matter system, or if these two types of active matter share a more complicated interplay when they are combined. This project could possibly shine light on ways to make MT active matter more efficient with the integration of bacteria, leading hopefully to an MT active matter which can for example turn a microscopic gear, and generate power.

76. Recycling for Sustainability

Students: *Nicholas Smith, Willard Murphy*

Advisor(s): *Sara Saberi*

The goal of this project is to develop a model for recycling and waste management that will minimize the waste generation on campus. Waste generation is an increasing issue across the globe that needs to be addressed before its too late. This is evident on campus at WPI, as the amount of waste generated has increased exponentially year-to-year and will only continue to increase as more students enroll each year. We will test different hypotheses for knowledge, attitudes, and behaviors of students on campus and identify methods to address the areas of concern and significance on campus. The improvements we develop for these areas will be the focal point of our developed model. We hope that this project will be impactful for years to come.

Name of External Sponsor Collaboration: WPI Office of Sustainability

77. Changes in Acute Stress Response in Cells Affected with Fragile X Syndrome

Students: *Kirsten Southan, Chloe Sairs*

Advisor(s): *Natalie Farny, Louis Roberts*

The goal of this project is to examine the response of cells from a patient with Fragile X Syndrome (FXS), an autism spectrum disorder, to different types of environmental stress. We hypothesize that cells with FXS are more sensitive to stress than unaffected cells and will form stress granules more readily in response to environmental stressors. This differential stress response may provide a non-invasive diagnostic method in peripheral tissues to identify patients with FXS.

78. Design and Fabrication of Low-Cost Apparatus to Study Laser-Material Interactions for Additive Manufacturing

Students: *Jacob Spada, Matthew Woods, Jackson Brandin*

Advisor(s): *Sneha Narra*

This project focuses on a subset of metal additive manufacturing known as laser powder-bed fusion (LPBF). To further the capabilities of LPBF processes and understand how certain metal alloys interact with the laser, experimental trials must occur. We were tasked with designing and fabricating an economical laser melting system for experimentations with various metal alloy powders and inert gases. Some design requirements of this prototype system include an air-tight chamber to allow for pulling a vacuum and filling it with an inert gas. In addition, a laser-orienting mirror galvanometer will be designed and manufactured with the ability to be retrofitted with a high powered laser.

79. Mapping Transport Efficiency of Nuclear Pore Complexes - A Combined Simulation and Inference Scheme

Students: *Kamryn Spinelli*

Advisor(s): *Min Wu*

Nuclear pore complexes (NPC) tightly regulate nucleo-cytoplasmic transport, controlling the nuclear concentration of several transcription factors. Elosequi-Artola et al. showed that forces affect nuclear entry rates of the growth factor YAP/TAZ via pore stretching. Can we deduce the primary mode of sensing local forces: bending (change of curvature) or stretching (change of tension)? The answer to this question will enable NPC researchers to narrow their search for the corresponding force-bearing structure. We begin by developing a model of nuclear deformation under external localized forces. We will use this model to infer which local sensing mechanism is more likely at work. This is a pilot project between WPI and UMass Medical School.

Name of External Sponsor Collaboration: UMass Medical School

80. Interfacial Fluctuation of Microtubule-Based, Kinesin-Driven Active Drops

Students: *Megan Varney*

Advisor(s): *Kun-Ta Wu*

The goal of this project is to measure the stress exerted on a water-oil interface by an active fluid. Active fluid is differentiated from conventional passive fluid by its capability of converting chemical fuels to mechanical work. However, to this date, how the work affects a boundary along with how much work the active fluid can deliver remains unclear. To mend this knowledge gap, we placed the active fluid near a water-oil interface and observed how the active fluid deformed the interface followed by measuring the interfacial curvature to reveal the stress exerted by the active fluid. This work will enable quantification of output power of active fluid so as to pave the path to design of an active fluid-powered machine.

81. Analysis of Stigma Reduction Measures for Schizophrenia

Students: *Danny Warren, Rachel Smallcomb*

Advisor(s): *Kaitlyn Schneider, Jeanine Skorinko, James Doyle*

The goal of this project is to assess what methods of reducing biases against stigmatized populations are most effective. Our focus is on the difference between reducing the social distance for stigmatized populations and changing population norms to encourage thoughtful treatment of individuals at a social distance. We will do this by having participants either experience a simulation of auditory hallucinations found in schizophrenia (a stigmatized mental illness) while completing a series of mundane tasks, or watch a video of a neurotypical confederate completing that same experience. We will measure for changes in participants' stigmatizing beliefs as well as their perception of the social distance for the target population.

Name of External Sponsor Collaboration: Kaitlyn Schneider

82. Cellular Spreading and Realignment in Response to Cyclic Stretch on Soft Substrate

Students: *Leigh Whitehorn*

Advisor(s): *Kristen Billiar*

Strain avoidance is a well-documented behavior for many cell types exposed to cyclic uniaxial stretch for long time periods and on stiff substrates; however, our understanding of cellular reorientation at intermediate time intervals as well as on soft substrates remain limited. Here, we study how cells on soft substrates spread and reorient in response to cyclic stretch under short time intervals to provide more detailed data regarding the mechanical signals driving the strain avoidance phenomenon.

