INTERSECTIONS
SPRING SYMPOSIUM
APRIL 20TH, 2018
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Deep Learning Model Visualization Tool

Herman Lee, Department of Electrical Engineering and Computer Science; Ryan Li, Department of Electrical Engineering and Computer Science; Jeffrey Shen, Department of Electrical Engineering and Computer Science

Deep learning (DL) is a field of machine learning that utilizes neural networks to perform detection and classification tasks such as identifying cancerous cells or predicting disease progression. While DL has recently shown state of the art performance in these tasks, little is known about the features derived by these models to exhibit such exemplary performance. In the biomedical domain, this lack of clarity is especially frustrating as having evidence of an underlying signal, without the ability to identify the biological insights they are based on, severely limits the classifier’s utility in knowledge generation. To address this issue, a number of approaches have been proposed in attempts to elucidate the features learned by networks with the hopes of gleaning novel insights into the tasks. Here we introduce a web based framework which bundles several of these explanatory approaches into a single interface allowing for users to compare, interrogate, and ideally “understand” features contained within these highly performant models. Typically this process is performed by inverting the deep learning training process so that as opposed to optimizing weights given an input image to maximize task performance, input images themselves are optimized to maximize either neuron activation or classifier certainty. These glimpses into the model have helped in other domains identify features which are associated with strong activation of the presence of certain objects (e.g., faces) and textures (e.g., wrinkles). By applying similar approaches to decrypting the black box of networks in the medical context one may discover relevant biological insights yielding increased disease understanding for improved treatments options and prognosis.

Project Mentor: Dr. Andrew Janowczyk, Center for Computational Imaging and Personalized Diagnostics
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering and Computer Science

Analyzing the Effect of Urbanization on Phylogenetic signal in the Species Columba

Bissan Abboud, Biology, Case Western Reserve University

As the world’s population continues to grow exponentially, it is important to analyze how urbanization affects the phylogenetic diversity of the species inhabiting these urban hubs, as it has been shown that our rapid urbanization is directly tied to a loss in species biodiversity. To analyze whether this loss in biodiversity is observed in pigeons, common city-dwelling birds, we will measure the degree of phenotypic similarity between urban bird species when compared to that of non-urban bird species. Due to the inherent phylogenetic relationship between all species, it is helpful to analyze this relationship with respect to phylogenetic signal, the statistical non-independence among species trait values. To measure phylogenetic signal in respect to a Brownian motion of evolution, the K statistic was produced to estimate the strength of phylogenetic signal across traits, and a generalization of this, Kmult, was derived by also incorporating covariance matrices to account for multivariate datasets. In this study, using the phytools package in the R statistics program we will analyze the strength of phylogenetic signal in body size for urban and non-urban species of Columba by using multivariate data on length, height, and weight calculated on a time-calibrated phylogeny. It is hypothesized that the value of Kmult for urban species will be closer to one than that of non-urban species – suggesting closer related species are more phenotypically similar to one another in urban species – because cities are a rather homogenous environment, in few phenotypic characteristics suitable for the environment. If the results of this analysis show that the Kmult value for the urban species is greater and closer to 1 than that of the non-urban species, a potential cause may be due to some urban environmental stressor preventing the random chance of evolutionary changed, suggested by the Brownian model of evolution.

Project Mentor: Professor Jean Burns, Department of Biology
Peripheral IV Catheter Sterilization Device

David Lin, Department of Biomedical Engineering; Gabriel Jimenez, Department of Biomedical Engineering; Jack Gong, Department of Biomedical Engineering; Megha Mansey, Department of Biomedical Engineering; Nurahn Abouzahra, Department of Biomedical Engineering

150 million intravascular (IV) devices are used every year in the United States alone. These catheters can bring infections rate of 2 to 30 per 1000 catheter used. A more convenient and effective method to reduce IV catheter infection is called for. It is found that the most likely site for contamination is the site of drug administration. Most of the IV catheters currently available on the market do not contain any sterilization solution. In addition, most of the IV injection protocols require nurses to clean the injection port using ethanol swab for 30 seconds, which only disinfects and not sterilizes and is insufficient to inactivate all the contaminant, such as superbugs, and is often not followed strictly by nurses. Our design utilizes UV light as a means to sterilize the IV catheter port. UV light between the wavelength of 185-254 nm has been shown effective in destroying a wide spectrum of bacterium. UV light has 3 types bands: UV-A, B, C. UV-C light initiates between two particles of thymine, one of the bases that make up DNA. If this is extensive enough from long enough of a duration of UV light and with enough intensity, the damage to the DNA can be extensive enough that the cell will die. This method of sterilization does not contribute to the evolution of superbugs through overuse of antibiotics as well as being extremely efficient.

Project Mentors: Professor Colin Drummond, Department of Biomedical Engineering; Professor Williams, Department of Biomedical Engineering; Hillary Bedell, Department of Biomedical Engineering

A Liquid Crystal Based Electron Shower Detector

Raymond Adkins, Department of Physics; Dr. Charles Rosenblatt, Department of Physics; Dr. Rolfe Petschek, Department of Physics; and Dr. Ben Monreal, Department of Physics;

There are numerous applications of liquid crystals spanning many fields of technology. This project has involved using well known properties of liquid crystals to design a charged particle detector. Polymerized liquid crystal films were fabricated with one surface being a transparent electrical conductor, and the other open to air. These films were designed so that an optical change in the layers occurs when charged particles are deposited on the surface. This allows for the creation of displays that show the spatial arrangement of deposited charges. The project explored different liquid crystal and polyimide combinations to create stable hybrid aligned and homeotropically aligned open cells. We have developed an electron source which generated the electrons needed to test the liquid crystal layers. Finally, we have done several tests to better understand the mechanism for inducing a transition in the layers, and to make the liquid crystal films more useful for charged particle detection.

Project Mentor: Professor Charles Rosenblatt; Department of Physics
Purification of Secreted Protein, Acidic and Rich in Cysteine (SPARC) Implicated for its Effects on Intraocular Pressure

Zaid Al Bahrani, Department of Chemistry

Glaucoma is one of the leading causes of irreversible blindness in the world, with primary open angle glaucoma (POAG) being the most common form. Glaucoma is a group of diseases that damage the optic nerve due to an increased intraocular pressure, leading to loss of vision. SPARC is a 40 kDa matricellular glycoprotein which has been studied due to its effects on extracellular matrix interactions and collagen binding. Specifically, manipulation of the SPARC gene in mice has shown that SPARC-null mice have a 15-20% decrease in intraocular pressure compared to the wild-type due to increased drainage of aqueous humor. Further, the aqueous humor of individuals with POAG have up to a 3-fold increase in TGFβ-2, a potential upstream regulator of SPARC. Understanding SPARC’s effects on ocular health is central to combating the major cause of blindness. To study SPARC, the protein’s molecular structure must be understood so that an isolated and purified sample of protein can be analyzed. Purification and isolation of the protein are paramount for further study of its effects on various facets of ocular health. Following various purification methods such as buffer exchange and chromatography, Western blot analysis using a monoclonal antibody was utilized to identify the presence of the protein.

Project Mentor: Doctor Min Hyung Kang, Case Western Reserve University

A Window into Metabolite Changes of Live Bacteria Following Drug Infusion

Yaqeen Aljawad, Department of Biochemistry; Samuel Lee, Department of Chemistry; Grant Whitmer, Pre-Doctoral Fellow; Drs. Paul Carey & Marianne Pusztai-Carey, Department of Biochemistry

Drug potency is usually quoted as the minimum inhibitory concentration (MIC) that prevents bacterial growth. However, MICs provide no molecular insight into how the drug prevents growth after entry into the cells. Our group has developed a technique, supplemented by Raman spectroscopy, a laser source providing structure analysis. This technique can quantitate metabolite changes brought about by drug infusion into live bacteria under controlled conditions.[1] As a function of infusion time, we can quantitate changes in nucleic acid and protein populations as well as major changes in members of the Krebs Cycle such as citrate in cells. Our experiments compared the kinetics of metabolic changes brought about by two clinically used drugs, meropenem and imipenem, going into Escherichia coli. These drugs are of similar structure yet the MICs are 0.0625μg/mL and 0.25μg/mL respectively. The key question is: are the MICs related to the speed and magnitude of the observed metabolic changes? In hopes of further understanding the bacterial-drug response and improving our outlook on antibiotic development, we aim to decipher this complex problem involving the influence of the different MICs.


Project Mentor: Dr. Paul Carey, Department of Biochemistry

Intersections: SOURCE Symposium and Poster Session
**In-situ Resource Utilization on Mars**

Emily Anderson, Department of Chemical Engineering; Abigail Cawoski, Department of Chemical Engineering; Grace Gaskin, Department of Chemical Engineering; Matthew Wallace, Department of Chemical Engineering

To make NASA’s mission to Mars feasible, in-situ resource utilization allows resources to be generated on Mars instead of transporting them from earth. NASA is designing a system that will generate oxygen on Mars. This involves capturing CO₂ from the atmosphere, which is pressurized and then sent through a solid oxide electrolyzer (SOE). The purpose of our project is to design a system to recycle unreacted CO₂ in order to save energy. A mixed stream of CO₂ and CO leaves the SOE which allows for an opportunity to recapture the already pressurized CO₂. Membrane separation, absorption, adsorption, and cryogenic fractionation were investigated to determine their energy usage, mass, and volume. After preliminary analysis the group decided to pursue adsorption as the most feasible option in terms of energy and readiness of the technology. Adsorption processes allow for a range of fractional recoveries based on the temperature and pressure ranges of operation. This freedom of design is useful in terms of minimizing energy in terms of recovery, as 100% recovery is not required for the process. This presentation will describe the design of the separation system.

*Project Mentor: Uziel Landau, Department of Chemical Engineering*

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**The Relationship Between Subjective and Objective Language Assessments For Second-Language Learners**

Kaitlynn Arredondo, Department of Psychological Sciences; Dr. Lauren Calandruccio, Department of Psychological Sciences

This study examines the relationship between subjective and objective measures of language proficiency for assessing language dominance. Two groups of participants (Spanish-English and Mandarin-English bilinguals) completed the Bilingual Language Profile (BLP; Birdsong, Gertken & Amengual, 2012) and the Versant English Test (Pearson ©) to assess their English language proficiency. The BLP is a self-reported measure and is specifically designed to be a multi-measure questionnaire that reflects the gradient nature of language dominance and the many factors influencing it, including: age of acquisition/exposure, years of schooling, frequency/function of use, linguistic environment, language attitudes, proficiency, and processing ability. The Versant is an automated speech recognition test that assess the spoken language skills of non-native speakers by measuring the participants sentence mastery, vocabulary, fluency, and pronunciation. The BLP is freely available and can be administered using google forms. Typically, an examiner helps the participants fill out the form. The Versant is a costly test, which needs to be purchased per participant, however, it is completed independently by the participant, thus saving the examiner time. The purpose of studying whether there is a relationship between self-reported and objective measures of language proficiency is to determine if indeed both measures are necessary to understand language dominance, or if one of the measures is predictive of the other. Only having to administer one of the two test forms would increase test efficiency and cost. Data will be presented for 18 Mandarin-English bilinguals and 10 Spanish-English bilinguals. The relationship between the two measures will be reported.

*Project Mentor: Dr. Lauren Calandruccio, Department of Psychological Sciences*
MotionSense Wave™: Electronic Faucet

Scott Atkinson, Department of Electrical Engineering

MotionSense Wave™ is a product of Moen Incorporated. It is a member of the MotionSense™ line of electronic faucets. It has a handle to adjust the flow and temperature of the water, as well as an infrared sensor to turn the flow of water on and off. In the handle is a circuit board that uses light detection to determine what the temperature and flow should be when the handle is in a certain position. There is a third circuit board that acts as a communication hub for the faucet. This is meant to ensure that the proper sensor hierarchy remains intact, as well as storing data. While on Co-op, this was the largest project that was worked on. Contributions include schematic capture, printed circuit board layout design, and output fabrication. Testing, validation, and verification was also done on both hardware and firmware throughout the project.

Project Mentor: Brian Frackelton, Moen Incorporated

Modifying Low-Emissivity Glass for Use with Surface Enhanced Raman Spectroscopy

Jessica Bailey, Department of Chemical and Biomolecular Engineering; Andrew Moore, Department of Chemical and Biomolecular Engineering; Jeffery Sagerer, Department of Chemical and Biomolecular Engineering; Anna Wertheim, Department of Chemical and Biomolecular Engineering

Low-emissivity glass is already used successfully as a testing medium for IR reflective spectroscopy due to the embedded silver layers. However, as Raman spectroscopy becomes more prevalent, there is a need for similar, simple testing slides like the kind used in IR. Simple Raman testing is particularly important for applications in forensics and medicine. To make a surface Raman active, nanoscale features formed from metals like silver or gold need to be present. This project involved creating small silver features on low-e glass slides to convert them to active surface enhanced Raman spectroscopy slides. Both surface roughening and silver coating methods were used to create micro and nanoscale silver features which were then tested for Raman activity. In addition to Raman testing, the original surface of the low-e glass was characterized for surface roughness using white light interferometry. Subsequently, the SERS converted slides were also imaged using interferometry to examine the silver features. Future work involves improving the features for enhanced Raman signal, with eventual patents and manufacturing if successful.

Project Mentor: R. Craig Virnelson, Kevley Technologies
Faculty Sponsors: Professor Daniel Lacks, Department of Chemical and Biomolecular Engineering; Professor Uziel Landau, Department of Chemical and Biomolecular Engineering
Hand Tremor Reduction Device

Aneeka Ayyar, Department of Electrical Engineering; Andrew Kirby, Department of Electrical Engineering; Hilary Qin, Department of Electrical Engineering

Our project is a hand tremor reduction device that will target essential tremors, a translational movement on the vertical axis that occurs typically when the person is trying to perform an action. Current orthotic solutions are expensive and limited to correcting certain kinds of tremor motion. By interfacing an Arduino with the servo motor and accelerometer/gyroscope sensors, our device will be able to mitigate the tremor in real time. This project focuses on the electrical components of this project - developing a robust algorithm to translate the tremor into a force to mitigate the motion. This device steps away from current products on the market for tremor patients by offering them a device that is made to work with an individual patient. The device is easily programmable to omit a selected frequency based on the patient’s needs. Currently, the targeted tremor has a frequency of 10 Hz and an amplitude of 2.5 inches. Future iterations of this project will use the developed algorithm to focus more on the most efficient mechanical approach to omit the tremor motion.

Project Mentor: Professor Michael Fu, Department of Electrical Engineering and Computer Science; Professor Evren Gurkan-Cavusoglu, Department of Electrical Engineering and Computer Science

Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering and Computer Science

Automated Segmentation and Radiomic Characterization of Visceral Fat on Bowel MRIs for Crohn’s Disease

Iulia Barbur, Case Western Reserve University Department of Biomedical Engineering; Jacob Kurowski, The Cleveland Clinic (United States); Kaustav Bera, Rajat Thawani, Case Western Reserve Univ. (United States); Jean-Paul Achkar, Claudio Fiocchi, Marsha Kay, Rishi Gupta, The Cleveland Clinic (United States); Satish Viswanath, Case Western Reserve Univ. (United States)

Crohn’s Disease is a relapsing and remitting disease involving chronic intestinal inflammation that is often characterized by hypertrophy of visceral adipose tissue (VAT). While an increased ratio of VAT to subcutaneous fat (SQF) has previously been identified as a predictor of worse outcomes in Crohn’s Disease, bowel-proximal fat regions have also been hypothesized to lend a role in inflammatory response. However, there has been no detailed study of VAT and SQF regions on MRI to determine their potential utility in assessing Crohn’s Disease severity or guiding therapy. In this work we present a fully-automated algorithm to segment and quantitatively characterize VAT and SQF via routinely acquired diagnostic bowel MRIs. Our automated segmentation scheme for VAT and SQF regions involved a combination of morphological processing and connected component analysis, and demonstrated DICE overlap scores of 0.86±0.05 and 0.91±0.04 respectively, when compared against expert annotations. Additionally, VAT regions proximal to the bowel wall (on diagnostic bowel MRIs) demonstrated a statistically significant, higher expression of four unique radiomic features in pediatric patients with moderately active Crohn’s Disease. These features were also able to accurately cluster patients who required aggressive biologic therapy within a year of diagnosis from those who did not, with 87.5% accuracy. Our findings indicate that quantitative radiomic characterization of visceral fat regions on bowel MRIs may be highly relevant for guiding therapeutic interventions in Crohn’s Disease.

Project Mentor: Dr. Satish Viswanath, Department of Biomedical Engineering
Periodic Liquid Crystal Order: Theory and Simulations

Gavin-Rae Barnaby, Department of Physics; Rolfe Petschek, Department of Physics

Hard Tetrahedra and shapes close to hard tetrahedra pack well when they are oriented in ways different from their neighbors. The Petschek group has hypothesized that long-range periodic orientation or liquid crystal order explains the complicated crystalline structures that form in computer simulations of such particles. This project will continue this work. An existing simulation program will be run with slightly different parameters in order to obtain better data, and to test if other crystalline structures are better than ones that are currently known, either for hard tetrahedra or for similar shapes.

Project Mentor: Rolfe Petschek, Department of Physics
Faculty Sponsor: Rolfe Petschek, Department of Physics

The Role of Dentistry in the U.S. Opioid Epidemic: A Literature Review

Makenna Basore, Department of Psychological Sciences

While the main uses of opioids have changed throughout centuries, they are primarily used today as one of the most effective analgesics to treat acute and chronic pain in both dental and non-dental procedures. The objective of this literature review is to understand the role of a dentist in the opioid epidemic and the existing policies and regulations surrounding opioid prescribing practices. This review will examine the prevalence of opioids in dentistry, existing preventative opioid misuse and prescribing practices, and alternatives for pain management. Although dentists represent a minority of prescribers, they prescribe a large portion of initial prescription opioids, causing them to be the second-leading prescribers behind primary care physicians. To treat pain caused by dental procedures, immediate-release opioids are prescribed for short-term use. While extremely effective, these drugs are easily misused and abused because they offer quick pain relief, relieve stress and anxiety, and amongst other effects, induce a sense of euphoria. The rate of misuse and addiction has become a national public health issue due to the fact that opioids represent the fastest growing type of drug abuse, are the most common cause of unintentional overdose, and lead to more deaths annually than all illicit drugs combined. The literature revealed numerous preventative opioid misuse measures and prescribing practices dentists can utilize to lower the risk of opioid misuse, including screening patients, setting expectations and boundaries, and using opioids as a last resort. Additionally, alternative treatment options for pain management are available, such as prescribing non-opioid medications or practicing various surgical techniques to decrease postoperative pain. While measures currently do exist to prevent the spread of opioid misuse, there is still much to learn about proper use of opioids and prescribing practices that can be utilized by dentists in the future.

Faculty Sponsor: Sharon E. Milligan, Ph.D., MPH, Jack, Joseph and Morton Mandel School of Applied Social Sciences
A Leader’s Role in a Nation’s Stability

Hannah Berends, Department of Anthropology; Melvyn Goldstein, Department of Anthropology

This research examines two contrasting systems of rule, rule by inheritance as seen in Great Britain and rule by incarnation, as practiced in Tibet. The paper examines the similarities and differences of the systems traditionally and how they have changed in the modern era. The sovereign of Great Britain customarily serves as the British Head of State and the Supreme Governor of the Church of England, while the Dalai Lama is the overall figurehead typically associated with Tibet politically and religiously. Both possess little actual power in the 21st century due to shifting views in favor of democracy and secularism. The Queen of England and the Dalai Lama continue to act as stabilizers for their nations, though. Many citizens, including those of the younger generation, venerate the Queen and view the monarchy as a virtuous role model. In Tibet, the Dalai Lama remains revered by many despite living in exile in India and is a source of hope for those in the global exiled community. Unfortunately, while the British sovereign continues to act as a binder for the citizens of Great Britain following a significant change in the monarchy’s power, the Dalai Lama has not due to several weaknesses of the rule by incarnation system. Yes, religion and the Dalai Lama have traditionally held the people of Tibet together, but in modern times with the people divided over whether to fight for independence or become an autonomous part of China, a traditionally isolated leader bounded by religion cannot alone reunite the people and end the question of independence.

Project Mentor: Professor Melvyn Goldstein, Department of Anthropology

A Study on Daily Cycles in Activity Levels of Coyotes (Canis latrans)

Shireen Bhatia, Department of Biology and Department of Spanish

In the state of Ohio in recent years, coyotes, Canis latrans, are the top predators as opposed to black bears or bobcats. They are currently found in all 88 counties of the state, speaking to the species’ ability to adapt to different environments (Metroparks). A study examining coyotes’ feeding behaviors found that while coyotes can survive on anthropogenic sources, their health was negatively affected (Murray et al., 2015). Even with this disadvantage, cities like Cleveland, Ohio still appear to have a coyote problem in suburbs and close to University circle. Part of the solution is understanding how the activity levels of coyotes change throughout the day and at what points their activity levels are the highest. A previous study that looked specifically at how activity levels in coyotes were impacted due to human persecution found that there were higher activity levels during diurnal hours in response to less human persecution (Kitchen et al., 2000). A unique opportunity to observe this comes from 3 coyotes currently housed at the Cleveland Museum of Natural History Wildlife area. My hypothesis is that activity levels vary in a predictable manner with time of day. Alternatively, activity levels could vary with other environmental factors or feeding times. This study aims to achieve an answer to this question through three steps. 1. Take video of the three coyotes interacting throughout the day. 2. Digitize the video clips in order to measure the coyotes’ relative distances and movements. 3. Relate changes in activity with time of day and/or feeding schedule.

Project Mentor: Dr. Roy Ritzmann, Department of Biology
Co-creation of an Intervention with African American Older Adults to Manage Stress Associated with Self-management of Hypertension

Gabrielle C. Blackshire, Department of Nutrition; Dr. Kathy D. Wright, School of Nursing; Dr. Karen Moss, School of Nursing; Dr. Lenette Jones, School of Nursing; and Dr. Carolyn Harmon, School of Nursing

Many older adults have to manage multiple chronic conditions and for African American older adults the most prevalent chronic condition is hypertension. Hypertension must be self-management, but managing a chronic condition such as hypertension can lead to stress. Additionally, there are disparities in hypertension self-management that disproportionately affect African Americans that can increase stress. Therefore, knowledge of self-management behaviors and preferences are needed to create interventions to help African American older adults deal with hypertension and its effects. Thus, a descriptive qualitative study was created by researchers to conduct focus groups to elicit feedback on self-management behaviors and then co-create an intervention with participants to help cope with the stresses of managing hypertension. The focus groups were conducted with community dwelling African American adults, aged 60 and older, who were diagnosed with hypertension (N=31, n=20 women; n=10 men). The sessions were documented utilizing field notes, audio recordings and graphic recordings. The themes that emerged from the focus groups found that the primary stressors for these older adults were communication, healthy eating, and sleep related to blood pressure self-management. To help participants deal with these stressors and promote healthy self-management behaviors, the study researchers conducted educational interventions lead by registered nurses and a dietitian.

Project Mentor: Dr. Kathy D. Wright, School of Nursing; Dr. Cheryl Killion, School of Nursing
Faculty Sponsor: Dr. James Swain, Department of Nutrition

Polymer Application to Make a Soft Worm-Robot

Noah Blatt, Alec Southern, Norbert Gratzl, Department of Mechanical and Aerospace Engineering

Worm robots are tubular robots powered by a series of actuators that allow them to move through the expansions and contractions of their sections in a sequential manner. The worm robots are planned to be used in piping/plumbing navigation and repair, and show a promise to be used as a medical tool in the human body. However, current models of the worm robots are composed of rigid components, limiting the mobility of the robots. By replacing these rigid components with light weight polymers, a “soft” robot will be developed. The soft robot will need to be able to maintain the structural requirements and peristaltic motion of the robot while decreasing the weight and improving its mobility. Three primary replacements will be considered in this project: (1) replacing the springs with lighter polymer strips; (2) replacing the heavier tubing with the lighter polymer tubing and (3) replacing the current actuators with “soft” actuators. The applications of the polymer will be tested to further reduce the weight of the robot and promote its mobility.

Project Mentor: Professor Roger Quinn, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Professor Robert Gao, Department of Mechanical and Aerospace Engineering
Developing to Developed: Entrepreneurship in Latin America

Noah Blatt, Department of Mechanical and Aerospace Engineering and International Studies Program; Kelly McMann, Department of Political Science

The new wave of technological entrepreneurship has emerged as a driver for social and economic growth within economies around the world. These companies, startups, specialize in various fields and use a multitude of technical innovations to solve the problem their company is based around. However, there is a disconnect between developed nations and developing nations with how these startups are supported. Developed nations tend to have high levels of private investment from angel investors, venture capitalists, and accelerators. Developing nations do not have the buy-in of the private sector and have turned towards promoting entrepreneurship in the form of state-sponsored accelerators. The most prevalent of these state sponsored accelerators is Start-Up Chile and has been successful in attracting entrepreneurs to the country. The disconnect between the forms of support has lead to a situation where more lucrative/developed companies tend to move to developed nations while developing nations have yet to develop a community of long term entrepreneurs. By analyzing the disparities between the two systems of funding, methods of strengthening the startup environments can be identified and implemented to improve the startup environments within the developing nations.

Project Mentor: Professor Kelly McMann, Department of Political Silence

Federation, Unrest and Authority: The Vietnam War Era at Case Western Reserve University

Noah Boksansky, Department of History

The Vietnam War sparked protests on many college and university campuses throughout the United States, including in Northeast Ohio. Current historiography of higher education characterizes the Vietnam War era as a turbulent period on American campuses, which often saw some combination of violence, strikes, and restrictions on freedoms of speech and academic freedom. This historiography is limited, however, in that it largely uses the student and government perspective and takes a skewed focus towards “elite” or large public institutional cases. Case Western Reserve University is a fascinating case to study in that it was a newly federated institution located in a politically active city with professors and students expressing a diverse variety of opinions on the war. Utilizing a wide array of primary documents, oral histories, and secondary historiographies, my project aims to characterize the CWRU administration’s response to Vietnam War-era activism and discuss CWRU in the context of local and national issues.

Project Mentor: Dr. John Grabowski, Department of History
Faculty Sponsor: Dr. Gillian Weiss, Department of History
Cadherin 6 (Cdh6) is required for thrombus formation in vivo

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The balance between hemostasis and thrombosis is tightly controlled and has catastrophic consequences when it is disrupted. Adhesion molecules have a critical role in hemostasis and thrombosis, mediating the formation of platelet plugs (hemostasis) or a clot (thrombosis). Therapeutically blocking primary adhesion systems to prevent thrombosis, however, leads to bleeding complications. We postulate that targeting secondary adhesion systems will prevent thrombosis while sparing hemostasis. The adhesion molecule Cadherin 6 (Cdh6) has been characterized on platelets, although its function remains unclear. The goal of this study was to determine the contribution and molecular mechanism of Cdh6-mediated platelet adhesion during thrombosis. Cdh6−/− mice demonstrated a prolonged thrombosis time in the Rose Bengal model, with 25% of knockout mice forming a full occlusion compared to 100% of wild-type mice (p=0.002). In the FeCl3 model, 37.5% of Cdh6−/− mice formed a full occlusion compared to 100% of wild-type mice (p=0.02). Tail bleeding assays yielded no difference between wild-type and Cdh6−/− mice (119±38 vs 159±61 s, p=0.11). Contrary to a previous report, Cdh6 was not expressed on mouse platelets, supporting negative data yielded from aggregation and platelet function experiments. Next, we showed cdh6 expression in the vessel. These data suggest that Cdh6 on other cells is participating in heterotypic interactions with platelet receptors to form a stable thrombus. Finally, we determined that Cdh6 mediates heterotypic adhesion with integrin αIIbβ3 on platelets. These results demonstrate that Cdh6 is physiologically important during thrombus formation in vivo, but does not impact platelet function and hemostasis. Our studies indicate that Cdh6 is a targetable receptor in thrombosis.

Project mentor: Dr. Marvin Nieman, Department of Pharmacology

### Parametric Scoliotic Spine Model with Materials that Simulate In Vivo Support

Sarah Breland, Department of Mechanical and Aerospace Engineering; Mengyao “Alice” Li, Department of Mechanical and Aerospace Engineering

Scoliosis is the abnormal curvature of the spine and affects approximately 7 million people in the United States alone. Advanced modeling of scoliotic spines can improve corrective devices and training for treatment of scoliosis. This project presents a computer model of scoliotic spines and a physical model of spines encased with silicone simulating the restorative forces within the body. The SOLIDWORKS computer aided design (CAD) model assumes individual vertebrae are previously created and lays out how each vertebrae can be controlled in all three dimensions and all three rotations to model any spinal configuration given computed tomography (CT) scans. The physical spine is created by pouring silicone into a mold which allows it to coat the anterior of the spine and hold it in a specific configuration. The silicone is selected such that its durometer and Young’s modulus closely mimic the soft tissues surrounding the anterior vertebral bodies. Final deliverables of this project include a parametrically driven CAD model with documentation for setting up the model and a user manual for manipulating the model and a physical model as described above with procedural documentation to be used for improved design in the future. The current models serves as proofs of concept. Later iterations need to more rigorously address material choices, cost, and manufacturing. The long term goal of this research is to streamline these two types of models, allowing the CAD model to directly drive creation of the physical model.

Project Sponsor: Michael Nilsson, Innovative Delta Technology, LLC
Faculty Advisor: Dr. Clare Rimnac, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering
**Exploring Molecular Structures of Promising Acceptors for Organic Photovoltaics**

Carson Britt, Department of Chemistry; Geneviève Sauvé, Department of Chemistry

Organic photovoltaics (OPVs) offer a promising lightweight, flexible, solution processable, and printable alternative to crystalline silicon photovoltaics. The active layer of OPVs usually consists of a blend of a conjugated polymer donor and a fullerene-derivative acceptor, with the optimized high efficiencies of ~10%. However, fullerene derivatives have several disadvantages, namely poor absorption of visible and infrared light, and an inability to easily tune energy levels. An acceptor that overcomes these limitations could potentially lead to higher efficiencies.

Azadipyrromethene (ADP) is one promising acceptor; it absorbs in the visible to near-IR region of the solar spectrum, and its energy levels are easily tuned by adding substituents to the ADP core. The benefits of adding substituents to ADP are two-fold; they can enhance the optoelectronic properties by extending conjugation while simultaneously altering molecular geometry. Furthermore, the properties of ADP can be tuned through metal chelation. These structural modifications to ADP increase the volume of delocalized electrons, and make the molecule more conducive to transporting charge in multiple directions. Substituted ADP complexes have shown increased efficiencies when blended with P3HT compared to unsubstituted ADP.

In this study, we modified the ADP core by adding phenylacetylene to the distal and proximal positions, and then chelating these molecules into homoleptic zinc complexes. We examined the molecules capacity as potential electron acceptors, looking at the altered molecular geometries and absorption profiles in film and solution.

*Project Mentor: Professor Geneviève Sauvé, Department of Chemistry*

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**Diffusing Growth Factor Through Synthetic Hydrophobic Bone Material Using Pressure Vessel and Pump**

Dylan Brown, Department of Biomedical Engineering; Tyler Clarkson, Department of Mechanical Engineering; Meredith Haller, Department of Mechanical Engineering; Xinyou Ke, Department of Mechanical and Aerospace Engineering; Robert Gao, Department of Mechanical and Aerospace Engineering; Steven Eppell, Department of Biomedical Engineering

In biomedical applications it is often necessary for synthetic bone material to be implanted into living bone to assist with bone remodeling, fracture repair, or to improve function when patients suffer from degenerative diseases. To achieve osseointegration successfully, growth factor must be diffused through and absorbed by the synthetic materials. To ensure the synthetic bone materials have a proper stress-strain relation as well as a sufficient strength to function alongside human biological bone, the material must be crosslinked. Without crosslinkings, materials may have insufficient mechanical properties and cannot function properly. However, the crosslinkings of the materials make them hydrophobic, thus it is necessary to have a pressure vessel and pump to force the growth factor through the synthetic bone. Our goal is to make a pressure vessel that is both strong enough to contain the amount of pressure required to diffuse growth factor through the materials as well as be structured in a way that the materials will not be easily damaged. We will test our design with a prototype pump and use a water-dye combination to demonstrate a successful diffusivity. This mixture has a similar density, viscosity, and flow properties to the growth factor infused liquid. The materials will be cut in half and tested to see how far the dye and water are able to diffuse. A successful test will show absorbed dye throughout the entire specimen.

*Project Mentor: Robert Gao, Department of Mechanical and Aerospace Engineering  
Faculty Sponsor: Steven Eppell, Department of Biomedical Engineering*
**Our Story, Our Voice: Bolstering Women's Empowerment in Higher Education**

**Erin Buttars**, Department of Sociology and Biology

This study presents an evaluation of a women's empowerment program aimed at helping undergraduate women develop confidence in their voice and build connections with other women, both peers and professionals. Previous research supports that women's self-views have significant impact on their engagement in male-dominated spaces. Previous research has also supported that women rely on same sex role models for support when navigating the discrimination present in a gendered institution. The women's empowerment program was developed and advertised to students at Case Western Reserve University. It consisted of a keynote speaker, small group break-out sessions led by female faculty and staff, as well as an interactive component to help students see the impact of community overcoming fears and challenges. In a sample of 40 students, an evaluative survey provided data to analyze the impact that academic major and female role models have on participant endorsement of statements regarding confidence, community, and empowerment. The importance of universities exposing female undergraduates to successful women within their field and having supportive programs within an academic institution is highlighted.

*Project Mentors: Dr. Karie Feldman; Dr. Sue Hinze, Department of Sociology; Case Western Reserve University*

*Faculty Sponsor: Dr. Karie Feldman, Department of Sociology*

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**Flammability Testing of Thin Leaf-like Materials as a Function of Water Content**

**Jaime Capetillo**, Department of Mechanical and Aerospace Engineering; **Julian Masullo**, Department of Mechanical Engineering; Michael C Johnston, Department of Mechanical and Aerospace Engineering.

Forests are extremely important to an ecosystem and their preservation is a national interest. However, wildfires often take place with an alarming frequency and the effective control of these wildfires has been a challenge. It has been reported that the severity of a wildfire is directly related to the dryness of the surrounding plant life. This research is concerned with evaluating the effects different factors like humidity, wind and fuel characteristics have on fires. We will be testing materials such as Kevlar and Nomex while varying parameters and locating the conditions at which a fire is extinguished. Using a wind tunnel and L.O.I. (Limiting Oxygen Index) device we simulate the parameters of a traditional wildfire, such as dryness and strong winds. Using a balance fixed in the L.O.I. device we measure the rate at which a material burns using the given parameters. It has already been shown that a high humidity level makes it harder for fires to spread. However, the exact conditions in which wildfires are extinguished remain poorly-understood. The proposed research aims at providing a deep understanding on how these fires react to natural conditions, thus allowing better fire suppression methods to be created. Currently only Nomex and Kevlar are being tested however other materials may be tested depending on results.

*Project Mentor: Professor James Tien, Department of Mechanical and Aerospace Engineering.*

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Generating a Drosophila Model of primary ovarian insufficiency via CRISPR-Cas9

Cody Calhoun, Department of Biology; Anlu Chen, Department of Biochemistry; Laura Shapiro-Kulnane, Department of Genetics and Genome Sciences; Helen K. Salz, Department of Genetics and Genome Sciences

Primary ovarian insufficiency (POI) is a disorder characterized by amenorrhea and loss or dysfunction of ovarian follicles prior to the age of 40. POI occurs in 1-3% of reproductive age women, however, it's rare in adolescents. Mutations in SF1, FOXL2, FSHR and other genes have been associated with the disorder. However, the genetic basis of this disorder, and therefore pubertal ovarian development remain poorly understood.

To identify novel genetic causes of POI, we studied a consanguineous family of Israeli-Arab origin with POI and identified a missense mutation in the gene encoding mitochondrial ribosomal protein S22 (MRPS22 p.R202H). MRPS22 encodes a mitochondrial ribosomal small subunit protein that is found in species including mammals, fruit flies and nematodes. Therefore, we studied the role of mRpS22 in ovarian development, using an (RNAi)-mediated knockdown approach in Drosophila. Germline specific knockdown of the MRPS22 ortholog in Drosophila leaded to female infertility due to lack of germ cells, while the ovarian somatic cell knockdown is both viable and fertile. These demonstrate that mRpS22 is required for female germ cell development in Drosophila.

To further study the role of MRPS22 (p.R202H) in POI, we generated a CRISPR-Cas9 mediated knockin Drosophila model. The CRISPR-Cas9 technique utilizes an endonuclease that interacts with a guide RNA sequence to create specific double strand breaks. A donor sequence containing the desired mutation was co-injected into Drosophila embryos to be incorporated at the double stranded breaks. The Cas9 cleavage efficiency guided by desired gRNA was up to 80% and resulted in 45% lines with genomic editing, of which 18% lines were found with the desired knockin mutation. The phenotypes of these knockin lines were investigated, however, Drosophila with the desired human mutation in MRPS22 (p.R202H) was completely viable and fertile.

Project Mentor: Dr. David A. Buchner, Department of Genetics and Genome Sciences
Faculty Sponsor: Dr. Radhika Atit, Department of Biology

A Physical Training Strategy in a Mouse Model for Down Syndrome

Joyce Chu, Department of Biology; Melissa Stasko, Laboratory Manager; Dr. Alberto Costa, Department of Pediatrics

Delayed motor development and gait abnormalities have been observed in humans with Down syndrome (DS), as well as in the Ts65Dn mouse model for DS. The immediate aim of this research is to minimize abnormalities in gait dynamics in Ts65Dn mice by exposing them to intervals of moderate physical training from an early age. Longitudinal studies of 17 trisomic and euploid mice were conducted beginning at 17 days of age until adulthood at 35 days of age. The control group received no physical training, while the experimental group received training every other day. The gait dynamics of both groups were compared by assessing gait characteristics at 35 days of age. The gait dynamics of euploid mice with and without training were not significantly different. The trisomic mice that received physical training showed minimized gait abnormalities.

Faculty Sponsor: Dr. Alberto Costa, Department of Pediatrics
Project Mentor: Melissa Stasko, Laboratory Manager
Sensorized Cane for Fall Detection and Alert

Hana Chan, Department of Biomedical Engineering; Princess Honna, Department of Biomedical Engineering; Min Young Park, Department of Biomedical Engineering; Shounak Bose, Department of Biomedical Engineering; Cloay Maier, Department of Biomedical Engineering; Dhruv Seshadri, Department of Biomedical Engineering

Falls are the number one cause of injury and death from injury among older Americans. Emergency medical services for fall related injuries, including the ambulance ride and hospital stay, can cost several thousand dollars. These services are not only expensive, but they can take a considerable amount of time to reach the patient. This can lead to an increase in the severity of injury as the patient waits for help, if they are able to call out for help at all. There are around 4 million individuals aged 65 and older in the United States that use a mobility device such as a cane. However, even with a cane, older Americans are at a high risk of falling and completing day-to-day activities like going to the grocery store can be scary. We intended to provide these users and their loved ones a sense of security, without an excess financial burden, by integrating a fall detection and alert system into a standard-looking cane. Our sensorized cane contains a motion sensor coupled with a force sensor that, based on predetermined thresholds, will detect if the user has fallen, and immediately emit an audible alarm (sound alert) if a fall has been detected. The alarm will alert the people nearest to the elderly individual, so as to get the cane user immediate attention and help drastically reduce the time it takes for the user to get help through emergency medical services. This will thus reduce the chance for severe injury and immense medical bills due to a fall.

Project Mentor/Faculty Sponsor: Dr. Matthew Williams, Department of Biomedical Engineering
Project Mentor/Faculty Sponsor: Dr. Colin Drummond, Department of Biomedical Engineering

Fabric Embedded Pressure Sensors for a Worm Biorobotic

Haoyou Cheng, Department of Electrical Engineering; Dian Jin, Department of Electrical Engineering; Chenhui Yang, Department of Electrical Engineering

Nowadays, wearable technologies are growing in popularity rapidly in both business and research area. However, most commonly used electronic sensors in wearable technologies that detect and transmit data are made of hard and inflexible materials. These sensors would restrict wearer’s movements and the accuracy of the collected data. Recently, many research teams and scientific organizations have found ways to construct soft sensors in fabrics, which can flex with the bodies and increase the accuracy of collected data. This project is concerned with constructing effective fabric embedded pressure sensors on a worm-like robot to better detect and monitor its movement. Our primary task is to make the robot’s soft skin a pressure sensor, which could reveal the moving mechanism of the robot. Therefore, we designed a fabric pressure sensor model using Neoprene as our fabric surface and conductive threads as wires in the circuit. Then, we tested the model’s agility and availability to differentiate situations when the sensor touches the ground and not touching the ground. We have also checked its performance under conditions of bend and stretch. Experiments are underway to fabricate our sensor by depositing silver on the velostat to make the sensor more stable and agile. Additionally, we are planning to apply the same construction method to as many kinds of fabrics as possible to prosper the project’s popularity.

Project Mentor: Professor Kathryn Daltorio, Department of Mechanical and Aerospace Engineering
Sickle Cell Disease (SCD) is the most prevalent genetically inherited hemoglobin (Hb) disorder that can be fatal if left untreated. The current clinical standards for SCD screenings are expensive and centralized systems that demand high resourced infrastructure. HemeChip, a mass-producible microchip electrophoresis device, is a potential low-cost, point-of-care alternative to the current clinical standards, which separates, detects, and quantifies different Hb type(s). A strip of porous medium, made of Cellulose Acetate (CA), inside of HemeChip is where the hemoglobin separation takes place based on the pH of the electrolyte. HemeChip is a sealed closed (except a few openings) electrochemical device, which like any other closed electrochemical chip, faces in-chip evaporation and consequent condensation. The electrochemical process that takes place due to the applied electric field generates heat. The generated heat affects (i) the moisture capacity of the in-chip air, and (ii) the pH of the electrolyte. The moisture capacity of the in-chip air affects the evaporation of the electrolyte as well. The evaporation of the solvent from the electrolyte in the separation medium creates a change in the ion concentration. This change in ion concentration also results in a change of the pH in the separation medium. Thus, the heat generation and the consequent change in the hygrometric properties of the in-chip air and the change in electrolyte affect the hemoglobin separation process. To understand this intricate relationship better, there is a need to investigate how each of these factors affect the process. The proposed Computational Fluid Dynamics (CFD) analysis intends to investigate this complex process with a simplistic approach. With this approach, we will only investigate the thermal state inside HemeChip, without considering the porous separation medium. The separation medium acts as a resistive pathway between the electrodes to establish the electric field necessary for the Hb separation process. Interestingly, the porous separation medium has a characteristic dynamic resistance profile. In this study, we will perform a two-phase steady-state thermal analysis at different values along the characteristics resistance profile. This parametric study will emulate the quasi-steady state different stages of the dynamic behavior of the whole process. The computational results are validated against experimental data. The analysis will reveal the thermal contours and hygrometric state inside HemeChip.

*Project Mentor: Muhammad Noman Hasan, Department of Mechanical and Aerospace Engineering*
*Faculty Sponsor: Dr. Umut A. Gurkan, Department of Mechanical and Aerospace Engineering*

### Analysis of Cooling Systems

**Poyen Chen**, Department of Chemical Engineering; **Nathaniel Ginder**, Department of Chemical Engineering; **Jiwei Yao**, Department of Chemical Engineering; **Yuan Jiang**, Department of Chemical Engineering;

Cooling is a fundamental need for chemical company's running exothermic processes. Historically, the most efficient method of removing waste heat from a process is with a cooling tower. Water has a very large heat capacity and a large heat of vaporization. Cooling towers exploit these properties of water and remove heat via evaporation. Efficient cooling towers are necessary for plant safety and to maximize throughput of highly exothermic processes.

This project evaluated and improved the current Cooling Tower (CT) capacity of a real system which consisted of four cooling towers. The air flow rate was manipulated to achieve larger cooling capacities for each tower in the system. Higher air flow rates increase the amount of evaporation. New motors with more horsepower were used to increase the air flow rate via the fan mounted to the top of the towers. A simple economic analysis concluded the project and a reasonable payback period of 1.8 years was required to implement the new motors into the system.

*Project Mentor: Professor Uziel Landau, Department of Chemical Engineering*
Computer Extracted Features of Nuclei Shape, Architecture and Orientation from Initial H&E Tissue Biopsies Predict Disease Progression for Prostate Cancer Patients on Active Surveillance

Sacheth Chandramouli, Department of Biomedical Engineering; Patrick Leo, Department of Biomedical Engineering; Anant Madabhushi, Department of Biomedical Engineering

Following initial screening, prostate cancer (CaP) patients may opt for active surveillance (AS). AS requires routine screening procedures and defers curative treatment. Quantitative histomorphometry (QH) refers to the use of image-based features from digitized H&E tissue slides to quantitatively characterize morphology of disease patterns. In this work, we assess the ability of computerized features of nuclear shape, morphology and architecture from diagnostic biopsy images to predict CaP progression in AS patients. We gathered 191 (125 unfavorable and 66 favorable) AS patients who met the criteria of stage T1c, PSA < 10 ng/mL, Gleason sum (GS) ≤ 7, ≤ 2 positive cores, ≤ 50% core- involvement, PSA density < 0.15 ng/mL and life expectancy < 20 years. Increased tumor volume, GS, or PSA was termed unfavorable. Digitized H&E specimens were annotated by a pathologist for CaP regions. Nuclei were segmented from annotated regions and 216 features were extracted. Significant features were identified from our training set (60N), used to then create a QH based random forest model, and then subsequently validated on our testing set (131N). Significant features included shape features, Voronoi features, and the orientation of nuclei. The QH model yields an area under curve (AUC) of .75 on the testing set. When compared to the set of AS patients with proPSA measurements, the QH model yields an AUC of .79 while the proPSA model yield an AUC of .42. The shape features describe nuclear shape variation, relating to a loss of order.

Faculty Sponsor: Dr. Anant Madabhushi, Department of Biomedical Engineering

Reducing Sharps Container Related Hazards in the Operating Room

Akhil Bheemreddy, Department of Biomedical Engineering; Melanie Chetverikova, Department of Biomedical Engineering; David Garyantes, Department of Biomedical Engineering; Zohair Khan, Department of Biomedical Engineering; Sanjana Singh, Department of Biomedical Engineering

Sharps injuries continue to be an occupational hazard for surgeons, nurses, and anesthesiologists in the operating room. The goal of our project is to redesign the sharps container primarily used by the anesthesiologist. Specifically, our design aims to reduce harm caused by user error, prevent overfilling, and improve the tamper-proof capabilities of the container. To reduce user error, we’ve introduced a hinged dual-lid design, which prevents accidental injury during disposal. The lid is controlled by a foot pedal, which is also wired to a capacitive sensor that detects when the box is full and almost full. Both these states are indicated by two different LEDs. Also, when the box is full, it is forced to close, and an email is sent to the disposal company that the box needs to be replaced. There is a manual override to open the box when it’s full in case of an emergency. The lid also acts as an anti-tampering mechanism since the design restricts the user from having access to the contents of the box at all times.

Project Mentor: Peter Bielecki, Department of Biomedical Engineering

Faculty Sponsors: Dr. Colin Drummond, Department of Biomedical Engineering and Dr. Matthew Williams, Department of Biomedical Engineering

Intersections: SOURCE Symposium and Poster Session
Dual non-viral delivery from microparticles within 3D high-density stem cell constructs for enhanced bone tissue engineering

Melanie Chetverikova, Department of Biomedical Engineering; Alexandra McMillan, Department of Pathology; Peilin Ge, Department of Biomedical Engineering; Minh Khanh Nguyen, Department of Biomedical Engineering; Tomas Gonzalez-Fernandez, Trinity Centre for Bioengineering; Xiaohua Yu, Department of Biomedical Engineering University of Wisconsin-Madison; William L. Murphy, Department of Biomedical Engineering University of Wisconsin-Madison; Daniel J. Kelly, Trinity Centre for Bioengineering; Eben Alsberg, Department of Biomedical Engineering;

High-density mesenchymal stem cell (MSC) aggregates can be guided to form bone-like tissue via the endochondral ossification pathway in vitro when the culture media is supplemented with proteins, like growth factors (GFs) to guide the formation of a cartilage template followed by culture with hypertrophic factors. Recent reports showed controlled spatiotemporal delivery of chondrogenic transforming growth factor-β1 (TGF-β1) and chondrogenic and osteogenic bone morphogenetic protein-2 (BMP-2) from microparticles embedded within human MSC aggregates to avoid diffusion limitations and lengthy, costly in vitro culture that is needed with repeat exogenous supplementation. Since GFs have limited stability, localized gene delivery is a promising alternative to the use of proteins. Mineral-coated hydroxyapatite microparticles (MCM) capable of localized delivery of Lipofectamine-plasmid DNA (pDNA) nanocomplexes encoding for TGF-β1 (pTGF-β1) and BMP-2 (pBMP-2) were incorporated, alone or in combination, within MSC aggregates from three healthy porcine donors to induce sustained production of these transgenes. The three donor populations were investigated because of the noted MSC donor-to-donor variability in differentiation capacity. At week 2, delivery of pBMP-2 within Donor 1 aggregates promoted chondrogenesis followed by an enhanced osteogenic phenotype at week 4. Donor 2 and 3 aggregates did not promote robust glycosaminoglycan (GAG) production at week 2, but by week 4, Donor 2 aggregates with pTGF-β1/pBMP-2 and Donor 3 aggregates with both unloaded MCM and pBMP-2 enhanced osteogenesis compared to controls. These results show promotion of osteogenesis in stem cell aggregates through controlled, non-viral gene delivery within stem cell aggregates and indicate the potential need to screen donor MSC regenerative potential in response to gene transfer prior to clinical application. Overall, this work demonstrates a promising gene therapy approach to control stem cell fate in biomimetic 3D condensations for the treatment of bone defects.

Project Mentor: Dr. Eben Alsberg, Department of Biomedical Engineering

A Literature Review of Iron Metabolism, Status Data, and Related Concerns for Human Health

Miguel Chuidian, Department of Nutrition; Dr. James H. Swain, Department of Nutrition

This literature review discusses the role of iron in maintaining optimal human health. Iron homeostasis is maintained by numerous regulatory proteins which include various transporters and storage mechanisms. It is also affected by a variety of dietary factors which influence intestinal absorption such as animal tissues, phytic acid, polyphenols, ascorbic acid, and calcium. Iron status in humans is a nutritional topic of particular concern because many individuals around the world suffer from iron deficiency. Potential mothers, pregnant women, young children, and individuals who live in less developed countries are among those especially at risk. Such deficiencies may result in anemia, weakness, compromised immune function, and (among youths) impaired cognitive and behavioral development. Furthermore, iron overload (excess iron beyond recommended limits) is also a concern for some individuals due to its potential to promote inflammation, infection, and cancer risk. Further research and understanding of this essential micromineral will aid health care providers in more effectively treating and preventing iron-related disorders.

Project Mentor/Faculty Sponsor: Dr. James H. Swain, Department of Nutrition
A Phylogenetic Analysis of Feline Dental Structure on *Felidae* evolution

**Eric Chueh**, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

With cats being a common house pet in this day and age, phenotypic changes can be seen in their evolution to assist with the process of changing climates, varying diets, and gradual domestication. The *Felidae* family encompasses all living felids, ranging in size and form. Of the living *Felidae*, the *Pantherinae*—generally the bigger of the two subfamilies—possess imperfectly ossified hyoid bones, allowing the unhinging of the jaw (for bigger prey) and roaring; the *Felinae* by contrast are able to purr as their completely ossified hyoid bone allow vibrations in the larynx during respiration. With the increasing expansion of urbanization across the globe, promoting domestication while reducing wildlife area, it is reasonable to hypothesize a relationship between *Felidae* jaw structure and the progression of *Felidae* development in regards to species population and endangerment. Using a data set procured from Dryad recorded during a craniodental and prey study on the *Felidae*, as well as the family phylogeny from the Open Tree of Life, one can chart the evolution of these species and their dental structure variance as a function of time and population. Hypothetically, I predict a negative correlation between the size and enamel composition of the teeth of cats and the evolutionary distance from a common ancestor, and a positive correlation between the extinction/endangerment risk and the size of dental size and structure. Firstly, the data set and phylogeny analysis were performed through the *ape*, *picante*, and *phytools* packages in R. The mapped data was then analyzed for phylogenetic signal via Blomberg’s K and Pagel’s λ and charted for endangerment risk via comparison with the IUCN’s Red List of Threatened Species™, before accounting for variance with a phylogenetic PCA. The results were found to be supportive of the hypothesis, demonstrating an evolutionary trend of reduced jaw structure, allowing potential for biological and ecological implications regarding the role of human urbanization and progressive domestication on the evolution of cats.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

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Analyzing Commercialization Prospects of Rare Earth Metal and Oleochemical-Based Corrosion Inhibitors

**Anthony Cimo**, Department of Chemistry; Michael Goldberg, Department of Design and Innovation

Metal corrosion is a serious detriment to many forms of industry, and it is estimated that losses from corrosion are as high as 3% of US GDP. In prior decades, chromate was the most heavily used corrosion inhibitor, however chromate came under heavy regulatory restrictions due to its human and environmental toxicity. Commonly used replacements today, such as phosphates, are significantly less effective. Furthermore, future air quality regulations are looking to limit the use of volatile organic compounds (VOCs), further restricting viable replacements. Thus, there is a clear market need for compounds that are effective, non-toxic, and environmentally friendly. Here, rare earth salts and carboxylates (specifically based on cerium and lanthanum) and oleochemicals (specifically compounds derived from soybean and copaiba oil) are examined for commercialization potential through the lens of the Business Model Canvas and market research is used to determine key partners, key activities, key resources, value propositions, customer relationships, channels, customer segments, cost structure, and revenue streams.

Project Mentor: Michael Goldberg, Assistant Professor, Department of Design and Innovation

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**Active, Dynamic Stability Control System for Use in Small, High-Powered Amateur Rockets**

Vincent Cozza, Department of Mechanical and Aerospace Engineering; Benjamin Fruitman, Department of Mechanical and Aerospace Engineering; Richard Offhaus IV, Department of Mechanical and Aerospace Engineering

Few analysis of dynamic stability and control for current commercially small and high-powered amateur rockets is provided and this limits the ability of these systems to obtain consistent data. Scientific payloads that rely on this repeatability are thus required to use larger and more expensive systems, i.e. sounding rockets. This project aims to develop an active, dynamic stability control system that will allow smaller systems to more readily obtain repeatable performance characteristics. A simplified aerodynamic model will be developed to output stability and control derivatives given rocket geometry and a bench-top sample implementation will be constructed and implemented. Simulations will be conducted to validate control response stability.

*Project Mentor: Dr. Paul J. Barnhart, Ph.D., P.E., Department of Mechanical and Aerospace Engineering*
*Project Sponsor: Dr. Robert Gao, Ph.D., Department of Mechanical and Aerospace Engineering*

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**Mixed Reality Data Visualization**

Matthew Dean, Electrical Engineering; Steve Ruan, Electrical Engineering; Wenshao Zhu, Electrical Engineering; and Andrew Covarrubias Electrical Engineering & Computer Engineering

Mixed reality enables data analysis and visualization in an entirely new way through the use of technology such as HoloLens. With a mixed reality visualization of data, relevant parties (e.g. renovators, engineers, or maintenance staff) can better interpret specific sets of data in a clearer and defined way as well as getting data on demand and quickly without the need for setting up displays for said data. Using the HoloLens, our project aims to enable the visualization of energy usage data and temperature reading in real-time and in specific locations. This project would facilitate jobs that require access to real-time data to improve situational awareness. The visual data is intended to be displayed in real-time along with past data in an interactive manner using commands available to the Microsoft HoloLens. The HoloLens application will have the functionality to represent data in a meaningful way with the possibility of having a fully interactive user interface for the purpose of data analysis in the future. The data that will be represented is specific to a sensor, or sensor network, and the user will not necessarily have to look at just the sensor(s) for the visuals to appear. The application will also include a map that includes the sensor locations for the user.

*Project Mentor: Kenneth Loparo, Department of Electrical Engineering and Computer Science*
Effects of Internalized PLGA Nanoparticles on Gluconeogenesis in HepG2 Cells

Benjamin Crosby, Chemical Biology and Music; Dr. Andrei Maiseyeu, Cardiovascular Research Institute; and Dr. Alice Chaplin, Cardiovascular Research Institute

Approximately 29.7 million Americans are afflicted with type II diabetes mellitus, a disease characterized by chronic excess of blood sugar. Increased gluconeogenesis (GN), the production of glucose, has been linked to onset of type II diabetes. GN predominantly occurs in the liver, in which a pathway known as the Cori Cycle converts non-carbohydrate substrates (i.e. gluconeogenic substrates (GS)) into pyruvate and glucose. Poly(lactic-co-glycolic acid) (PLGA) is frequently used in drug delivery and biomaterials; however, the role of its degradation products, lactic and glycolic acid, in GN is unknown. The objective of this study is to establish the effects of PLGA nanoparticles on GN in hepatocytes, the cells often targeted by nanoparticles (NPs). In order to track NPs intracellularly, fluorophore-tagged NPs were prepared. We first conjugated PLGA to a fluorescent dye, AlexaFluor 647, using carbodiimide chemistry on solid support. This was followed by blending of PLGA-AlexaFluor 647 and bulk PLGA in acetonitrile, and subsequent nanoprecipitation in water. NPs were analyzed by dynamic light scattering in water and phosphate buffered saline (PBS). When measured in water, NPs gave a hydrodynamic diameter of 128.7±86.14 nm and polydispersity index (PDI) of 0.295, while in PBS NPs gave a diameter of 65.36±32.35 nm and PDI of 0.156. Human epithelial type II (HepG2) cells were subcultured at high density in collagen-coated dishes and incubated for 24 hours with NPs to allow for internalization. Cells were then incubated for 4 hours with 10 mM sodium lactate, a GS used by cells in GN. Following this incubation period, glucose concentrations were measured by fluorometric assay and lactate concentrations were analyzed by high-performance liquid chromatography. Through the analysis of glucose:lactate ratio, we hope to uncover previously unknown mechanisms of GN action of exogenous lactate in cells overloaded with NPs.

Project Mentor: Dr. Andrei Maiseyeu, Cardiovascular Research Institute

Improved Leg Design for Compliant-legged Robot for Amphibious Behavior in Surf Zones (CRABS)

Anna Krakora, Department of Mechanical and Aerospace Engineering; Ryan Curry, Department of Mechanical and Aerospace Engineering; Dr. Kathryn Daltorio, Department of Mechanical and Aerospace Engineering

Current autonomous robots with wheels and tracks have difficulty traversing surf zones due to the challenges posed by waves, sand, and rocks. A robot is currently under development that would use crab inspired locomotion in order to extend the reconnaissance ability of unmanned vehicles to surf areas. This project forms and integral part of the Compliant-legged Robot for Amphibious Behaviors in Surf-zones (CRABS) project and is concerned with the development of the robot’s legs. An initial leg linkage design exists, however, parameter optimization will allow for an increase in the leg’s mechanical advantage and overall functionality. In design of a new leg, particular attention was paid to improving the degrees of freedom in the legs motion and providing greater variability in its movement capabilities. New leg designs were modeled in Solidworks and prototyped using additive manufacturing. Through the evaluation of the leg’s grip strength, structural strength, stability, walking speed, range of motion, and design simplicity, both current and novel leg designs are compared to determine design effectiveness. The original design failed all evaluation criteria. Preliminary results show that new designs score higher across all evaluation criteria and prove that the crab inspired, compliant legged robot concept is a viable option for future autonomous vehicles. Further testing will be necessary to see if the ongoing design satisfies the above evaluation criteria.

Project Mentor: Dr. Kathryn Daltorio, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering
Generating GRAPPA Weight Sets for Undersampled Slices Using 3D Calibration Data in MRI

Evan Cummings, Department of Biomedical Engineering; Dominique Franson, Department of Biomedical Engineering; Nicole Seiberlich, Department of Biomedical Engineering

When imaging body motion using MRI, collected data often has to be undersampled in order to achieve the high frame rates necessary to image complex motion. Through-time radial GRAPPA is an algorithm used to reconstruct undersampled data. It requires a large set of fully-sampled calibration data in order to generate GRAPPA weight sets, which capture the relationships between neighboring collected and uncollected data points. However, when switching slice position or orientation, these weight sets change, so undersampled data collection must pause while calibration data is recollected. This investigation examines methods of interpolating weight sets for different slices and orientations within a volume using 3D calibration data. This will ideally allow doctors to switch slice position and orientation without having to pause scanning to recollect calibration data. A weight set interpolation system was tested on phantom data and on cardiac data collected in healthy volunteers. In the tested reconstruction process, an undersampled slice was collected between two fully-sampled calibration slices. The undersampled slice was then reconstructed using combinations of the weight sets from the calibration slices - either by applying one weight set to the undersampled slice, or using an interpolation of the two weight sets. In addition, the distance between the calibration slices was varied, as well as the position of the undersampled slice between the two. As a reference, the undersampled slice was reconstructed using a weight set calculated from fully-sampled data collected at the same position. These test conditions yielded varying results - some of the reconstructions were visually similar to the reference reconstruction. However, other reconstructions had significant visual artifacts, especially when there was a large distance between the calibration slice and the undersampled slice. Overall, with some modifications to the interpolation method used, this could be a possibility for improving the flexibility doctors have when using MRI as a motion imaging technique.

Project Mentor: Nicole Seiberlich, Department of Biomedical Engineering

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An analysis of diet quality of pregnant women in the U.S. by educational status

Allison Danko, Department of Nutrition

Inadequate nutrient intake during pregnancy, especially protein and certain micronutrients, can lead to a decrease in birth weight and long term health consequences for the child. Even though the quality of diet is known to be important, women receive little to no nutrition intervention during pregnancy. The purpose of this study is to determine the diet quality, measured via Healthy Eating Index (HEI) scores, and the difference in diet between education levels, for pregnant women to determine if they are in need of nutrition intervention. Examining HEI scores will show overall dietary patterns of pregnant women and where improvement needs to occur. Twenty-four hour recalls from pregnant women over the age of 20 were collected from the National Health and Nutrition Examination Survey (NHANES) from cycles between 2005-2014. The data were analyzed to calculate overall and subcomponent HEI scores using frequency and descriptive statistics for the sample overall and also by education category. Differences in HEI scores across education levels were assessed using one-way ANOVA. Five hundred and sixty-two pregnant women were included in the study and had an average HEI score of 52.0 (out of 100). Pregnant women scored lowest, less than 50% of maximum score, in the following subcomponents: greens and beans, whole grains, seafood and plant proteins, fatty acids, and sodium. Significant differences in subcomponent scores across education levels were noted in total fruit, whole fruit, whole grain, empty calories, and total HEI score. Based on the results, pregnant women are in need of educational nutrition intervention, specifically to those with less than a high school education.

Project Mentor: Rosanna Watowicz
**Recovery after Chronic Spinal Cord Injury due to Lenti-Chondroitinase and Intracellular Sigma Peptide**

Nicholas Curtis, Department of Biology; Adrianna Milton, Department of Neuroscience, School of Medicine; Bruce You, Department of Neuroscience, School of Medicine; Dr. Jerry Silver, Department of Neuroscience, School of Medicine

After contusive spinal cord injury (SCI), a potently inhibitory environment develops around the axons. In the case of a three-month chronic thoracic-level eight (T8) injury, this environment significantly reduces the ability of axons to regenerate; thus the functional recovery of the lower body is compromised. This chronic stage of SCI features upregulation of growth restricting chondroitin sulfate proteoglycans (CSPGs) in the glial scar and perineuronal net (PNN) near and distal to the lesion. An injection of Chondroitinase ABC (ChABC), rids the CSPGs of their inhibitory glycosaminoglycan (GAG) chains by means of enzymatic elimination. GAGs, when bound to the leukocyte common antigen-related family receptor protein tyrosine phosphatase sigma (RPTPσ), impairs fiber regeneration/sprouting at and around the SCI by inducing a dystrophic phenotype in growth cones. Intracellular Sigma Peptide (ISP) acts as a synthetic PTPσ receptor blocker, thereby inhibiting the PTPσ-GAG interaction. Both treatments promote axon regeneration. When injected acutely after SCI, ISP promotes recovery via axon sprouting through the PNN. ISP only treatment produced minimal therapeutic recovery, so the Silver Lab combined it with an administration of a lentiviral delivery of ChABC (Lenti-ChABC) to better overcome CSPG mediated inhibition of axon regeneration/sprouting through CSPG digestion. The combined treatment showed significant improvement of locomotion in chronic T8 contusive SCI in adult female rats. The rats, when treated with ISP, Lenti-ChABC, or both, showed increases in serotonin dense fibers caudal to the lesion (lumbar levels 2-4). Increased serotonergic innervation only in part aided motor recovery (thus suggesting some other mechanisms are also responsible for sprouting/regenerating in the model), as no correlation was found between high 5-HT fiber density and the animals with the best functional recovery. The results show that manipulation of the glial scar and PNN through enzyme and peptide therapy, three months after a contusive SCI, facilitates serotonergic nerve growth and recovery of some critical motor functions. As such, the model is clinically relevant to support a path for a translatable standard treatment for individuals suffering from paralysis due to chronic SCI.

*Project Mentor: Dr. Jerry Silver, Department of Neuroscience, School of Medicine*

*Faculty Sponsor: Dr. Hillel Chiel, Department of Biology*

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**The Utilization of Music Therapy during Physical Therapy & Rehabilitation for Patients with Developmental Delays**

Meghan Dayringer, Department of Biology

Physical therapy and music therapy were developed as separate practices, however, they can be used in conjunction with each other in order to maximize the outcomes. Music therapy is versatile by nature and has been used in many other fields throughout medical practices and widely used during the care and rehabilitation of patients with physical and cognitive developmental delays. Music Therapy incorporates these other practices and promotes growth in fine motor skills, muscular strength, increase in range of motion, and even more. While these are also goals of physical therapy, it makes sense to combine the techniques in order to create a relaxing, productive, and fun environment where development, control, and growth can flourish.

*Project Mentor: Dr. Richard Drushel, Department of Biology*
**Random Lasing in Liquid Crystals Doped with Dyes and Plasmonic Nanoparticles**

**Kelsey Darrah**, Department of Physics; Glynis Schumacher, Department of Physics; and Giuseppe Strangi, Department of Physics

Laser light is generated by merging two important physical mechanisms, amplification and optical feedback. Amplification is mainly due to gain materials, whereas the optical feedback is obtained through an optical cavity that allows for mode selection via light localization. This light localization mechanism is typically created using two mirrors. However, it is possible to replace this cavity with a multiple scattering material, such as dielectric particles or nematic liquid crystals. This partially-ordered system has demonstrated the ability to produce random laser action, using the fluctuations of the dielectric tensor to scatter and coherently amplify lightwaves. This phenomenon can be examined in both confined and boundary-free systems. This project will examine properties of this random lasing action in liquid crystals doped with fluorescent guest molecules and plasmonic nanoparticles. The main objective of this project will be the generation of random laser light in doped liquid crystals confined in different geometries in which we can control the optical feedback strength. The second objective will be to exploit local plasmonic field distribution to enhance overall the quantum yield of the gain material and the scattering of the system.

*Project Mentor: Professor Giuseppe Strangi, Department of Physics*

*Faculty Sponsor: Professor Rolfe Petschek, Department of Physics*

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**Honey: The Effect of Flora on Its Chemical Composition and Properties**

**Stephanie Collins**, Department of Chemistry

The focus of this capstone project is to develop a deeper understanding of the influences of floral sources on the chemical composition of honey. Honey has been known for its use as a sweetener, but also its health benefits as it has antioxidant and antibacterial properties. This literature review has found that not only the flora, but also the geographic location of the flora affects the composition of honey. The chemicals of interest in this study are found to be phenol-based compounds that are primarily flavonoids and phenolic acids. Although sugar and mineral composition are affected by flora as well, the phenolic compounds have the most significant role as they affect the most recognizable features such as color and flavor, as well as the antioxidant and antibacterial capacities of the honey.

*Project Mentor: Dr. Rekha Srinivasan, Department of Chemistry*
**Neonatal Wrist Band for the Detection of Sudden Unexpected Postnatal Collapse**

David Dang, Department of Biomedical Engineering; Ana Scalamandre, Department of Biomedical Engineering; Michelle Chin, Department of Biomedical Engineering; Dylan Brown, Department of Biomedical Engineering; He (Heather) Feng, Department of Biomedical Engineering; Tenson Cai, Department of Biomedical Engineering; Divya Joseph, Department of Biomedical Engineering; Xujia (Jessica) Li, Department of Biomedical Engineering; Carolyn Zheng, Department of Biomedical Engineering; Aoxue (Mia) Miao, Department of Biomedical Engineering

Sudden unexpected postnatal collapse (SUPC) is a rare, life threatening condition where a seemingly healthy baby suddenly experiences cardiac and respiratory failure. This usually occurs in the first few hours after birth when the newborn is in skin-to-skin contact (also known as kangaroo care) with the mother and not being monitored by medical devices. There exists two prevalent arguments, both for and against immediate skin-to-skin contact post delivery. It is comforting for the mother to hold her child directly after birth and research has shown benefits such as improved breathing pattern, improved oxygen saturation levels, and stabilization of the baby’s heart rate. On the other hand, the infant is at higher risk of SUPC during kangaroo care, as no monitoring devices are used to alert medical professionals should SUPC occur. Therefore, there exists a need to develop a device that monitors babies for SUPC while allowing the mother to have the beneficial skin-to-skin contact with her newborn.

Currently, the only safeguard against SUPC is parents being advised to alert hospital staff if they notice their baby turning blue or stop breathing. Since this is a subjective observation, we want to design a device that uses quantitative measures to directly alert nurses when the baby is experiencing symptoms of SUPC.

Our prototype will be a hypoallergenic wristband with a one-time use band and a multi-use electrical component which will be housed in an electrically insulated case. This wrist band with embedded sensors will be able to measure oxygen saturation level, heart rate, and temperature, while also cleaning the signals. The cleaned signals will be wirelessly transmitted from the wrist band to a “lilypad” monitor that will be clipped to the crib, which will then be programmed to analyze the data and transmit it to a main computer at the nurse’s station. Due Bluetooth’s limited range, the lilypad device acts to extend the area of coverage. Should any of the measured parameters fall below a pre-set threshold for a pre-set amount of time, or if any data is not being sent, the lilypad device will display a notification for medical staff.

*Project Mentor: Yiqiao Liu, Department of Biomedical Engineering*
*Faculty Sponsor: Dr. Colin Drummond, Dr. Matthew Williams, Department of Biomedical Engineering*
Designing a Multi-Purpose Pen for Everyday Use and Carry of College Students

Antonio Dempsey, Department of Materials Science and Engineering; Paul DiPippo, Department of Materials Science and Engineering

This pen is a crowdsourced idea built from undergraduate students on what they carry and/or utilize on a regular basis. With this pen students can have access to multiple tools that may not all fit into your pocket, and condense all of these items into a single pen. Some of these may include a laser pointer, a penknife, a bottle opener, and a key bar. It can then be carried everywhere a student goes while still fulfilling the original needs of the items. These will then be put into a CAD model using appropriate tools and then go through a materials selection process utilizing CES EduPack 2017. Due to the fact the preliminary materials will include a metal of some form for durability a prototype will not be built at this time.

Project Mentor: Professor K. Peter D. Lagerlof, Department of Materials Science and Engineering

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Critical Utility System Simulations in Pharmaceuticals Manufacturing

Emily Deng\textsuperscript{a}, Cristina DiFranco\textsuperscript{a}, James Madden\textsuperscript{a}, Rachel Swanson\textsuperscript{a}

\textsuperscript{a}Department of Chemical and Biomolecular Engineering, Case Western Reserve University

This project is a series of simulations used to optimize the material and energy use in producing water-related utilities for Vancomycin, a life-saving antibiotic. Since injectable pharmaceuticals are a heavily FDA-regulated industry, standard utilities must be further processed for manufacturing use. The refined utilities used at Xellia Pharmaceuticals are called critical utility systems and include water for injection (WFI) and clean steam (CS). The Aquality consulting team conducted process simulation and economic analysis of critical utility systems in compliance with cGMP standards. Several process parameters, such as a high pipe velocity in a turbulent flow regime, must be met in order to prevent microbial growth in the water lines and ensure operation of equipment within limitations. Energy, water, and equipment usage were optimized to balance loads from several manufacturing lines in the plant through Excel calculations. Cost drivers were analyzed to determine the cost per gallon of WFI and CS production. The goal of the process simulation was to minimize resource consumption while meeting the demands of increasing manufacturing load. Additionally, the team developed a user guide for the simulators to allow a smooth transition to the next system owner.

Project Mentors: Professor Daniel Lacks, Department of Chemical and Biomolecular Engineering; Professor Uziel Landau, Department of Chemical and Biomolecular Engineering
Project Supervisor: Joseph Yurko, Xellia Pharmaceuticals

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Risk Assessment in High-Achieving Adolescents

1Anshul Dhingra, 2Amelia Bahamonde, BS, 3Yolaine A. Civil, MD, 2,4Roland Alexander Blackwood, MD, PhD

1Department of Biomedical Engineering, Case Western Reserve University, 2Office for Health Equity and Inclusion, University of Michigan Medical School, 3Pediatrics and Communicable Diseases, University of Michigan Health System, 4Pediatric Infectious Diseases, University of Michigan Health System

Background: Adolescence is a period of social, physical, and psychological development. While it has its stages of exploration and experimentation, it is accompanied by a fair share of risky behaviors. Most health problems among adolescents are due to risky behaviors as opposed to biological dysfunction (genetic diseases, physiological ailments etc.) Almost 75% of the causes of death in the adolescent population are preventable, and therefore addressing these risky behaviors in health care visits is essential to reducing morbidity and mortality. The Rapid Assessment for Adolescent Preventive Services (RAAPS) is a 21-item questionnaire designed to identify risk factors in adolescents based on generally accepted risk categories. Objectives: Our goal was to evaluate and analyze the most prevalent risk factors in a general adolescent population at Michigan Medicine Health Clinics and compare this to risk factors of high-achieving adolescents in the MHSPEA program. The goal was to determine whether or not high-achieving students are more or less prone to risky behavior. Methods: RAAPS questionnaire was administered to adolescents, ages 13-19, coming to outpatient clinics at Michigan Medicine Health Clinics for annual health maintenance exams. Demographic characteristics were obtained from a retrospective chart review. The RAAPS questionnaire was constructed in the form of a Qualtrics survey and emailed to the current and previous cohorts in the MHSPEA program. The rates of high-risk behavior in both populations were determined and then compared using the Chi-squared test for categorical variables. Results: The average risky behavior score per adolescent was 1.95 in the general population and 3.53 in the PEA students. The prevalence in the top 7 risk factors between both groups was also greater in the PEA adolescents compared to the general population. PEA had six statistically significantly larger risky behavior categories, depression (p-value=0.0015), victim of bullying (p-value=0.0005), anxiety (p-value=0.0063), distracted driving (p-value=0.0001), no adult support (p-value=0.0002), and eating disorder (p-value=0.0481). Conclusions: PEA students are more prone to risky behavior than a general population of adolescents. High academic performance is not an indicator of reduced risky behavior, and we did not find any correlation at all between the two.

Project Mentor: Yolaine A. Civil, MD, Pediatrics and Communicable Diseases, University of Michigan Health System

Molecular Dynamic Simulation of Disease-Causing Mutation Y235S in Domain C1 of cMyBPC

Chang Yoon Doh, Department of Physiology and Biophysics, B.S. in Biochemistry; and Julian E. Stelzer, Department of Physiology and Biophysics, CWRU School of Medicine

Hypertrophic cardiomyopathy (HCM) is an inherited disease that affects about 1 person per 500 people in the human population worldwide, and the most common and frequent genetic causes of HCM are MYBPC3 gene mutations. Specifically, Y235S mutation in domain C1 of cardiac myosin binding protein C (cMyBPC) is implicated in actin or myosin binding and has been shown to cause disease phenotype in in vitro experiments (unpublished). In order to explore the structural basis for Y235S mutation induced functional changes in the heart, molecular dynamic (MD) simulation experiments were carried out using template based homology model of domain C1. Domain C1 of cMyBPC has important interactions with actin and myosin, and the MD simulation showed that the mutant C1 domain’s structural integrity was lost as seen through: A) shift from an organized turn to a random coil between B/C motifs and breakage of $3_{10}$ helix between C/D motifs, B) 53.94% reduction in hydrogen bonding occupancy of residue 235, C) destruction of R158-D246 salt bridge, D) 33.49% reduction in average solvent accessible surface area of residue 235 from 333.63±0.04 to 221.90±0.03, and E) alteration in van der Waals surface shape and electrostatic potential.

Project and Faculty mentor: Dr. Julian E. Stelzer, Department of Physiology and Biophysics

Intersections: SOURCE Symposium and Poster Session 27
The Effects of Host Diet, Life Span, and Home Range On Interspecies Host-Parasite Relationships

Nikola Dikic, Department of Biology; Dr. Jean H. Burns, Department of Biology

The lifestyle of a host organism can drastically impact that individual's susceptibility to certain parasites. Host Diets can increase the chance of coming into contact with different parasites, shorter living species may be more susceptible to infection, and having a greater home range may increase the spread of certain parasites by increasing the chance to come into contact with them. This experiment set out to find whether these three traits play a role in the infection rate of host species. To do this, data on 56 host species was attained through other studies found on Web of Science, Google Scholar, and PubMd. The data from these studies was standardized and multiple PGLS analyses with infection rate being the dependent variable and the three traits being the independent variables were done in R using the ape, picante, lmtest, hmisc, phytools, and roll libraries. The results showed that omnivores were at a greater risk for infection by parasites than herbivores. Furthermore, as the lifespan of the species decreased, the infection rate increased. Finally, as the home range of a species increased, the infection rate also increased. Although there are multiple variables at work, it is predicted that omnivores and species with an increased home range have higher infection rates due to the fact that they have a greater chance of coming into contact with parasites. Species with a shorter lifespan also have an increased infection rate due to an increased density caused by the increased fecundity seen in shorter living species.

Project Mentor: Dr. Jean H. Burns, Department of Biology
Project Mentor TA: Jennifer Murphy, Department of Biology

Reusable Acute Diagnostic Pulse-Oximeter

Deniz Dosluoglu, Department of Electrical Engineering and Computer Science; Colin Budka, Department of Electrical Engineering and Computer Science; George Enwia, Department of Electrical Engineering and Computer Science, John Gibbons, Department of Electrical Engineering and Computer Science

Pulse oximetry is a non-invasive tool that measures blood oxygen levels and is used for clinical diagnosis of respiratory diseases (including pneumonia). Current commercially-available pulse oximeters do not meet the needs of pediatric patients in middle and low income countries. The need for a durable, sustainable and low cost forehead pulse oximeter is present, which is a project that is currently being undertaken by the Global Health Design Collaborative (GHDC) at Case Western Reserve University. Our project is focused on selecting a microcontroller that can be integrated into the existing housing model and developing and implementing algorithms that can generate accurate peripheral capillary oxygen saturation (SpO2) and heart rate values.

Project Mentor: John Gibbons, Department of Electrical Engineering and Computer Science
Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering and Computer Science
Experimental Measurements of Fe Self-Diffusion in FeS at High-Pressure

Kylie M. Dollard, Department of Earth, Environmental, and Planetary Sciences

In the solar system, planetary bodies form by collisional growth. Information on the timing and manner of planetary collisions can be obtained through research on iron meteorites. Based on the chemical characteristics of these meteorites, scientists have inferred that they originate from ~60 distinct parent bodies, which were among the first bodies to form in the solar system. It is possible to estimate the size of these parent bodies by determining the cooling rates of iron meteorites. In order to determine this information, isotopes produced during radioactive decay can be measured and used to determine an age that corresponds to the temperature when the system became closed. This temperature depends on the rate at which atoms diffuse through a mineral as a function of temperature, which has to be determined experimentally. Troilite (FeS) is a mineral contained in virtually all iron meteorites, and various cooling speedometers based on chemical or isotopic exchange between metal and troilite have been proposed. There has been only one study of diffusion in troilite, and it is 44 years old (Condit et al., 1974). A simple way of determining diffusion coefficients in many materials is to measure the rate of growth of a reaction rim, which is normally controlled by diffusion. In this case, a convenient reaction is Fe (metal) + FeS2 (pyrite) = FeS (troilite). Diffusion experiments of this kind, which seem simple and straightforward, can be more complicated than they appear. Here we show that the growth of troilite between pyrite and metal at 2 GPa pressure is far too fast to be controlled by chemical diffusion through the troilite, and instead likely involves vapor-phase transport between grains during heating of the experiment. This type of rapid reaction is unlikely to apply to iron meteorites, which do not contain pyrite, but could be important in experimental and natural situations when one of the components (in this case sulfur) is volatile.

Project Mentors: Dr. Jim Van Orman, Chair of Department of Earth, Environmental, and Planetary Sciences; and Robert Moore, Department of Earth, Environmental, and Planetary Sciences

Design Improvements of High Velocity Gas Burner for Thick Wall Kilns and Furnaces

Kathryn Dzierwa, Department of Mechanical and Aerospace Engineering

High velocity gas burners are made to create heat treat options for many applications. The burner that this project focuses on is made specifically to work with thick wall applications, which may include ceramic kilns, galvanizing tanks, salt baths, lead and zinc pots, etc. The ultimate goals of this project: (1) optimize the design to reduce manufacturing costs; (2) increase life span by making the gas burners more repair-friendly and (3) improve versatility and dependability. These goals are realized through design optimizations, manufacturing processes, and demonstration through testing. Some design optimizations include: the air inlet, the stabilizer, the gas tube connection and the refractory connection. The manufacturing and demonstration include: a product prototyping, and testing for stability, emissions and other flame characteristics.

Project Mentor: Dennis Quinn, Product Development Manager, Fives North American Combustion, Inc.
Hydroponic Heating System for Urban Agricultural Development

Jasmine Heusey, Department of Mechanical and Aerospace Engineering; William Dorow, Department of Mechanical Engineering.

Hydroponic systems grow plants without soil by using the flow of nutrient rich water over the roots of the plants. This system is ideal for urban agricultural practices as it conserves space while producing a large amount of crop. The Community Greenhouse Partners of Cleveland is installing a hydroponic system for the growth of lettuce in an outdoor greenhouse. This creates a unique challenge as hydroponic systems require strict water temperature requirements in order to effectively grow plants and many plants cannot survive if temperatures get too low. Another challenge to the system development is the need for it to be as low cost as possible. Because the Community Greenhouse Partners are a non-profit organization, they rely on outside funds for projects like this. The system should be as low cost as possible so that the community will be willing and able to support it. This research is concerned with developing a low cost heating system that will allow the hydroponic lettuce to grow in the greenhouse year-round in order to maximize crop yield. The heating system consist of two parts. The first part heats the water for the system in a reservoir with the use of a resistive heating element. The second part heats the ambient air with a rocket stove mass heater. When fully developed the system should be able to keep both the ambient temperature in the greenhouse and the water temperature approximately 65°F. The ambient air should even under the harshest conditions never dip below 45°F and the water should remain above 60°F. The team will build the rocket stove mass heater and measure its heat output in order to ensure that the desired temperatures can be reached. Because of the season of the project, there will not be an opportunity to test the system in the environment it is designed for. However, modeling will be done to ensure that it will function properly in the winter.

Project Sponsor: Timothy D. Smith, Community Greenhouse Partners; Sunniva Collins, Department of Mechanical and Aerospace Engineering

Faculty Sponsor: Professor Robert X. Gao, Ph.D., Department of Mechanical and Aerospace Engineering

Insight into Mechanisms of Graves’ Disease

Tal Eitan: Biology Department; Karen Abbott, Ph.D.