Name of External Sponsor Collaboration: funded in part by the National Science Foundation

83. Design for Additive Manufacturing: An Integrated Robotic Arm and Hydraulic Manifold

Students: *Travis Wold*

Advisor(s): *Sneha Narra*

The goal of this project is to redesign a robotic arm for production using additive manufacturing. Additive manufacturing can disrupt traditional manufacturing methods with its ability to produce internal structures, reduce part counts, and minimize wasted material. This student aims to integrate the internal channels of the hydraulic manifold into the structural members of the robotic arm and optimize flow paths for decreased pressure drop. The final product will be compared to traditional robotic arms in terms of the arm's range, the ratio of its load capacity to total weight, and the resulting pressure drop.

84. Analysis of University Endowment Spending

Students: *Robert Wondolowski, Danielle Angelini, Katherine Brophy*

Advisor(s): *Barry Posterro, Jon Abraham*

The goal of this project is identified is to identify the best spending rule to maximize purchasing power of university endowments while also maintaining steady yearly spending each year. An endowment is an asset owned that is supposed to support an organization in perpetuity; in the case of most universities, it is a large sum of money that is invested in various assets, and managers decide how much to spend each year. Researchers aim to understand the strengths and weaknesses of spending rules in order to discover the best spending rule to meet a certain institution's needs.

85. Self-Driving RC Car - Team 1

Students: *Kyle Wood, Joshua Rondon, Thomas Kim, Anthony Marge*

Advisor(s): *Pradeep Radhakrishnan, Kaveh Pahlavan*

The goal of this project to design and implement a modular self driving system with sensors that can be integrated onto any scale RC car. This project explores the possibility of creating an autonomous modular self-driving package using both a neural network with machine learning, and a combination of various sensors to tackle a variety of track conditions. While driving, the car will provide a constant stream of data for the user to observe during operation on a webpage. The end goal is to have a trained car that can operate without human interaction and navigate all terrain. The application of this project leads directly into autonomous rovers that are used for data collection and mapping.

86. Magnesium Hydride Slurry as a Alternative Aerospace Fuel

Students: *Yi Jie Wu*

Advisor(s): *Adam Powell, Jagannath Jayachandran*

The goal of this project is to understand the feasibility and to simulate the combustion of magnesium hydride and comparing it to the combustion of dodecane. Metal fuels are an excellent alternative to traditional hydrocarbon fuels since they do not produce greenhouse gases when combusted. Magnesium hydride can also be produced with no direct greenhouse emissions to the atmosphere. Using Cantera, an open source thermal equilibrium simulator, the equilibrium of the hydride and hydrocarbon combustion reactions were simulated and analyzed.

87. Weather Impacts on PV Systems

Students: *Markus Zimmermann, Matthew Scherrer, Barry Aslanian, Christian Curll*

Advisor(s): *Maqsood Mughal, Sundari Ramabhotla*

The goal of the project is to model and create a system to show the effects of cloud coverage on an installed photovoltaic system and the impacts on the electrical grid. When a cloud disrupts a solar panel system by blocking the sun, the electrical output varies in reference to the initial output. This variation ripples across the grid and can impact other systems along the line. Initially, to adjust for this phenomenon a test is done at an output lower than initially expected. This is sufficient, however, does not consider all preventable scenarios. We will be analyzing irradiance data for areas provided with the electrical output of a system and make a model to accurately indicate a flicker moment on the grid and compensate accordingly.

Name of External Sponsor Collaboration: Eversource Energy

88. NASA Lunabotics Mining Competitor

Students: *Harrison Burack, Nicole Kuberka, Kevin Bimonte, Cara Freedman, Mark Hogan, Joseph Hogan*

Advisor(s): *Joshua Cuneo, Nicholas Bertozzi, Therese Smith*

The goal of this project is to build a robot that could efficiently collect regolith and rock samples from Mars and the Moon. The techniques used on this robot could help NASA develop rovers and robots to analyze the surface of Mars and the Moon before humans begin travel. Our robot will compete in the NASA Lunabotics Competition against other colleges and universities to assist NASA in their research.

89. Tissue-Type Recognition

Students: *Irene Wong, Yixue Wang, Kayla M. Swiston, Floris J. Van Rossum*

Advisor(s): *Andrea Arnold, Loris Fichera*

This project aims to address concerns surrounding in-office laser surgeries in the throat. Currently, surgeons have difficulty determining when the laser procedure successfully targets harmful cells, but minimally damages healthy tissue. The team is conducting research on various laser-tissue interactions in order to build mathematical models and classify whether the tissue is healthy or unhealthy based on the estimation of certain tissue parameters. The fact that these parameters change over time will allow us to monitor the change in the tissue properties resulting from laser exposure, which would assist the surgeon to determine the stopping point of the laser procedure.

90. Financial Pricing Engine

Students: *Pavee Phongsopa, Vital Tavares, Nicholas Wotton*

Advisor(s): *Song Qingshuo, Gu Wang*

The goal of this project is to create a trading artificial intelligence that can accurately determine the trend of the market and essentially make profit by trading according to that prediction. Trading stocks succesfully can be difficult to achieve because if its innate unpredictability due to the fact that there are thousands of trades every minute with undefined volatility. We hope that in this project we can create a working model by making an improvement on the existing mathematical formulas and putting them into functional program.