Hyperthyroidism is characterized by the thyroid gland’s overproduction of thyroid hormone. Graves’ disease (GD), an autoimmune disorder, is the most common cause of hyperthyroidism. The body experiences muscle weakness, mood swings, anxiety, bulging eyes, and heart palpitations, among other highly irritating symptoms. Graves’ disease has both a genetic and environmental compound that factor into its occurrence while its exact cause remains to be determined. Treatments currently in existence have major side-effects that alter the quality of life of patients. Current treatments attempt to balance thyroid hormone production between hyperthyroid and hypothyroid functionalities as relating to thyrocytes. This study explores the mechanisms involved in the causality of GD as it relates to the self-antigens of thyrocytes and discusses potential treatments utilizing the mechanism of preventing rejection of allografts to eliminate the autoantibody reactions leading to GD. The study also explores the virus priming leading to GD and discusses how further cross-reactions of self-antigens with tissues that do not provoke autoantibody reactions could diminish the effects of GD. Additionally, we examined possible treatment options concerning the adjustment of thyrocyte death modulators that exist more prevalently in thyroids under hypothyroidism. The latter approach is part of a larger effort to discuss how hypothyroidism and hyperthyroidism relate to one another, mechanistically, and to try to resolve one by the implementation of effectors of the other. These mechanical insights can be used to theorize different methods to potentially reduce symptoms and treat hyperthyroidism.

Project Mentor: Dr. Karen Abbott, Department of Biology
Percutaneous Endoscopic Gastrostomy (PEG) Insertion and Anchoring Device

Kelsey Bean, Department of Biomedical Engineering; Katherine Burelbach, Department of Biomedical Engineering; Yuxuan Cheng, Department of Biomedical Engineering; Annamarie Drechsler, Department of Biomedical Engineering; Caitlin Fernandez, Department of Biomedical Engineering; and Sayde Slobodien, Department of Biomedical Engineering

Percutaneous Endoscopic Gastrostomy (PEG) feeding tubes are widely used as a route of feeding and nutritional support in patients with a function gastrointestinal system who require long-term enteral nutrition. A PEG procedure constructs a track between the stomach and the abdominal wall where the feeding tube will be placed. After a track has formed, a feeding tube with an attached anchoring component is placed. The anchor serves to stop the tube from falling out of the stomach. To reduce trauma during insertion of the PEG tube, anchors are collapsible for insertion, and can expand once in the stomach.

The current collapsible anchor designs require maintenance from patients and often do not fit snugly enough against the stomach lining to prevent leakage of fluid. The expanding mechanism of the current anchor designs is a balloon that inflates by filling with saline solution. Patients must constantly monitor the volume of the balloon solution to keep the anchor effective. A new PEG feeding tube design that improves the internal anchoring device while maintaining easy insertion will allow patients and caregivers to more easily insert the feeding tube without compromising the tube quality.

To mitigate the risk of tube dislodgement due to balloon deflation, the current study proposes an alternate PEG feeding tube anchor design that expands through mechanical folding in place of a balloon. By using a different expanding mechanism, the device mitigates complications from balloon deflation and may reduce hospital readmission as a result.

The proposed origami-inspired anchoring device will mitigate trauma by adding less than ½ inch of diameter to the PEG feeding tube during insertion. The silicone component attached to the peg tube will fold into an expanded anchor once inserted, anchoring the tube in the stomach.

Project Mentor: Dr. Colin Drummond, Department of Biomedical Engineering
Other contributors: Dr. Matthew Williams, Department of Biomedical Engineering; Peter Bielecki, Department of Biomedical Engineering; Dhruv Seshadri, Department of Biomedical Engineering; Dr. Amitabh Chak, University Hospitals Department of Gastroenterology

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Enhanced Ultrafast Intersystem Crossing Dynamics for 6-Selenoguanine Relative to 6-Thioguanine

Kieran Farrell, Department of Chemistry; Matthew Brister, Department of Chemistry; and Dr. Carlos Crespo-Hernández, Department of Chemistry

Intersystem crossing from an electronically excited singlet state to a triplet state is a classically forbidden process that typically occurs with lifetimes no faster than hundreds of picoseconds in organic molecules. As a result, intersystem crossing pathways may be less competitive with faster singlet state relaxation processes resulting in diminished triplet yields. Sulfur substitution of carbonyl oxygen atoms on DNA nucleobases has been shown to open an ultrafast intersystem crossing pathway, which in some cases dominates excited state relaxation, resulting in high triplet yields. Substitution with a heavier group 16 element in lieu of sulfur should increase the intersystem crossing rate and enhance triplet yields. Using time-resolved absorption spectroscopy, supported by Time-Dependent Density Functional Theory computations, the excited state dynamics of 6-selenoguanine are revealed and compared to those of 6-thioguanine. A comprehensive electronic relaxation mechanism is proposed, indicating enhancement of intersystem crossing both to and from the triplet manifold resulting in an efficiently populated, yet short lived triplet state. In addition to examining fundamentally interesting photochemistry, this investigation provides insights relevant to technologies exploiting excited triplet state populations.

Project Mentor: Professor Carlos Crespo-Hernández, Department of Chemistry

Evolutionary relationship between diet preference and migration selection traits

Yassin B. El-Najjar Department of Biology and Department of Chemistry

There are established hypotheses regarding avian migration, including Cox’s “stepping stone” hypothesis, Levey’s “evolutionary precursor” hypothesis, and Vincze’s “energy trade-off” and “behavioral flexibility” hypotheses. Migratory species are adapted to develop smaller brain sizes and head features not only as a measure to reduce flight costs but also because of phylogenetic lineage patterns. This study compares species of migratory and non-migratory birds in terms of migration distance (km), prey preference, and physical measurements of head areas (brain, eyes) to illustrate that the selection for larger brain size by prey preference (“diet” hypothesis) and the selection for smaller brain size by migratory flight both contribute to the diverging evolution of relative brain sizes of bird species. Phylogenetic principal component analysis, involving picante, ape, and phytools packages in R (Kembel et al. 2010), is used in this project; the traits of cranial size (eyeball size, telencephalon size, brain mass, brain size) and migration distance for the set of bird species is compared to study which has the largest variance. This analysis helped account for traits with large variance and knowing the extent of that variance. Phylogenetic signal is also used to understand the extent of dependence among trait values (diet and migration) due to phylogenetic lineage. pPCA results showed little variance among close relatives for migration distance and larger variance compared to more distantly related species. The positive correlation found between fruit preference and migration status supports my hypothesis that preference of prey also plays a role in evolutionary morphological patterns. These results indicate a significant effect of prey preference on the evolution of avian migration.

Project Mentor, Faculty Sponsor: Dr. Jean Burns, Department of Biology, Case Western Reserve University
Synergistic Targeting of EZH2 and Androgen Receptor Suppresses Proliferation, Invasiveness and Induces Cell Cycle Arrest in Castrate Resistant Prostate Cancer Cells

Victoria El-Hayek, Department of Psychology; Eswar Shankar, Department of Urology; Daniel Franco, Department of Biology; Omair Iqbal, Department of Biochemistry; Rajnee Fnu, Department of Urology; Sanjay Gupta, Department of Urology

Androgen receptor (AR) has emerged as an important therapeutic target in the treatment of metastatic prostate cancer as evidenced by androgen deprivation therapy (ADT). While almost all metastatic prostate cancers initially respond to ADT, in general disease reemerges in the form of castration-resistant prostate cancer (CRPC). Enzalutamide (ENZU), a second-generation AR antagonist, exhibited survival advantage in CRPC patients, show relapse within a year, activating AR in these tumors. Recent genomic studies reveal AR-regulated genes contribute to CRPC emergence. Enhancer of zeste homolog 2 (EZH2), the catalytic member of the polycomb repressor complex PRC2 is upregulated in CRPC that interacts with AR. Association between EZH2 and AR might be a cause for developing chemoresistance, suggesting a novel combination therapy could be efficacious in CRPC treatment. Castrate-resistant human prostate cancer C4-2B and 22Rv1 were treated with EZH2 inhibitor GSK126 and AR antagonist ENZU individually and in combination. Treatment of CRPC cells individually with GSK126 and ENZU (2.5-80 µM) for 24 h exhibited a partial suppressive effect in cell growth. Using GSK126 and ENZU combination at 1:1, 1:5, 1:10 and 1:20 micro-molar ratio exhibited increased cell growth inhibition, where 1:10 ratio showed synergistic effect in inhibiting cell growth in both cell lines. This combination caused marked increase in G0/G1-phase cell cycle arrest followed by cell death, inhibition of migration and invasion in both cell lines. Furthermore, combination treatment led to significant reduction in the protein expression of AR and EZH2 in both cell lines, compared to individual treatments. Our study provides new possibilities of uncovering a novel path of treating CRPC by simultaneously targeting EZH2 and AR using a combinatorial approach.

Project Mentor: Sanjay Gupta, Department of Urology

"There are no Black women here. I'm not welcome in this company": The Lived Experiences of Professional Dancers of Color

MaryTherese Escueta, Departments of Sociology & Dance

This life history project examines the lived experiences of professional dancers of color. There is a gap in the literature for professional dancers of color, their voices, and their experiences. They are underrepresented within professional concert dance companies and have faced documented racial discrimination. It is imperative that we understand the how and why of this racial underrepresentation. Life histories or oral histories are a method of qualitative, empirical data collection that provide the opportunity for the participant to use their own voice to narrate their experiences and acknowledge the power differential that frequently occurs between researcher and participant. My study was conducted from September 2016 to December 2017. I received IRB approval in early October 2016 and recruited seven participants. I conducted two in-person open ended interviews with each participant, each interview lasting between 1-2.5 hours. After conducting the interviews, the audio was transcribed and I used grounded theory to engage in line-by-line coding. Several themes emerged from the analysis and black feminist theory helped frame these concepts within the larger American society. To my knowledge, no oral histories of professional dancers of color exist. This study aims to fill this gap in the academy. By further understanding these dancers' experiences, we can better understand the raced hierarchies in the dance world.

Project Mentor and Faculty Sponsor: Dr. Mary Erdmans, Department of Sociology
An Improved Control System for Rotational Electrode Electrochemical Alignment Device

Umit Levent Erol, Department of Mechanical Engineering

Collagen is the most abundant protein in the human body, and the building block of tendons. This makes collagen a very promising biomaterial for tendon reconstruction and repair. However, most lab-made collagen constructs lack the mechanical strength for demanding applications like orthopaedic repairs. Electrochemically aligned collagen (ELAC) threads are pure collagen structures produced by aligning collagen molecules using a constant electric field. ELAC threads are highly aligned, mechanically robust, and are suitable for demanding tissue engineering applications such as sutures and orthopaedic scaffolds. A rotational electrode electrochemical alignment Device (REEAD) is used for producing continuous ELAC threads.

A control system with semi-autonomous capabilities was designed and built, and tested for the current and next generation REEAD to minimize the need for an operator during ELAC production. The system was designed by considering the process for thread fabrication, as well as the operating conditions and feedback from current and past users of the REEAD. The new control system is powered by a single board computer. An image processing algorithm uses a live video feed to measure the tension of the thread and controls production speed to keep the tension in an optimum range to reduce breakage while increasing consistency. The controller features a user-friendly graphical user interface (GUI), motor drivers, and other input/outputs in a compact and portable package. The control system was tested in production and was able to produce threads continuously. Future work includes optimization of the software and improvement of the REEAD for higher volume production with better speed and efficiency.

Project mentor: Prof. Ozan Akkus, Department of Mechanical Engineering, Department of Biomedical Engineering

Design and Fabrication of a Kinetics and Kinematics Concepts Demonstration Kit

Zachary Ewaska, Department of Mechanical and Aerospace Engineering

The goal of this project is to design and fabricate a teaching and demonstration kit for three classes: Dynamics, Vibrations, and Actuators and Drivetrains. Many of the concepts from dynamics, like properties of gyroscopic motion and impact, can be hard to grasp for some students. This project is being undertaken to create quality demonstration pieces to help students understand what is being taught in class. For general use, a collapsible coordinate system is included. For dynamics, a multi-use rotating shaft with handles and suspension points is included. Quick attaching counterweights are being included for the shaft and are used to demonstrate the moments induced by products of inertia. A flywheel that can attach to the shaft is included for the demonstration of gyroscopic motion. A reusable impact demonstration is also being included. This demonstration consists of a peg and holder capable of supporting 300lb of static loading and remaining stationary, while the peg remains drivable by dropping a weight on it (impact). Additional demonstrations that were considered include a set of springs and masses for vibration demonstration, and drivetrain demonstrations including a four bar linkage, planetary gearing demo, and a worm and worm gear demo. These additional demonstrations will be included depending on budget and time constraints. Finally, the fabricated demonstrations will be packaged in a carrying case for transport convenience.

Project Mentor: Professor Richard Bachmann, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Professor Robert Gao, Department of Mechanical and Aerospace Engineering
Improvement of Computerized Rotational Jet Spraying of Polymers for Biofabrication of Composite Tubular Scaffolds

Umit Levent Erol, Department of Mechanical Engineering

Computerized rotational jet spraying (CORJET) is a biofabrication method for manufacturing tubular scaffolds from a variety of materials. Immiscible materials can be combined by spraying coating nano-thin layers of polymer solutions onto a spinning mandrel to produce scaffolds that incorporate synthetic polymers like poly(caprolactone) (PCL) and poly(lactic-co-glycolic acid) (PLGA), natural polymers like collagen, as well as drugs and growth factors. These scaffolds provide the mechanical robustness of synthetic polymers and the tissue integration properties of biological polymers, making them a desirable choice for medical devices such as stents and scaffolds.

This project further improves and explores CORJET as a biofabrication method by enhancing its usability, characterizing the effects of production parameters on the final product, and performing a drug delivery study in vitro. The current CORJET prototype was improved by redesigning mechanical components such as the syringe pump and the syringe pump clamp. A control software was developed in Python to operate the machine based on production parameters such as the number and thickness of layers. The effects of these parameters on the surface morphology the final product were then evaluated using Scanning Electron Microscopy (SEM) and general production guidelines were established. Lastly, the drug delivery potential of CORJET scaffolds was evaluated by delivering the anti-inflammatory drug Mometasone Furoate (MF) in in vitro macrophage cultures. The inflammatory response of macrophages was evaluated and constructs made with CORJET were shown to be an effective medium for delivery.

Project mentor: Prof. Ozan Akkus, Department of Mechanical Engineering, Department of Biomedical Engineering

Synthesis of iron-sulfur compounds to model diffusion as a function of pressure

Alexandra M. Faccenda, Geological Science; Jeffrey S. Pigott, Department of Earth, Environmental, and Planetary Sciences; Julien Chantel, Department of Earth, Environmental, and Planetary Sciences; Zhicheng Jing, Department of Earth, Environmental, and Planetary Sciences; and James Van Orman, Department of Earth, Environmental, and Planetary Sciences

Iron sulfide minerals are important constituents of iron meteorites, which are the frozen remnants of asteroidal cores. The rates at which atoms are transported through iron sulfides by diffusion are critical to interpreting the chemical and isotopic signatures preserved in iron meteorites, which can yield information on their cooling histories and the size of their parent asteroids. Iron sulfides may also be present in the cores of terrestrial planets, and may have a significant influence on their deformation behavior, which is also controlled by diffusion. In this study, we made the first measurements of diffusion in FeS and Fe$_2$S$_2$ minerals at high pressure. Diffusion couples consisting of iron (Fe) and pyrite (FeS$_2$) or Fe and troilite (FeS) were compressed in a Walker-type multi-anvil press to pressures of 7-20 GPa, and heated to 1073 K for times between 1 and 16 hours to form FeS and Fe$_2$S$_2$ layers, respectively. The width of the reaction layer at a given pressure was found to be proportional to the square root of time, consistent with diffusion-controlled growth. We modeled the measured growth rates to determine the Fe diffusion coefficient through the reactant sulfide phase, and we find that the logarithm of the diffusion coefficient decreases linearly with pressure.

Project Mentor: Professor James Van Orman, Department of Earth, Environmental, and Planetary Sciences
Data Acquisition System for Determining the Lifetime of Thin Films for Micropackaging UnderAccelerated Lifetime Conditions

Daniel Faix, Department of Electrical Engineering and Computer Science; Hao Chong, Department of Electrical Engineering and Computer Science; Dr. Christian Zorman, Department of Electrical Engineering and Computer Science

There is significant interest in developing MEMS technologies for implantable medical devices that require high functionality and low form factor. The state-of-the-art for micropackaging implantable electrics involves the use of metallic enclosures. For chronic applications, suitable alternative materials to metal structures for packaging have yet to be identified. To research and identify these materials for micropackaging, interdigitated electrodes (IDEs) with thin films- the materials used micropackaging- deposited by atomic layer deposition are subjected to accelerated lifetime testing (ALT) to determine the success and failure of the thin film. To help determine the success or failure of the thin film, a data acquisition system is needed to measure the resistance of the samples, control which sample’s resistance is being measured, monitor the temperature, and collect data. The data acquisition will use an Arduino Uno and continuously measure the resistance of the IDEs. The resistance will be recorded using a wheatstone bridge that contains three 100 MOhm resistors. Whenever the resistance of the IDE drops below 100MOhm and the bridge balances, the thin film fails and data acquisition ceases. To induce failure, the IDEs will be subjected to accelerated lifetime testing where the IDEs are soaked in a saline solution at three different temperatures- 60, 70, and 85 degrees celsius, which are monitored by the Arduino Uno. The data collected will yield graphs of resistance vs. time at the three different temperatures to observe the amount of time the thin film lasts before it breaks down. The arduino will continuously run using a while loop to measure the resistance of each sample.

Project Mentor: Dr. Christian Zorman, Department of Electrical Engineering and Computer Science

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Defining the Specifics with Language Impairment and Ambiguous Language Deficits

Madeleine Farnham, Department of Psychological Sciences; Leah Beekman, Department of Psychological Sciences

Understanding and responding to ambiguous language, such as sarcasm, is a necessity for communication, particularly during the adolescence years (Nippold, 2007). Students who can easily incorporate ambiguous language into their lexicon show increased social and academic skills (Durkin & Conti-Ramsden, 2010), and while this is an important aspect of communication and the inability to comprehend this form of language can be detrimental, there are limited standardized tests to identify which areas of ambiguous language students with language disorders can or cannot understand. This pilot study recruited an adolescent with specific language impairment (SLI) in order to administer standardized and non-standardized language tests to help determine any strengths and weaknesses in the specific domains of ambiguous language. The non-standardized tests’ validity were examined using a correlation test with the standardized test, the CASL. One non-standardized test looked specifically at the ability to define multiple-meaning words, metaphors and oxymorons and the other test looked at the student’s ability to understand and use sarcasm. The subtests of the CASL that have direct relationships to sarcasm use were used as the comparison for the non-standardized tests. Data was collected for all tests and analyses of the data will involve t-test and correlation testing. The results are anticipated to give feedback on the validity of the two tests that are compared to the CASL and provide a better understanding of the specific problem domains someone with SLI may possess.

Future directions involve using these non-standardized tests as part of pre- and post-testing for an intervention project that teaches students, with language disorders, how to identify and respond to sarcasm appropriately.

Project Mentor: Dr. Angela Ciccia, Department of Psychological Sciences
Model reduction and modeling error compensation for MEG inverse problem

Peter Fedrizzi, Department of Mathematics, Applied Mathematics and Statistics

Neurological research and medicine rely on magnetoencephalography (MEG) and other non-invasive functional imaging techniques to study the activity within the brain. MEG localizes active sources using external measurements of the head’s magnetic fields by solving the associated inverse problem. Conventional methods that incorporate the conductivity structure of the head, such as finite element of boundary element methods, are accurate but computationally too expensive for some applications. We examine implementing lighter, closed-formula substitutes, like the Biot-Savart model, in place of sophisticated alternatives, correcting the model by accounting for the model discrepancy between an accurate and approximate model. From a classical standpoint, model reduction introduces an irreconcilable modeling error which depends on the unknown sources we aim to find. In the Bayesian paradigm, the modeling error is treated as a Gaussian random variable. We developed an error sampling scheme which generated a large ensemble of realizations using a published anatomical prior and other careful assumptions. To give shape to the modeling error distribution, we find the ensemble mean and covariance matrix. Further analysis demonstrates the component-wise normality of the error distribution. Our model reduction was applied to an optimization algorithm which successfully converged to a stationary source.

Project Mentor: Dr. Erkki Somersalo, Department of Mathematics, Applied Mathematics and Statistics

Hydraulic Braking System for an Off Road Vehicle

Caroline Felner, Department of Mechanical and Aerospace Engineering

This project presents the design and manufacture of the hydraulic brake system that will be implemented on the car for the 2018 CWRU Baja SAE team. Each year, the CWRU Bajaj SAE team designs and builds a single-seat off-road vehicle to be raced and tested in SAE competitions across the country. The primary requirement of the brakes system is that it is able to fully lock the wheels when the car is traveling at maximum speed. The brakes system utilizes custom calipers and pedals. The mathematical analysis of forces based on friction, line pressure, and the force with which the driver must press the brake pedal have been carried out for these components. The adjustable parameters include caliper piston size, pedal ratio, and rotor size. This mathematical model provided the basis for the Solidworks designs of the components, which have been completed and tested with computer FEA. In addition to the primary requirement, this project aims to resolve issues from previous designs. One such issue was leakage at the bleeder valve due to aluminum thread deformation and part interference. Another concern was assembly difficulty due to the omission of larger tolerances required for welded parts. These experience-related observations also affect the final design. With the new design, the hydraulic brakes will be able to provide close to 1000 pounds of clamping force at 60 pounds applied to the pedal, and will be easily attachable and removable from the car. The full system must be completed and assembled by the first competition in mid-April.

Faculty sponsor: Professor Richard Bachmann, Department of Mechanical and Aerospace Engineering
**Generalizing Robotic Skill Acquisition in Simulation Using Deep Neural Networks**

**Austin Feydt**, Department of Electrical Engineering and Computer Science

It takes a human years to master a single skill, but this mastery is completely lost upon death. A robot’s ability to learn a skill is an extremely valuable quality, as it can then be distributed to other robots immediately. This research is concerned with the task of teaching a robot to identify an object and then successfully pick it up by localizing the object. In order to speed up data collection, all images of the objects and the robotic finger’s corresponding pose were collected in a computer simulation, rather than in the physical world. This data was then used to train multiple neural networks to both successfully classify the objects, as well as correctly pose the robot’s fingers to pick them up. Future research will involve using these neural networks with a physical version of the objects and the robot, as well as introducing new objects to the robot.

*Project Mentor: Professor Wyatt Newman, Department of Electrical Engineering and Computer Science*

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**An Improved Transfer System for Wheelchair Users in Fitness Centers**

**Gabriella Fioravanti¹, Bailey McMahon¹, Vinson Chu¹, Mo Chen¹, Robert Hawk¹**

1. Department of Biomedical Engineering, Case Western Reserve University

To maintain independence, wheelchair users must learn to perform daily activities, such as bathing and exercising, without assistance. Moving in and out of a wheelchair is one of the greatest challenges in completing these tasks. While there are many devices on the market to assist with transferring out of a wheelchair at home and in medical facilities, one area of neglect is within workout centers. Physical fitness is a key factor in living a long, healthy life, but wheelchair bound patients are at a disadvantage since they have limited access to fitness equipment. The Americans with Disabilities Act (ADA) mandates spacing standards for equipment at gyms, but there is currently no device that enables wheelchair patients to move independently between their wheelchair and a workout bench or machine. Therefore, the majority of workout machines are ultimately wheelchair inaccessible. Our group has created a transfer device that aims to fill this need for wheelchair users, enabling active wheelchair bound patients to independently position themselves to any standard workout machine and safely move onto the machine and then back into their wheelchair. A user simply positions the device between their chair and the workout machine, slides themselves onto the seat of the device, raises themselves to the height of the machine or bench, and transfers onto the workout equipment. Our hope is that through our device, wheelchair users can find greater independence and live healthier lifestyles.

*Project Mentors: Dr. Colin Drummond, Dr. Matthew Williams, Department of Biomedical Engineering*

*Project Sponsor: Greg Wagner*

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*Intersections: SOURCE Symposium and Poster Session*
Polyadenylation Site Analysis via QPCR Analysis of RNA from Testis Genes in Mice

Colter Flynn, Department of Chemistry

The human genome has about 20,000 protein coding genes. This number of genes is roughly comparable to the number retained by less complex organisms. How could the blueprint for the human body – in all its astounding complexity – be stored using roughly the same amount of information as a fruit fly? It is nowadays commonly believed that a main contributor to our structural complexity lies in the augmentation and the regulation of gene expression via mRNA and various gene isoforms. The control of RNA production and degradation is a crucial element of gene expression and is key in the formation of complex and specialized cells. What this research aims to do is contribute to our understanding of the mechanisms involved with how RNA expression changes over time in genes associated with spermatogenesis in adolescent and adult mice. One of the ways in which mRNA can be regulated is through the use of multiple Polyadenylation sites (PA sites) that influence the longevity of the RNA molecule and protein synthesis. In this experiment, RNA from mouse testes was collected at postnatal days 6, 19, 25, and from adult mice. We then used qRT-PCR to determine the relative levels of alternative RNA isoforms generated by use of alternative PA sites. The DNA product was then analyzed via QPCR to determine the relative presence of various RNA PA sites and how expression of those PA sites changed as the mice aged. Our data shows that gene expression in the mouse testis involves stage-specific expression of alternative RNAs.

Project Mentors: Professor Donny Licatalosi, Center for RNA Molecular Biology

Mobile Musical Tesla Coil for Educational Purposes

Xyla Foxlin, Department of Mechanical and Aerospace Engineering; Dr. Richard Bachmann

This project entails the design of a Mobile Musical Tesla Coil. A Musical Tesla Coil is a form of plasma speaker where musical notes are produced by varying the spark output frequency of the device. Musical Tesla Coils appear frequently at science museums’ electricity shows across the country, but they are rarely if ever mobile and able to travel to individual classrooms. The device described here is capable of being easily transported, runs off of typical wall voltage, and can be safely operated within a classroom environment. The device is also “plug-and-play” compatible with any musical instrument equipped with a piezo-electric pickup. The Mobile Musical Tesla Coil is mounted on a cart that also serves as a transportation case, and is enclosed within a Faraday cage to ensure student safety. The Faraday cage can be easily removed for outdoor demonstrations. A circuit has been designed to sample the pickup signal and drive the coil. Because the pickup outputs up-bow strokes as negative from down-bow strokes, the circuit must first invert the down-bow signal. Rectified signals are then converted into an LED blink frequency. The light output from the LED travels along a fiber optic cable to circuitry at the Tesla Coil, which functions similarly to a transformer but is operating at the circuit’s resonant frequency. This adds energy at each cycle, until eventually the voltage is high enough that a spark breaks out and discharges the circuit. By controlling the number of sparks per second via a microcontroller, the output of the device can be perceived as musical notes. The output is within the audible frequencies of about 20Hz to 1000Hz.

Project Mentor: Dr. Richard Bachmann, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering
Investigation of Conformational Dynamics of RRM 1 & 2 of hnRNP H via $^{19}$F NMR and EPR

William Ford, Dept. of Chemistry, Case Western Reserve University; Imogen Henry-Campbell, Dept. of Chemistry, CWRU; and Liang-Yuan Chiu, Dept. of Chemistry, CWRU

The human heterogeneous nuclear ribonucleoprotein H (hnRNP H) RNA recognition motifs 1 and 2 (RRM1/2) is known to regulate alternative splicing in the Human Immunodeficiency Virus (HIV) life cycle. Alternative splicing enables HIV to generate more than 40 transcripts from a single HIV genome. However, there is currently no structural information for how the hnRNP H recognizes the G-tract RNA. This research aims to use $^{19}$F NMR to understand how hnRNP H binds to DNA at various positions on the hnRNP H1/2 surface. Integrated biophysics methods, such as $^{19}$F NMR and electron paramagnetic resonance (EPR), were utilized to address this question. Fluorine Nuclear Magnetic Resonance Spectroscopy ($^{19}$F NMR) is an effective method of probing a protein's DNA/RNA binding affinity, as well as its conformational changes. Because fluorine does not naturally occur in proteins, adding a fluorine NMR spin label, such as 3-bromo-1,1,1-trifluoroacetone (BTFA), allows for the quick and relatively simple determination of spectroscopic peaks.

Upon binding with a fragment of DNA, significant chemical shifts were observed on the wild-type protein on cysteine-22 (C22), C122, and C187 residues, which agree with the binding information derived from the heteronuclear single quantum coherence (HSQC) titration experiment. Furthermore, hnRNP H shifts from an equilibrium favoring open conformation to one favoring closed conformation. BTFA labeling at different residue positions on the protein gives different degrees of equilibrium shift upon titration with DNA. Preliminary $^{19}$F NMR data indicates that the protein does indeed exhibit two conformations, the major conformation being closed.

Alongside NMR is Electron Paramagnetic Resonance (EPR), which is similar, in principle, to NMR. However, an organosulphur spin label, MTSL, is used instead of BTFA. Using EPR, the distance between two labeled residues can be measured, which can provide more information regarding the conformational structure of the protein. Future experimentation aims to utilize double electron-electron resonance (DEER), which can actually quantify said distance between the target residues.

Project Mentor: Dr. Blanton S. Tolbert, Dept. of Chemistry, Case Western Reserve University

The Open Threat Exchange: A Statistical Visualization

Elizabeth Fregoso, Department of Electrical Engineering and Computer Science

The Open Threat Exchange is an open-source collection of network hits to and from known malicious actors on the internet. As of today, these hits are able to be accessed by anyone who creates a free account with the Exchange, but the current statistical information provided by the system itself is limited, and the data is not presented in a way that is immediately accessible to those unfamiliar with the terminology of network intrusion detection. I hope to provide solutions to both of these issues with OTX-V, a program that more comprehensively presents OTX hit information while also running additional statistical analysis on the data that can prove useful across a number of applications in network security.

Project Mentor: Dr. Soumya Ray, Department of Electrical Engineering and Computer Science
Convergence of PI3K-Akt and NF-κB increase aggressiveness in Prostate Cancer

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² Department of Pathology
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Prostate cancer is the second-leading cause of cancer related deaths among men. The American Cancer Society estimates that nearly 30,000 men will die from prostate cancer in 2018. Clinical outcome is often unpredictable, prompting research into biological markers to determine treatment and prognosis. Several signaling pathways have been indicated as important markers in the progression of prostate cancer. Transcription factor NF-κB and PI3K-Akt are important pathways involved in cell survival and oncogenesis. Research in our laboratory has found that upregulation in NF-κB and Akt is correlated with increased prostate cancer progression. These two pathways work independently of each other, but research suggests they converge. In this study, we investigated the effect of convergence of these two pathways in driving aggressiveness in prostate cancer. We hypothesize that activation and convergence of the NF-κB and Akt pathways leads to increased aggression in prostate cancer. Immunohistochemistry analyses showed that co-localization of the NF-κB subunit, RelA/p65, and phosphorylated-Akt was more prevalent in the nucleus of highly aggressive cancer, compared to benign tissues. Western blotting was used to estimate protein expression and immunoprecipitation showed high association between NF-κB and Akt. In cell culture, androgen-responsive human prostate cancer LNCaP and androgen-refractory PC-3 cells were treated with pharmacological inhibitors, targeting the Akt and NF-κB pathways separately and in combination. Both cell lines possess mutated PTEN and constitutively active Akt, while PC-3 cells also show constitutive activation of NF-κB/p65. Ectopic expression of NF-κB/p65 in LNCaP cells demonstrate a significant increase in cell survival, doubling time and invasiveness, compared to vector-alone cells. Altogether, our result suggests that the convergence of PI3K-Akt and NF-κB pathways induces prolong cell survival and drives aggressiveness of prostate cancer.

Project Mentor: Dr. Sanjay Gupta, Department of Urology
Faculty Sponsor: Dr. Arnold Caplan, Department of Biology

Activation of Silylketenes with Lewis Acids

Emily Glasser, Department of Chemistry; Racheal Matthews, Department of Chemistry

Polymers play a vital role in everyday life. A polymer's atomic composition and chemical structure dictates its properties, functions, and applications. This indicates a polymers' monomer dictate the behavior and function of the polymer. Previous work in the Pentzer lab has focused on silyl ketenes as monomers, which are a unique class of aldoketenes that possess both a C=C double bond and a C=O double bond. They are ideal for study due to their thermal stability and lack of tendency to undergo thermal polymerization, but are still reactive under appropriate conditions. Recently, Xiang et al. experimentally demonstrated the anionic polymerization of triisopropyl (TIPS) ketene initiated by the tert-butoxide anion. TIPS-ketene can undergo propagation via through both the C=C and C=O bonds. The work presented herein will report the effects of solvent, different molar ratios, and purification methods on the yield of small molecules by the reaction of silyl ketenes activated with different Lewis acids, with different nucleophiles. The solvents studied were toluene, diethylether, THF, acetonitrile, and dioxane. Theses studies allowed investigation into ideal conditions for controlled initiation and thus polymerization.

Project Mentor: Dr. Emily Pentzer, Department of Chemistry
Cationic ECO/siRNA Nanoparticles for Drug Resistant Prostate Cancer

Kaelyn Gasvoda, Department of Biomedical Engineering

Affecting 11.6% of the men in the world, prostate cancer is one of the most prevalent forms of cancer in men. Our lab also focuses on the development of simple, safe, and smart multifunctional lipids that can efficiently deliver siRNAs to cancer cells. One such example is ECO, a pH-sensitive multifunctional lipid carrier that has garnered attention for its clinical potential. The nanoparticles can mediate silencing of expression of oncogenes with RNAi and has been proven to work in other kinds of aggressive cancers. Prostate cancer can develop metastasis and resistance to standard anticancer drugs such as Paclitaxel. Metastasis has been associated with the biological program known as epithelial to mesenchymal transition (EMT). Studies have shown that eIF4E, eukaryotic translation initiation factor, can be linked to overall drug resistance and/or EMT in cancer cells. Herein, the prostate cancer cell lines DU145, PC3 have been selected as the non-drug resistant lines while the drug resistant lines, DU145-DR and PC3-DR were selected. Since PC3 and PC3-DR is more a progressive type of prostate cancer than DU145 and DU145-DR, these cell lines will be monitored to see the effect of silencing eIF4E has on the overall aggressiveness. After exposure to ECO/siE4F, the exposed cell will be characterized through genetic expression of the mRNA and protein assays of the cells. Our results will provide data on the effect of silencing eIF4E on the overall drug resistance and/or EMT in prostate cancer cell lines, and thus provide a potential therapeutic method to treat drug resistant and/or progressive cancer. Furthermore, the multifunctional ECO/siRNA nanoparticles will illustrate a versatile platform of delivery of therapeutic siRNA for treating cancers.

Project Mentor: Xujie Liu, Department of Biomedical Engineering
Faculty Sponsor: Zheng-Rong Lu, Department of Biomedical Engineering

Engineering Fertilizer: Struvite Precipitation Utilizing Ion-Binding Peptides

Caroline Gillette, Department of Chemical Engineering; Colin Sonnfeld, Department of Chemical Engineering; Sanjana Kamath, Department of Chemical Engineering; Dr. Julie Renner, Department of Chemical Engineering

Nitrogen and phosphorus, when present in excess, are the main culprits behind issues such as eutrophication, a phenomenon which harms water quality and aquatic life. In addition, phosphorus is a limited resource which will soon run out at the current utilization rate. Hence, recycling these excess nutrients is of growing environmental importance for the agricultural industry. Production of struvite, NH₄MgPO₄·6H₂O, a slow release fertilizer has the potential to provide a very feasible and economical solution. Protein engineering could potentially enhance this chemical process. Our novel approach involves the addition of a phosphate binding peptide which serve to enhance the reaction that produces struvite. This research involves the use of a mixture of salt solutions at a variety of pH levels to mimic natural wastewater and test the yield of struvite precipitate. X-ray diffraction and scanning electron microscope were utilized to analyze both composition and structure of precipitated compounds. Baseline composition and percent recoveries were established for a range of pH values, and past literature suggests low purity and recovery at neutral pH. Quartz crystal microbalance, isothermal titration calorimetry, and dynamic light scattering will be used to investigate the binding capabilities of the selectively binding peptide to adsorb phosphate. Circular dichroism will be used to analyze peptide structure.

Project Mentor: Dr. Julie Renner, Department of Chemical Engineering

Intersections: SOURCE Symposium and Poster Session
“Molecular Mechanisms Underlying Respiratory Circuit Assembly During Development”

Kiran Garg, Department of Spanish; Michaela Edmond, Department of Neuroscience

In order to survive, all mammals must correctly carry out the breathing process. Breathing is a motor behavior governed by circuits in the brain stem and spinal cord. Respiratory diseases such as Sudden Infant Death Syndrome, sleep apneas, and respiratory failure caused by Amyotrophic Lateral Sclerosis (ALS) are caused by disruption in these breathing circuits. Though breathing is a basic life function, the molecular mechanisms underlying the assembly of respiratory circuits during development remain largely unexplored. This summer, my research sought to anatomically define respiratory circuit assembly in order to consider alternative treatments for respiratory dysfunction.

A key neuronal population in the respiratory circuits is the phrenic motor neurons (MNs) that innervate the diaphragm muscle. The Philippidou lab has demonstrated that the development of phrenic motor neurons requires sustained activity of Hox5 genes (Philippidou et al., 2012). Hox5 genes are responsible for encoding transcription factors necessary for gene regulation. Mice that lack Hox5 genes in their motor neurons exhibit defects in clustering, axon guidance, dendritic orientation and diaphragm innervation. While we have established a transcriptional program required for phrenic motor neuron development, it is unclear whether this program interacts with activity-dependent mechanisms during development.

In this project we tested whether blocking activity of the motor neurons projecting to the diaphragm by deleting the enzyme that makes acetylcholine (ChAT mutants) will “rescue” the defects caused by Hox5 deletion. We chose to test this because blocking activity in MNs is known to increase innervation. I hypothesized that Hox5/ChAT double mutants would show increased innervation compared to the single Hox5 knockout mutant. This study supported the hypothesis that the Hox5/ChAT double mutant would have increased innervation when compared with the single Hox5 mutant, demonstrating that genetic and activity-dependent programs interact during development to establish diaphragm innervation patterns.

Project Mentor: Polyxeni Philippidou, CWRU Department of Neurosciences

Cyber Physical Farming Robot for Organic Farm Weed Control

Clarissa Goldsmith, Department of Mechanical and Aerospace Engineering; and Nick Szczecinski, Department of Mechanical and Aerospace Engineering

For countless farmers, weeding poses a significant and laborious task throughout the growing season. The labor involved with manual weeding is prohibitively expensive to many, and those willing to provide such labor are becoming increasingly scarce. In addition, the cost of herbicides, the evolving chemical resistance of weeds, and environmental concerns necessitate an elimination of the use of chemicals. Autonomous robots stand to reduce cost and labor and increase efficiency in the dull and laborious weeding process, as they could be capable of extensive durations in fields for weeding and could adapt to drastically changing operating conditions, which would overall greatly increase farm productivity. This project sought to capitalize on this new opportunity through the development of a legged autonomous robot for precision weeding on farms, known as AgroBot, specifically the development of a single leg actuation system for prototyping purposes.

Project Mentor: Dr. Roger Quinn, Department of Mechanical and Aerospace Engineering
Optimization of Premium Gasoline Production via Increased Olefin Recovery

Amalia Gitosuputro; Miguel Guan; Chul-Oong Kim; Jordan Reed, Department of Chemical and Biomolecular Engineering

Gasoline containing a higher percentage Alkylate, which is made from reacting C₃/C₄ olefins with isobutane, results in higher octane values. Gasoline containing high octane number has high economic value which allows premium gasoline to burn smoothly in high compression turbocharged sports cars. This research involved recovering the highest possible percentage of olefins from an existing stream that was previously burned for fuel, and doing it with a cost efficient process.

The Marathon Petroleum refinery in Canton currently has out of service equipment made available for this project. The idea behind this project is that by integrating a distillation column and other equipment into the existing system would increase the C₃/C₄ olefin recovery and result in higher profits. Other low-cost equipment were considered to be used in the refinery system such as a rental chiller, heat exchanger and three-phase drums. Various scenarios of using currently unused equipment and other low-cost equipment were simulated by using the petroleum engineering simulation program HYSYS. Several factors were considered while developing the optimal sequence including installation costs, utilities for running equipment, and overall returns from the resulting process. The internal rate of return (IRR) was used to determine whether the process was a success; an IRR of 25% or greater over a twenty year period was necessary to deem the sequence viable. The optimal sequence was then integrated seamlessly into the existing process to eventually produce premium grade gasoline.

Project Mentor: Michael Bothe, Marathon Petroleum
Faculty Sponsor: Dr. Daniel J. Lacks, Department of Chemical and Biomolecular Engineering; Dr. Uziel Landau, Department of Chemical and Biomolecular Engineering

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Design and Experimentation of Darrieus Helical Wind Turbine

Alberto Gonzalez Campos, Department of Aerospace and Mechanical Engineering; Dr. Mario Garcia-Sanz, Department of Electrical Engineering & Computer Science.

It is difficult and expensive to develop and test new full-scale wind turbines. However, it is possible to create reliable lab-scale prototypes that match their dynamic characteristics. Currently, horizontal axis wind turbines (HAWTs) are the mainstream of the wind power industry due to their efficiency and energy output. However, their structural layout and large equipment require frequent maintenance and higher installation costs. On the other hand, vertical axis wind turbines (VAWTs), including the egg-beater Darrieus design, offer significant advantages over HAWTs. These offer lower operation and maintenance costs due to fast access to components on ground level, no yaw system due to its omnidirectional lift capabilities, low rotating speed decreasing noise levels, and high wind speed resistance for safe operation. Thus, the research project focus on (a) studying, analyzing, and designing an innovative Darrieus helical wind turbine concept, (b) evaluating its aerodynamic performance, low-vibration characteristics, and overall construction lay-out, (c) testing its power output performance in the fully-instrumented wind tunnel at the Control and Energy Systems Center with controlled wind speed conditions. By comparing our new design with a standard Darrieus VAWT, we will be able to assess its overall efficiency, production feasibility, and implementation in future designs. As the wind tunnel experiments with the lab-scale prototypes show similar performance to the real-scale systems when adjusting up the results, the research would allow us to develop new wind energy concepts for the Darrieus helical blade-type design, its rotor configurations, and possible control systems.

Project Mentor: Dr. Mario Garcia-Sanz, Department of Electrical Engineering and Computer Science.

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Post-Consumer Polypropylene: A Sustainable Alternative to Nissan Leaf® Steel Fenders and Doors

Aditi Gore, Department of Macromolecular Science and Engineering; Robert Semco, Department of Macromolecular Science and Engineering; Maria Vratsanos, Department of Macromolecular Science and Engineering

In an effort to increase sustainability through reducing fuel consumption and material waste, a steel alloy car door and fender were redesigned using post-consumer plastics. The main challenge was to determine a class of recycled polymer that would be capable of matching the mechanical, thermal, and chemical properties of steel alloys, while maintaining an excellent aesthetic standard. After careful consideration of material properties and environmental impact, recycled polypropylene stood out as the ideal material to reduce the overall weight of the Ultra Green Nissan Leaf® and capitalize on its fuel efficiency. With additional support from energy absorbing foam inserts, the Nissan panels can be compression molded into specified designs and coated with additional resins to comply with critical user needs while maintaining overall aesthetics. CES EduPack was used as a material profiler to determine a number of viable material candidates, and computer modeling was conducted in SolidWorks to validate the material’s ability to meet federal impact regulations when applied to the geometry of the components. Replacing steel alloys with post-consumer polymers in the design of car fenders and doors has been shown to significantly reduce the carbon footprint of the automotive fleet, in terms of both reduced fuel cost and material waste.

Faculty Project Mentor: Dr. David Schiraldi, Department of Macromolecular Science and Engineering

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Oxidation Prevention of Roasted Coffee Beans via Nitrogen Flushing

Sydney Gray, Department of Chemical and Biomolecular Engineering; John Kilbane, Department of Chemical and Biomolecular Engineering; Zoe Krump, Department of Chemical and Biomolecular Engineering; Marin Pecirep, Department of Chemical and Biomolecular Engineering

Rising Star Coffee is a Cleveland based coffee company looking to expand coffee sales beyond their local coffee shops. In order to sell their product in large retail chains, the shelf life of the coffee must be extended from 14 days to 45 days. Previous research shows that coffee beans oxidize in the presence of oxygen, resulting in stale coffee. A technique known as nitrogen flushing has been suggested in order to decrease the oxidation of the beans. With this method, shelf life has been shown to increase since all of the oxygen in the sealed bag is replaced with nitrogen. In order to nitrogen flush the bags, an air tight nitrogen dome prototype was assembled, containing a heat sealer and oxygen sensor. Coffee bags filled with freshly roasted coffee were placed inside the nitrogen dome. While nitrogen was flushed into the system, an oxygen sensor was used to trigger the sealing of the bags once the gas inside was less than two percent oxygen. The remainder of the project focused on improving the initial prototype so that it can be used widely in the commercial market. The quality control specialist at Rising Star tested nitrogen flushed coffee at periodic times between 15 and 45 days to determine if nitrogen flushing actually extended the shelf life. Due to the time-based nature of the project, data collection is currently underway.

Project Advisors: Dr. Daniel Lacks, Department of Chemical and Biomolecular Engineering; Brandon Riggs, Rising Star Coffee

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Analysis and Design of a Wastewater Treatment Alternative for Case Western Reserve University Southside Greek Residential Housing

Christian Griffith, Department of Civil Engineering, Marisa Harkins, Department of Civil Engineering, Augustine Kazek, Department of Civil Engineering, Xiaozhou Zhang, Department of Civil Engineering

As societal values continually shift towards a focus on sustainability and the environment, engineers must acknowledge this shift and mirror it in their work. At the forefront of this movement should be civil engineers, whose infrastructure should continue to highlight the cutting edge in innovative environmental design. This is made especially evident by the tendency of newer construction projects to pursue LEED certification. One of the most important aspects of this certification system is the requirement for “water efficiency”. One way to achieve this goal is to have an onsite system capable of treating wastewater and recycling it back to the site for non-potable uses, such as flushing. While this can be done through a simple package plant, this involves the use of harsh chemicals for treatment and disinfection. A more aesthetically pleasing and environmentally friendly alternative to this is a treatment system known as a “Living Machine”, which uses the natural polishing and purification process of wetlands to effectively treat wastewater. For this project, a Living Machine-inspired wastewater treatment technology was designed to serve Southside Greek Residential Housing on the Campus of Case Western Reserve University. The work required for this system includes structural engineering to design the greenhouse that surrounds the Living Machine, hydraulic engineering to determine the size and flow of the system, geotechnical engineering for the foundation of the greenhouse and the pipe running between the Living Machine and the residential housing, and systems engineering for the solar panels that help to power the pumps and airlifts used by the system.

Project Mentor: Lance Wanamaker, Department of Civil Engineering

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Polymeric Still Design for Traditional Distillation of Spirits

Christian Grimme, Department of Macromolecular Science and Engineering, Polymer Science and Engineering; Benny Zelkin, Department of Macromolecular Science and Engineering, Polymer Science and Engineering; Nate Jurcago, Department of Macromolecular Science and Engineering, Polymer Science and Engineering

The goal of this project is to develop a proof-of-concept distillation apparatus constructed entirely from polymeric materials that is capable of producing a wide variety of spirit and liquors. The system consists of a reflux still design, with an approximately 200 liter boiler paired with a copper mesh packed column and dephlegmator. The copper acts as both a heat exchanger, thus aiding vapor condensation, and removes undesirable, foul tasting sulfurous compounds from the final product. This product will offer a cheaper alternative to traditional steel or copper stills without sacrificing performance or spirit quality. The still will be constructed of a commodity polymer chosen for its excellent resistance to heat and mechanical properties and coated with polytetrafluoroethylene which meets FDA food grade standards and organic solvent resistance. A copper heating element will be located at the bottom of the apparatus to allow the distillation process to occur while only needing access to standard US electric outlet.

Project Mentor: Professor David Schiraldi, Department of Macromolecular Science and Engineering

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Unification of Gauge Couplings in Grand Unified Theories

Axel Gross, Department of Physics; Pavel Fileviez Pérez, Department of Physics; Clara Murgui. Departamento de Física Teorica, IFIC, Universitat de Valencia; Kurt Hinterbichler, Department of Physics

While the Standard Model has been verified on numerous occasions and is successful in predicting a large number of observed phenomena, it is incomplete. It fails to explain many of the current problems in physics, such as the dichotomy of the forces or the origin of baryon asymmetry. One possible extension of the Standard Model is a Grand Unified Theory (GUT), which describes particle interactions as the action under a single symmetry group which spontaneously breaks into the Standard Model symmetry groups at low energies. This is attractive because it presents the opportunity to represent the Standard Model in a more elegant way, and at the same time attempt to explain some of the issues with the Standard Model. While Grand Unified Theories have had some successes; for example, prediction of the quantization of electric charge, they have struggled with many other things, most notably proton stability. The simplest of Grand Unified Theories is the SU(5) GUT. Although unrealistic, as it predicts wrong values of both fermion masses and the Weinberg angle, it provides a useful prototype for how Grand Unified Theories could work.

One of the important predictions of Grand Unified Theories is that, at the grand unification scale, the coupling strengths of the Standard Model forces will unify into a single coupling strength. While it is known that coupling strength changes with energy scale, obtaining a unification of all three couplings at the same energy is difficult, and requires the introduction of new particles into the theory. We explore the possibilities of simple additions to both the Standard Model and the SU(5) Grand Unified Theory that lead to a unification of the couplings at the grand unification scale.

Project Mentor: Pavel Fileviez Pérez, Department of Physics, and Kurt Hinterbichler, Department of Physics
Faculty Sponsor: Rolfe Petschek, Department of Physics

Northern Power 100 kW Wind Turbine Direct-drive to Gearbox Conversion

Hanke Gu, Zack Teitelbaum, Department of Material Science & Engineering

A conversion system to transform our on-campus Northern Power 100 kW wind turbine from directly-driven to gearbox-operated is proposed. The higher power outputs is due to greater mechanical-to-electrical energy conversion efficiency. The Dassault Systèmes SOLIDWORKS was used to model the parts and assembly for a gearbox and tools within SOLIDWORKS were used to estimate the stresses on our gearbox components. The materials were chosen using CES EduPack to meet required minimum strength and to achieve lower cost. Simple calculations such as estimated payback time and conversion efficiency were made to illustrate the practicability of this gearbox.

Project Mentor: Professor Peter Lagerlof, EMSE379, Department of Material Science & Engineering
Matricellular protein Cysteine-rich angiogenic inducer 61 (CCN1/CYR61) attenuates fibrogenic response in trabecular meshwork cells

Ishita Gupta, Department of Biochemistry and Cognitive Science; Dr. Padmanabhan Pattabiraman, Department of Ophthalmology and Visual Sciences

Glaucoma is an optic neuropathy—the leading cause of irreversible blindness in the world. Primary open angle glaucoma is a common form of glaucoma characterized by elevated intraocular pressure (IOP), which is a major risk factor for retina damage. Normal IOP is maintained via the balance in a fluid called aqueous humor (AH), which is mainly drained via the trabecular meshwork (TM) outflow pathway. Obstruction in TM due to excessive extracellular matrix (ECM) deposition and tissue fibrosis impedes AH drainage leading to IOP elevation and increased risk of glaucoma. Profibrotic cytokine transforming growth factor-β2 (TGFβ2) is elevated in AH of glaucoma patients for unknown reasons. TGFβ2 signaling in TM induces production of α-smooth muscle actin and ECM like collagen and fibronectin leading to tissue contraction and fibrosis. Agents that reduce tissue fibrosis decrease IOP. This study investigates the role of CCN1 protein, a secreted matricellular protein, that binds to and signals via integrins in the regulation of TM contractile properties and aqueous humor outflow homeostasis in human TM tissue. CCN1 is a part of the CCN family, which consists of 6 different secretory proteins. It regulates cell migration, proliferation, cell morphology, as well as cell-to-cell interactions and cell-to-matrix interactions via integrin binding. It is also significantly induced by VEGF165 and attenuates TGFβ2 mediated increase in alpha-smooth muscle actin and collagen Iα. Interestingly, we found that CCN1 shows anti-fibrotic effects and also can attenuate TGF-β2 signaling. As seen, CCN1 aids in decreasing the cytoskeletal integrity and plays an important role in regulating fibrogenic responses in TM. This suggests the potential role of CCN1 to decrease outflow resistance and act as potential therapeutic target for the lowering of IOP and treatment of glaucoma.

Project Mentor: Dr. Padmanabhan Pattabiraman, Department of Ophthalmology and Visual Sciences
Faculty Sponsor: Dr. Carol Toris, Department of Ophthalmology and Visual Sciences

Using Wavelet Bases to Model Correlations in the Cosmic Microwave Background

James Gurian, Department Of Physics; Craig Copi Department Of Physics; Glenn Starkman, Department of Physics

Conventionally, fluctuations in the Cosmic Microwave Background (CMB) are represented by a superposition of spherical harmonics whose amplitudes are independent Gaussian random variables. These arise from an underlying theory in which perturbations in the early universe are superpositions of Fourier modes whose amplitudes are given by independent Gaussian random variables. However, this predicts infinite distance correlations in the perturbations which correspond to large angle correlations in the temperature of the CMB. This is inconsistent with observation. One possible explanation is that the perturbation field was actually generated by compactly supported basis functions rather than Fourier modes. Here we explore the correlation properties of several such “wavelet bases” in one dimension and compare them to a 1-D model of the usual Fourier picture of the CMB. We find that wavelet bases do provide substantial improvement in relevant statistical measures of correlation over our Fourier model. Significantly, our results do not depend sensitively on the particular choice of wavelet. Since nature almost certainly did not choose the particular wavelets we studied, it is important that our results be basis independent. This result is of particular importance as groundwork for generalizing this idea to the full three dimensional problem, where all but the simplest wavelets will be numerically intractable.

Project Mentors: Dr. Craig Copi, Department of Physics and Dr. Glenn Starkman, Department of Physics
Exploring the potential role of PODXL-1 as a platelet-interactive protein on cancer cells

Kara Hageman, Department of Biomedical Engineering; Aditya Girish, Department of Biomedical Engineering; Dr. Anirban Sen Gupta, Department of Biomedical Engineering

In recent years several reports have demonstrated that platelets play unique mechanistic roles in facilitating the metastatic spread of cancers. Activated platelets are known to interact with the cancer cells to promote intravasation, to bind to cancer cells in vasculature to form a protective microthrombotic cloak around them to protect from immune surveillance, and facilitate binding to vascular endothelial wall at distal site for metastatic colony formation. To this end, an exciting area of research is the exploration of surface-interactive mechanisms between active platelets and cancer cells. Past studies in the Sen Gupta laboratory have indicated that β3 integrin and P-selectin motifs expressed on active platelet surface at high density, can have direct or mediated binding interactions with cancer cells. Building on this, my current research is focused on exploring the potential role of protein podocalyxin (PODXL) expressed on many metastatic cancer cell lines to mediate interaction with platelets. PODXL is a transmembrane sialomucin protein belonging to the CD34 family, is typically expressed in podocytes of the kidneys, but is reportedly upregulated on numerous aggressive cancer cell lines. Sialomucins can interact with selectins and therefore the underlying hypothesis of the current research project is that PODXL on cancer cells can mediate binding interactions with P-selectin on active platelets. For the current project, HeLa cells, a cervical cancer cell line, were chosen as the model cancer cell. The level of PODXL expression on HeLa cells was measured via immunofluorescence techniques and flow cytometry. The interaction of activated platelets and HeLa cells was analyzed via fluorescence microscopy. Whether the interaction is P-selectin dependent, was tested by inhibition assays using P-selectin-specific antibodies. Ongoing and future research will focus on elucidating the potential role of PODXL on cancer cells for selectin-mediated binding to platelets.

Project Mentor and Faculty Advisor: Dr. Anirban Sen Gupta, Department of Biomedical Engineering

Fabrication and Electrical Characterization of Layered van der Waals Oxides

Yang Han, Department of Physics; and Kyle Crowley, Department of Physics

Two-dimensional (2D) van der Waals (vdW) materials have been widely studied in recent decades. Among 2D vdW materials, transition metal oxides with 2D vdW structure have drawn the most attention because of their potential in electronic applications. Although the performance of most 2D transition metal oxides does not exceed that of conventional material, which is silicon, for electronic devices, these materials are still worth being investigated due to their unique electrical properties, and their fundamental properties have not been fully explored. In this project, we will fabricate MoO₃ thin films on SiO₂ substrates using vacuum deposition and rapid thermal process. We will focus on the effect of different annealing conditions on the structure and the electrical properties, such as conductivity and carrier mobility, of the fabricated MoO₃ thin films. This work will demonstrate whether MoO₃ has the potential for novel applications in electronic devices.

Project Mentor: Professor Xuan Gao, Department of Physics
The emergence and dissemination of antibiotic-resistant bacteria due to the sub-therapeutic use of extended-spectrum cephalosporins in the livestock industry and its impact on treating serious bacterial infections in children

Sophie Hamer, Department of Biology; Professor Dianne Kube, Department of Biology

After many years of misuse of antibiotics in the livestock industry, the rapidly increasing number of antibiotic-resistant bacteria has become a widespread public health issue. The housing of livestock in concentrated animal feeding operations (CAFOs) as well as the subtherapeutic use of antimicrobials for growth promotion and feed efficiency have made agricultural antimicrobial use the major driver of antimicrobial resistance. There has been significant evidence that in the livestock industry, particularly within CAFOs, animals can act as reservoirs of multidrug-resistant (MDR) organisms and the large indiscriminate use of antibiotics in veterinary medicine has led to the selection of resistant bacteria that can be spread among other animals, food, and the environment. The expansion of MDR organisms has potentially life-threatening clinical significance as the number of effective antibiotics for humans is reduced. The use of and emergence of resistance to extended-spectrum cephalosporins by the livestock industry is particularly problematic, as this class of antibiotics is important for treating severe and sometimes life-threatening bacterial infections in children such as Salmonella enterica. With insufficient government action taken to address this issue, it has become increasingly essential that systematic change is brought about to slow the emergence of resistant bacteria due to the livestock industry. This research aims to examine the effects of the emergence of innumerable such cases of antibiotic resistance and aims to demonstrate the importance of studying cephalosporin-resistant bacteria and its impact on treating infections in children. Furthermore, this research aims to call attention to the misuse of antibiotics, specifically extended-spectrum cephalosporins, in the livestock industry and the subsequent impact on the prevalence of resistant bacteria. This research then aims to explore ways in which we may move forward in addressing the issues surrounding antimicrobial resistance due to the livestock industry from the perspectives of the involved stakeholders.

Project Mentor: Professor Dianne Kube, Department of Biology

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Urban Garden Irrigation Efficiency Improvement

Grant Mlack, Department of Chemical Engineering; Lucas Thompson, Department of Chemical Engineering; Daniel Hong, Department of Chemical Engineering; Josiah Hanson, Department of Chemical Engineering

The objective of this project is to implement an automated irrigation system in a local community garden. This garden has been maintained by CWRU students the past few years, with additions being added each year by different groups of senior chemical engineering undergraduate students. The irrigation system currently consists of a rainwater reservoir with solar panels that provide power to the pump that distributes the water through an irrigation system in a plant bed. However, the pump is currently turned on and off using a timer system and there’s no method for determining the water level in the rainwater reservoirs. As such, this project seeks to improve this system by adding a level detection unit in the rainwater reservoirs, and a soil moisture sensor. The level sensor will store data on the water level in the storage tanks over time, as well as act as an initial condition for whether or not the water pump can be turned on. If the level is too low, then there’s no point in the pump being on. Also, this will provide insight on whether or not the rainwater collection system is working effectively or needs to be improved in the future. The moisture sensor will measure the water content in the garden beds, and if it is below a certain threshold then this will trigger the pump to turn on and dispense water. This makes the water distribution more efficient, since if it is only based on a timer then it'll still turn on even if it is currently raining.

Project Mentor: Daniel Lacks - Head of Chemical Engineering Department

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The Effect of Carotenoid Supplements on the Development of the Bombina orientalis

Kayla Harris, Department of Biology; Mike Moore, Department of Biology

Carotenoids are organic molecules essential for photosynthesis, producing color, increasing immune function, and acting as antioxidants in animals, especially through transmission of maternal yolk. While some taxa such as plant, bacteria, and fungi can produce their own carotenoids, animals must obtain them in their diets. While these general benefits of carotenoids are well established, studies have shown that there may be costs associated with carotenoid consumption. The benefits and costs of carotenoids is especially mixed in amphibians, which are facing declining populations worldwide, in part due to disease. We set out to explore the effects of carotenoid supplementation on the fire-bellied toad (Bombina orientalis) through two routes, direct acquisition and through maternal diet. The fire-bellied toad is a known consumer of carotenoids in the wild. In the first part of this experiment, each tadpole was either fed a regular diet, or a diet with carotenoid supplements. After three weeks, their size, length, and developmental stages were compared. Our results showed that the tadpoles without the carotenoid supplement were significantly larger, more developed, and had a higher rate of survival than the tadpoles that received the supplement. The second part of the experiment will be conducted in the same way. This time, however, the adult female fire-bellied toads were fed the carotenoid supplement while producing eggs. The purpose of this half of the experiment is to determine whether tadpoles who are used to consuming carotenoids from the yolk will be more able to process carotenoid supplements during tadpole development. This research will provide insight to the changes in dietary needs of fire-bellied toads during and after development.

Project Mentor: Dr. Ryan Martin, Department of Biology

Better Pencil Case: Utilizing Think[Box] in Design and Prototyping

Bronson Hausmann, Robert Kidwell, Natalie Steinway, Department of Material Science

A pencil case was designed with the goal of optimizing material performance to cost with an emphasis on increased functionality. Segmented compartments were designed to separate individual pens, allowing for individualized protection for fragile pens. This design addressed the shortcomings of single-pocket pencil cases, which can cause surface scratching of pens and pencils from constant contact in the single compartment. The case was made using a polymer fabric with an intermediate endoskeleton layer made from monolithic polymer paneling. This allowed for flexibility at joints while maintaining structural integrity. Materials selection was performed using CES Edupack and the final design was built using resources available at Think[box]. The case can be manufactured at low cost, and relatively easily using materials available to Case Western undergraduates. The pattern designed by the group and materials chosen are available and easy to follow, allowing for any student to take advantage of the underutilized sewing capabilities offered at Think[box].

Project mentor: Professor Peter Lagerlof, Department of Material Science and Engineering

Intersections: SOURCE Symposium and Poster Session
Woody: Hardware Design and Behavioral Control of a Low Budget Social Robot

Daniel Hayosh, Department of Mechanical and Aerospace Engineering; Alexander Brandt, Department of Mechanical and Aerospace Engineering; Xiao Liu, Department of Mechanical and Aerospace Engineering; Tao Liu, Department of Mechanical and Aerospace Engineering

Woody is a social robot, designed to be low-cost and easy to assemble so that anybody with a set of DXF files can laser cut parts, purchase a low number of electronic components, and assemble their own social robot. This project specifically discusses the hardware, which is built as a platform to test control algorithms which will be iterated and implemented into the robot. The platform must be able to perform a variety of gestures while being strong enough to support itself and anything it manipulates. The majority of the hardware is built using laser cut 0.25" plywood, and glued together. The components are designed to be identical where possible for modular robot design. The first piece of the hardware is the shell and skeleton. This main piece of the body houses a number of the electronics, including the Arduino, Raspberry Pi, and speaker. Two arms connect to the body. These arms have four degrees of freedom each, and are powered by Dynamixel AX-12A motors. A gripper is mounted to the end of each arm. Each gripper possesses one degree of freedom, but is also able to rotate about the wrist. To grip different size objects, a living hinge mechanism was used in the fingers. Different spacing of the cuts along the gripper were tested to determine a balance between malleability and strength. Lastly, a head is mounted to the top. The head contains two cameras at the eyes and two degrees of freedom at the neck. In order to evaluate the success of the platform, it will be programmed to perform several basic gestures, which will then be witnessed by human subjects. The feedback from users will help to improve Woody’s ability to interact in a social setting, which will in the future lead to more refined and complex behaviors.

Project Mentor: Professor Kiju Lee, Department of Mechanical and Aerospace Engineering

(Fe85-xGa15+x)92Zr8 Nanocomposite Magnetic Alloy Design

Jonathan Healy, Department of Materials Science and Engineering; B. Dong, Department of Materials Science and Engineering; M.A. Willard, Department of Materials Science and Engineering

Currently, there has been a need for highly magnetostrictive materials within tunable magnetoelectric sensors comprised of a piezoelectric core. The magnetostrictively induced displacement of the magnetostrictive material is translated into an electric current via the piezoelectric core. Utilizing materials with higher saturation magnetostriction than the currently used Metglas 2605CO would greatly increase the sensor’s tunable range. (Fe-Ga) alloys have previously displayed promise for applications requiring magnetically induced displacement due to their high saturation magnetostriction (>400 ppm in single crystals) while melt-spinning these alloys still yields a high magnetostriction (>100 ppm). Therefore, it has been proposed to melt spin Fe-Ga ribbon with the addition of Zr, for added glass formability, in the composition (Fe85-xGa15+x)92Zr8 to produce a high magnetostrictive ribbon material that may be used in tunable inductor applications.

Project Mentor: Professor Matthew A. Willard, Department of Materials Science and Engineering
Determining Aggregation Characteristics of Sophorolipid-(Zn)porphyrin Polymers Through Chain Modulation of Sophorolipid Motifs

George Heidbreder, Department of Physics; Kyle Peters, Department of Physics; and Dr. Ken Singer, Department of Physics;

Conjugated sophorolipid-(Zn)porphyrin are organic molecules that exhibit the interesting ability to self-assemble into helical nanostructures driven by hydrogen-bonding, and possess structural characteristics driven in part by steric hindrances within the sophorlipid’s hydrocarbon chain. When assembled, these molecules are expected to exhibit favorable charge transport properties through pi-stacking of the porphyrin core. These features make SL-(Zn)porphyrin compounds an attractive avenue of development for optoelectronic applications, such as organic photovoltaics and nonlinear optical materials. An advantage of this material is that structural modifications are achieved readily through chemical modifications providing highly tunable structural features, and preliminary data has shown that slight modifications to the sophorolipid motif result in drastic changes in the assembled nanostructures. The influence of the compound’s structural features on the self-assembled state is poorly understood, and this project will aim to characterize the mechanism of self-assembly in regards to varying the hydrocarbon chain structure of the Sophorolipid motif.

Project Mentor: Dr. Ken Singer, Department of Physics;

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Investigating Conformational Dynamics and Ligand Binding of hnRNP H12 by 19F NMR and EPR

Imogen Henry-Campbell, Chemistry Major, Department of Chemistry; Liang-Yuan Chiu, Department of Chemistry; William Ford, Department of Chemistry

hnRNP H protein regulates the alternative splicing events in the HIV genome. Alternative splicing enables the HIV virus to generate more than 40 transcripts from a single genome. hnRNP H contains three RNA recognition motifs (RRM) that recognize G-rich RNA elements in an unknown way. Our preliminary data suggests that in solution, hnRNP H12 exists in multiple conformations, with the majority in a compact form and the minority in an extended form. We aim to understand the mechanism hnRNP H12 plays in recognizing G-tract RNA. To do this we used integrated biophysics methods like 19F NMR and EPR Spectroscopy. These techniques allow further understanding of the mechanism of binding interactions of hnRNP H and G-rich RNA/DNA in solution.

19F NMR is an effective way to probe conformational dynamics and binding effects because of its high sensitivity, wide spread chemical shift range and relatively easy to assign signal. Multiple sites on hnRNP H were selectively labeled with 3-bromo-1,1,1-trifluoroacetone (BTFA) in solution. The 19F NMR spectra shows evidence of a minor population in both cases and agrees well with relaxation dispersion data. This suggests that H12 is undergoing a slow conformational exchange (µs-ms) in solution. 19F NMR titration experiments show that C22 and C122 sites are involved in the G-tract DNA recognition which agree with the NMR HSQC titration experiments. Additionally, preliminary EPR Spectroscopy data was collected on two hnRNP H residues labeled with MTSL. To further understand these phenomena, EPR Double Electron-Electron Resonance (DEER) measurement should be used, as the distance between MTLS labelled residues can be determined. 19F NMR combined with other techniques provides a great approach to study the conformational dynamics of proteins and binding specificity of ligands.

Project Mentor: Dr. Blanton Tolbert, Department of Chemistry
Using Phylogenetic Signaling to see if closely related parasites have similar effects on the behavior of their hosts

Jorge Hernandez-Gonzalez, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Parasites are organisms that benefit from its relationship with a host. While parasite-host relationships can vary significantly, many parasites alter host behavior to favor their own growth. This experiment tackles the question of if there is a relationship between how closely related parasites are and their way of altering host behavior. Closely related parasites will have similar altering effects on the behavior of their hosts. To be able to test this hypothesis, a phylogenetic signaling analysis is done in the R program with the use of the ape package. This phylogenetic signal analysis is done since it has been previously observed with other organisms that there is a tendency for species that are more closely related to have similar traits. Analysis of parasite phylogeny and data are done to test if there is evidence of phylogenetic signal between closely related parasites and their methods of altering host behavior. The study found that there is no evidence that supports that closely related parasites had more similar methods of altering host behavior than distant related parasites. If the closely related parasites had been found to alter host-behavior in similar ways and are therefore beneficial to the parasites in a similar way, then this would mean that there would have been evidence for phylogenetic signaling. However, the results indicate that closely related parasites do not alter host-behavior similarly, and that therefore there is no evidence of phylogenetic signal. This could be explained by how the hosts of these parasites are strongly pressured to naturally select traits that stop the parasites from effectively altering their behavior, which means that parasites are then pressured to change their methods of altering host behavior quickly.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

Low Cost Frequency Hopping Spread Spectrum Radio

Sophia Hestad, Department of Electrical Engineering; Stephen Marquis, Department of Computer Engineering; David Merriman, Department of Electrical Engineering and Computer Science

In radio communication the practice of spread spectrum transmission is achieved in a number of ways. One of these techniques is called frequency hopping spread spectrum, which involves changing frequencies at a set interval and along a set pattern known by both the transmitter and the receiver. While this technology is well known and well implemented, it is also cost prohibitive, with spread spectrum radios generally costing a minimum of $2000. Our goal is to create a low cost radio, at around a tenth of the cost of standard spread spectrum radios, capable of frequency hopping spread spectrum transmission by using an fpga to program a radio for frequency hopping transmission, allowing amateur radio operators to experiment with spread spectrum in a more accessible manner. Our approach was to use an arduino uno mated with a ham radio shield functioning as a software defined radio to achieve spread spectrum transmission. In order to stay within FCC regulations for spread spectrum transmissions, we will be doing all of our transmission in the UHF band between 430 and 450 MHz, and recording all spread spectrum transmissions with records of said transmissions being kept for a one year period. We have also acquired amateur radio licenses to allow us to make lawful radio transmissions on amateur bands.

Technical Advisors: David Kazdan Department of Electrical Engineering and Computer Science; John Gibbons, Department of Electrical Engineering and Computer Science

Faculty Sponsor: Greg Lee, Department of Electrical Engineering and Computer Science
Benzoxazine Studies using Gaussian Simulations

Tyler Heyl, Department of Chemical and Biomolecular Engineering, Lu Han Department of Macromolecular Science and Engineering, Daniela Iguchi, Department of Macromolecular Science and Engineering, Phwey Gil, Department of Chemical and Biomolecular Engineering, Victoria Sedwick, Department of Macromolecular Science and Engineering, Carlos Arza, Department of Macromolecular Science and Engineering, Seishi Ohashi, Department of Macromolecular Science and Engineering, Daniel Lacks, Department of Chemical and Biomolecular Engineering, Hatsuo Ishida Department of Macromolecular Science and Engineering

After 25 years of research on benzoxazine, there are still fundamental questions that have not been answered. The complex structure and polymerization mechanism of benzoxazine can be blamed. Gaussian simulation of benzoxazine, along with experimental results can start to answer some of these questions. For example, polymerization of benzoxazine can be detected by the disappearance of a 960-900 cm$^{-1}$ band in FTIR. Researchers widely excepted that this peak was assigned to C-H out of plane bending of the benzene ring. However, after a potential energy distribution analysis concluded via a Gaussian simulation, that backbone vibrations from the oxazine ring is the primary contribution along with phenol ring torsion. Also using a Gaussian simulation, the natural charge of each element can also be calculated. When summing the natural charges of the phenol benzene ring and plotting it against the polymerization temperature of different substituted phenol benzoxazine monomers there is a noticeable trend. At around 265°C there is a horizontal asymptote with decreasing negativity. Then the trend decreases exponentially with increasing negativity of the natural charges. This suggests that in the benzoxazine polymerization mechanism the phenol plays a role in initiating the ring open polymerization. With Gaussian simulations, researchers are able to obtain a more fundamental understanding of such a complex molecule.

Project Mentor: Professor Hatsuo Ishida Department of Macromolecular Science and Engineering

Macrophage Activation by Orthopedic Wear Particles is Inhibited by Polymyxin B

Matthew Hoffa, Department of Biology; Alexander Rascoe M.D., University Hospitals Department of Orthopedic Medicine; Brian Fort, Department of Orthopedics; Edward Greenfield, Ph.D, Department of Orthopedics

Wear particle-induced inflammatory osteolysis is an important cause of orthopedic implant failures. Evidence suggests this inflammatory response is partially the result of the activation of toll-like receptors (TLRs) of macrophages by pathogen associated molecular patterns (PAMPs) such as lipopolysaccharide (LPS), found on orthopedic wear particles. Presence of wear particles and their associated PAMPs leads to the production of TNFα, a key inflammatory cytokine. We quantified TNFα mRNA using real-time PCR as our measure of inflammatory response because TNFα production is an early marker of the inflammatory response by macrophages. Polymyxin B, an inhibitor of LPS, limits the production of TNFα by macrophages in the presence of soluble LPS and titanium particles with adherent, purified LPS. However, Polymyxin B has not previously been shown to be effective in limiting this inflammatory response to titanium particles with adherent bacterial debris. These particles have LPS, mixed with other bacterial debris, on their surface, and serve as a more representative model of wear particles in vivo. In this study, Polymyxin B limited TNFα production in the presence of both titanium particles with adherent bacterial debris and titanium particles with adherent LPS. The inhibitory effect of Polymyxin B was nearly identical for both types of titanium particles across the range of Polymyxin B doses used. Using a lactate dehydrogenase assay as a measure of cell death, we determined that PMB limits TNFα production at doses that do not induce cell death. By treating macrophages from TLR2 and TLR4 knockout mice with Polymyxin B, we are currently working to further determine the specificity of the inhibitory effects of Polymyxin B on LPS, as LPS relies on TLR4 for its effects. Our results suggest a potential clinical translation for PAMP inhibiting drugs to be used to combat wear particle induced implant failures.

Project Mentor: Dr. Edward Greenfield, Department of Orthopedics
Faculty Sponsor: Dr. Susan Burden-Gulley, Department of Biology
Speech-on-Speech Masking: Effects of Prosodic Variance

**Ann Holmes**, Department of Psychological Studies; **Monroe Chen**, Department of Psychological Sciences, Department of Cognitive Science; **Lauren Calandruccio**, Department of Psychological Sciences

This study was designed to explore the effects of prosody on performance in a two-talker masker. This project included recording a corpus of stimuli, the same 21 lists of sentences in three prosodic conditions: normal (conversational speech), exaggerated (described as "happy or excited"), and flat prosody (monotone). Participants were assigned a prosodic condition talker which they listened to in four masker conditions: normal prosody, exaggerated prosody, or flat prosody. This experimental design seems to be one of the first to use natural prosodic speech, not prosodic contours created using digital manipulation, choosing instead to manipulate the prosody naturally in recording. The results indicate that any time the prosodic condition of the target was the same as the masker (normal target, normal masker etc.), listeners had a hard time separating the streams of speech. Likewise, different prosody targets from maskers indicated improved performance (flat target, exaggerated masker etc.). One other interesting finding is that normal prosody targets were least affected by the changing prosody of the maskers, meaning performance was almost the same in all conditions. This could suggest that because we most often hear what we labeled "normal prosody" in our lives, it is most resistant to the effects of turning focus away from the target speech towards the masker.

*Project Mentor: Dr. Lauren Calandruccio, Department of Psychological Sciences*

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Intensive Care Unit Stress Monitoring Device

**Steven Cady**, Department of Biomedical Engineering; **Kaelyn Gasvoda**, Department of Biomedical Engineering; **John Hovater**, Department of Biomedical Engineering; **Katherine Koning**, Department of Biomedical Engineering; **Sunakshi Puri**, Department of Biomedical Engineering; **Jacob Rayyan**, Department of Biomedical Engineering;

Stress in patients in the Intensive Care Unit can delay recovery time. Caregivers need an effective way to quantitatively measure stress of patients who may be incapable of communicating it, so that they may alter patient treatment as needed to reduce stress and therefore reduce recovery time. Current solutions rely on an arbitrary, outdated system of asking the patients a standard set of questions that are subjective and prone to bias. The need is for a more effective way of quantifying patient stress using an evidence based approach through analysis of physiologic signals. The proposed solution is a stress monitoring device that caregivers can utilize to create a more effective recovery plan. This wearable device will record galvanic skin response signals emitted from the fingers, and along with the patient's heart rate and heart rate variability, input this data into a microprocessor. The microprocessor will analyze the continuous flow of signal using an algorithm that will output a real time display of an objective stress measurement index value and graphs of the data over a set time range. Our goal is for the device output display to give the caregivers a better understanding of the mental and physical stress state of their patients.

*Project Mentor: Sriram Boppana, Department of Biomedical Engineering*
*Faculty Sponsor: Colin Drummond, Department of Biomedical Engineering*

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Maximal Response to mTOR Inhibitors in Breast Cancer Models Requires Suppression of FAK Signaling

Jennifer Hoffmann, Department of Biochemistry; Leslie Cuellar Vite, Department of Pharmacology; Kristen Weber Bonk, Department of Pharmacology; Jennifer Yori, Department of Pharmacology; Dr. Ruth Keri, Department of Pharmacology, Department of Genetics, and Division of General Medical Sciences-Oncology

The PI3K/AKT/mTOR pathway is important for maintaining cell survival mechanisms and is highly activated in breast cancer. However, targeting this pathway has proven difficult due to inhibitor toxicities and reprogramming of downstream signaling pathways. One of the most well characterized reprogramming events occurs with the mammalian Target of Rapamycin (mTOR) inhibitor, rapamycin, which causes rebound activation of AKT. Reactivation of AKT further stimulates growth, proliferation, and survival pathways in cancer. Furthermore, we have found that rapamycin increases activation of focal adhesion kinase (FAK) in various breast cancer cell lines. FAK is a key component of focal adhesions, which triggers many downstream signaling pathways including the PI3K/Akt/mTOR pathway. This suggests that FAK activation is necessary for the rebound activation of AKT induced by rapamycin. If so, dual inhibition of FAK and mTOR should block the increased AKT activity induced by rapamycin and provide a more efficacious treatment than either drug alone in vitro and in vivo. Short term treatment of MDA-MB-231 breast cancer cells with FAK inhibitor, defactinib, blunted rapamycin-induced AKT activity. Furthermore, long-term exposure to the combination of rapamycin and defactinib caused an additional decrease in cell number compared to either drug alone. We then utilized the Chou-Talalay method to evaluate the extent of drug synergy in MDA-MB-231 cells. We determined that the drugs are synergistic at doses ~10-180 fold lower than the IC50 for either defactinib or rapamycin. To assess clinical relevance, we generated orthotopic xenografts using the MDA-MB-231 breast cancer cell line and treated tumor-bearing mice with defactinib, rapamycin, or the combination. The combination of rapamycin and defactinib further decreased tumor growth compared to either treatment alone and exhibited no toxicities. This provides preclinical data supporting dual FAK and mTOR inhibition as a new combinational therapy for circumventing mechanisms of resistance to mTOR inhibitors and effectively treating breast cancer.

Project Mentor: Dr. Ruth Keri, Department of Pharmacology

Modeling the Dynamics of Motor Protein Myosin VI

Yuta Hozumi, Department of Mathematics

Myosin VI is a molecular motor that is essential for most biological function. It transports nutrients and organelles, and acts as an anchor that supports the structural integrity of cell membrane protrusions. With recent advances in technology, single particle analysis is an emerging field of research because we can now experimentally record the dynamics of proteins, and compare the experimental data with the theoretical results. Understanding individual proteins is essential for understanding the connection between proteins and diseases; therefore, studying myosin will allow us to learn more about possible physical and biological effects of genetic mutation in myosin. Many unresolved questions remain about this structure and how it influences motor function, and fitting the experimental data to the theory will elucidate some of them.

Project Mentor: Professor Michael Hinczewski, Department of Physics.
Characterizing the Thermal Properties of Shape-Memory Polymer Composites Using the Dynamic Plane Source Method

Ryan Honens, Department of Mechanical and Aerospace Engineering; Benjamin Whitman, Department of Mechanical and Aerospace Engineering; and Steve Hostler, Department of Mechanical and Aerospace Engineering

The Energy Innovation Laboratory is developing a thin film shape-memory polymer that has the potential to act as a thermal switch with varying thermal properties. Methods that analyze the in-plane thermal properties of the thin film polymers have already been thoroughly developed and tested; however, the need for through-plane thermal property analysis has yet to be addressed. The dynamic plane source (DPS) method is a transient heat source method that allows for the calculation of both the thermal diffusivity and thermal conductivity in the through-plane direction. Using a thin (0.25mm) heater powered by a constant current source, the temperature at the surface of two surrounding, identical samples is recorded over time using a type K thermocouple. The samples are surrounded by heat sinks of aluminum that have much higher thermal conductivities which produces a relatively adiabatic environment within the critical section which minimizes error. The heater, samples, and heat sinks are pressed together to ensure good thermal contact. In an effort to produce reliable and repeatable results, a vertical test rig for clamping all the necessary components together has been constructed. The DPS method has successfully been validated by this research for samples of size no thinner than 15mm. Further experimentation to validate the effectiveness of the DPS method for thin film samples is currently underway.

Project Mentor: Doctor Steven Hostler, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Professor Alexis Abramson, Department of Mechanical and Aerospace Engineering

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CO₂ Batch Absorption Cooling

Michael Balog, Department of Mechanical and Aerospace Engineering; Oliver Hudgins, Department of Mechanical and Aerospace Engineering; Stefan Roeseler, Department of Mechanical and Aerospace Engineering

Batch absorption cooling uses low-grade heat (solar thermal, waste heat, etc.) to drive the refrigeration process rather than electricity. This system can be used to provide cooling to areas without electricity, useful in third world countries or recreational vehicles. It could also be applied in factories or large manufacturing processes where waste heat is abundant. However, absorption cooling acceptance has been slow to catch on due to its use of toxic refrigerants (ammonia). Our proposed system will use CO₂ which is a non-toxic, non-flammable coolant. The process is carried out by first adding heat to the absorber liquid to separate the CO₂. Then, the CO₂ is expanded to create a cold liquid which can be used for space cooling. Our team is creating a model for cooling analysis in addition to specifying a prototype device to be used in actual lab testing. The constructed model uses various thermodynamic analyses such as the Peng-Robinson equation for a mixture of two fluids. These analyses specify the relative concentrations of the coolant when mixed with the absorber. Using these specified states and NIST software, the properties of each fluid at any phase of the process can be determined. The temperature of the cold CO₂ is calculated from integrating the pressure-temperature diagrams of a CO₂ refrigeration process with the data accumulated from our Peng-Robinson analysis. Another objective of the thermodynamic iterations is to prove that a pump is not required to transfer vapor CO₂ in the system. Batch absorption cooling using CO₂ has the potential to be an environmentally and cost friendly form of refrigeration applicable in a variety of situations.

Project Mentor: Professor Steve Hostler, Department of Mechanical and Aerospace Engineering

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FirstEnergy Substation Battery Replacement and SCADA RTU Replacement Co-op Project

Zakary Hurd, Department of Electrical Engineering; Dan Paul, FirstEnergy Substation Design Supervisor

This FirstEnergy Co-op project included replacing control building backup batteries and replacement of a substation SCADA (Supervisory Control and Data Acquisition) RTU (remote terminal unit) which is used to relay information to a regional control center. The approach for both of these designs was relatively similar. The first step was to access the substation drawing database and pull the current structural, electrical, wiring, and one-line diagrams to determine the scope of what the design would entail. In the case of the battery replacement, a lot of reworking of the wiring drawings had to be done due to the fact that the alarm scheme for the new battery was much different than the one that was currently in place. Careful study of all of the drawings for that substation was needed to determine the power that the battery would need to supply in order to meet the demands of the substation in the case of loss of power. This involved calculating the power draw of the lighting receptacles, alarm systems, circuit breakers, transformers, and various other smaller systems in the substation, which ended up being a significant task. As for the SCADA RTU replacement, careful tracing of the wiring diagrams of all the systems that the RTU interacted with was required, which included the circuit breakers, transformers, and electrical panels and metering in the substation. All of these are directly wired to the RTU for communication purposes, so there were dozens of different wires and circuits that needed to be traced out. Determining how these wires and circuits would connect into the new RTU scheme had to be done as well, as the previous RTU was over 25 years old and very outdated. Almost the entire wiring scheme needed to be changed. This project provided real world engineering experience and tangible results for both myself and FirstEnergy

Project Mentor: Dan Paul, FirstEnergy Substation Design Supervisor

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NuLyfe

Dina Benayad-Cherif, Computer Science; Jesse Cavendish, Computer Science; Lauren Jahnke, Computer Science; Emma Vaughan, Computer Science

NuLyfe is a web application that will allow users to plan for relocating to a new city. The goal of NuLyfe is to simplify the moving process and help users adjust to their new financial situation based on a new salary and a new cost of living. Users will be able to visit our site and be led through a series of key planning steps.

The first step will be to have the user enter pertinent information regarding their relocation including their current location (city, state), their new location (city, state), income, and when they will be relocating. This will help us filter their moving options to best suit the user’s needs. The next step will be transit options for relocation. This includes flying, driving, or bus. The third step will be relocation service such as U-Haul and U-Box. The fourth step will be housing assistance. There will be various filters set by the user to specify their desired proximity to work, nightlife, restaurants, etc. and desired neighborhood or zip code. The fourth step will be transit assistance to work. There will be options for public transit, drive, walk, or bike. The final step will be budgeting assistance. Budgeting assistance will take into account the user’s income and cost of living in that city, and return information about how much the user should plan to spend on things like gas, groceries, rent etc.

Faculty Sponsor: Soumya Ray, Associate Professor Department of Electrical Engineering and Computer Science

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A Time Series Analysis of Degradation in PV Modules in Comparison to the Koppen-Geiger Climate Zones

Suk Hyun Hwang, Department of Computer Science; Ahmad Karimi, Department of Computer Science; Alan Curran, Department of Material Science; Dr. Roger French, Department of Material Science

Solar energy is one of the most promising sources of renewable energy. However, due to the nature of how it works, these Photovoltaic (PV) modules must be placed outdoors, where it is exposed to the harsh environment, which causes degradation. We want to find the relationship between the climate and degradation of the PV modules.

Efficiency is measured by (Power Output)/(Received Solar Irradiance). If we know the power output and solar irradiance, we can accurately see the degradation in efficiency. If we see the degradation in efficiency and compare it around the globe in different Koppen Geiger climate zones, we can find the effect the climate has on the degradation of PV modules.

However, the sensors are untrustworthy because of degradation and drift. This leads us to use SolarGIS data. SolarGIS is weather data from satellites (https://solargis.com). We believe that this data is more trustworthy than individual sensors because of the sheer amount of money and effort that went into making these compared to flimsy individual sensors.

Using SolarGIS datasets have their own issues, especially the data that we get includes the part of the day when it is cloudy and during the night time. These periods of the day, when the solar irradiance is low or fluctuating rapidly due to the clouds, are not useful for the algorithms that we use to model power time series. If all these issues are fixed, we have data good enough to analyze.

The project cleans and selects only the good data from the enormous amount that SDLE has. After the data is cleansed, a month-by-month model and year-by-year model will be made to analyze clearsky data points for smoother analysis, which will allow us to find the specific relationship between the climate and degradation of PV modules.

Project Mentor/Faculty Sponsor: Professor Roger French, Department of Material Science.

Development of the Skull and Congenital Craniofacial Abnormalities : An Embryologic and Literature Review

Amber Jin, Department of Biology

Congenital craniofacial anomalies occur as the result of abnormal growth of head and facial bones during development. This embryological review focuses on the formation of cranial bones during normal development. From this, understanding how the irregular formation of the bones can lead to orofacial clefts, craniosynostosis, and hemifacial microsomia, some of the most common craniofacial anomalies. These abnormalities can lead to many other medical issues, which include vision and hearing problems/loss, speech development problems, and swallowing issues. Improper formation of the flat bones of the cranium can also impede the growth of the brain and cause brain damage. It is known that most congenital craniofacial anomalies have multifactorial causes that are either genetic and/or environmental. Current treatment for craniofacial anomalies occur after birth through surgical procedures and rehabilitation. The aim of this paper is to better understand the genetic research being done in this field and what preventative measures can be taken to decrease the chances of being born with a craniofacial anomaly.

Faculty Sponsor: Dr. Scott W. Simpson, Department of Anatomy
Implementing a Forward Genetic Screen (VBIM) to Identify Novel Proto-Oncogenes involved in Metastatic Breast Cancer

Abhinav Kakuturu, Department of Biology; Nathaniel Robinson, Department of Pathology

Metastatic breast cancer (MBC) is the second leading cause of cancer-related death in women in the United States. Metastasis is incurable and there is no targeted treatment available to manage metastatic lesions. Rather, treatment options for MBC are based on treating the symptoms of MBC and increasing the quality and length of life for patients. Clearly, more effective and targeted methods are needed to properly treat the underlying disease mechanism. To this end, we developed a novel validation-based insertional mutagenesis (VBIM) forward genetic screen that allows breast cancer cells to resume proliferative growth and avoid metastatic dormancy. The VBIM construct expresses GFP and is flanked by CRE-lox sites. When expressed in dormant breast cancer cells, VBIM provide for an unbiased whole genome approach to identify proto-oncogenes capable of driving disseminated cells to emerge from dormancy and recur. A corollary states that these novel proto-oncogenes may serve as important drug targets to alleviate MBCs. We utilized murine D2.0R breast cancer cells that readily acquire dormant phenotypes after colonizing the lungs of mice, and when propagated in 3D-organotypic cultures in vitro. As such, D2.0R cell clones were infected with VBIM lentiviral particles and monitored for their growth in 3D-cultures and in the lungs of mice. Six clones were isolated and labelled as “convertants” (i.e., became outgrowth proficient), a designation validated by a reversal in their outgrowth abilities following infection with CRE-recombinase to excise the VBIM construct (i.e., or “revertants”). The VBIM insertion point was mapped through reverse- transcribing RNA from one of the validated clones. The resulting cDNA was amplified using VBIM-specific primers prior to cDNA sequencing. In doing so, we identified mouse 18S ribosomal RNA as a novel mediator of metastatic outgrowth. Current efforts aim to determine how altered expression of 18S ribosomal RNA drives emergence from dormancy.

Project Mentor: Professor William. Schiemann, General Medical Sciences-Oncology
Faculty Sponsor: Professor Ronald Oldfield, Department of Biology

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LED Performance Wearable

Samuel Morrison, Department of Electrical Engineering and Computer Science; Trino Mitra, Department of Electrical Engineering and Computer Science; and Tyler Keen, Department of Electrical Engineering and Computer Science

With new Internet of Things (IoT) technology available at lower prices, choreographers are experimenting with new ways to enhance performances with visual effects. Some contemporary performances include a series of LEDs or projections that compliment the performers’ movements. The issue with this technology is that it requires performers to completely synchronize with the light coordination and for the choreographer to have extensive programming knowledge or outsource to somebody who does. This project is concerned with developing an LED performance wearable as a better alternative. We developed an apparatus that uses the performer’s movements to control LED strips attached to each of their limbs. To provide the most variety in performances, each LED is addressable and different visuals are available for selection. Our apparatus allows performers to be spontaneous without losing the added effects of the LEDs.

Project Mentor: John Gibbons, Director of Sears Undergraduate Design Laboratory
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering & Computer Science

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A Data Analytics Approach to Identifying Saving Opportunities and Inefficiencies

Shreyas M. Kamath, B.S. Engineering Physics; Arash Khalilnejad, Department of Electrical Engineering and Computer Science; Rojiar Haddadian, Department of Mechanical and Aerospace Engineering; Ahmad M. Karimi, Department of Electrical Engineering and Computer Science; William J. Koehrsen, Department of Mechanical and Aerospace Engineering; David R. Blincoe, Department of Electrical Engineering and Computer Science; Quinn C. Kennedy, Department of Electrical Engineering and Computer Science; Roger H. French, Department of Material Science and Engineering; Alexis R. Abramson, Department of Mechanical and Aerospace Engineering

Commercial buildings are responsible for about 36% of the total electricity consumption in the United States. Out of this consumed electricity, 30-50% is wasted. Current strategies to identify inefficiencies involve traditional building audits that are expensive, time-consuming and invasive. EDIFES (Energy Diagnostic Investigator for Efficiency Savings) is a project developing a software platform for virtual energy audits, that combines machine learning, statistical inference, domain knowledge in mechanical engineering and High Performance Computing (HPC). EDIFES aims to use a high-fidelity, non-invasive, and timely data analytics approach to identify inefficiencies and opportunities for savings using limited, yet readily available utility and environmental data. Classical time series decomposition, clustering and filtering are statistical approaches used to analyze the data sets to reveal valuable information about building characteristics and operational patterns that are otherwise unobservable. Furthermore, the analysis is being developed to achieve disaggregation (of HVAC, lighting and plug load), a process that is critical for gaining crucial insight into building energy efficiency. Machine learning algorithms such as random forest regression, artificial neural networks, and deep learning are being used to develop building predictive models of electricity consumption. These predictive models can be used to forecast potential energy savings into the future if certain energy conservation measures are implemented. With these methods, we can compare a single building's behavior against a population of buildings located in the same climate zone with the same building type and derive further insights.

Project Mentors: Professor Alexis R. Abramson, Department of Mechanical and Aerospace Engineering; Professor Roger H. French, Department of Material Science and Engineering

Improving Group Outing Facilitation

Quinten Hutchison, Department of Computer Science; Victoria Kelly, Department of Computer Science; Jacob Kessler, Department of Computer Science

CRWL is a group-management cellular phone application that will allow users to manage and track their group of people as they go about their night. It will allow users to create a group and have a single location for them to manage every aspect of going out for the night. It will allow designated owners of the group to create an itinerary, invite members, and then fill the itinerary with events that show when, where, and what the group will be doing throughout the night. The owner or owners of the group will be able to update this itinerary on the fly, notifying every member of the group of the change. Group chat will also be available for all members of the group, allowing them to message each other text and images. This product will facilitate large group outings, specifically in the context of a bar crawl event. Although only supported on iPhone devices currently, this application has the possibility of being expanded to other cellular device formats in the future.

Project Mentor: Dr. Soumya Ray, Department of Computer Science
Recognition of Factor VII-CD142 Signaling Axis as a Novel Senescence Pathway in Glioblastoma

Sophia Kang, Department of Chemistry; Won Jun Lee¹, Ph.D.; Yeonghwan Kim¹, Ph.D.; Jeongwu Lee¹, Ph.D.

¹Department of Stem Cell Biology and Regenerative Medicine, Lerner Research Institute, Cleveland Clinic

Senescence acts as a physiological barrier against tumor initiation and progression by inducing a permanent cell cycle arrest. While senescent cells are often observed in the pre-malignant stages of tumors, recently emerging data demonstrate that tumor cell senescence also occurs in fully malignant tumors including glioblastoma. The anti-tumor characteristic of senescence can be exploited for cancer therapy, but this possibility has been underestimated to date. Commonly recognized characteristics of senescence include morphological features, positive staining for senescence-associated β-galactosidase marker (SA-β-Gal), and the engagement of key effector pathways such as p16, p53, and RB pathways. Through high throughput screening (HTS), we have discovered that CD142 is a novel cell surface marker for successful identification of senescent tumor cells. CD142, also called Tissue Factor (TF), is a transmembrane receptor for Factor VII, which is known to initiate blood coagulation cascade, but the roles of CD142 in cancer have been largely unknown. We have found that CD142 expression in tumor cells is increased after irradiation and/or chemotherapy. More importantly, activation of CD142 signaling induces an intrinsic signaling process that plays a role in tumor cell senescence and apoptosis. Based on these findings, we hypothesized that Factor VII-CD142 signaling axis is a novel senescence pathway that can be targeted for therapeutic purposes. Our lab has aimed to approach glioblastoma treatment by finding a mutant FVII that will activate the intrinsic pathway that plays a role in senescence without activating the extrinsic coagulation pathway that may lead to hypercoagulation.

Project Mentor: Dr. Jeongwu Lee, Department of Stem Cell Biology and Regenerative Medicine, Lerner Research Institute, Cleveland Clinic

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Developing Capability for Locomotion of Compliant-legged Robot for Amphibious Behaviors in Surf-zones (CRABS)

James Kaminski, Department of Mechanical Engineering; Jay Tewani, Department of Mechanical engineering; Alexander Behr, Department of Mechanical Engineering

The development of a crab-like robot that can operate in the surf zone -- both on land and underwater has been put forward. The objective for this robot is to develop legs that act as a single compliant manipulator to walk on sandy terrain and around or over obstacles that may be found in such an environment. The current prototype is unstable, falling into an effectively broken state after several gait cycles, due to its weak joints and improper fastening method. The original gait pattern additionally moved the crab forward one step then backward half a step, making for inefficient locomotion. The current legs act like blades that cut through the sand, failing to provide friction or sufficient reactive normal forces to keep the robot above the sand. This project is concerned with replacing the current fasteners to improve stability and develop foot prototypes that can interface with the current leg and help provide the reactive forces necessary to achieve locomotion on sand. We will produce several different foot designs, each roughly conic to disperse forces, with varying widths and point angles to determine a design that will display appropriate characteristics in sand. For purposes of our testing, we also need to develop a protective barrier, similar to a plastic sled below the body, to shield the delicate components from sand damage. Movement on even, sandy terrains will be tested first, followed by the scenarios of uneven sandy terrains and various inclines to gauge the robot's capabilities before gravitational forces overcome friction and the reactive forces of the sand. To quantitatively measure the forces exerted by the robot, we will perform tow tests in each of the aforementioned scenarios. Other evaluation criteria include the aped at which the robot can move and the degree of incline the robot can traverse.

Project Mentor: Professor Kathryn Daltorio, Department of Mechanical Engineering
Beginning to view consciousness as a gradient for the purpose of improving healthcare delivery

Mark Kaminski, Department of Biology and Department of Psychology

The links between our sense of self and our complex neural circuitry allowing us to experience consciousness are not completely understood. There is general consensus in the field that consciousness arises from the complex communication between different brain areas that are each responsible for different components that allow us to develop a sense of self. Multimodal neurons in the intraparietal sulcus are responsible for visuomotor integration and communicate with multiple brain areas including, but not limited to, the extrastriate body area which is responsible for perception of the body in space. The communication between these key neural components can be measured in wave frequencies (as well as other methods like fMRI), which give us an idea of the activity of these individual areas and the degree to which they are communicating with each other. Different brain frequency emissions correspond with different states of awareness, including fully alert, asleep, dream states, anesthesia/coma states, postictal states, and cardiac arrest. A lesser understood concept is the idea of seeing consciousness on a series of levels, or viewing it as a gradient. Many health care providers either view consciousness as an all or nothing state, or as a gradient that can easily be observed through a series of subjective examinations. These methods might be falsely creating a direct causal relationship between level of cognition and level of consciousness, which might not always be true. For example, case studies have shown that individuals in cardiac arrest receiving CPR can be fully capable of experiencing conscious awareness. This can create scenarios where providers are making false assumptions about a patient’s conscious state, which can lead to inappropriate choices of treatment. In order to provide the most just and ethical patient care experience possible, we need to start viewing consciousness as a complex interplay of multidimensional global states, in other words as a series of gradients arising from each individual brain area and their communication with each other. Although experts in the field might already view a person’s consciousness in this way, implementing this information as common training and treatment across all levels of healthcare is essential. This current presentation attempts to evaluate the most up to date research on conscious state gradients and propose methods to implement this research into training and protocols for future health care systems.

Project Mentor: Professor Dianne Kube, Department of Biology

Determining the Origin of the Turtle

Jarrett Kong, Department of Biology; Dr. Jean Burns, Department of Biology

The origin of the turtle has been a longstanding debate in vertebrate zoology. This was due to the lack of fossils of evolutionary ancestors. However, the discoveries of millions of years old stem turtle fossils has shed light on the evolutionary process turtles have undergone. The existence of these transitional fossils has provided researchers answers to long sought after questions, such as how the shell evolved. A major discovery, Odontochelys semitestacea’s remains proved that the plastron developed much earlier than the carapace. Most recently, Pappochelys rosinae’s discovery proves that the modern plastron evolved from a serial fusion of gastralia. From these new developments, researchers have theorized an aquatic origin for ancestral turtles with the plastron being an evolutionary response to attacks from underwater predators. We plan on verifying these claims by uncovering the original habitat with the use of phylogenetic principle component analysis on carapace shape and other physical adaptations turtle’s have evolved to suit their environment. By further compounding the results with ancestral state reconstruction, we hope to determine if the turtle originated from an aquatic or terrestrial environment.

Project Mentor: Dr. Jean Burns
Simple Social Card Game

Lee Kelvin, Department of Electrical Engineering and Computer Science; Qianxiang Ma, Department of Electrical Engineering and Computer Science

This project is inspired by board games like Magic the Gathering and Hearthstone. We took the ideas we liked, rejected flaws we spotted and invented new concepts. This project is a continuation of a previous project from another class we took. There are features, such as Encryption, database, level system, versus-AI mode, that were unable to be implemented due to time constraint. Given another semester to continue this project, we plan to implement all the mentioned feature. The Encryption will feature RSA. We plan to add entropy into RSA to make it harder to break. We will add random string onto message, so that a same message will result in different ciphertext. The length of the random string will be varied. To make sure the intended recipient knows which portion is the random string, a number will be encrypted with El-Gamal cryptosystem and placed in front of the message. The level system will allow player to earn in game currency and allow player's card to gain level after each battle. Once a card reaches certain level, it can be special practiced to be permanently morphed into a different card with improved ability. This feature will be supported by the database system. The versus-AI mode allows 2 players to play together against an AI opponent. This mode intends to encourage increased social interaction besides providing another way to earn in game currency to level up their cards.

Project Mentor: Professor Soumya Ray

Design of a Modular Cubesat System for Natural Disaster Monitoring and Communications Relaying

Kate Erickson, Department of Mechanical and Aerospace Engineering, Scott Kars, Department of Mechanical and Aerospace Engineering, and Dr. Kul Bhasin, Comsat Architects

Small satellites have become increasingly popular over the last decade due to their low cost and complexity compared to larger systems. A market exists for cubesats which can perform functions usually reserved for multimillion dollar satellites such as Earth surveillance and high resolution surface imaging. A cubesat carrying a high resolution camera, infrared imaging systems, or radiation detection sensors has the potential to provide low cost monitoring of natural disasters or military surveillance. Additionally, communications with NGSO (Non-Geostationary Orbit) commercial satellite constellations would allow for the quick relaying of images and data to ground stations across the globe at high data rates. A modular cubesat system is being developed which will be flown in pairs, with one satellite carrying imaging and sensor payloads and the other containing a dedicated RF communications system. With one cubesat trailing its partner in the same orbital track by some small distance, surveillance data can be crosslinked between the two via an ultrahigh frequency (UHF) communications system, and then relayed to commercial satellites via an L-Band system onboard the second satellite. NGSO constellations such as IridiumNEXT will allow for this data to be downlinked to relevant ground stations in the United States regardless of which region of the world the cubesats happen to be over. This system would be the first of its kind and would represent a significant advance in the sophistication and applicability of cubesats. With the support of NASA, these cubesat pairs would be launched from the NanoRacks Cubesat Deployer (NRCS) aboard the Kibo module of the International Space Station. The NRCS launches cubesats into an orbit between 400 and 415 kilometers above the Earth’s surface at an inclination of 51.6 degrees, allowing the modular cubesat system to survey 95% of the Earth’s surface.

Project Mentor: Dr. Kul Bhasin, Comsat Architects
Hololens for the Blind

Alec Bortnick, Department of Electrical Engineering and Computer Science; Ross Kasal, Department of Electrical Engineering and Computer Science; Ashley Roberson, Department of Electrical Engineering and Computer Science

People with total blindness face many challenges in their daily lives; these challenges may include navigating to a new location, avoiding obstacles in their path, including other people, or even finding an item in their house. Even with assistance, those with total blindness lack full independence in their day-to-day routine. Our work is designed to improve the independence of someone with total blindness in navigating through our world. Using a Microsoft Hololens device we can create a map of an environment with instructions on how to navigate through it without colliding with any obstacles. With use of this device it will give the user an audio warning when they are approaching an object they may collide with. Once the warning is issued the user will be given another audio cue telling them to turn left or right in order to avoid the object and the Hololens will then put them back on their original path. Our project is not limited to an area the user has been through hundreds of times and will be fully capable of navigating a user through an area they have never set foot in. Since we will program nodes into the path, the device will always know how to get the user from point A to point B as long as all the audio cues are adhered to. This project is specifically designed to help those who may feel neglected and resigned to using old or outdated methods of navigation. Our work will not only provide them the means to navigate new and old environments, but will also give people a sense of independence they may not have felt before.

Project Mentor: Dr. Mark Griswold, Department of Radiology
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering and Computer Science

CANE-NECT: Connecting Safety & Stability with Every Stride

Rahul Ramraj, Department of Biomedical Engineering; Ryan Hall, Department of Biomedical Engineering; Patrick Scanlon, Department of Biomedical Engineering; Chung-ang Tsao, Department of Biomedical Engineering; Gabrielle Kiefer, Department of Biomedical Engineering

Eighty-seven percent of fall occurrences in elderly populations involve the use of walk assist devices, and medical costs for these falls exceed $30,000 for a single hospital stay. Such falls are often the first domino in a cascade of detrimental events and medical complications. Our team proposes a solution that enables fall prevention and detection for walk assist device users. With a simplistic device capable of being externally affixed to walk-assist devices, we aim to address this problem on three fronts: clinical, assisted living, and residential use. Fall detection and prevention will be achieved through the use of a microprocessor that collects data from a 3-axis accelerometer/gyroscope combination sensor, processing and transmitting the data via bluetooth. An Android and IOS compatible web platform will be used to retrieve and analyze this data. Clinicians can further analyze this data to determine if the user's mobility has deteriorated and if the user requires a new form of mobility assistance. Through the use of our product, we hope to reduce the frequency of falls, decrease fall complications, and provide a proactive rather than retroactive approach to fall mitigation and prevention.

Faculty Sponsors: Professor Colin Drummond, Department Biomedical Engineering
Professor Matthew Williams, Department Biomedical Engineering
**Coupling a Spiking Neuron Model with a Kinetic Model of Feeding in Aplysia californica**

**Tate Keller,** Systems Biology, Department of Biology; **Jeffrey Gill,** Department of Biology; **Shannon Stork,** Department of Electrical Engineering and Computer Science

To understand how animals interact with their changing environments to survive, it is crucial to understand how an animal’s nervous system interacts with the rest of its body. The feeding system of the marine mollusk *Aplysia californica* is an important model to consider in neurobiology because large, identifiable neurons control the muscles that allow the animal to feed. *Aplysia* rely on a structure known as the buccal mass, which contains muscles that are responsible for extending another structure, the odontophore, outwards to grasp and pull food into the body. *Aplysia* are constantly challenged with grasping irregularly shaped foods and must decide how best to effectively swallow this food. Sutton et al. (2006) created a kinetic model of the buccal mass to illustrate how *Aplysia* feed. The model allows for variations of motor neuron activation as input, and change in these neural inputs is responsible for triggering a kinetic response in the model. In the original version of the model, neuronal inputs were represented as the collective average firing frequencies. To better understand how the motor neurons of *Aplysia* coordinate adaptive behavior, I replaced the original neural inputs of this kinetic model with a simple but highly flexible neuronal model developed by Eugene Izhikevich (2003). I replicated the Izhikevich model and implemented it within the software for the kinetic model of the buccal mass to model motor neurons of the *Aplysia* feeding system. Since the Izhikevich model parameters control model neuron characteristics such as maximum firing rate, the parameters of each model neuron were fit based on maximum firing rates of neurons from experimental data. In addition, I have added software that animates the biomechanical movements of the modelled buccal mass in two dimensions. This work will help us better understand how real nervous systems solve problems in a changing environment.

*Project Mentor and Faculty Sponsor: Dr. Hillel Chiel, Department of Biology*

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**Design of a Fatigue Crack Growth Test Fixture**

**Jenna Krynicki,** Department of Materials Science and Engineering; **Bethany Cook,** Department of Materials Science and Engineering; and **Benjamin Palmer,** Department of Materials Science and Engineering

Currently, 5xxx series aluminum (Al) alloys are most commonly used in naval applications, because 5xxx series Al is strong (solid-solution strengthened with magnesium) and lightweight; qualities that are necessary for naval ships. The main issue with using this alloy in ships is that the alloy can become “sensitized” after exposure to temperatures of 70°C and above for extended periods of time. With exposure to high temperatures, Al-Mg (Al₃Mg₂) particles, or the β phase, will precipitate out of solution along the grain boundaries. The β phase is anodic to the Al host matrix, thereby creating a pathway for corrosion and stress corrosion cracking, and thus decreasing the strength and lifetime of these alloys.

The two main orientations of the alloys that are mechanically tested (and exhibit different mechanical behavior) are the long-transverse (LT) and short-transverse (ST) orientations. Currently, only the LT orientation can be tested during fatigue crack growth in CWRU’s Advanced Manufacturing & Mechanical Reliability Center. Typically, the ST orientation behaves worse in tension due to its increased grain boundary area. The variance in mechanical properties of these two orientations requires that both orientations be mechanically tested. For this project, new grips will be created to hold the thin ST specimens in the existing specimen holders. These new grips serve to raise the ST specimen, so that the inner notch can be tested and crack growth can commence. Additionally, a certain kind of glue will be selected to adhere the new grips to the ST specimens. This project will allow for 5xxx series Al to be more accurately studied for naval applications.

*Project Mentor: Professor Peter Lagerlof, Department of Materials Science and Engineering*
Sleep State Classification through EEG Signal Analysis

Justin Beiriger, Department of Electrical Engineering and Biomedical Engineering
Natalia Gawlik, Department of Biomedical Engineering
Tao Hu, Department of Biomedical Engineering
Dominic Kizek, Department of Biomedical Engineering
Jamie Yu, Department of Electrical Engineering and Biomedical Engineering

The purpose of the project is to create an automated sleep-stage classification device with applications in both clinical and ambulatory settings. The main use of the device is to monitor EEG signals in patients with brain diseases away from the hospital. Electroencephalography (EEG) is used in clinical testing to evaluate the electrical activity of the brain. Alzheimer’s disease, autism, and epilepsy are just a few named diseases and disorders that alter brain activity and consequently produce EEG abnormalities observable during sleep. The five distinct stages of sleep and other abnormalities can be identified by observing characteristics of an EEG signal, such as power and frequency. The outcome of this project will impact the way in which sleep disorders and brain diseases are monitored and treated.

Clinicians desire more frequent access to these patients, who often cannot make it to the hospital for daily checkups, e.g. epileptic patients cannot drive. It is important for physicians to analyze patients’ responses to new treatments and to monitor disease progression. This device will collect and analyze data from patients’ homes that physicians can use to inform treatment plans, without the patient ever visiting the hospital. We built a self-contained device that acquires EEG data from the head and paired it with a novel signal processing algorithm that will classify sleep stages and provide quantitative data to clinicians. Additionally, we developed a desktop application for clinicians to use for easy data upload, analysis, and interpretation by means of visual graphs and charts. Through verification protocols, we tested our device against technical specifications we determined early in the design process. The device has high priority level in the healthcare industry, as it provides useful information regarding the progression of sleep-affected diseases.

*Project Mentor: Dr. Michael Decker, Department of Nursing*
*Faculty Sponsor: Dr. Colin Drummond, Department of Biomedical Engineering*
*Dr. Matthew Williams, Department of Biomedical Engineering*

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Extension of the ability to store heat by microencapsulating multiple phase change materials with graphene oxide carbon nanosheets

John Kwon, Department of Chemistry; and Paul Advincula, Department of Macromolecular Science and Engineering

Phase change materials (PCMs) are capable of storing latent heat by changing their phases (for example, melting), which can be useful in managing and harvesting thermal energy. A common problem associated with PCMs is difficulty in handling during phase and volume changes, as well as low thermal conductivity which prevents full utility. Recently, we developed a method to encapsulate the PCM stearic acid with reduced graphene oxide (rGO) carbon nanosheets using a Pickering emulsion as a template and demonstrated that this composite has improved thermal conductivity while containing the PCM material over a wider temperature range, even while the PCM undergoes phase change repeatedly. Herein we will present with extension of this approach to a multitude of PCMs, including lauric acid and capric acid, which have complimentary phase change windows to stearic acid. By incorporating the three encapsulated PCMs together, the composite can store energy over a wide temperature range, extending the applications beyond those available with current state-of-the-art systems.

*Project Mentor: Professor Emily Pentzer, Department of Chemistry*

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How sentence-level prosody affects speech recognition for native-Mandarin speakers and simultaneous English-Mandarin bilinguals

Jessica Kong, Department of Psychological Sciences

This study examines how prosodic cues facilitate speech recognition in competing background noise for both sequential (native Mandarin speakers with English acquired as a second language) and simultaneous (Mandarin and English acquired at the same time) bilingual Mandarin-English speakers compared to a control group of monolingual English speakers. The project uses a speech corpus of 21 lists of sentences each recorded in three prosodic conditions: normal prosody (conversational), flat prosody (monotone), and exaggerated prosody (very happy and excited). These sentences were used for both target and masker speech, with each target condition presented with the three masker conditions. In Mandarin, prosody is used to differentiate between the meanings of specific words. Prosody in English differs in that it typically conveys emotion, sentence form, and meaning. Due to these different experiences using prosody, we predict that the exaggerated target speech will be the easiest target to understand, as listeners should be able to use the exaggerated prosody to segregate the target speech from the masker. However, when the exaggerated speech is competing in the background, we anticipate it will have the opposite effect, and cause significantly greater interference for the listener, resulting in poorer performance. We also anticipate that the flat target will be most detrimental to native English speakers, as they are accustomed to using sentence level prosody to help them understand speech in noise, while sequential bilinguals should be least impacted by this change in prosody. Data will be presented for 18 sequential and 18 simultaneous bilinguals.

Project Mentor: Dr. Lauren Calandruccio, Department of Psychological Sciences

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Novel Role of S-nitrosothiols in CFTR Cell Membrane Stabilization

Julia Knight, Department of Biochemistry and Department of English; Dr. Khalequz Zaman, Department of Biochemistry and Department of Pediatrics; and Dr. Benjamin Gaston, Department of Pediatrics and Department of Physiology

Cystic fibrosis (CF) is an inherited disorder of defective chloride transport genes that plug off mucus, sweat, and digestive cells, resulting in progressive damage to multiple organs. S-nitrosothiols (SNOs) are small, native, endogenously produced signaling molecules that serve as S-nitrosylating agents; levels of these molecules are low in the CF airway. This project evaluates the potential interaction of SNOs with cochaperone C-terminus Hsc70 interacting protein (CHIP), an E3 ubiquitin ligase which targets improperly folded CFTR for degradation. We found that CHIP is expressed in primary human bronchial epithelial and CFBE41o- cells expressing either wild type or mutant F508del CFTR. We demonstrated that SNOs significantly reduce CHIP expression, which allows F508del CFTR to properly mature, and increases its stability at the cell membrane; in the presence of SNOs, our data show significantly higher levels of mature CFTR. We also investigated the interaction of CHIP with CFTR at the cell surface by transfecting cells with siRNA duplexes specific for CHIP, followed by cell surface labeling techniques. After knocking down CHIP, we showed elevated levels of mature cell surface CFTR. These transfected cells were then incubated with SNOs, which further increased mature CFTR. In addition, we demonstrated that GSNO, a particular SNO compound, S-nitrosylated CFTR associated CHIP. Furthermore, we found that GSNO-treated cells had significantly lower levels of ubiquitinated CFTR than untreated cells. These data suggest that S-nitrosylation of CHIP by GSNO inhibits CHIP’s E3 ubiquitin ligase function and obstructs CFTR ubiquitination, thus impeding a key step in targeting CFTR for degradation. We also demonstrated cellular co-localization of CFTR and CHIP in CFBE41o- cells using confocal microscopy and immunoprecipitation assay. We showed once again that exogenous GSNO reduced CHIP levels. We conclude that SNOs effectively reduce CFTR degradation by CHIP, resulting in active, mature CFTR on the bronchial epithelial cell surface.

Project Mentor: Dr. Khalequz Zaman, Department of Biochemistry and Department of Pediatrics

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Cut your losses: efficiency of information transmission in molecular communication

Benjamin Kuznets-Speck, Department of Physics; Dr. Michael Hinczewski, Department of Physics; Dr. Peter Thomas, Department of Mathematics, Applied Mathematics and Statistics; and Dr. Andrew Eckford, Department of Electrical Engineering and Computer Science (York University)

Molecular communication is a central facet of problems such including deciphering the principles governing physiological signaling (occurring constantly in cellular and neuronal transduction networks) and optimization in synthetic biology. These problems are illuminated by a quantitative description of the information transmitted in a given system and the relationship between said system’s characteristic timescales and its efficiency of information processing. Information theory provides an abstract formalism in which to study communication channels, while thermodynamics accounts for the physical constraints inevitably present in biological ‘information engines’, though a general unification of these theories remains incomplete. In particular, when measuring the cost of reliable information transfer, there exists two separate, and possibly compatible, perspectives: rate-distortion theory dictates a specific functional form that cost be measured in for a channel to perform optimally while thermodynamics requires this cost to be an entropy production. In this study, we will apply both of these formalisms to a simple model of synaptic signaling and examine consequences of unifying these perspectives using a technique known as probabilistic matching.

Project Mentors: Professor Michael Hinczewski (primary), Physics; Professors Peter Thomas and Andrew Eckford

Deposition and Characterization of ZnSnSb₂ for Phase Transition Studies

Kevin Kwock, Department of Physics; Prof. Gary Chottiner, Department of Physics; and Prof. Kathleen Kash, Department of Physics

ZnSnSb₂ is predicted to have interesting crystal structures and phase transitions that have not yet been carefully confirmed by experiment. Previous studies have shown ZnSnSb₂ to have a phase transition around 473 K from the chalcopyrite phase to a cation-disordered phase that has been attributed to Zn-Sn exchange defects. However, the cation disorder could also be the result of random stacking of the chalcopyrite phase and a second pure phase, commonly referred to as the copper-gold phase. Low-angle x-ray diffraction (XRD) and x-ray photoemission (XPS) may distinguish between these two models. By studying this material, we also gain better insights into crystal structures of other ternary semiconductors of the same class.

We use physical vapor deposition and Knudsen Cells to control the deposition and stoichiometric ratio of zinc, tin, and antimony. A quartz crystal microbalance is used to measure the rate of evaporation onto the substrate while thermocouples monitor the temperature of the Knudsen cells. The deposited film is annealed after evaporation to promote the formation of the chalcopyrite phase. Films are characterized by x-ray diffraction (XRD), energy dispersive x-ray spectroscopy (EDXS), and x-ray photoemission spectroscopy (XPS) to determine crystal structure, composition, and the cation ordering of the material.

Project Mentors: Professors Gary Chottiner and Kathleen Kash, Department of Physics
Faculty Sponsor: Professor Rolfe Petschek, Department of Physics
Ketamine rapidly reverses cognitive deficits and induces dendritic spine growth in mouse models of RTT

Saloni Lad, Department of Neurosciences; C. James Howell, Department of Neurosciences; Dr. David Katz, Department of Neurosciences

Rett syndrome (RTT) is a neurodevelopmental disorder caused by loss-of-function mutations in the X-linked gene encoding the methyl CpG-binding protein 2 (MeCP2), a master regulator of transcription. Common features of RTT include loss of motor skills, respiratory dysregulation, and cognitive deficits (Katz et al. 2016). The MeCP2 mutant mouse model recapitulates many phenotypes of the human disorder, which are modelled by an increase in apneas, decreased fear memory retrieval, and a reduction in mature dendritic spines. Excitatory pyramidal neurons of the medial pre-frontal cortex (mPFC) are of particular interest due to their roles in cognitive and behavioral outputs such as learning and memory and have shown decreased neuronal function in mouse models of RTT (Sceniak et al., 2015; Kron et al., 2012). This study attempts to determine which domain(s) of the excitatory pyramidal neuron are affected by MeCP2 mutations and test ketamine’s ability to induce dendritic spine growth in the mPFC and rescue cognitive function. To answer this question, MeCP2 mutant mice were treated acutely with ketamine and dendritic spine morphology was measured. To visualize dendritic spines, we crossed Thy1-GFPm, which allows for visualization of sparse cortical neurons, into MeCP2 Null and wildtype mice. Our results demonstrate that both total and mature spine densities in oblique branches were significantly reduced in MeCP2 mutant mice, and these deficits were rescued by treatment with ketamine. We next asked if this rescue in excitatory connectivity was associated with a positive effect on cognition by testing treated animals using cue-dependent fear conditioning, an mPFC dependent task. We find that both short-term and long-term memory of cue-dependent fear conditioning were rescued by treatment with ketamine. These data highlight the potential of low-dose ketamine as a therapy for RTT-like symptoms by increasing excitatory input to pyramidal neurons in the mPFC.

Project Mentor: Dr. David Katz, Department of Neurosciences
Faculty Sponsor: Dr. Rebecca Benard, Department of Biology

Investigating the Role of Photophore Patterns in Etmopterus Lanternshark Species

Jessica Lalonde, Department of Biology; Dr. Ronald Oldfield, Department of Biology

The genus Etmopterus of deep-sea sharks contains many species with unique anatomical coloration patterns, called photophore markings, which are used in bioluminescence. The genus contains 41 recognized species each with distinct photophore flank and caudal fin markings which produce a unique light signature for intraspecies signaling. In classical taxonomy, morphometric measurement data were collected using anatomical characteristics. Classical body structure measurements can be standardized across species by comparing common features and provide quantitative differentiation between species. However, taxonomy purely based on classical body features does not take into account age or size and did not recognize photophore markings as a distinguishing feature between species. In this study, classical morphometric measurements are applied to comprehensively measure the photophore flank and caudal fin markings on four species of Etmopterus: Etmopterus lucifer, Etmopterus bullisi, Etmopterus pusillus, and Etmopterus splendidus. The measurements are then used to identify differences in the geometric shape and length of the photophore marks in a T-test analysis. The goal of the investigation is to show that photophore patch differences across species provide an effective means of distinguishing species. This study represents a complete comparison of photophore patches in this genus, with a novel recording of the quantitative patch lengths in E. bullisi and E. pusillus. It was determined that flank and caudal markings are clearly distinguishable features both qualitatively and using morphometrics across all species.

Project Mentor: Professor Ronald Oldfield, Department of Biology.
The Turtle that Doesn’t Belong: Applying Hydrogen Isotope Analysis of Hydrated Volcanic Tuffs to Estimate the Paleoelevation of the Andean Plateau During the Miocene

Colleen Laird, Department of Earth, Environmental, and Planetary Sciences

During the Miocene, 5-23 million years ago, layers of water-carried sediment and volcanic ash were deposited in an ancient basin located in modern-day Bolivia. Since deposition, this basin has risen to an average elevation of >3km as a part of the Andean Plateau. Today, these sediments contain a record of the region’s geologic history as well as many fossil remains. In structural geology, sedimentology and paleontology, this region is an active area of research. One of the most important questions being asked is, “How and when did the Andean Plateau rise to its current elevation?” To address this issue, researchers have applied many geochemical methods, paleontological restraints and structural models to estimate the elevation and uplift rate of the Andean Plateau at various times during the Miocene epoch. The initial goal of our research was to address the disagreement between two, incompatible paleoelevation estimates from the Quebrada Honda study site by adding additional paleoelevation data. To study this site with a different approach than previous studies, the novel technique of analyzing the Deuterium/Hydrogen (D/H) ratios of water preserved in hydrated volcanic tuffs was selected due to its promising results in developmental studies (Dettinger and Quade, 2015). However, our data provided unrealistic results, projecting the paleoelevations of multiple ash layers substantially higher than their current elevations. To discover the flaws in our experimental methods, we discuss how the issues of tuff diagenesis and sample contamination may have skewed our results and how these effects may be lessened in future experiments.

*Project Mentors: Dr. Beverly Saylor, Department of Earth, Environmental and Planetary Sciences; Dr. Darin Croft, Department of Anatomy*

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5yncr: A Multi-Platform, Peer-to-Peer File Distribution System

Matthew Bentley, Department of Computer Science; Brett Johnson, Department of Computer Science; David Lance, Department of Computer Science; Jack La Rue, Department of Computer Science; Alexander Tryjankowski, Department of Computer Science

Currently, there does not exist an open-source system that allows for file distribution via a distributed Peer-to-Peer (P2P) framework, with various other features we find useful. As such, we have set out to develop such a platform. Our desired application would allow users to select a folder to sync, and then provide a unique ID to other users, allowing them to download the most recent version of said files. The application should look for changes to files, like additions, deletions, and modifications, and sync them to others who are subscribed to the folder. File owners should be able to set permissions so that, by default, anyone with the ID can read files, but only specific people can modify them. The primary and secondary owners may authorize changes, while all others subscribed to the drop can propose modifications. Transfer will be done in the same style as BitTorrent, with users downloading from other users that have each chunk. The system will first use a tracker-style program to coordinate, eventually being replaced by a distributed hash table (DHT).

*Project Mentor: Professor Soumya Ray, Department of Computer Science*

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**Cancer Patients’ Interest And Willingness To Pay For Integrative Therapies**

Olivia Larbi, Case Western Reserve University; Bethanny Bristol, University Hospitals; Ming Li, Case Western Reserve University; Kate Daunov, University Hospitals; Sean Hobson, University Hospitals; Barbara Daly, Case Western Reserve University; Susan Mazanec, Case Western Reserve University; Sarah Rolfe, University Hospitals; Nancy Tamburro, University Hospitals; Kim Day, University Hospitals; Samuel Rodgers-Melnick, University Hospitals; Richard T. Lee, Case Western Reserve University

Integrative therapies have been increasingly utilized as a way of alleviating symptoms. This study examines cancer patients’ interest and willingness to pay for integrative therapies at the University Hospitals Seidman Cancer Center (SCC) and its satellite centers. SCC patients were surveyed from October 2017 to March 2018. A cross-sectional survey instrument asked patients about five specific integrative therapies (acupuncture, therapeutic massage, mediation therapy, music therapy, and yoga therapy) and to rate their familiarity, interest, and experience. 270 patients agreed to complete the survey. Most were Caucasian (53.0%) between the ages of 55-64 years old (30.6%) with an almost equal distribution of men (45.8%) and women (53.4%). Most had been a patient for <5 years at SCC (79.9%), completed high school (97.8%) and made <$60,000 per year as their household income (57.6%). In general, patients were unfamiliar with these services - about 50% of patients responded that they were not familiar with acupuncture (49.5%), yoga therapy (47.5%), and meditation therapy (46.4%), making these three the least familiar services. In contrast, therapeutic massage was the most familiar service (34.8%). On average, patients responded that they would pay $1-20 for each service. They were most interested in paying for therapeutic massage (51.2%). If a doctor or nurse recommended the service, responses of ‘interested’ and ‘very interested’ for each service increased, and most drastically for music therapy (from 41.2% to 54.3%) and yoga therapy (from 31.5% to 43.8%). When told the service would be provided for free in a clinical trial, responses of ‘interested’ and ‘very interested’ increased the most in yoga therapy (from 31.5% to 44.8%) and acupuncture (from 29.2% to 40.5%). Cost (53.7%) and transportation (24.0%) were the main barriers identified. Overall, there was a range of interest for the five integrative therapies and cost was identified as a common barrier.

*Project Mentor: Dr. Richard T. Lee, Case Western Reserve University*

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**Twin to Twin Transfusion Syndrome: A Literature Review**

Keira Leaich, Department of Biology and Department of Spanish

Twin-to-Twin Transfusion Syndrome (TTTS) is a condition manifesting as anastomoses of placental blood vessels of monochorionic-diamniotic twins. The resultant unidirectional blood flow from the “donor” twin to the “recipient” twin creates a hemodynamic imbalance, which causes each twin to have its own distinct prenatal and postnatal symptoms and outcomes. Due to unpredictable progression through the disease stages, management and choice of therapy have been widely debated. Studies have been focused on making recommendations for therapy type based on outcomes in each of the five disease stages as well as assessing the associated cardiac and neurologic outcomes.

*Faculty Sponsor: Dr. Richard Drushel, Department of Biology*
**Characterization of POU6 and potential binding partners in *S. mansoni***

**Jasmine Lee**, Department of Biology; Dr. Emmitt R. Jolly, Department of Biology; Stephanie Wood, Department of Biology

Schistosomes infect over 200 million people worldwide, largely in poor, rural, and tropical regions. The parasite invades the human host in freshwater and migrates to the gut or bladder, where it matures and mates producing eggs that can cause devastating symptoms including fibrosis of vital organs. Praziquantel has been the primary oral drug for decades, but drug resistance and the continuing prevalence of infection underscore the importance of studying the worm's complex biology. Five schistosome species are responsible for human disease; *S. mansoni* is one of the leading causal species. Throughout the animal kingdom, POU and SOX proteins contain highly conserved domains that mediate their role as master regulators during embryogenesis. POU6 appears to be important to neurogenesis and may potentially be vital to the schistosomula’s neural development post-infection. The analogs of POU6, POU2, and one SOX variant (“SmSOX”) in *S. mansoni* have all been cloned into bacterial vectors and sequenced. The objectives of this project were to describe the general transcriptional activity of POU6, and to test for any binding interactions between POU and SOX proteins. A quantitative PCR was performed with RNA collected at various stages of development to create an expression profile for SmPOU6. Both SmPou6 and SmSOX transcripts were found to be upregulated in schistosomula. A yeast one-hybrid variation was performed to check for SmPOU6 transcriptional activity, and yeast two-hybrids were done to elucidate protein-protein interactions between SmPOU6 and SmSOX; SmPOU6 and SmPOU2; and SmSOX and SmPOU2. We used two selective conditions, histidine and alpha-galactosidase. We found that SmPOU6 was not a strong activator and interactions between SmPOU6 and SmSOX, and SmPOU6 and SmPOU2, were weak. These data suggest that while these proteins interact in mammalian cells during development, they may have alternative roles during the development of more ancient parasitic schistosomes.

*Project Mentor: Dr. Emmitt R. Jolly*

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**Demonstration of Surface and Bulk Plasmon Polaritons using Ag Nanoparticle Coupled Hyperbolic Metamaterials**

**Ted Letsou**, Engineering Physics, Department of Physics; Dr. Mohamed ElKabbash, University of Rochester, Department of Physics; and Dr. Giuseppe Strangi, Department of Physics

Metamaterials are becoming one of the fastest growing research fields in nanophotonics. A specific sub branch of metamaterials, known as Hyperbolic Metamaterials (HMMs), are extremely anisotropic, nanofabricated structures, which cannot be found in nature at optical wavelengths. HMMs are comprised of thin metal-dielectric stacks that support the propagation of both surface and bulk waves known as plasmons. Unfortunately, coupling to these modes either requires intensive electron-beam lithography etching, or complicated prism based structures that are appended to the surface of the HMM. In this work, we demonstrate the excitation of both surface and bulk plasmon polaritons (SPPs and BPPs) using Ag spherical nanoparticles as coupling elements to the surface of both thin metallic films and HMMs. Furthermore, we provide several advantages to using HMMs as opposed to metallic films. First, we demonstrate their increased efficiency to coupling surface excitations due to their higher local density of states (LDOS). And second, we show control over the location of SPPs and BBPs excitation using effective medium theory (EMT). In addition, we theoretically explore the effects of different materials, sizes and distributions of nanoparticles on plasmonic coupling abilities. These surface and bulk excitations can be exploited for the use of chemical and biosensing, subwavelength optical imaging, and solar cells.

*Project Mentor: Dr. Giuseppe Strangi, Department of Physics*
Portable Vacuum-based Cold Brew Coffee Maker

Chloe Lim, Department of Mechanical and Aerospace Engineering

Traditionally, producing cold brew coffee requires anywhere between 12 to 72 hours, a significantly higher amount of time than the 6 minutes or less it takes for capsule-based, French-press, and drip coffee methods. Despite the longer wait time, cold-brewing continues to surge in popularity due to its trendy flair, smoother taste, and mild health benefits. This project explores the possibility of improving the accessibility of cold brew production for travelers and the day-to-day consumer as well as its ability to ride on the drink's ever-increasing popularity as a means of emerging as a successful, commercial product. We are developing a portable vacuum-based cold brew coffee maker that incorporates a small vacuum pump along with a simple user interface and circuitry that utilizes a 555 timer under monostable operation. Through our design, we are (theoretically) able to remove air within the sealed container, lowering the pressure within and allowing water to boil at room temperature, creating a "cold" coffee. In the future, we plan on expanding our current design to maximize portability through devising a more suitable container and compact vacuum seal as well as developing a more convenient and technological user-interface. When the device is fully developed, the portable vacuum-based cold brew coffee maker can be expected to maintain similar or better levels of portability, functionality, and cost compared to other coffee makers available in the market. Additionally, it may have the potential to be applied to brewing other types of drinks such as cold-brewed tea.

Faculty Sponsor: Dr. Sunniva Collins, Department of Mechanical and Aerospace Engineering

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Distributed vs. Centralized Propulsion System for Small Satellites

Erika D. Limón, Mechanical and Aerospace Engineering; Dr. David J. Barnhart, Lockheed Martin and Nick Denning, Lockheed Martin

Small satellites have low mass and reduced size, and are able to carry out different space missions with an intention of reducing cost and assembly time. However, technical challenges that come with small satellites is the lack of room for a propulsion system. The typical centralized propulsion system for orbit insertion and attitude control requires a large propellant tank and complex plumbing to thrusters placed around the structure. In this project, we propose a distributed system, where small and fully contained propulsion units replace the thrusters, thus eliminating the need for a large tank and complex plumbing. The ultimate goals are to evaluate a distributed propulsion system against a traditional centralized system and draw conclusions on optimal usage of these systems through a trade study and CAD models.

Project Mentor: Dr. David J. Barnhart, Lockheed Martin

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Systematic Study of the Electrochemical Performance of Au/Ag Nanostructures and their Application in Cortisol Sensing

Jae Hee Lim, Department of Chemistry; Monica Navarreto-Lugo, Department of Chemistry

The effect of nanostructuring on the electrochemical performance of a series of Au/Ag nanostructures with and without graphene nanoplatelets (G) as carbon matrix support and β-cyclodextrin as capping agent, were systematically investigated using the ferri/ferrocyanide couple as a redox active test probe. A series of Au/Ag nanostructures of different sizes, shapes, and composition were prepared and characterized using a combination of transmission electron microscopy (TEM), atomic absorption spectroscopy (AAS) and cyclic voltammetry (CV). The synthesized hollow, porous Ag/Au nanocages showed improved electrochemical performance, which can be attributed to the nanoreactor cage and edge effects and their improved dispersion in G after their surface modification with β-cyclodextrin. This novel nanocomposite system has been used in the detection of cortisol, and has demonstrated promising results in the monitoring of the stress biomarker.

Project mentor: Dr. Anna Cristina S. Samia, Department of Chemistry

 Effects of Starvation on Aggression in Betta splendens

Cheryl Lin, Department of Biology; Lindsey Robinson, Department of Biology

_Betta splendens_ are small polychromic freshwater fish that are known for their aggressive behavior. The physiological status of the _Betta_ impacts the intensity and duration of the fish’s aggressive displays due to the exertion required to maintain effort during combat. Our research is concerned with understanding the impact that starvation has on the aggressive displays of the _Betta splendens_ when exposed to their mirror image. Under stress, the fish could save their energy reserves for finding food or use their energy on displaying aggression due to their territoriality tendencies. Our hypothesis is that the longer the starvation period, the greater the decrease in aggressive display tendencies in _Bettas_. Data have been collected after 0, 4, and 8 days of starvation for a small sample size. This period does not create a long-term health risk for the fish as they are able to live up to 14 days without being fed. Gill cover erection duration, number of lunges, and number of air gulps were all recorded and analyzed over a five-minute period during each of the three days for each fish. Videos were taken and analyzed to understand the changes in aggressive displays throughout the period of starvation. Controls were run to ensure there was no habituation to their image in the mirror. All fish were obtained from a local vendor and kept individually in the same size temperature-controlled tanks to ensure external factors stayed constant. The results of this experiment are interesting because they help us understand the impacts that changes on the _Betta_’s physiologic state can have on its behavior.

Project Mentor: Dr. Roy Ritzmann, Department of Biology

Intersections: SOURCE Symposium and Poster Session
Combined IDO1-deficiency and 1-d-methyl tryptophan treatment promote T-dependent antibody production but have no effect on disease development in lupus-prone B6.Nba2 mice

Jessica Liu, Department of Immunology; Erin Yamamoto, Department of Immunology; Emma Keller, Department of Immunology; and Laura Davison, Department of Immunology

Indoleamine-2,3-dioxygenase (IDO) is a rate-limiting enzyme that degrades the amino acid tryptophan via the kynurenine pathway. The metabolism of tryptophan inhibits T cell proliferation and promotes regulatory T cell-mediated immune suppression. Previous literature suggests that IDO is up-regulated in autoimmune diseases such as rheumatoid arthritis and systemic lupus erythematosus. Our research shows that the IDO protein and total IDO enzymatic activity are significantly elevated in B6.Nba2 mice, a strain that spontaneously develops lupus-like disease, compared to B6 controls. Surprisingly however, neither pharmacologic inhibition nor IDO gene ablation altered disease characteristics or progression although dual inhibition significantly improved the T-dependent antibody response. Finally, we found that IDO was primarily produced by SignR1+ marginal zone macrophages although also expressed by CD19+ plasmacytoid dendritic cells and plasma cells.

Project Mentor: Dr. Trine Jorgensen, Department of Immunology
Faculty Sponsor: Professor Deborah Harris, Department of Biology

Deep Learning for Automated Volumetric Lesion Segmentation on radiographic imaging

Chi Zhang, Department of Computer Engineering; Chen Shen, Department of Computer Engineering; Tongtong Liu, Department of Electrical Engineering.

Volumetric tumor annotations are advantageous in a variety of medical imaging problems, however manually delineating tumor boundaries across 3D imaging data is tedious work for researchers and radiologists. A deep learning framework has been designed to provide “radiologist-like” annotations of large volumes of medical imaging data by training a convolutional neural network (CNN) from a partially annotated data set. This tool would greatly expand the size of data sets used to develop radiology-based decision support platforms and increase the clinical viability of advanced 3D image analysis approaches. It can be applied to any medical imaging modality, and is applied in this project to 3D lesion segmentation on lung CT and breast MRI.

Project Mentor: Professor Anant Madabhushi, Department of Biomedical Engineering; Nathaniel Braman, Department of Biomedical Engineering; Prateek Prasanna, Department of Biomedical Engineering.
Dissecting the Angular Momentum of Dark Matter Halos

Sam Llaneta, Department of Physics; Andreas Berlind, Department of Physics & Astronomy, Vanderbilt University; Manodeep Sinha, Centre for Astrophysics and Supercomputing, Swinburne University of Technology; Victor Calderon, Department of Physics & Astronomy, Vanderbilt University; Ari Maller, Department of Physics, City University of New York

We want to test the current theory that the dark matter of a halo imparts its angular momentum on infalling gas, dust, and stars that ultimately forms the disks of galaxies. Under this model, the spin of dark matter halos should correlate strongly with the disk size of galaxies that form within them. We will investigate the possibility of measuring the spin of dark matter halos in large cosmological simulations by measuring the orbits of their subhalos. To do this we will first examine the relationship between the direction and magnitude of the spin angular momenta and spin parameters of host halos and the orbital angular momenta of their subhalos. A correlation between these quantities in the simulation may indicate an empirical relationship between them that we can observe. We will use a large N-body dark matter only simulation to examine a large and thorough set of halos. The next step will be using the simulation to determine whether such a relationship is observable from the radial velocities of galaxies as viewed from a fixed point. The ultimate goal of this project is to measure the spin of the host halos of populations of galaxy groups from earth using the redshifts of galaxies within the groups. This will hopefully shed insight on the validity of our current understanding of disk formation in galaxies.

Project Mentor: Andreas Berlind, Vanderbilt University Department of Physics and Astronomy
Faculty Sponsor: Rolfe Petschek, Case Western Reserve University Department of Physics

Prion Protein (PrP\(^c\)) in the Trabecular Meshwork: Implications for Glaucoma Pathogenesis

Michael Lonigro, Department of Biology and Department of Psychology; Ajay Ashok, Department of Pathology; Neena Singh, Department of Pathology

Glaucoma is a widespread eye disease involving retinal damage and progressive vision loss, often by way of heightened intraocular pressure. Glaucoma is often comorbid with notorious neurodegenerative diseases such as Alzheimer’s or Creutzfeldt-Jakob disease. While a variety of studies have focused on the mechanics of retinal and optic nerve cell behavior during glaucoma and the aforementioned neurodegenerative diseases, fewer have been based around the major site of aqueous humor outflow, the trabecular meshwork (TM). Moreover, few studies have investigated the relationship between the TM and the various proteins implicated in neurodegenerative diseases, such as prion protein (PrP\(^c\)) and amyloid precursor protein (APP). In this study, immunocytochemistry as well as Western blot analysis were conducted to characterize the localization of neurodegenerative proteins such as APP and PrP\(^c\) within human TM cells. PrP\(^c\) silencing was used to explore the interplay between PrP\(^c\) and the expression of TM cell proteins implicated in glaucoma or involved in cytoskeletal arrangement and extracellular matrix (ECM) composition. APP and PrP\(^c\) were found to be expressed within the TM. PrP\(^c\) was found to have a variety of interactions with proteins vital to the physical characteristics of the TM tissue, as well as proteins implicated directly in glaucoma pathogenesis. PrP\(^c\) silencing induces changes in the TM cells that are similar to those observed in TM tissue as a whole during glaucoma development, such as upregulation in myocilin production, the disruption of cytoskeletal arrangement, and the augmentation of ECM composition. These findings portray the multifunctional prion protein as a potential mediator of aqueous humor outflow and glaucoma development in the TM. The results open the floor to future study of the exact mechanics of PrP\(^c\)'s interactions with relevant ECM or glaucoma-associated proteins.

Project Mentor: Neena Singh, Department of Pathology
Faculty Sponsor: Barbara Kuemerle, Department of Biology
Non-alcoholic steatohepatitis (NASH): The Disease, The Drugs, The Future

Andrew Lopez, Department of Chemistry

Non-alcoholic steatohepatitis (NASH) is an advanced form of fatty liver disease which sees inflammation, fibrosis, and ultimately cell death in the liver. It is the second leading cause of liver disease in the U.S. Currently no pharmaceutical treatment is approved to treat this disease or its symptoms, though many companies are in the midst of running clinical trials to that effect. This research explores both the science surrounding the disease and its manifestation as well as the economics of the drugs once approved. Multiple clinical trial results are analyzed for each class of drug currently being studied; Faresenoid X Receptors (FXRs), Dual PPAR alpha delta agonists, CCR2/CCR5 antagonists, and apoptosis signal-regulating kinase 1 (ASK1) inhibitors. Molecular structure of the drugs and their behavior/efficacy within the body will be a point of focus. A sales forecast was constructed using pertinent patient population data and information on clinical relevancy to explore the potential market size of the disease for each year following drug approvals. While many Wall Street analyst are forecasting the market for drugs in this space to peak in the tens of billions of dollars a year in sales, our scrutinization of these claims find some underappreciated headwinds, which may ultimately result in disappointment for investors.

Project Mentor: Mark Votruba, Department of Economics
Faculty Sponsor: Professor Emily Pentzer, Department of Chemistry

Reusable Solar Water Disinfection Sensor

Kathryn Lundgren, Department of Chemical Engineering; Sanjit Datta, School of Medicine, Annika Sinha, School of Medicine, Eric Salomon, School of Medicine, David Pfau, School of Medicine, Mona Yuan, School of Medicine, Charit Tippareddy, School of Medicine, Michaela Cooley, School of Medicine, Gordon MacDougall, School of Medicine

Of existing water purification techniques, solar disinfection (SODIS) is one of the most cost-effective. Due to its low cost, wide applicability in global water-stressed regions, and high efficacy in preventing waterborne illness, UV irradiation is a technology with great potential. As easy as it sounds, SODIS does have limitations and drawbacks; in response, Billion Bottle Project has developed a reusable dye-based sensor to help drive adoption of solar irradiation (SODIS). The cost of the proposed device is under $1, making it far more affordable than any competitor long-term. Responding only to UV irradiation more accurately than visible light illustrates to users that solar radiation is unique from other light sources, enhancing belief in the efficacy of SODIS. First of its kind, the sensor will simplify SODIS education by obviating the need for users to account for weather, water, and bottle factors to determine exposure time. Eliminating concerns is likely to improve efficacy, reliability, and user compliance. Through these benefits, the availability of a sensor makes SODIS more accessible, promoting its adoption and thereby preventing waterborne illness. Billion Bottle Project's sensor is a unique and important add-on to the solar disinfection method that can increase the quality of lives in communities around the world. Implementing this type of user-friendly sensor will lead to decreased cases of diarrheal diseases and will increase the access to clean water in communities that use solar disinfection as their primary treatment technique.

Project Mentor: Professor Daniel Lacks, Department of Chemical and Biomolecular Engineering
Faculty Sponsors: Dr. Sam Mesiano, Case Western Reserve University School of Medicine; Dr. Susan Wentz, Case Western Reserve University School of Medicine

Intersections: SOURCE Symposium and Poster Session
Gum Stain Assassins

Madison Lyons, Department of Chemical Engineering; Maggie McClarren, Department of Chemical Engineering; Julie Oswald, Department of Chemical Engineering; and Courtney Walker, Department of Chemical Engineering

Scot Laboratories, located in Chagrin Falls, OH, produces a large variety of consumer and commercial cleaning products to removal difficult stains. Scot Labs’ marketing and research and development departments identified an opportunity in the market for a commercial product designed to remove gum stains from sidewalks. Each year, there are over 500 million pounds of gum waste, making gum litter the second most common form of litter next to cigarette butts. The gum stain removal business over a billion dollar industry. Current gum removal methods use steam, consuming large amounts of excess water. Our team is committed to finding an effective, environmentally friendly, and economically sustainable alternative solution. First, our team will replicate twenty year old gum on the sidewalk in lab. During the winter months of Cleveland, this process is especially crucial as gum stains are frequently covered in snow and therefore untestable. Our team will accomplish this by exposing gum to a variety of environmental factors: UV light, heat, cold, rain, and pressure. Once accomplished, we will move on to the removal stage. We will test three removal methods; chemical, pressurizing, and freezing. The most effective method will be explored further and have a environmental and economic thorough analysis done to ensure that the product is within our gross profit margin and safety guidelines given to us by Scot Labs.

Project Mentor: Professor Dan Lacks, Department of Chemical Engineering

The Intersection of Alzheimer’s Disease and Serotonin

Jodie Makara, Department of Chemistry

Alzheimer’s Disease is a form of dementia impairing memory, thinking, and behavior. Alzheimer’s progressively gets worse overtime and while there are no current cures, research has found treatments to temporarily stop the worsening of symptoms. This literature review analyzes the various implications serotonin has had with Alzheimer’s across multiple studies. Serotonin, or 5-hydroxytryptamine (5-HT), receptors in the serotonergic system is involved with learning and memory. Looking at the mechanisms involved with these receptors raises the possibility for potential adjunct therapeutics in combination with existing treatments to improve symptoms of memory loss and learning deficits, common in Alzheimer’s. Much research done with selective serotonin receptor ligands is currently in the pre-clinical or early clinical phase and only a few drugs are potentially able to alter the progression of the disease.

Project Mentor: Professor Rekha Srinivasan, Department of Chemistry
QuickTutor: A Tutoring Application Done Better Through Python

Aditya Malik, Department of Electrical Engineering and Computer Science; Mammen Kurien, Department of Electrical Engineering and Computer Science; Kian Alikhani, Department of Electrical Engineering and Computer Science; Nathan Walls, Department of Electrical Engineering and Computer Science

The current tutoring application used by Case Western Reserve University doesn't offer a quick and easy way to receive help from students easily. It is difficult to receive immediate help in any subject or topic, and often times there aren't enough people on the platform to provide students with answers to their problems. QuickTutor aims to solve these issues by creating a simple request-based platform where anyone with a "case.edu" account can submit tutoring requests and receive assistance. QuickTutor is a web-based application that is written in HTML and Python, with the help of Flask based frameworks such as Flask-SocketIO to handle messaging communications. We used Python since it would allow us to develop easily routing pages and also for simple integration with SQLite3. Users will be able to easily post a help request and other students who are logged in to the website can choose to help you right away, either through our chat communication feature or meeting up in person. The application will strictly follow the guidelines listed out by Case Western's academic integrity policy. QuickTutor will change the way students interact with other students and provide a platform for receiving class aid to everyone.

Faculty Sponsor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science

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Efficacy of a Remotely Delivered Play Intervention for Children with Prader-Willi Syndrome

Carolyn Manuck, Department of Biology, Department of Psychological Sciences; Olena Zyga, Department of Psychological Sciences; Dr. Anastasia Dimitropoulos, Department of Psychological Sciences

The purpose of this investigation is to determine whether children with Prader-Willi syndrome show changes in play abilities over the course of a remotely delivered, play-based intervention. Prader-Willi syndrome (PWS) is a neurodevelopmental disorder characterized by hyperphagia, food-seeking behavior, and social-cognitive traits similar to those seen in autism spectrum disorders, including repetitive and ritualistic behaviors, lack of flexibility, and social difficulties. In autism, problems with social-cognitive development are associated with a decreased ability to carry out pretend play, a deficit that has also been shown in PWS. Interventions designed to build positive play behaviors are used to improve social-cognitive functioning in autism, and the Dimitropoulos lab has designed a similar intervention to improve play in children with PWS. The current project aims to determine whether children with PWS show improvements in play over the course of the intervention. Due to the rareness of PWS, the 12-session intervention was delivered remotely over videoconferencing software to 13 children with PWS between the ages of 6 and 12. Using the Telehealth Play Intervention Coding System, an observational coding system developed for this intervention, 13 variables were assessed relating to pretend play duration and quality during sessions 2, 6, and 12. For each variable, a repeated measure ANOVA and post hoc analysis will be used to look for variance in the means between each session. It was hypothesized that scores on the play-related variables coded will improve across all three sessions examined. This data will allow researchers to determine the occurrence and direction of any changes in play variables over the course of the intervention. This knowledge will help researchers improve the intervention to better affect play, and may ultimately lead to the development of a remotely accessible intervention to improve play and social-cognitive development in children with PWS.

Project Mentor: Dr. Anastasia Dimitropoulos

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Understanding market needs and trends in off-highway driveline additives

Ryan Hawthof, Department of Chemical Engineering; Ondrej Maxian, Department of Chemical Engineering; Emily Rybak, Department of Chemical Engineering; and Aaron Pang, Department of Chemical Engineering

The modern day off-highway market is rapidly changing from domination by Caterpillar Inc. into a more diversified portfolio of companies. In this research, we seek to assess the current market trends and determine how Lubrizol is positioned to respond to them. In particular, the rapid ascent of Komatsu Inc. and other companies into to the global original equipment manufacturer (OEM) market will necessitate some change on the part of Lubrizol, which has previously worked primarily with Caterpillar. Here we first quantify the state of the OEM market by looking at the trends in market share of key OEMs. Next we examine which oil companies (Lubrizol's customers) are best equipped to respond to the changes in the OEM market, and how this will in turn affect the sales of Lubrizol. Finally, we break the off-highway fluid market into segments so that Lubrizol can fine-tune their product, price, placement, and promotion to each segment depending on customer needs.

Project Mentors: Stephen Eck and Lilla Voros, the Lubrizol Corporation
Faculty Sponsors: Uziel Landau and Daniel Lacks, Department of Chemical Engineering

Parent-Child Interactions in Children with Prader-Willi Syndrome: Response to Intervention

Danica Mavroudis, Department of Psychological Sciences; Anastasia Dimitropoulos, Department of Psychological Sciences; and Olena Zyga, Department of Psychological Sciences

Children learn and develop important skills through pretend play. These skills range from emotional expression to problem solving in a safe environment. Play interventions have been used in populations of children with neurodevelopmental disabilities to teach skills and change behavior. The introduction of parents or caregivers into play interventions has been effective for scaffolding and assisting children in learning though play. Prader-Willi Syndrome (PWS) is a neurodevelopmental disorder that has characteristics of deficits in social and emotional functioning. For children with PWS, play interventions have been shown to be helpful for teaching skills and improving social behavior. The purpose of this study is to understand what aspects of parent-child interaction may be helpful or detrimental to a child's engagement in the play session.

The Parent-focused Remote Education to Enhance Development (PRETEND) study involved a six-week play intervention in a group of preschoolers and their parents. The study included twenty typically developing children and seventeen children with Prader-Willi Syndrome (PWS). Children with PWS can have deficits in social and emotional functioning, making play interventions important for this population. One aspect of the PRETEND study was a five-minute interaction between parent and child who were instructed to play as they would at home. Parents were scored on their response to the child, instances of unsolicited help, and general involvement in the play session. Children were scored on their social competence and interest. These scores were compared between groups of typically developing children and those with PWS, as well as compared with parent’s perception of their child’s communication, cooperation, and engagement.

It is hypothesized that parents who have a positive response to their child, are involved in the play session, and have few instances of unsolicited help will facilitate an environment where their child is interested in play. By comparing typically developing children to a sample of children with PWS, this study hopes to identify differences in parent and child behavior. The findings from this study may include implications for future interventions in PWS that involve positive and beneficial interactions between parent and child in play.

Project Mentor: Professor Anastasia Dimitropoulos, Department of Psychological Sciences
Using mathematical tools to characterize chromatin geometries in x-ray crystal structures

Ondrej Maxian, Department of Chemical Engineering; Stefjord Todolli, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS); Dr. Wilma K. Olson, Center for Discrete Mathematics and Theoretical Computer Science (DIMACS)

Eukaryotic cells house their DNA in a highly compact, yet incredibly dynamic chromatin structure. This non-uniform and dynamic structure enables many processes of biological relevance, such as gene expression. The motions of chromatin facilitate the process of bringing together protein components, such as those required for transcription, that are situated far apart along the DNA sequence. A complete account of the connection between the local features of DNA and protein and global motions of chromatin is vital in understanding these processes.

Until now, the packing of NCPs has been studied physically via X-rays and cryogenic electron microscopy (cryo-EM), with few to little mathematical tools available. We have developed tools to quantitatively evaluate the amount of interaction between two nucleosomes on their faces and sides, as well as to give biological meaning to the regions of interaction. We apply our methods to X-ray crystal and cryo-EM structures, in the process confirming much of the existing observations while developing new insights into some atypical structures. In the process, we show how our tools can be used to predict new regions of biological interaction in chromatin.

Faculty Mentor: Wilma Olson, Rutgers University Department of Chemistry

Platform for Intuitive Control of IoT Devices Using Hand Tracking and Gesture Recognition

Morgan McMahon, Department of Electrical Engineering and Computer Science; Anno van den Akker Department of Electrical Engineering and Computer Science; Johanna Fritzinger Department of Electrical Engineering and Computer Science

As smart devices continue to play a larger role in our everyday lives we consistently find that one of the biggest impediments to main stream adoption of such devices is an inconvenient and cumbersome interface. This is especially true in domestic applications where most IoT devices rely on a mobile or desktop application. With this in mind, our goal was to develop a platform that augments the way we interact with connected devices and connected device platforms, such as computers, lighting systems, TVs, and other media devices. To solve this problem, we have developed an intuitive glove like “controller” capable of interpreting hand and finger gestures. The system utilizes an array of accelerometers and gyroscopes from which we can compute absolute orientation of the fingers and hands. By combining these fusion sensors with a powerful MCU, WIFI, and Bluetooth our platform is capable of controlling devices such as TVs and computers, as well as existing IoT device such as Philips Hue.

Project Mentor: Professor Kenneth Loparo, Department of Electrical Engineering and Computer Science
Constraining the Topology of the Universe: An Analysis of Oblique Rotated Slab Spaces

Tyler McMaken, Department of Physics, Department of Music; Joshua Osborne, alumnus; and Professor Glenn Starkman, Department of Physics, Director of the Institute for the Science of Origins

In this study, we aim to fill a gap in current searches for non-trivial cosmic topology. For a flat cosmology, the Universe may be described by one of 18 topologically distinct manifolds. Previous analyses of the correlation matrix for temperature fluctuations in the cosmic microwave background (CMB) have been used to constrain the possible configuration of the Universe were it each of the candidate manifolds. Surprisingly, this task has not been exhaustively performed for the full set of possible manifolds that admit flat geometries. In particular, fundamental domains that are not right prisms have been omitted, as have slab spaces in which the identification of opposite planes includes rotation by an arbitrary rational angle. In this study, we first tabulate and examine the parameter space required to fully describe each flat Euclidean manifold, including information about fundamental domain dimensions and tilt angles, face-pairing rotation angles, observer position, and observer orientation. We then generalize the scalar wave-operator eigenmodes of the two manifolds that include two infinite dimensions, known as the slab spaces, to allow for arbitrary obliqueness and rational face-pairing rotation angles. Finally, expanding in terms of spherical harmonics to examine modes from the perspective of an observer arbitrarily located and oriented within a slab space, we compute the pixel-pixel correlation on the surface of last scattering for each candidate. This can serve as the basis for a future comparison to the CMB as observed by the Planck Collaboration in order to constrain these candidate topologies.

Project Mentor: Professor Glenn Starkman, Department of Physics

Vaccine Cold Chain Backpack: Improving Outreach Efficiency to Patients in Uganda

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Many patients in Uganda die each year from curable diseases due to workflow inefficiency for outreach healthcare workers and limited access to potent vaccines. These vaccines are carried to various outreach locations and must remain within an optimal temperature range of 2-8°C to be effective upon administration. Outside of this range, vaccines lose their potency and leave patients susceptible to preventable morbidity and mortality. In addition, travel time can reach up to 4 hours for patients living far from health centers, so this temperature range must be maintained for extended periods of time. To mitigate these issues, our team has collaborated with the Global Health Design Collaboration organization and designed a vaccine backpack with a novel vaccine dispenser. The prototype for this backpack, which can be seen during the presentation, has an insulated pocket that contains a specialized removable cooler. This cooler allows the handler quick and easy access to several columns of vaccines organized by type. The backpack also includes specific compartments for other essential outreach materials (e.g. logbook, sharps containers, syringes). Furthermore, by resolving these key issues of vaccine temperature maintenance and improved workflow via carrier organization, this vaccine backpack design is an effective solution to reduce the number of preventable deaths in underdeveloped countries.

Project Mentor: Colin Drummond, Department of Biomedical Engineering

Intersections: SOURCE Symposium and Poster Session
Assessing and Improving Efficiency of Industrial Silica Dust Collection
Connor Medlang, Department of Chemical and Biomolecular Engineering, Molly Simich, Department of Chemical and Biomolecular Engineering, Grace Tritchler, Department of Chemical and Biomolecular Engineering, Qingliu Wu, Department of Chemical and Biomolecular Engineering
Momentive Performance Materials purifies sand which is later used to manufacture quartz rods; a material heavily used in the semiconductor manufacturing industry. During the purification process, silica dust particles are formed, which are considered to be particles sized 50 microns or less. These dust particles are suspected to be causing hydrogen gas bubble defects when fusing the quartz rods, ultimately causing product loss and creating waste within the company. Their current sand purification process includes an industrial dust collection system aimed to remove any dust formed in process. This project focused on determining where dust is created in process, quantifying the amount of dust before and after the dust collector, and determining the efficiency of their current set-up using particle size distributions. We also investigated why dust may be causing gas bubble defects during fusion. Silica particles consist of a silicon dioxide crystal lattice with hydrogen atoms capping the structure at the surface of each particle. During fusion, these hydrogen atoms must escape which may be the cause of the gas formation in the quartz tubes. For smaller particles such as dust, the surface area to volume ratio is comparatively large, and therefore there are more hydrogen atoms per volume of silica. By removing the majority of dust, we theoretically remove the majority of hydrogen atoms which cause gas formation. It is likely that the dust is not a primary cause of defects since there are many factors that can cause them and dust was found to be statistically insignificant percentage of the final sand. A secondary cause of gas formation could be due to moisture content in the sand during fusion. Assessing this cause will require investigation into the drying step of the sand purification process, which we were asked not to look into.
Project Mentor: Professor Dan Lacks, Department of Chemical and Biomolecular Engineering

Van Horn Field Revitalization
Myles Anthony, Department of Civil Engineering; Nicholas Merchant-Wells, Department of Civil Engineering; Ryan Merlau, Department of Civil Engineering; Samuel Shiau, Department of Civil Engineering
Due to CWRU's location in the City of Cleveland, there is a limited amount of space that can be used for athletic teams to practice and for general recreational activities. The CWRU athletic department is home to 17 varsity teams, 17 club teams, and numerous intramural leagues, but only 1 multi-sport turf complex (on the north side of campus). As a result, it is difficult for teams to schedule times for competitions and practices throughout the year. This proposed project would transform Van Horn field into a multi-sport turf complex with locker rooms, storage facilities, a trainer room, and lounge areas, creating a space for teams based on the south side of campus. A project of this type involves architectural, geotechnical, structural, and environmental design as well as the discipline of construction management. The main architectural considerations are the aesthetics of placing a new building on a previously unoccupied grass field, how this new building would function, and how it interacts with other buildings as well as the people who will be using it. Geotechnical work involves design of foundations for the new building and of retaining walls to enable leveling the field (it is currently sloped). The scope of the hydraulic engineering design includes a subgrade infiltration bed which will reduce runoff to combined sewers. Structural work includes design of floor slabs, load-bearing walls, columns, roof framing, and roof decking such that the structure can maintain functionality under all expected loads. Lastly, the construction management scope focuses on creating and optimizing an accurate schedule and price estimate for the project, choosing the appropriate construction delivery type and contract type to maximize economy.
Project Mentor: Lance Wanamaker, Department of Civil Engineering

Intersections: SOURCE Symposium and Poster Session 85
HIF1α-2α cerebral knockout effects on potential cognitive function improvements following environmental enrichment in mice

Viral Mistry, Department of Physiology and Biophysics; Dr. Kui Xu, Department of Physiology and Biophysics; Alireza Abdollahifar, Department of Physiology and Biophysics; Sahej Bindra, Department of Physiology and Biophysics

Hypoxia-inducible factor-1α & 2α (HIF1α-2α) are transcription factors critical to the neurobiological response to hypoxia, a condition when the body is low in oxygen, by inducing short-term vasodilation and long-term angiogenesis. Angiogenesis is also strongly related to cognitive improvements made through environmental enrichment in mice. Since HIF1α-2α are crucial to angiogenesis, it is of interest if cerebral knockouts for the HIF1α-2α transcription factors would prevent gains in cognitive function from environmental enrichment. Experiments are currently underway to see how the HIF1α-2α knockout mice, which have been bred in-house, perform on a Y-maze working memory test compared to control HIF1α-2α floxed mice prior to and after one week of environmental enrichment. After the behavioral experiments are complete, relevant regions of the brain will be compared for differences in capillary density, to establish quantitative differences in capillary density as it relates to rodent activity and cognitive performance.

Project Mentor: Joseph LaManna, Ph.D, Department of Physiology and Biophysics
Faculty Sponsor: Dianne Kube, Ph.D, Department of Biology

Patient Autonomy in East Asian Culture: Family-Centered Medical Decision Making

Marissa Miyagi, Department of Bioethics and Department of Cognitive Science; Dr. Insoo Hyun, Department of Bioethics; Dr. Kyra Rothenberg, Department of Psychological Sciences; Dr. Lihong Shi, Department of Anthropology

Although common in East Asian cultures, the concept of family-centered medical decision making is novel in Western cultures. As compared to a patient-centered model, this model implicates the family in the decision-making process. As a result, the standards of patient autonomy are vastly different in Western cultures as compared to East Asian cultures. In the West, the gold standard is informed consent, where it is believed that a patient can make the best decision if given all the information available. Using this standard, physicians go directly to a patient with information, leaving the decision to inform family members or others up to the patient. In East Asian cultures, it is widely believed that truth can be harmful and it is sometimes better to withhold information. This model employs the family as the go-between, where physicians give the information to the family first and they then decide whether the patient should be informed. These differing models create tension for Western medical professionals. What obligations do physicians have to a patient’s family? What are the ethical implications of including the family in the decision making process? While avoiding imperalistic and paternalistic forces on patients, concerns about maleficient outside forces that include the family in the decision making process are also raised.

Project Mentor: Dr. Kyra Rothenberg, Department of Psychological Sciences

Intersections: SOURCE Symposium and Poster Session
A Quantitative Schlieren System for Microgravity Flame Diagnostics

**Genesis Mlakar:** Department of Mechanical & Aerospace Engineering, **Nathaniel Glasser:** Department of Mechanical & Aerospace Engineering, **Daniel Souza:** Department of Mechanical & Aerospace Engineering

A Schlieren diagnostics system has been developed to study the temperature and flow characteristics of flames in a microgravity environment. The system was designed and built to be used at the 2.2 second Drop Tower at the NASA Glenn Research Center and is adaptable for future use at the 5.18 second Zero Gravity Research Facility. The hardware of the system uses a white light emitting diode as a light source along with steering mirrors, condensing and collimating lenses, and a motor controlled knife edge which blocks approximately 40% of the incoming light. A wedge prism assembly is used for calibration to ensure no deflection of the light path occurs during image collection. This project especially places a large emphasis on the effectiveness of the calibration process. Studying a laminar flame creates a specific circumstance concerning the quantitative analysis of the system. Schlieren images of diffusion flames obtained are processed using background subtraction and deconvolution methods to obtain radial intensity profiles. The quantitative temperature measurement is achieved by calibrating the system against the computational results of the structure of a methane diffusion flame in normal Earth gravity (1g).

**Project Mentor:** Professor Fumiaki Takahashi, Department of Mechanical & Aerospace Engineering

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Effects of Immigration on Fertility in America

**Inez Moore,** Department of Anthropology and Biology

Both immigration and reproductive healthcare are highlighted subjects in American culture and media today. The way in which these multifaceted, complex issues intersect can be anthropologically viewed to allow an insight into both and to assist in making the experience for healthcare professionals and patients better.

By looking into the history of rates of immigration to America and the immigrant’s fertility rates as well as examining the current rates, trends can be found. With these trends, this research investigates what effects migration has on fertility. By surveying studies done across fields and spanning across years, the tendencies for pull factors and what effects immigration has on a woman’s fertility immediately after immigration and in the long term, regardless if they become a citizen or not can be found. The problems an immigrant faces with fertility will also be explored. Methods of family planning and the current state of how an immigrant make a choice of which methods to use will be highlighted. The same will be done with infertility services. This is a lesser explored topic and hopefully will be able to bright new information to the discussion.

The research attempts to understand how communication and terminology within the healthcare field can be improved for the experience of immigrants. Patient-centered language is investigated to give healthcare professionals the best understanding of individuals and communities. By looking at European and other other countries’, the deficits in America’s system could be lessened. In order to be able to understand the steps needed to move forward, a deep understanding of the context and current situations is deeply researched.

**Faculty Sponsor:** Lihong Shi, Department of Anthropology

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Intersections: SOURCE Symposium and Poster Session
Software Development Co-op at Keithley Instruments

Samuel Morrison, Department of Electrical Engineering and Computer Science

During my seven months at Keithley Instruments, I developed applications for the company’s new measurement product, implemented hardware calibration tests, and improved my project team’s software automation. In addition to typical measurement functions used in a circuits lab, engineers benefit from specialized apps that help them perform certain tasks. With my team’s advisement and help from a developer in Keithley’s Beijing office, I progressed the new Keithley app store from a folder of prototypes to a series of refined applications ready for release. I also had the opportunity to improve the process of testing the hardware’s capability to make quick readings. The scripts I wrote charted settling times for scans of varying types and scopes. There were also time-consuming processes adjacent to project work that could be reduced with automation. One of the scripts I wrote saved hours by quickly updating the project’s internal cost database whenever a new bill of materials was received. This allows the team to easily keep track of the parts and labor cost of each unit as the project progresses. I used similar techniques to automatically track sprint progress for issues in each department.

Project Mentor: John Wadalowski, Keithley Instruments
Faculty Sponsor: Gregory Lee, Department of Electrical Engineering and Computer Science

Dynamo: An Interactive Computer Science Tutorial Web Application

Andrew Hwang, Department of Electrical Engineering and Computer Science; Jack Mousseau, Department of Electrical Engineering and Computer Science; Justin Ferri, Department of Electrical Engineering and Computer Science; Maria Kuznetsov, Department of Electrical Engineering and Computer Science

Computer science college curriculums center heavily on the understanding of algorithms such as Breadth First Search. However, since students often learn these algorithms before they can successfully code them, it can be difficult to work through examples to understand the process behind the final image. Currently, online educational tools for computer science are clunky and do not allow for custom input of data. This project addresses the lack of customizable visualization tool currently available. Using React.js and MongoDB, Dynamo is able to convert graphs into dynamic visualizations with an easily editable GUI. The frontend component will be generated using React.js, and Node.js will handle the backend components and the interaction between the frontend and backend while the database server will be managed using MongoDB. Dynamo is MIT-licensed and available at https://github.com/jmousseau/dynamo.

Faculty Sponsor: Professor Soumya Ray, Department of Electrical Engineering and Computer Science
Designing Optical-based Prosthetic Hand Control

Emma Briggs, Department of Biomedical Engineering; Kwan Lau, Department of Biomedical Engineering; Jay Mulye, Department of Biomedical Engineering; Daniel Primachenko, Department of Biomedical Engineering; and Xun Zhao, Department of Biomedical Engineering

The majority of current prosthetic designs are only able to use one type of grip to grasp objects. They can easily grasp regularly or symmetrically shaped objects; but grasping asymmetrical, irregular, or thin objects are more challenging. Controlling individual finger motion can increase the number of grip orientations available. Optical distance sensors can be used to control the motion of individual fingers towards an object, providing an individualized grip for the object detected. By adding optical sensors and EMG activation to a 3D printed prosthetic, we can develop a prosthetic hand that is better suited to grasping a variety of objects.

Project Mentors: Professor Matthew Williams, Department of Biomedical Engineering; and PhD student Brian Sanner, Department of Biomedical Engineering

Health and Health-Seeking Behavior among Undocumented Latinx Immigrants in the United States as a Function of U.S. Immigration Policy

Deanna Nelson, Department of Anthropology

An individual’s overall health and their health-seeking behavior can be greatly impacted by their environment and day-to-day experiences. Inaccessibility to health care, whether it be due to economic or sociopolitical reasons, not only negatively impacts the affected individual’s physical and mental health, but also has the potential to become a public health concern as diseases and illnesses go untreated. This project aims to examine the impacts of U.S. immigration policy on the health and health-seeking behaviors of undocumented Latinx immigrants through a literature review of academic articles, media sources, and fact sheets. Specifically, this project aims to analyze these impacts across three distinct time periods: Prior to the introduction of Deferred Action for Childhood Arrivals (DACA) (2001 - 2011), the introduction and implementation of DACA (2012 – 2015), and the recent shift in U.S. immigration policy/the rescission of DACA (2016 - 2018). This project also discusses potential anthropological, psychological, economic, and legal concerns and offers suggestions for the future.

Project Mentor and Faculty Sponsor: Professor Lee Hoffer, Department of Anthropology
The Effects of Urbanization on the Phylogenetic Diversity of Select Species

Arjun Nandy, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

As human population around the world continues to skyrocket, more and more of the earth is being urbanized to compensate. Urbanization often occurs at the expense of the natural wildlife. However, certain species have managed to survive and even thrive in urban environments. Since there is almost zero chance that urbanization is going to stop around the globe, I decided to investigate why certain animals are able to survive in urban environments while others cannot. It was hypothesized that only animals with high levels of phylogenetic diversity are able to adapt to an urban environment, since if a city contained many distantly related species there would be a larger chance that one of them would contain a unique physiological trait that could allow it to survive. To test my theory, experiments are currently underway to use the R packages ape and picante to run a phylogenetic diversity analysis and a mean pairwise distance analysis on several animals who have both urban and rural populations around the world. The two populations will then be compared and contrasted with each other. Ideally, the rural populations should have high levels of phylogenetic diversity while the urban populations should have large mean pairwise distances, since the toxic city conditions will reduce richness. In Canberra Australia, the urbanized area had a lower species richness of frogs, compared to the rural areas, during the years of 2002-2014. Such results could imply that urbanized areas have reduced phylogenetic diversity, or it could also show that an adaptable trait is being conserved amongst the urban frog species.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

Behavioral Patterns Effect on Transmission of Infectious Diseases in Primates

Medha Narwankar, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Behavioral patterns such as innovation and social learning underlie culture at the cost of affecting culturally transmitted traits among animal species. Infectious diseases, similarly, could be a cost associated with cultural transmission, which is studied in greater detail in this research project. The hypothesis investigated questioned whether or not social learning and exploratory behaviors, such as innovation and extractive foraging, compensate for existing infection. The data used in the analysis methods consisted of 127 primate species which reported values for body mass, group size, and geographical range size. Phylogenetic comparative methods were used throughout the analyses to test the hypothesis against the data parameters. More specifically, after phylogenetic relationships were established between all 127 primate species, bootstrap analysis was run to ensure the reproducibility of each branching point. From this analysis it was better understood, which primates had stronger validation from the bootstrap analysis and were used in further analyses such as phylogenetic signaling and phylogenetic principal component analyses. Ultimately it was understood that there exists a positive association between pathogen richness and rates of social learning and exploratory behaviors. With these results, it was then concluded that the spread of infectious diseases are also positively correlated with social learning and exploratory behaviors. Since high pathogen richness is underlined by behavioral patterns such as social learning and exploratory behaviors, the hypothesis underlined in this research is strongly supported in that an increase in pathogen exposure probably plays a significant role in the cultural evolution of primates.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

Intersections: SOURCE Symposium and Poster Session 90
Parasites and Primates: A Phylogenetic Comparative Analysis of Incidences of Helminth and Intracellular Parasites in Primate Hosts

Serena Natt, Department of Biology, Department of Medical Anthropology

Parasites have played an integral role in human evolutionary history by charting the course of what traits may be favorable to evolve in order to avoid parasite infection. Because of this, understanding parasite function and the interactions which occur within the mini-environment of host body are fundamental to the prediction of parasite behavior in the future as well as the long-term development of treatments to protect parasitic infection. Data for this study was obtained from DRYAD and reflected the average helminth prevalence, intracellular and extracellular parasite richness in 70 primate hosts. The phylogenies of the primate hosts and the helminth species were created. The phylogeny of the primate species was generated on 10k trees. The bootstrap values and overall confidence in the clades of these phylogenies were significantly confident and for the most part were over 0.90. A phylogeny of the helminth species was then constructed based on the Global Mammal Parasite Database. The bootstrap values for this phylogeny were significantly lower than that of the primate phylogeny with some values being fairly low. This could be due to the fact that the helminth phylogeny is less well studied. A cross-comparison analysis revealed that similar primate species shared similar rates of infection of the parasites *Strongyloides* and *Tricholis*. Moreover, after plotting the incidence of intracellular parasites against the richness of these two helminth species, it was found that primate species who had high rates of infection of these two parasites had higher rates of infection of intracellular parasites. Hookworms common in human populations such as *Strongyloides* and *Trihcolis* modulate the immune response in manner that makes the internal environment of the human host more susceptible to infection of intracellular parasites. However, because the incidence of extracellular parasites in these hookworm populations with low, this also indicates that there is an aspect of competition between larger parasites in the internal environment preventing overall susceptibility to infection by larger, extracellular parasites.

*Faculty Sponsor: Dr. Jean Burns, Department of Biology*

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Genomic Representation in an Agent-Based Model of Mosquito Populations

Sam Nutt, Department of Biochemistry; Veena Mehta, Jon Jay College of Criminal Justice; Margaret MacDonell, Argonne National Laboratory; Charles Macal, Argonne National Laboratory; and Jessica Trail, Argonne National Laboratory

Mosquito-borne diseases affect most of the world’s population, making them a key concern for global security. Gene editing techniques and gene drive mechanisms, such as homing endonuclease genes, CRISPR insertions, and Wolbachia infection, are used to suppress disease transmission by mosquitoes. We are developing approaches to incorporate these gene drive mechanisms into genomic representations of mosquitoes for agent-based modeling that could be used to guide vector control measures.

*Project Mentor: Margaret MacDonell, Argonne National Laboratory Environmental Science Division*

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The temperature dependency of *Macoma tenta*’s metabolic activity

**Sarah Newcomb**, Department of Earth, Environmental and Planetary Sciences; Dr. Peter McCall, Department of Earth, Environmental and Planetary Sciences

Benthic organisms play an important role in their marine environments and in the bioturbation of seafloor sediments. Bioturbation is the process that is responsible for the physical and chemical composition of these sediments. One such benthic organism is *Macoma tenta*, a small, 1.2-1.7 cm long, deposit feeding, marine bivalve found in harbors along the Northeast coast of the United States. They are known to filter out pollutants from their surroundings as they feed on silt-clay surface sediments with their inhalant siphon and eject feces and pseudofeces into the overlying water through their exhalent siphon. Marine invertebrates such as *Macoma tenta* are poikilotherms -- their metabolism and feeding rate are affected by the ambient water temperature, which varies greatly (2-24°C) over the course of the year. We conducted laboratory experiments to measure the egestion rate of *Macoma tenta* over the temperature range 3-24°C, mirroring the range of conditions seen annually. We report the temperature dependence as $Q_{10}$, a measure of the temperature sensitivity of physiological processes due to a 10°C increase. Our results show $Q_{10}$ values of 1.23 ± 0.32 for the 5°C to 15°C increase and 1.48 ± 0.26 for 15°C to 24°C increase. When compared to the $Q_{10}$ of other poikilotherms and deposit feeders (reportedly between 2-3), these values show a low temperature dependence. Additionally, the $Q_{10}$ values are not statistically different, which indicates that the rate of egestion increases linearly with temperature as opposed to the exponential relationship we had anticipated. This unexpected result may provide insight on the adaptations *Macoma* has made to survive, as well as information on how the rising sea temperatures will affect this species and the surrounding benthic environment.

*Project Mentor: Dr. Peter McCall, Department of Earth, Environmental and Planetary Sciences*

Effect of Metal Contamination on Sediment Reworking Behavior by *Leptocheirus plumulosus*

**Joseph Nooger**, Geological Sciences, Evolutionary Biology, Dr. Peter McCall, Department of Earth, Environmental, and Planetary Sciences

The interface between the water column and sediment on the bottom of most bodies of freshwater and saltwater are zones of importance because they serve as habitat for many species of organism and are involved in the transport of nutrients, organic material, and pollutants between the sediment and water column. Work has been done to assess the harm that sediments contaminated with toxic environmentally stable chemicals and heavy metals have on the health and behavior of benthic organisms; the marine amphipod *Leptocheirus plumulosus* is one commonly used organism to investigate sediment reworking behavior. One previous set of experiments has investigated the effects that sediment contaminated with polychlorinated biphenyls and heavy metals from New Bedford Harbor, MA as well as PCB’s alone has on sediment reworking rate by *L. plumulosus*. This experiment investigated the effects of a suite of heavy metal contamination (cadmium, chromium, copper, lead, zinc) at concentrations similar to those found in New Bedford Harbor sediment, using a fluorescent tracer particle technique for measuring sediment mixing. Measurement of both burial velocity and bioturbation coefficient were used to determine that there was a significant loss in bioturbation activity by *L. plumulosus* when living in sediment contaminated with the mix of heavy metals found in New Bedford Harbor. The average sediment burial velocity dropped from 0.1084 cm/day in control sediment to 0.06098 cm/day in contaminated sediment, a loss of 44% of normal activity. Bioturbation coefficient dropped from 0.1164 cm²/day in clean sediment to 0.05448 cm²/day in contaminated sediment, a loss of 53% of normal activity. Additionally, there was a noticeable change in the timing of activity, with the control organisms burrowing quickly during days 0 to 6 and then leveling off, while the contaminated organisms burrowed quickly for days 0 to 3 and then leveling off.

*Project mentor: Dr. Peter McCall, Department of Earth, Environmental, and Planetary Sciences*
Utilizing Lizard Phylogeny to Identify Mechanisms of Adaptive Thermal Tolerance

John Patrick O’Hagan, Department of Biology

As the threat of climate change continues to grow, the organisms most at risk will be those unable to quickly adapt to the warmer temperatures. Believed to be most at risk are the species which have specialized in their thermoregulatory mechanisms to have small thermal thresholds perfectly suited to their current environments. Tropical lizard species are a common model organism into this issue, and different research has shown an ability to quickly adapt in some species while an inability to adapt in others. However, it is difficult to begin to pinpoint the mechanisms or genetic basis for this ability to quickly adapt to thermal thresholds. Thus, a phylogenetic analysis of the currently available data mapped to the tree of lizard phylogeny, may provide valuable insight into these complex thermoregulatory mechanisms. By combining and utilizing available data with a phylogenetic tree of these lizard species, trends begin to emerge in which species may be able to adapt to quickly changing temperatures. By utilizing phylogenetic and statistical analysis these trends can then be identified and quantified so as to give likely candidate mechanisms. The findings suggest a strong phylogenetic signal for upper thermal limits and that those species best able to adapt are those in environments further from the evolutionary constrained limits. This may serve as a useful start point for future full experimental testing of these species to identify the genetic basis of and serve as useful model data for ecologists looking to understand which species may be the winners or losers in the face of climate change.

Project Mentor: Dr. Jean Burns, Department of Biochemistry

Ascertaining the Biophysical Contributions of a Solvent-Exposed, Conserved Aromatic Residue in Insulin

Brian O’Rourke, Department of Biology; Nischay Rege, Department of Biochemistry; Nelson B. Phillips, Department of Biochemistry; and Michael A. Weiss, Department of Biochemistry

Insulin is a peptide hormone secreted by pancreatic beta cells in response to increased interstitial glucose levels. The molecule’s use in treating Type I Diabetes Mellitus (T1DM) and Type II Diabetes Mellitus (T2DM) drives the investigation of structure-function relationships within the insulin molecule, which could aid in the development of effective therapeutic analogs. The “aromatic triplet” of amino acids spanning residues 24-26 in the insulin B chain was previously identified as a region that is critical for the structural stability of the insulin molecule and for its part in binding to the insulin receptor (IR). Although it is highly conserved because of a functional requirement in the insulin-IR complex, residue Phe^{B25} does not have an apparent role in maintaining the structure of the insulin molecule, which differentiates it from the other members of the aromatic triplet, residues Phe^{B24} and Tyr^{B26}. In order to establish the significance of the native phenylalanine residue at the 25th position of the B chain, we performed an amino acid screen at the position, which demonstrated that only aromatic substitutions Tyr^{B25} and Trp^{B25} yield biologically active molecules. Experiments to further characterize these analogs are currently underway, which should reveal the importance of the position for activity and stability of insulin.

Project Mentor: Dr. Nelson B. Phillips, Department of Biochemistry
Faculty Sponsor: Dr. Susan Burden-Gulley, Department of Biology
Hololens Modeling of Electromagnetics

Yennmay Chia, Department of Electrical Engineering; James Fojtasek, Department of Electrical Engineering; Courtlen Oates, Department of Electrical Engineering

The Hololens is an interactive tool that allows the user to engage with digital media in reality. From its first introduction to Case Western Reserve University, professors and departments have experimented and successfully been able to use the Hololens to model the human anatomy and electric fields based on a point charge and a spherical capacitor. Since concepts in classes such as electromagnetics may be difficult for students to grasp and visualize, the purpose of our project is to model the method of images, a method used to calculate the electric field created by a point charge towards a conducting surface. The program for the Hololens that we will develop will contain a point charge and a flat conducting surface with electric field lines going from the the point charge to the flat surface. Some of the features of the program will include providing the user the ability to move the point charge towards and away from the conducting flat surface. Another important feature will allow the user to make the conducting surface disappear to show how the field lines actually are calculated using another ‘mirrored’ point charge.

Project Mentor: Professor Soumyajit Mandal, Department of Electrical Engineering
Faculty Sponsor: Professor Michael Martens, Department of Physics

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Increased Neuronal Iron Disregulation Facilitates Activated Microglial-Ferritin Autoimmune Mechanism In ALS

Ogoegbunam Okolo, Department of Biology; Ju Gao, Department of Pathology; Luwen Wang, Department of Pathology; Mikayla Huntley, Department of Pathology; Sandra L. Siedlak, Department of Pathology; Xinglong Wang, Department of Pathology

Iron, a key regulatory metal, has been strongly implicated in the pathogenesis of Amyotrophic Lateral Sclerosis (ALS). Iron imbalance as a by-product of neuronal oxidative stress is a hallmark characteristic of ALS. Persistent iron disregulation results in increased levels of regulatory iron-binding proteins, specifically ferritin. Ferritin is a ubiquitously expressed intracellular protein responsible for regulating iron homeostasis. Coupled with altered protein levels is the increased activation of microglia, a macrophage in the Central Nervous System. Microglia are thought to have a protective role on neuronal structures at an early stage, although when activated may initiate autoimmune responses by engulfing vital neuronal machinery.

Immunohistochemical staining and western blot analyses were conducted on both spinal cord and cortical tissue samples that were prepared from human ALS tissue. As a control, tissue samples from non-diseased individuals were also analyzed in order to investigate the relationship between glial cells and iron proteins. The morphology of many ferritin-positive cells was indicative of activated microglia, and staining adjacent serial cortical sections revealed the co-localization of ferritin and microglia. Cross-sectional slides of the spinal cord were prepared from the wild type and transgenic mice models that overexpressed the enzyme superoxide dismutase. These slides were analyzed in order to examine whether the ferritin-microglial co-localized interaction can be reproduced in an animal model. This comparative analysis of both human and animal models is vital toward uncovering converging pathologic mechanisms that propel neurodegenerative disorders, and further contextualize the findings present in current literature.

Project Mentor: Dr. Xinglong Wang, Department of Pathology
Faculty Sponsor: Dr. Stephen Haynesworth, Department of Biology
Black Phosphorus Field Effect Transistors: Device Physics and Performance

Bradley Odhner, Department of Physics

We are nearing the end of Moore’s law. Silicon based transistors, the amazing technology that led to the huge growth of Silicon Valley, are rapidly approaching a point where they will not be able to progress anymore. In their stead, we must look to other ways to create transistors that can be smaller, faster, and more efficient to power tomorrow’s computers, cell phones, and other everyday objects. Black phosphorus is one promising candidate. A 2D material, it has the capability to supplant silicon as the new mainstream base of transistors. Before that point however, there is still much research to be done to fully characterize the properties of black phosphorus so that future effort can be put towards mass production of new transistors. This research examines some properties of black phosphorus Field Effect Transistors (FETs) that will be relevant for a larger deployment of the technology.

Project Mentors: Philip Feng, Department of Electrical Engineering & Computer Science, Mary Anne Tupta, Keithley Instruments

Automated Medication Disposal System

Ethan Cravener, Department of Electrical Engineering and Computer Science, Electrical Engineering Major; Varun Garg, Department of Electrical Engineering and Computer Science, Electrical and Computer Engineering Majors; Daniel Hoskins, Department of Electrical Engineering and Computer Science, Electrical and Systems & Control Engineering Majors; and Shelby Ovrom, Department of Electrical Engineering and Computer Science, Electrical and Computer Engineering Majors.

Opioid and prescription medication abuse is extremely prevalent in today’s society. A lack of an ecosystem for medication disposal has led to unaccountability of medication disposal post sales. This has had detrimental effects on society - illegal drug circulation, water contamination, and unsafe child access. Our project investigates a way to provide a convenient and secure way to dispose of medication, and collect feedback from the user regarding the disposal.

Our solution would be a kiosk located in pharmacies or drug stores making it convenient for users to drop off medication. The project can be broken into three sections: the secure enclosure for medication drop off, the scanning system and related software, and the user-interface screen and related software. Users will go to the kiosk, log in to their account using tablet interface, scan their pill bottle using the tablet, provide feedback, deposit the drug bottle, and receive a rebate. A weigh scale, developed as part of our project, inside the kiosk will determine the weight of the pills deposited, and send the information to the android tablet, which will decide and dispense a rebate amount.

Project Mentor and Technical Advisors: Professor Kenneth Loparo, Department of Electrical Engineering and Computer Science; Dr. Shanina Knighton, Frances Payne Bolton School of Nursing Post-Doctoral Fellow
Senior Design Advisor: Professor Gregory Lee, Department of Electrical Engineering and Computer Science

Intersections: SOURCE Symposium and Poster Session
Effectiveness of Securinine Derivatives in Acute Myeloid Leukemia Treatment

Natasha Oldford, Department of Biochemistry; Sheela Karunanithi Ph.D., Department of Pathology; Ruifu Lui, Department of Pathology; Anne Roe, Department of Pathology; Stephen Moreton, Department of Pathology; David Wald M.D., Ph.D., Department of Pathology

Acute Myeloid Leukemia is a fast growing cancer that originates in the bone marrow. The National Cancer Institute estimates that in 2017, over 21,000 new cases of AML will be diagnosed. Current methods of treatment are toxic to older patients; creating a need for new treatment options that are more efficient and less toxic. Our goal is to develop a novel drug that induces differentiation of AML cells. Securinine is a natural compound from the plant Securinega suffruticosa that can inhibit growth of leukemia cells. However, securinine has a low potency and high toxicity, creating a need for new derivatives for securinine to be a more effective anticancer agent. Among the synthesized securinine derivatives tested, compound 250 and 317 were found to exhibit anti-cancer properties at a higher potency and lower toxicity than the parent drug. These two derivatives were tested in vivo AML models that suggested a decrease in the AML burden on the mouse. Our preliminary studies suggest that these derivatives can activate p38-MAPK to induce their effects. Our future work will focus on understanding the exact mechanism underlying securinine action.

Project Mentor: David Wald M.D., Ph.D., Department of Pathology; Sheela Karunanithi Ph.D., Department of Pathology

Structural Optimization and Manufacturing of a Compact Diaphragm Pump

Adam Pardo, Department of Mechanical Engineering; Dr. Ozan Akkus

Current diaphragm pumps rely on the motion of a single nonlinear membrane encased in a hard plastic or metallic shell. As applications for small scale soft robots in medical application progress, there is a need for a completely flexible and high capacity pump. Through this project, we will investigate the viability and optimization of flexible materials for use in a diaphragm type positive displacement pump similar to the muscle skeletal blood pump system. The final product utilizes stiff, linear fibers encased in a flexible membrane, creating a sealed chamber capable of volume contraction. The geometrical optimization of both fibers and membrane for maximized displacement per force applied will be studied by Solidworks. A targeted pumping capacity will be selected to be 100 cubic centimeters through a height differential of 25 centimeters, which is similar to the capacity of human heart. The multi-material 3D printing technique will be used to complete the product.

Project Mentor: Dr. Ozan Akkus, Department of Mechanical Engineering
Effects of Sustainability Disclosure

Sanam Patel, Accounting Department

The focus of this research studies the U.S. Securities and Exchange Commission’s reporting regulations regarding sustainability and the current state of disclosure for public companies. It explores whether the fundamental principles of accounting and reporting lay groundwork for mandating reporting for environmental, social, and governance issues and initiatives that companies engage with. To decide whether these subjects are of material importance, and therefore relevant to reporting, it was important to determine how corporate social responsibility practices affect different aspects of a company. This research analyzed the stock prices of the top ten publicly traded companies on the 2017 Global CSR RepTrak and their top five competitors listed by the NASDAQ to review if those who were reputedly engaged in CSR practices had a positive correlation with increase in stock prices over a 5-year period. Additionally, the work interpreted how public opinion and employee opinion, regarding corporate social responsibility, affects companies in various aspects.

Project Mentor: Dennis Conrad, Accounting Department

Model & Analysis of an Offshore Floating Wind Turbine with Pitch Control (OFWTwP)

Darshan G. Parikh, Department of Mechanical & Aerospace Engineering and Department of Electrical Engineering & Computer Science; James C. Schmidt, Department of Electrical Engineering & Computer Science; Jose Nazario, Department of Electrical Engineering & Computer Science; Dr. Mario Garcia-Sanz, Department of Electrical Engineering & Computer Science.

Wind turbines adopted for offshore use have generally been mounted on towers that have foundations in the seafloor. However, as wind turbines are taken into deeper waters, this foundation becomes highly impractical. Wind turbines operating at water depths of 50 meters or more take advantage of floating structures that are stabilized through a variety of mechanical means. The implication of a floating structure, however, is the likelihood for the base to tilt in the face of oncoming waves. When the tilt of the structure occurs (anti)parallel to the direction of the wind, the aerodynamic efficiency of the turbine is significantly affected. This research project explores whether pitch control can mitigate these efficiency losses by building an effective lab-scale wind turbine that has a collective pitch control system and a floating structure based on a Stewart platform able to emulate potential tilt angles faced by the floating wind turbine under different sea conditions. Methods of integrating the wind turbine prototype and software with the floating platform are explored. In addition, wind tunnel tests at the Control and Energy Systems Center are performed to understand the open-loop behavior of the floating wind turbine, ultimately leading to both a closed-loop pitch control system and a maximum power point tracking strategy based on a torque control system, all designed using microcontrollers, MATLAB and Simulink.

Project Mentor: Professor Mario Garcia-Sanz, Department of Electrical Engineering & Computer Science
Faculty Sponsor: Professor Robert X. Gao, Department of Mechanical & Aerospace Engineering

Intersections: SOURCE Symposium and Poster Session
Increased Parasite Diversity among Migratory Bird Species

Kaitlin Pataroque, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Pathogens such as parasites have various evolutionary strategies to exploit characteristics of their hosts. Parasite diversity is dependent on physiological and ecological host characteristics. Previous studies have shown that the migratory patterns of avian species are related to parasitic infections; species that are more migratory have, on average, greater parasite loads. This research seeks to determine whether this pattern is due to an increase in geographic distribution, change in habitat, or other factors related to migration. This study analyzes previously published data sets using the R programming language to examine 153 species of Accipitridae (predatory birds) and Anseriformes (water birds). Phylogenetic comparative analysis methods are utilized to incorporate evolutionary history into statistical analysis. Larger host range and the usage of additional habitat types is hypothesized to be associated with higher parasite species diversity, because these hosts have a greater range of possible pathogens that can infect it. The nematode parasite diversity of the migratory bird species were examined in relation to their migratory behavior. The picante, ape, phytools, and lmtest packages in R were used to create a Phylogenetic Generalized Least Squares (PGLS) model, which revealed that there was a positive correlation between host range and the number of different nematode species in the host, as hypothesized ($p<0.05$). This suggests that there is a cost to migration due to parasite exposure or vulnerability. The findings from this study of nematode species and their avian hosts can be extrapolated to provide a theoretical model of other host-parasite interactions. Further understanding of parasite action and host ecology can aid in realizing risks for acquiring parasites, and can also help provide parasite-avoidance strategies for humans.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

RoadPrintz: Localization and Hardware Optimization

Jerray Dewa, Department of Electrical Engineering & Computer Science; Lauren Eberly, Department of Electrical Engineering & Computer Science; Reena Patel, Department of Electrical Engineering & Computer Science; Dr. Wyatt Newman, Department of Electrical Engineering & Computer Science

RoadPrintz is a robot under development for autonomously painting pavement markings such as bicycle signs and arrows. Currently, pavement markings are applied manually, which can lead to inefficiencies and safety hazards. With RoadPrintz, road workers will be able to send the robot out on the road to localize itself and precisely print desired signs. This continuation from last semester’s project focuses on further development of both software and hardware, including the implementation of image localization software into ROS and the construction of a new 2 degree of freedom robot arm. The ultimate goals of this project are to improve the robot’s object detection precision and the accuracy of its marking ability. By implementing OpenCV libraries, the image processing software finds objects in images taken by the robot and provides their locations in reference to the robot frame. With this information, the robot arm can travel to these desired locations and, in this case, illuminate the detected objects with a laser pointer. The new robotic arm includes two small servos to control the position of the laser pointer for accurate and precise placement. The final test of this project simulates the robot’s ability to locate a street marking and paint over it. This test includes placing a painted marker on the ground and sending the robot out to locate it, then restarting the robot from a different location and allowing it to autonomously navigate back to the marker to illuminate it. Successful runs of this test ensure that the robot has effective localization abilities as well as a precise marking system.

Project Mentor: Professor Wyatt Newman, Department of Electrical Engineering & Computer Science
Solar Powered Phototherapy Device for Treatment of Jaundice in Infants

Amber Phillips, Chemical Engineering; Ivy Petsinger, Chemical Engineering, Saukhy Gumidyala, Chemical Engineering

Neonatal jaundice affects over 60% of infants worldwide and causes permanent brain damage if not treated within the first 48 hours of life. Jaundice occurs due to an inability of the baby's liver to fully process bilirubin, causing it to build up in the blood of the baby. Typical treatment is simple. The baby is placed under blue LEDs for a period of 24-48 hours. The wavelength of the light and the spectral intensity breaks down the bilirubin, making it water-soluble and allowing the baby to excrete the substance in its stool or urine. Though the treatment process is simple, it remains unavailable to the majority of individuals living in African countries, due to both lack of electricity and lack of healthcare facilities. Over 70% of individuals in Nigeria, for example, lack access to healthcare facilities. Therefore, our goal is to create a mobile phototherapy treatment system run by solar panels. Our design currently costs less than $100 and can be attached to any surface, allowing it to be used inside a healthcare facility or inside a home. It’s irradiance is approximately $40 \, \text{W/cm}^2$, well over the $30 \, \text{W/cm}^2$ minimum required for treatment and requires only 2.54 W of power to operate each light. In total the device would require 120 W*h per treatment, and each solar panel can provide 240 W*h per day.

Project Mentor: Professor Dan Lacks, Chemical Engineering

Impact of Intraspecific Variation on Extinction Risk

Claire Plunkett, Department of Mathematics, Applied Mathematics and Statistics; Robin Snyder, Department of Biology

Intraspecific variation has been largely ignored in population models, but in reality there are differences in vital rates between all individuals that may affect the extinction risk of the population. One such vital rate with intraspecific variation is the rate of reproduction of an individual. To investigate extinction risk for several starting population sizes, a diffusion approximation is used. This diffusion approximation is based on demographic stochasticity, which is the amount of variation in a population’s total reproductive value each time step due to fluctuations between individual’s life processes. The calculation for demographic stochasticity of a model involves the distribution of traits and vital rates in the population and takes into account any included intraspecific variation.

Given an integral projection model (IPM), demographic stochasticity can be calculated with and without intraspecific variation. Additionally, demographic stochasticity and extinction risk can be estimated using simulations of an individual-based model (IBM). For an IPM modeling Artemisia ordosica, the number of seedlings an individual produces when flowering is modeled with and without intraspecific variation. As compared to a model without individual variation, there is an insignificant increase in demographic stochasticity and thus extinction risk when including variation in this trait with a coefficient of variation of 0.3.

Project Mentor: Dr. Robin Snyder, Department of Biology
Six Sigma Analysis of CWRU Chemical and Biomolecular Engineering Department

Natasha Jacobson, Department of Chemical and Biomolecular Engineering; Olivia Taliaferro, Department of Chemical and Biomolecular Engineering; and Stephanie Plut, Department of Chemical and Biomolecular Engineering

The Chemical and Biomolecular Engineering Department at Case Western Reserve University would like to increase undergraduate student satisfaction because of historic verbal complaints and lower job placement rates in the past few years. Poor student satisfaction could lead to students leaving the department, poor alumni relationships, fewer alumni donations, student disinterest, and a poor reputation. This work’s goal was to find the most significant trends in student dissatisfaction by using a Six Sigma approach. The areas of greatest focus in this study were advising, communication, curriculum, and job/graduate school placement. The sources of dissatisfaction were identified through surveys, open source websites, and historical feedback data. Based off of the identified causes of dissatisfaction, solutions were suggested. Solutions included development of resource references for advisers, implementation of advising worksheets to aid in continued communication between student and adviser, and information sources for students on curriculum opportunities and career development.

Project Mentor: Professor Daniel Lacks, Department of Chemical and Biomolecular Engineering

Economic Analysis of United States Antitrust Enforcement Strategy 1910-1945

Tyler Powell, Department of Economics

The early 20th century was filled with economic, social, and geopolitical volatility in the United States. Antitrust enforcement fell to extremely low levels in the midst of the First World War and the Great Depression. This decline was motivated by government policies that allowed self-regulation by industry and provided antitrust immunity in exchange for production and labor decisions that benefitted the government. I analyze the interaction that led to these policies as a pair of strategic games between the government and the firm. First, the government and firm interact every day in a simultaneous game with incomplete information. This game will never yield collaboration and immunity. It is solved by two Nash Equilibriums: competitive firms and average enforcement; collusive firms and strict enforcement. Second, in times of crisis, government and firms interact in a sequential game with the government as the first mover. This game does not have a simple Nash Equilibrium. I simulate this game using randomly assigned parameters to prove that the outcomes observed during World War I and the Great Depression can be explained by this model. My simulations show that it is possible to have parameters that obey the assumptions of antitrust theory and result in government leniency, firms cooperating with lenient government, and firms cheating a collaborative system to the detriment of the government and the consumer.

Project Mentor: Professor Jenny Hawkins, Department of Economics

Intersections: SOURCE Symposium and Poster Session
The Effect of Shark Liver Lipid Concentration on Average Swimming Depth

Alejandra Quintana De La Torre, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Sharks are an ancient species that have a broad distribution in marine and freshwater habitats. Sharks of varying shapes and sizes inhabit different depths in the ocean; they rely on hydrostatic lift to remain buoyant at their respective depths. Since sharks do not have swim bladders like their bony fish counterparts, they rely on their liver’s lipids stores to determine buoyancy. By maintaining lipid and gas reservoirs, sharks are able to generate hydrostatic lift in order to remain afloat. Hydrostatic lift relates to the pressure caused by the weight of the lipids. Thus, increased lipids translate to increased pressure, allowing sharks to stay afloat. The lipids of interest are squalene, diacyl glyceryl ether (DAGE), and triacylglycerol (TAG). This research aims to explore what lipid concentrations enable sharks to live at different depths and whether this is a species-specific phenomenon by using phylogenetic signal analyses. If closely related shark species have similar lipid concentrations than distant relatives, they would be said to have phylogenetic signal in lipid concentration. I have chosen to analyze the Squalidae family because it has been studied the most among shark species. I hypothesize that closely related members of the Squalidae family, such as Squalus montalbani and Squalus mitsukurii, have similar lipid concentrations and should inhabit similar ocean depths. In shallow dwelling species the liver composition was primarily composed of TAG, and less than 1% squalene. Conversely, the deep-sea Squalidae species’ livers consisted of about 90% squalene and DAGE. Squalene is highly sought after and is commonly used in cosmetics, sunscreen, and dye. The population decline of some species of the Squalidae family may be attributed to fishing for the squalene in their liver oil. Conservation efforts can be improved to protect deep-sea Squalidae species.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology

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Deletion of the Interleukin 10 Receptor in B lymphocytes increases TLR 4-mediated production of IL-10

Montserrat Quintana, Department of Biochemistry; Abigail Dooley, Department of Inflammation and Immunity; and Neetu Gupta, Department of Inflammation and Immunity.

Interleukin 10 produced by B cells exerts immunosuppression in a variety of contexts through downregulation of pro-inflammatory cytokines. However, the mechanisms and pathways underlying B cell IL-10 production are poorly understood. Specifically, it is unclear if the B cell IL-10 receptor (IL-10R) plays a role in regulating B cell IL-10 production in response to LPS. In this study we investigated the role of IL-10R expressed on B cells in the molecular regulation IL-10 production using an LPS-induced model of inflammation. We generated mice with B cell-specific conditional deletion of the IL-10R by breeding MB1cre/+ mice with IL-10Rfl/fl mice. Interestingly, IL-10R-deficient B cell produced significantly greater levels of LPS-induced IL-10 as compared to MB1cre/+ controls. The increase in IL-10 secretion was due to increase in IL-10 mRNA expression. These findings were recapitulated when the function of IL-10R was blocked using a specific blocking antibody in wild type B cells. Thus, our data suggest that a functional interaction between the IL-10R and TLR4 signaling cascades regulates B cell IL-10 production.

Project Mentor: Neetu Gupta, Department of Inflammation and Immunity, Cleveland Clinic
Real-Time MRI-Guided Robotic Active Catheter Current Output Characterization

Matthew Haberbusch, Department of Electrical Engineering & Computer Science; Isidora Radovanovic, Department of Electrical Engineering & Computer Science; Mengxi Wu, Department of Electrical Engineering & Computer Science

Atrial fibrillation is a type of heart arrhythmia that is characterized by the irregular beating of the atria, which are the upper two chambers of the heart. Catheter ablation is a surgical procedure that is used to treat this condition. A surgeon inserts catheters into the patient’s vein and guides them towards the patient’s heart. Electrical impulses are used to induce the arrhythmia, and an electrode on the tip of a catheter is used to destroy the abnormal tissue responsible for the arrhythmia. Our goal for our project was to develop a software system that can characterize and calibrate the current output of the existing robotic active catheter system in the Medical Robotics & Computer Integrated Surgery lab at Case Western Reserve University. For the current robotic active catheter system, there are six channels of current outputs, and each of the channels has current fluctuations in comparison to the set desired current output. Our software system ensures more reliable, accurate operation of the robotic active catheter system by detecting the offsets in the current output and determining how much the potentiometers should be adjusted for each channel in order to align the actual current output with the desired current output.

Project Mentor: Dr. Cenk Cavusoglu, Department of Electrical Engineering & Computer Science
Faculty Sponsor: Dr. Gregory Lee, Department of Electrical Engineering & Computer Science

Process Monitoring for Additive Manufacturing

Carlos Lizarraga, Department of Mechanical and Aerospace Engineering; Ishaan Rao, Department of Mechanical and Aerospace Engineering; and Lovish Mehdiratta, Department of Mechanical and Aerospace Engineering

Process monitoring and its optimization are essential to quality assurance in additive manufacturing, especially in fused filament fabrication (FFF) process. In FFF, parts are manufactured by the deposition of layers of molten thermoplastic material through a nozzle. Inherent variability and lack of quality assurance has been a barrier in adopting this technology. Most quality controls for additive manufacturing products are limited to offline methods, however, real-time monitoring is essential. In this project, we focus on identifying key process parameters, e.g. layer thickness, extrusion temperature, etc. that affect the quality of products. A design of a real-time process monitoring system through a MATLAB interface will be developed to detect nozzle clogging. The data will be collected from multiple sensors: thermocouples, infrared sensor and accelerometers. A classification algorithm will be used to classify the experimental data and then fed into the image processing system to detect process drifts.

Project Mentor: Dr. Peng Wang, Department of Mechanical and Aerospace Engineering
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering
Bax is a 21kDa protein that plays an essential role in the activation of cellular self-destruction process known as programmed cell death or apoptosis. Bax is normally expressed in the cytosol as an inactive (non-toxic) form in living cells. In response to cytotoxic stresses, Bax changes its confirmation to become an active (toxic) form and translocates to the outer mitochondrial membrane. At the mitochondria, Bax forms a multimer, damaging mitochondrial activity and releasing Cytochrome C from the intermembrane space. In the cytosol, Cytochrome C will activate the cell death-inducing proteases called Caspases. Bak is a homologous protein of Bax, and it has been shown that a Bax/Bak double knockout can confer mammalian cells resistant to various types cytotoxic stresses. The Matsuyama laboratory has developed a novel cell-based screening system of Bax/Bak inhibitors (BBI). BBI-4 was identified as a novel cell death inhibitor which inhibits Bax activation. Our recent study suggests that BBI-4 has an influence on mitochondrial and glycolytic activities in the cell. The present study will discuss the mechanism of how BBI-4 control cellular fate to die or survive.

Novel drugs such as BBI-4 could be used to prevent the premature death of essential cells required for life, such as neural, hematopoietic, and cardiovascular cells.

**Project Mentor: Professor Jeffrey Coller, Department of Biochemistry**

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**Wearable Biopotential Measurement System for Epilepsy Monitoring**

Keying Chen, Department of Biomedical Engineering; Neha Reddy, Department of Biomedical Engineering; Shaunak Roy, Department of Biomedical Engineering; Andrew Strimaitis, Department of Biomedical Engineering; Ragul Yuvaraj, Department of Biomedical Engineering; Colin Drummond, Department of Biomedical Engineering; Sriram Boppana, Department of Biomedical Engineering; and Matthew Williams, Department of Biomedical Engineering

About 1 in 26 Americans suffer from epilepsy, a neurological disorder that causes seizures due to abnormal nerve cell activity. The frequency of seizures, the characteristic symptom of epilepsy, is highly varied and unpredictable. Tracking seizure activity and frequency aids doctors in providing effective medical therapies. There are many types of seizures induced by various diseased brain areas, and our approach focuses on occipital lobe epilepsy, the form with the fewest solutions, treatments, and therapies. Current problems with epilepsy monitoring systems used in clinical research settings are physical bulkiness, restrictive nature with regards to daily hospital activities, and lack of portability. Our device is a ski hat fitted with electroencephalography (EEG), electrooculography (EOG), and motion sensing capabilities. The device targets usage with research study patients in hospitals to enable clinicians to collect multiple real-time seizure-characteristic signals that can be wirelessly transmitted to a remote processing unit: EEG, EOG, and accelerometer data will be recorded and sent through an OpenBCI Cyton board. The key tenets of our design are comfort, portability, and minimal intrusiveness to daily hospital activities.

**Project Mentors: Colin Drummond, Department of Biomedical Engineering; and Matthew Williams, Department of Biomedical Engineering**

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The Effect of Nonprobative Images on Truthiness

Jacob Rich, Department of Psychology

Truthiness is the feeling or belief that something is true, regardless of logic, evidence, or facts. This research is concerned with the effect of nonprobative images on truthiness. Nonprobative images do not provide any evidence to whether or not a statement is true, but may have an impact on whether or not we believe a statement is true. To investigate this, two groups of volunteers were shown a series of trivia statements, which they would judge as either true or false. Half of these statements were accompanied by nonprobative images, which were related to the question they were accompanying but provided no evidence or hint as to whether or not the statement was actually true. The other half of the questions had no accompanying image. For the second group of volunteers, questions that had been accompanied by images in the first group no longer had images, and vice versa. What was ultimately found was that in general, the volunteers tended to respond “true” more often to the questions accompanied by the nonprobative images. These results can be utilized to further the knowledge we have on how certain things can inflate subjective feelings of truth and what constitutes this feeling of truth.

Project Mentor: Professor Robert Greene, Department of Psychology

Exoskeleton for Fall Damage Mitigation

Andrés Robert, Biomedical Engineering, Saigopal Somasundaram, Biomedical Engineering, David Black, Biomedical Engineering, Peilin Ge, Biomedical Engineering, Jing Pu, Biomedical Engineering, Weston Salerno, Biomedical Engineering

One in every four Americans aged 65 and older fall each year, and every 19 minutes an elderly person dies from a fall related injuries. In 2014 alone, fall injuries cost American patients over $31 billion. Often caused by these falls, resulting hip injuries are the most lethal, costly, and impactful. While a device does exist currently in the market to aid in fall mitigation, it is expensive, and is largely untested. In order to address this gap within the medical device industry, we have designed a device that acts as an exoskeleton for fall mitigation, aiming to reduce the impact and injury that falls have on a patient, primarily surrounding the hip and tailbones. The device will be comprised of a belt which houses inflatable airbags, that upon detection of a fall from an accelerometer unit, will deploy, protecting the hips and tailbone. Consideration for the patient is given to make the device comfortable to wear, while mitigating fall damage. The primary target market consists of elderly populations in nursing homes and hospitals where the usage of the device would be maximized, as well as supported by trained professional staff. Future uses of the device are numerous, ranging from at-home use for the elderly, as well as expansion into fall-prone industries, such as equestrian, active sports, high risk occupations, and the military. With an ever aging population, and growing need for preventative medicine, the exoskeleton for fall mitigation offers a solution to the growing problem of fall injuries.

Project Mentors: Professor Colin Drummond, Department of Biomedical Engineering; Professor Matthew Williams, Department of Biomedical Engineering; Brian Sanner, Department of Biomedical Engineering
The Impact of Russian Culture on Financial Reporting

Andrés Rios, Department of Accountancy

Russia has undergone significant financial reform in the last 20 years. Most of these reforms represent significant strides toward the convergence of east and west, including the national adoption of IFRS in 2012. By adopting IFRS, Russia sought to attract foreign investors and encourage stable economic development in a country with a 70-year long communist legacy. Despite the efforts of convergence, significant cultural differences still exist that present obstacles for the implementation of IFRS in Russia. This research seeks to understand the Russian accounting culture, how it impacts financial reporting, and what it means for foreign investors.

Project Mentor: Professor Dennis Conrad, Department of Accountancy

Esophageal catheter for temperature and pressure measurements in ablation procedures

Eric Black, Department of Biomedical Engineering; Ramon Correa, Department of Biomedical Engineering; Samuel Guadagnino, Department of Biomedical Engineering; Larissa Martinez, Department of Biomedical Engineering; Dr. James Reynolds, Case School of Medicine; Griffin Rial, Case Western Reserve University; Katherine Rodgers, Department of Biomedical Engineering

Atrial fibrillation is a condition affecting roughly 2.7 million Americans that can lead to blood clots and stroke. If standard anti-arrhythmic medications fail, the clinician will perform a corrective ablation procedure to create scar tissue in the region of the heart causing the arrhythmia. During these procedures, clinicians typically place an additional catheter in the esophagus to monitor temperature changes and prevent esophageal damage. Despite this precaution, fistulas between the heart and the esophagus form in 0.05% of procedures, with a mortality rate near 93%. Thus, there is a need for a more robust and sensitive method of monitoring esophageal damage in real time. Our team has created a novel esophageal catheter that will map pressure and temperature changes with improved sensitivity in order to prevent fistula formation. Clinicians will be able to track changes in temperature and pressure on a monitor in real time, allowing for quick corrective action to occur. * Include any other features of the device too that are important*. This new esophageal catheter may improve quality of care for the cardiac patients and reduce costs associated with surgery complications and re-hospitalization rates.

Project Mentor: Dr. James Reynolds, Case School of Medicine

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Design and Manufacture of Payload for Solid-Fuel Microgravity Combustion Experiment

**Evan Rose**, Department of Mechanical and Aerospace Engineering; and **Dr. Vedha Nayagam**, Department of Mechanical and Aerospace Engineering

The rate at which flames spread over a solid fuel surface gives a measure of the flammability of the fuel in a given environmental condition. Historically, opposed and concurrent flame spread rates over stationary solid fuel samples have been studied in great detail, and standardized flammability test methods have been developed based on flame spread rates to screen materials used in a spacecraft. This project supports a study to investigate the effect of longitudinal vibration on opposed-flow flame spread over thin solid fuels. The longitudinal vibration of the fuel is hypothesized to alter the boundary layer characteristics adjacent to the fuel surface, and accelerate the flame spread process. Preliminary tests under normal gravity conditions support this hypothesis. The objective is to produce an experimental setup to test flame spread rates in microgravity onboard the Blue Origin New Shepard suborbital vehicle, which provides a microgravity environment for approximately three minutes. During the experiment, the fuel vibration frequency and acceleration will be varied and the resulting flame spread process will be recorded for later analysis. This project focused on the development of the three main mechanical components of the experimental payload: the vibration mechanism, the fuel fixture and ignition system, and the payload enclosure.

*Project Mentor: Dr. Vedha Nayagam, Department of Mechanical and Aerospace Engineering*

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Simulating Sensory Axons to Predict Action Potentials in the Vagal and Splanchnic Nerves

**Josh Rosenberg**1,2, Jessica Gaines, BS3, Katharine Polasek, PhD3, Platon Lukyanenko1,2, and Matthew A. Schiefer, PhD1,2

1Louis Stokes VA Medical Center APT/FES Center
2Department of Biomedical Engineering, Case Western Reserve University
3Department of Engineering, Hope College

According to the Center for Disease Control, more than 36.5% of U.S. adults are obese, with medical costs exceeding 147 billion in 2008. Neuromodulation can provide a means of reducing excess body weight (EBW) that is less invasive than bariatric surgery. The vagal and splanchnic nerves relay information about the stomach, and stimulation of these nerves have shown the potential to reduce EBW in individuals by producing sensations of satiety in individuals, but trial results have been inconsistent and stimulus parameters vary widely. In order to fine tune stimulation parameters, entire nerves, consisting of thousands of axons, are simulated in a MATLAB version of the nerve model developed by McIntyre, Richardson, and Grill in NEURON. However, due to the nonlinearity and complexity of the model, simulating axons is a slow process on top of the fact that the model potentially has to be applied to thousands of axons per nerve. This project seeks to simulate sensory axon responses to varied patterns of electrical stimulation in these nerves in order to develop a linear approximation model. A linear approximation model can be constructed by creating a surface characterized by the strength duration curves of axons within the desired nerve. Such a model would allow direct comparisons of stimulation parameters against the model to evaluate whether the input parameters will elicit an action potential without additional simulations. This would dramatically reduce the amount of time necessary to optimize stimulation parameters by no longer requiring full nerve simulations for subsequent parameter comparisons after the initial simulations to build the model. This model will be used to quickly fine tune stimulation parameters to work towards producing desired neural patterns of activity, such as those associated with satiety.

*Project Mentor: Matthew Schiefer, PhD, Louis Stokes VA Medical Center Advanced Platform Technology Center*
Mitigating Bed Fall Injuries in Retirement Homes by Lowering of Bed & Side-Cushion Attachments

Ilana Roth, Department of Biomedical Engineering; Gitanjali Kaw, Department of Biomedical Engineering; Haosheng Li, Department of Biomedical Engineering; Justin McMahon, Department of Biomedical Engineering; Alexander Nesvisky, Department of Biomedical Engineering

Injuries due to bed fall is incredibly common among retirement home residents and hospital patients. Bed rails are used among hospitals to reduce falls, however, Ohio law does not allow for restraining barriers, such as hand rails, in retirement or nursing home settings. This law is due to residents feeling a loss of autonomy or increased isolation due to the restriction of free movement. To work with this limitation, came the idea of lowering the bed to reduce the fall distance, however many companies have already done this. In order to improve upon these devices, an accessory of side flaps with memory foam cushioning will be added to the long sides of the bed. When the bed is at its maximum height, the side flaps will hang down and out of the way, creating minimal obstruction. As the bed height reduces, the side flaps will flare out to the sides creating a gradual incline from the top of the mattress to the floor, in the event that a user would “fall” out of bed, they would more “roll” out of bed. The reduction in height and cushioning of the side flaps are intended to mitigate injury if someone were to fall out of bed. The height of the bed will be controlled by pushing up and down buttons, thus the user has complete control over what height they would like and if they are uncomfortable with the flaps flared out.

Project Mentors: Dr. Colin Drummond, Department of Biomedical Engineering; Dr. Matthew Williams, Department of Biomedical Engineering; Brian Sanner, Department of Biomedical Engineering

Multi-Step Modular Drain Catcher

Lizzy Kalikasingh, Department of Materials Science and Engineering; Frances Seo, Department of Materials Science and Engineering; Wyatt SaintClair, Department of Materials Science and Engineering

In kitchen drains without garbage disposals and bathroom drains, clogging occurs frequently and oftentimes things are lost down the drain. Because of this, drain stoppers or catchers are used. Stoppers do not allow water to flow while catching anything that would cause clogging making it difficult to remove such debris, and traditional catchers are often unhygienic and are very unsatisfying to clean. They also only have one mesh or hole size so the various debris going down the drain usually sticks together and can clog the catcher. The solution we propose is a multi-step drain catcher which will provide a solution to all types of items which clog or fall down drains. With three nets total, each one will catch finer and finer items in order to separate things one wants not to fall down the drain. These types of objects range from personal items, such as rings and earrings, to hair or leftover food particles. The apparatus will be easy to install and remove as well as clean without having to touch the debris caught in the nets by hand, making it much easier to use than traditional drain catchers.

Project Mentor: Professor Peter Lagerlof, Department of Materials Science and Engineering
An Obesity-Generating Diet Drives Glioblastoma Progression

Gustavo Roversi, Department of Chemistry; Anthony Gromovsky, Cleveland Clinic Lerner Research Institute

Glioblastoma (GBM) is the most prevalent and malignant brain tumor and accounts for 52% of all primary CNS tumors. GBM occurs in 2-3 per 100,000 adults per year. There are no known causes for GBM, yet recent work suggests that obese women are at greater risk of developing GBM. We asked whether a high-fat diet (HFD) drives GBM cell growth and cancer stem-cell properties? We hypothesized that the metabolic shift induced by a HFD promotes GBM cell growth and enrichment of cancer stem-cells. Syngeneic GBM cells (GL261, CT2AL, and KR158L), were stereotactically injected into the brains of wildtype mice and survival and tumor engraftment rate were determined in high-fat versus standard-chow-fed mice (10 mice/group). Five BSA-conjugated fatty acids (dHGLA, LA, OA, AA, and PA) were added to recapitulate a HFD in vitro. Cell proliferation was investigated using the Cell-Titer Glo viability assay and stem-cell properties were assessed by tumor-sphere formation under conditions of limiting dilution in the presence of 10, 50, and 100 μM fatty acids and compared to vehicle controls. Our studies demonstrated that tumor bearing mice injected with 5x10^3 and 5x10^4 CT2AL and GL261 cells on a regular chow diet had a median survival of 40 days compared to 24 days of tumor bearing mice on a HFD. Interestingly, we noted a three-fold increase in tumor formation in mice fed a high-fat-fed compared to chow, suggesting an increase in tumor stem-cell frequency. GB cells treated with 10 μM OA and 10 μM LA demonstrated a 28% and 50% increase in cell viability respectively as well as a two-fold increase in sphere formation. These results were seen in the CT2AL, GL261, and KR158L as well. Other fatty acids had either no or an adverse effect on cell viability and stem-cell enrichment. In summary, HFD significantly lowered survival of GBM bearing mice and increased tumor stem-cell frequency while certain fatty acids increased GBM cell growth and tumor sphere formation in vitro. Future studies will be needed to elucidate the cellular mechanisms.

Project Mentor: Dr. Daniel Silver, Cleveland Clinic Lerner Research Institute
Faculty Sponsor: Dr. Rekha Srinivasan, Department of Chemistry

Addressing Ambiguous Language Deficits Within the Autism Spectrum

Cheyanne Sebolt, Department of Psychological Sciences; Leah Beekman, Department of Psychological Sciences

The capability to understand ambiguous language is extremely important (Le Sourn-Bissaoui et al 2012). This pilot study focused on one specific area of ambiguous language: sarcasm. By the middle school age, children themselves are beginning to use sarcasm quite frequently (Volden and Phillips 2010). The specific middle school population that was focused on throughout this study involved those in middle school with an autism spectrum disorder (ASD) diagnosis, because this population often does not understand sarcasm (Volden and Phillips 2010). For this pilot study, a 13-year-old diagnosed within the autism spectrum, specifically a high-functioning ASD diagnosis, was recruited and then tested with two standardized and two non-standardized tests. The two standardized tests used were the CASL and the KBIT, while the two non-standardized tests measured either the participant's ability to identify multiple-meaning words, oxymorons, and metaphors, or the participant's ability to identify, respond to, and manipulate sarcastic or serious scenarios. The purpose of this pilot study was to determine if the intervention in sarcasm could successfully be used to improve understanding of ambiguous language in populations with high-functioning ASD. Implications of these results could eventually lead to a normalized intervention used by speech-language pathologists to teach sarcasm.

Project Mentor: Dr. Angela Ciccia, Department of Psychological Sciences
**Synthetic Peptide Modulation of Protein Tyrosine Phosphatase Sigma Increases Oligodendrocyte Migration Across Inhibitory Chondroitin Sulfate Proteoglycans**

**Chandrika Sanapala**, Department of Neuroscience; **Amanda P. Tran**, Department of Neuroscience; and **Dr. Jerry Silver**, Department of Neuroscience

Multiple sclerosis (MS) is an autoimmune disease of the central nervous system that attacks the myelin of nerve fibers, causing death of oligodendrocytes, which leads to functional neuronal degeneration (Patrikios et al., 2006). Although the body attempts to remyelinate the axons, the oligodendrocytes (OL) are not able to fully compensate for the loss of the myelin sheath. Repeated remyelination attempts leads to the formation of a plaque buildup (Franklin and FFrench-Constant, 2008). During this plaque buildup, inhibitory chondroitin sulfate proteoglycans (CSPGs) are released and cause a scar-like formation. Recent studies have demonstrated the effects of CSPGs on oligodendrocyte progenitor cell (OPC) maturation (Keough et al., 2016). Intracellular Sigma Peptide (ISP) is a peptide aiding functional recovery of axons in an inhibitory molecular environment (Lang et al. 2015). By examining the method by which ISP fosters OPC migration, we will gain an enhanced understanding of ISP and its usage in functional recovery through remyelination. CSPG is inhibitory in spinal cord injury (Snow et al., 1988; Snow et al., 1990; McKeon et al., 1991; DeWitt et al., 1993; DeWitt et al., 1994; Kurazono et al., 2001; et al., 2012). If CSPG is indeed involved in MS, adding ISP will increase myelination. I hypothesize that ISP will allow for migration of OPC, which may lead to possible functional neuronal recovery in MS patients. OPC cannot migrate into areas in which it is needed, due to CSPG. CSPG inhibits OPC differentiation as it prevents OPC from being able to remyelinate, and this may be because OPC migration is inhibited. In order to investigate this mechanism, I will be using a spot assay of increasing CSPG. I will extract OPC in culture, and will test with ISP in the gradient of the spot assay. Following this, I will image spots for CS-56, a CSPG antibody, to examine OPC migration. Based on preliminary experiments and research, I expect that ISP will indeed allow for OPC migration, altogether hopefully providing insight into a possible treatment for MS.

**Project Mentor: Dr. Jerry Silver, Department of Neuroscience**  
**Faculty Sponsor: Dr. Hillel Chiel, Department of Biology**

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**The Effects of Deep Brain Stimulation on Sleep and Cognition in Parkinson's Disease Patients**

**Sai Anusha Sanka**, Department of Cognitive Science, Dr. Stephanie Towns, Neuropsychology

Deep Brain Stimulation (DBS) is often used to surgically treat the motor symptoms associated with Parkinson's disease (PD); however, various studies have also shown that DBS results in changes in sleep and cognition. To gain a better understanding of these changes and further validate them, 29 research studies spanning two decades (1992-2016) were selected and reviewed to understand the effects of Subthalamic Nucleus, Globus Pallidus internus and Thalamic DBS. Though the timeframe of each study differed, the studies showed significant decline in verbal fluency and verbal memory and reduced memory performance as memory load increased. With regards to executive function, PD patients on and off DBS were shown to be equally impulsive even when controlling for risk attitude. Subjective sleep quality increased overall post DBS even though daytime sleepiness remained unchanged. Sleep dysfunction decreased overall and DBS procedures also re-established normal Rapid Eye Movement (REM) sleep in the patient population. These studies collectively present various significant changes with regards to sleep and cognition individually, suggesting that DBS can be potentially used to treat more than the motor symptoms of PD. None of the studies, however, assess both simultaneously, even though they are interrelated. This begets for further research to assess how changes in one facet can affect another to better understand and optimize patient outcome.

**Project Mentor: Dr. Stephanie Towns, Neuropsychology**  
**Faculty Sponsor: Professor Fey Parrill, Department of Cognitive Science**
Detection of Variance Through Genotypic Analysis of African, Malagasy and Southeast Asian populations in Relation to CYP2D6 and G6PD Genes

Poorvi Satya, Department of Biology

Malaria, the infectious disease spread by infected mosquitoes, persists as a problem worldwide, leading to high numbers of deaths per year in certain parts of the world, despite the development of improved assays and drug treatment procedures. Using data collected from Africa, Madagascar, and Southeast Asia, my research attempts to outline the possible differences between populations by looking at two genes that play a vital role in the process of drug treatment: CYP2D6 and G6PD. Based upon the genotypic foundation of an individual, having a deficiency in either of these genes can be harmful to treatment, causing acute hemolytic anemia in the case of a G6PD deficiency treated with antimalarial drug primaquine, and causing an inability to properly metabolize drugs within the body when CYP2D6 is deficient. Along with these two genes, I will also be looking at other genes not related to malaria for the purpose of a control. Using samples collected from Madagascar in Fall 2017 as well as African and Asian samples derived from the 1000 genomes project, a genotype population resource, the goal of this project is to ultimately create a principal component analysis for unsupervised clustering analysis that explains the relationship between different genotypic variances in the population. Using bioinformatics tools including programming language Perl in a Linux/Unix environment, the process of filtering large amounts genotype data to derive necessary information is conducted. Due to discrepancies between different platforms of data collection, research into the appropriate conversation methods and methodical accounting of single nucleotide polymorphisms within the existing population must be done. Once fully completed, the analysis should provide further information about the mechanisms that cause certain forms of resistance and deficiencies within populations with a high risk of malaria.

Project Mentor: Dr. Ricky Chan, Institute for Computational Biology
Faculty Sponsor: Christopher Cullis, Department of Biology

A Physiologically Accurate Regime to acquire an L-Sit Straight Arm Press to Handstand

Jared Shanks, Department of Dance and Dean’s Approved cross-department student of Performance Kinesiology

This project reviews exercise physiology literature in order to support the formation of a training plan that would lead to a scientific, thus efficient acquisition of the gymnastics skill of an L-sit straight arm press to handstand. The paper states exercises followed by supporting evidence as to the specific physiological mechanisms that those exercises target. The mechanisms focused on include the effect of training on strength and flexibility with special attention to the overlaps regarding active flexibility, the length tension curve, and muscular control in the end ranges of motion. A secondarily this paper will put one place a large portion of the relevant research for any athlete or performing artist looking to safely train to increase their flexibility.

Project Mentor: Dr. Richard Drushel, Department of Biology
Radiomic Features of Rectal Tissue Sub-compartments on T2w MRI Can Differentiate Poor and Favorable Treatment Responders in Rectal Cancer

Amrish Selvam, Department of Biomedical Engineering and Computer Science; Jacob Antunes; Rajat Thawani; Kaustav Bera; Jacob Brady; Joseph Willis; Raj Paspulati; Anant Madabhushi; Satish Viswanath

Nearly 40,000 patients are diagnosed with rectal cancer every year in the United States alone. Neoadjuvant chemoradiation (NAC), radiation targeted at tumor and surrounding tissue, is currently used as the first-line of treatment. Pre-surgical T2w MRI are used to assess favorable/poor responders, which is crucial for personalized follow-up, but treatment related effects prevent accurate identification. However, radiomics, the computerized extraction of imaging features, may be able to capture sub-visual heterogeneity within different tissue compartments on post-NAC MRI. Therefore, combining specific radiomics features from different rectal tissue sub-compartments could help better identify favorable responders to NAC. We identified radiomic T2w MRI features that were able to discriminate favorable and poor rectal cancer responders to NAC by quantifying appearance of (1) viable residual tumor, (2) non-tumor rectal tissue adjacent to the tumor, and (3) nontumor rectal tissue outside the axial plane of the viable tumor. Pixel-wise radiomic texture feature maps were extracted to capture statistical and structural measures of heterogeneity within the 3 annotated subcompartments. Statistics were computed from each texture feature map distribution. Significance testing was employed to rank features based on ability to discriminate between poor and favorable responders to NAC. Then a machine learning classifier was constructed using top radiomic statistic from each annotated subcompartment. The classifier’s performance was evaluated using sensitivity and specificity. The top feature statistics from each sub-compartment was compared against concatenation of top statistics from all 3 using quadratic discriminant analysis (QDA). After analysis, it was found that each sub-compartment had a different top ranked radiomic descriptor, which reflected differential NAC response in each region. However, combining top radiomic descriptors from each subcompartment yielded the best overall sensitivity and specificity. Therefore, combined analysis of treatment response in sub-compartments within and around the rectal tumor may improve treatment response assessment to NAC.

Project Mentor: Professor Satish Viswanath, Department of Biomedical Engineering

An air-supported treadball used for assessing changes to tethered optomotor walking behavior of a flesh fly during haltere manipulations and brain recordings

Xiaoyu Shen, Department of Biology; Dr. Nicholas Kathman, Department of Biology; Dr. Jessica Fox, Department of Biology

All flies have a set of reduced hindwings called haltères that sense body rotations during flight. Some flies, such as the flesh fly, Sarcophaga, oscillate their haltères during walking as well as during flight. In order to investigate the role of haltères in controlling these behaviors, we developed a system to track walking direction and speed of the tethered fly on an air-supported ball that is tracked by a camera system. The walking speed and direction also can control the position of the visual pattern on an LED arena surrounding the ball. Additionally, the tethered fly can be rotated with a motor to simulate yaw flight rotations. The stability of this tethered behavioral setup also allows us to use extracellular recording techniques to record from a central brain region in the fly, known as the central complex. This region is previously known to integrate haltere and visual information and be involved in reporting and direction animal heading direction. With these tools, we can observe neural correlations with both imposed rotations and self-directed movements of the fly, with and without it’s haltères.

Project mentor: Dr. Jessica Fox, Department of Biology
Material Influences on Fatigue and Fracture of Dental Arch Wires

David Scannapieco, Department of Materials Science and Engineering; Janet Gbur, Department of Materials Science and Engineering; John Lewandowski, Department of Materials Science and Engineering

A variety of geometries and materials are used for the correcting wire in orthodontic braces in order to achieve specific results or for use in a multistage treatment. Large springback, low stiffness, and high formability are desired properties for orthodontic arch wires and often reported in literature; however, fatigue behavior is less often investigated. This study will determine the geometric and material influences on the fatigue lifetime and fracture behavior of common arch wires. As-received arch wires composed of stainless steel, beta-titanium, and Nitinol representing circular, square, and rectangular wire cross sections from 0.014 inch to 0.025 inch dimensions were tested in tension and fully-reversed flex bending fatigue in ambient air. Fracture surfaces were observed in light and scanning electron microscopy and analyzed for fracture characteristics such as crack initiation, propagation, and overload. Stainless steel exhibited the highest UTS, followed by Nitinol and then beta-titanium. Stainless steel also possessed the highest elastic modulus, followed by beta-titanium, then Nitinol. All materials showed high levels of ductility, with beta-titanium having the highest reduction of area followed by Nitinol, then stainless steel. Tension samples all showed expected cup-cone fracture surfaces. At high cyclic strains, Nitinol exhibited the highest number of cycles to failure, followed by stainless steel. At low cyclic strains, Nitinol also exhibited the highest number of cycles to failure, followed by beta-titanium. All three materials showed ductile fracture characteristics, beta-titanium and stainless steel exhibited high levels of plastic deformation on the fracture surface whereas Nitinol had a very flat fracture surface without much deformation. Future work will include more in-depth analysis of fatigue fracture characteristics and comparisons across varying cyclic strains, material, and cross-sectional geometry. Analysis of material characteristics will include inclusion chemistry, presence of voids, and other metallurgical factors.

Project Mentor: John Lewandowski, Department of Materials Science and Engineering

Self-Supporting Knee Brace

Alexander Shimek, Department of Mechanical and Aerospace Engineering

Multiple sclerosis, muscular dystrophy, Parkinson’s and progressive muscle weakness are all characterized by an inability to carry a normal stride which subsequently results in frequent falls. Traditionally, knee braces are used to provide support to the knees to prevent this; however, this project aims to construct a more preventative knee brace with a locking mechanism. It will provide support when the user’s knee fails and prevent him/her from falling while maintaining the profile and weight of a typical knee brace. Initial designs and iterations will be focused on me and keeping me safe and upright using a preventative technique that activates every time I step. The mechanism is weight actuated which will lock the brace in the upright or zero degree position as long as there is weight on the leg. This allows for near full range motion in all other situations. This mechanism is purely mechanical and is a reduced version of the technology used in a stance control KAFO (knee-ankle-foot orthosis). As proof of concept, to-scale models have been generated. From there, a 3D model of the entire brace and mechanism along with a Finite Element Analysis or FEA will uncover which parts of the brace will undergo the most stress. This analysis helps in deciding on a material for the construction. If the design proves successful, I will use the prototype myself to test for safety and mobility. Should the design work after this preliminary testing, it may be refined further and offered to patients suffering from muscle weakness both clinically and on the market.

Project Mentor: Professor Malcolm Cooke, Department of Mechanical Engineering
Faculty Sponsor: Professor Robert Gao, Department of Mechanical Engineering
Regulation of Dendritic Branching by RAB-10 Phosphorylation

Bhooma Shivakumar, Department of Biology; Shu Chen, Department of Pathology

Dendrites are frequently branched as a vital component of a neural circuit in receiving correct input to the neuron. Delivery of membrane and protein cargoes are essential for dendritic growth and arborization. Though much is not known about this mechanism, a GTPase RAB-10 has been identified as a key regulator of membrane transport and dendritic morphogenesis in Caenorhabditis elegans PVD sensory neuron. RAB-10 plays a role in the trafficking of intracellular vesicles containing plasma membrane and proteins required for PVD dendritic growth. Recently, RAB-10 has been identified as substrate of LRRK2, a kinase linked to Parkinson’s disease (PD). This research aims to compare 4 unique strains of transgenic C. elegans expressing hyper-active LRRK2 mutants in PVD neurons (1SC17-7, 1SC17-4, 1SC4-4, AND 1SC16-4) along with a control (WYIS592) in order to qualitatively characterize the differences in dendritic arborization due to LRRK2-mediated RAB-10 phosphorylation. Since abnormalities in dendritic branching may occur as the nematode ages, the worms were age synchronized through spot-bleaching. After the C. elegans LRRK2 mutants developed to adults by day 6 post larval stage; the prevalence of 1°, 2°, 3°, and 4° dendrite branches, fusion of dendrites, and beading along the dendrites branches was observed using a fluorescent microscope for 10 nematode per strain over a period of two days. Our results may reveal whether RAB-10 phosphorylation by LRRK2 modulate dendritic branching, providing potential insights into the role of LRRK2-RAB-10 signaling pathways in neuronal function and in PD pathogenesis.

Project Mentor: Dr. Shu Chen, Department of Pathology
Faculty Sponsor: Professor Barbara Kuemerle, Department of Biology

Stress Evaluation in Joint Coupling

Alastair Bastian, Department of Mechanical and Aerospace Engineering; Thomas Milyo, Department of Mechanical Engineering; Mateusz Siewierski, Department of Mechanical Engineering

Dual ferrule fittings are commonly used to connect metal tubing in high-pressure fluid systems such as those found in chemical refineries and oilrigs. These fittings work by plastically deforming ("swaging") metal collars ("ferrules") onto the tubing to create a permanent, leak-proof seal. Tylok, a Cleveland-based company, manufactures these fittings and other fluid system components in their Euclid plant. This fitting method is popular because of its simplicity and reliability. Our research is concerned with performing a finite element analysis (FEA) of Tylok's size 12, 316/316L stainless fitting. This analysis should show how the ferrules, tube, nut, and body deform during assembly. The evaluation methods include FEA in both Solidworks Simulation and Ansys Structural Mechanics. The analysis can be verified by testing stresses on or deformation of the physical parts and ensuring the physical measurements match what the simulation predicts. Additionally, the analysis should provide insight into where high stress concentrations exist as well as estimates of stress magnitudes. This knowledge should allow Tylok to evaluate their current fitting design and materials for possible improvements. Furthermore, this work should provide a framework for Tylok to perform FEA on additional fitting sizes and materials.

Project Mentors: Dr. Sunniva Collins, Department of Mechanical and Aerospace Engineering; Mr. Jesse Henning, Tylok International, LLC
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering
**Phylogenetic analyses of snake toxicity effects on longevity and size**

*Mario Slagle*, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Based on many evolutionary models, venomous organisms are expected to have longer lifespans than non-venomous organisms due to the evolution of delayed senescence as a result of lower extrinsic mortality. We hypothesize that venomous snakes have a longer lifespan and are larger on average than their non-venomous counterparts, despite previous studies claiming that this is not the case. We constructed a phylogeny including snakes from the families Colubridae, Elapidae, Lamprophiidae, and Viperidae using gene sequences from GenBank, which were aligned in MEGA7.0, constructed into a matrix in Mesquite3.2, and imported into MetaPIGA3.1, where the phylogeny was modeled. We then ran a PGLS analysis in R on data collected in a 2013 study, using the packages Hmisc, APE, phytools, and Picante, to determine the relationships between longevity, size, and toxicity. Through PGLS analysis, we concluded that longevity is a function of size in all sampled taxa (p < 0.01), and that on average, toxic snakes lived 1.5x longer (p < 0.05) and were on average 2x as long (p < 0.05) as their non-venomous counterparts. We were able to conclude with confidence that venomous snakes have a longer lifespan and are larger on average when taking phylogeny into account. This suggests that as a result of reduced extrinsic mortality, venomous snakes experience delayed senescence and are able to grow larger on average.

*Faculty Sponsor: Professor Jean H. Burns, Department of Biology*

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**Structure and Stabilization of Laminar Jet Diffusion Flames**

*Logan Smith*, Department of Mechanical and Aerospace Engineering, Dr. Fumiaki Takahashi, Department of Mechanical and Aerospace Engineering

In early 2012, NASA's Structure and Liftoff In Combustion Experiment (SLICE) was conducted within the Microgravity Science Glovebox (MSG) aboard the International Space Station. This Structure and Stabilization of Laminar Jet Diffusion Flames experiment is a continuation of NASA's SLICE, furthering research on flame liftoff conditions in earth's gravity. The experiment will enhance our understanding of the physical and chemical processes influence on flame liftoff limitations. In addition it gathers data regarding soot formation and thermal radiation. In the experiment, a gaseous fuel departs from a fuel tube into a duct, in which the air flows with the same direction as the jet. The jet is ignited at low fuel velocities, creating a stable flame attached to the burner's rim. From low speed, the fuel flow and/or co-flow of air are gradually increased until the flame lifts from the burner's rim and/or blows out. The fuel and air velocities are measured to determine the lift-off limits of the flame. Fuel type (methane, ethane, or ethylene) and concertation are varied to gain a larger scope from the results. Fuel jet diameter is also varied in order to observe its effect on liftoff limitations. The experiment is conducted in UL Fire and Combustion Laboratories at Case Western Reserve University and NASA Glenn Research Center.

*Project Mentor: Professor Fumiaki Takahashi, Department of Mechanical and Aerospace Engineering*

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Lyme Disease Vaccine Controversy: Why are we still without?

Savanna Smoker: Department of Biology.

Lyme disease is the most common tick born disease in the United States and is caused by the bacteria Borrelia burgdorferi. Despite the high incidence of Lyme disease there is currently no vaccine available. From 1998-2002, a vaccine under the name LYMErix was on the market but was eventually pulled due to low consumer buy in and unsubstantiated claims that the vaccine elicited an autoimmune response. Since then research on possible vaccine targets has been rampant and some vaccine candidates have been successful in mice. Several targets have produced an immune response but ultimately did not offer protection, such as BB0405, BbHtrA, and OspC. Study of outer surface protein A (OspA) vaccines show efficacy and the LYMErix vaccine was an OspA targeted vaccine. OspA is essential for the formation of lipid rafts in the outer membrane of B. burgdorferi. These prokaryotic forms of lipid rafts could contribute to the pathogenicity of B. burgdorferi as the bacteria utilize host lipids for raft formation. Another surface lipoprotein BBA64 is also implicated in B. burgdorferi pathogenicity in mammals. Vectors deficient in BBA64 cannot infect mice and, therefore, this lipoprotein is another promising vaccine candidate. This project ultimately aims to explore the mechanisms of likely vaccine candidates against the causative agent of Lyme disease. Specifically, the role of prokaryotic lipid rafts in the pathogenicity and dissemination of infection is explored. This discussion is a critical first step in addressing why no Lyme disease vaccine is currently on the market despite an incidence of approximately 300,000 cases in the U.S. each year.

Project Mentor and Faculty Sponsor: Professor Karen Abbott, Department of Biology.

Musical Acoustics Across the Quantitative-Qualitative Boundary

Will Spallino, Department of Music and Department of Physics; David Kazdan, Department of Electrical Engineering and Computer Science

Musicians’ descriptions of desired outcomes for rooms dedicated to music are not always sufficient for designers to produce those outcomes; performance ensemble leaders’ dissatisfaction with the Maltz Performing Arts Center on CWRU’s campus is a prime example of this disconnect. The primary complaint about musically problematical spaces typically concerns its acoustics; therefore, research in acoustics has the potential to find solutions for these complaints. This project seeks to bridge the gap between the qualitative descriptions of the musical approach to acoustics and the quantitative approach taken by architectural acousticians, consultants, and designers. By having volunteer musicians perform in various rooms on CWRU’s campus and collecting both audio recordings and survey responses for each performance, we hope to capture quantitative and qualitative data, which may grant us insight on how varying acoustical parameters correlate to musicians’ experiences in a room. Tests are in progress, and spectral analysis is the primary analytical technique. Recording equipment is borrowed from the CWRU Department of Music, and MATLAB (obtained from the CWRU Software Center) is the primary analytical tool. Correlations will be identified by consistency of participant responses in the qualitative domain in conjunction with consistent phenomena occurring in the power spectra of performance recordings. This study’s results will help future researchers focus their efforts on key aspects of architectural acoustics rather than attempting to find the problem through repeated trial-and-error testing.

Project Mentor: David Kazdan, Department of Electrical Engineering and Computer Science
Faculty Sponsor: Rolfe Petschek, Department of Physics

Intersections: SOURCE Symposium and Poster Session 115
Investigating Strategies to Clarify Treatment Targeting Pathological Hyaluronan Matrices in Hyperglycemic Conditions

Christine Smothers, Department of Nursing; Valbona Cali, Department of Biomedical Engineering, Aimin Wang, Department of Biomedical Engineering; and Vincent Hascall, Department of Biomedical Engineering

Hyaluronan is a glycosaminoglycan present in the extracellular matrix on the surface of connective tissue cells, and propagates inflammatory environments, particularly those induced by diabetic hyperglycemia. There is a growing connection between elevated glucose levels, alterations in hyaluronan function, and physiologic changes associated with diabetes. Identifying the role of hyaluronan in the pathologies of inflammatory diseases can contribute to future optimization of treatment of hyperglycemia, the major cause of diabetes, and diabetic comorbidities (which can include non-alcoholic fatty liver disease, specific cancers of the liver, colon, pancreas and/or bladder, cardiovascular failure, and bone fracture).

This research is concerned with the cellular impact of using xylosides to treat hyperglycemia instead of heparin, the current potential mode of treatment. In hyperglycemic conditions, hyaluronan matrix is produced not only at a higher rate by the resident connective tissue cells, but also in a pathological form that recruits pro-inflammatory leukocytes from blood circulation and local resident tissue. However, the pro-inflammatory leukocytes do not remove excess hyaluronan matrix, which prevents tissue repair. Xylosides and heparin achieve therapeutic effects by promoting anti-inflammatory leukocytes that are able to remove the pathological hyaluronan matrices and stimulate tissue repair through different cellular mechanisms. Thus, the goal is to identify which mechanism is the most effective in reducing pro-inflammatory hyaluronan matrices.

This project aims to clarify strategies that will elucidate the cellular impact of these treatment methods; namely, cultures of the monocytic U937 cells and Fluorophore-Assisted Carbohydrate Electrophoresis (FACE) to measure hyaluronan matrices. Initial investigation of these strategies shows useful potential for research in the future. U937 cell cultures can be induced with each treatment condition to stimulate the cell response under investigation. The characteristics of hyaluronan produced by these cells can then be identified through FACE. Identifying these strategies offers insight into future directions for the overall research.

Project Mentor: Dr. Vincent Hascall, Department of Biomedical Engineering

A Feasibility Study on Implementing a Microgrid in University Circle, Cleveland

Rishi Solanki, Department of Electrical Engineering

With the advent of green energy technologies and the strain on energy grids growing every year, there is an increased need for improved reliability and resiliency, and one particular solution to easing the burden on the nation’s aging energy infrastructure is the development and deployment of microgrids. A microgrid is a small network of energy customers with a local source of supply that is usually connected to a centralized national grid but is able to function independently. This study examines the feasibility of implementing a microgrid in the University Circle neighborhood of Cleveland, Ohio. This study has identified University Circle as a prime target for microgrid implementation as it has a number of significant institutions for the greater Cleveland area which demand reliable power. This study seeks to examine the feasibility of microgrid implementation by examining the requirements that need to be met in three key areas: regulation, technology, and economics.

Project Mentor: Professor Ken Loparo, Department of Electrical Engineering and Computer Science
A New Algorithm to Quantify Maximum Discs in Galaxies

Nathaniel Starkman, Departments of Physics and Astronomy

Maximum disc decompositions of rotation curves place a dynamical upper limit to the mass attributable to stars in galaxies. The precise definition of this term, however, can be vague and varies in usage. We develop an automated algorithm to robustly quantify maximum disc decompositions and we apply it to 175 galaxies from the SPARC database. For high-mass, high-surface-brightness galaxies, the maximum disc mass-to-light ratio is $\sim 0.7 \, \frac{\text{M}_\odot}{\text{L}_\odot}$ in the Spitzer 3.6 $\mu$m band. This is close to or only slightly above the expectations from stellar population models. For low-mass, low-surface-brightness galaxies, the maximum disc mass-to-light ratios are very high, which is unphysical for standard stellar population expectations. This confirms that low-mass, low-surface-brightness galaxies are sub-maximal.

Project Mentor: Prof. Stacy McGaugh, Department of Astronomy
Project Contributors: Dr. Federico Lelli, European Southern Observatory, Germany; and Prof. James Schomber
Department of Physics, University of Oregon

Wearable Hand Tremor Reduction Device using Mechanical Suppression

Aidan DeSanto, Department of Biomedical Engineering, Biomaterials; Jing Yang, Department of Biomedical Engineering, Biomaterials; Rui Xin, Department of Biomedical Engineering, Devices and Instrumentation; and Noah Staton, Department of Biomedical Engineering, Biomaterials

It is estimated that nearly 11 million Americans suffer from essential and Parkinsonian tremors, the vast majority of which being essential tremors. With the onset of tremors, it can become much more difficult for a patient to perform small object manipulation, i.e. eating, writing, etc. Our project seeks to significantly reduce tremors in the hand through a two part, wearable device. Our design combines an adjustable wrist weight to provide inertial resistance to tremors at the wrist and pistons for dampening of unwarranted finger motions. The design uses purely mechanical suppression because it would be non-invasive, low cost, and is non-specific to the nature of the tremor, whether it be Parkinson's or essential. Our design seeks to allow users to regain independence in performing activities of daily living such as writing, eating, and use of a touchscreen device. Our device is currently in its second iteration of prototyping.

Project Mentor: Platon Lukyanenko, Department of Biomedical Engineering
Faculty Sponsor: Professor Matthew Williams, Department of Biomedical Engineering
Faculty Sponsor: Professor Colin Drummond, Department of Biomedical Engineering
Analysis of Nanowire Micro-Fluidic Tweezers

**Tessa Stevens,** Department of Mathematics, Applied Mathematics and Statistics and Department of Physics; Project Mentor: Dr. Longhua Zhao, Department of Mathematics, Applied Mathematics and Statistics

Nanowire fluidic tweezers are tumbling nanorods that create vortices in fluids and manipulate particles. The rotation speed and direction of the tweezers can be controlled using various methods, such as magnetic or electric fields. These tweezers can then be used to safely transport particles in fluids without having to apply force directly to the particle by instead manipulating the fluid around the particle. This research is concerned with modeling the flow of fluid as controlled by the fluidic tweezers. The goal is to create a model that can be used to determine how to manipulate the fluidic tweezers in order to move a particle immersed in fluid in a desired direction. The motion of fluid around the fluidic tweezers was calculated in three-dimensions using the Stokes equations of fluid motion. The integrals for the exact velocity field were evaluated in Matlab in the body frame. Then, the resulting velocities were converted into both the lab frame and the moving body-frame. The motion of different initial points of the fluid were plotted over time in both frames. These plots were analyzed to determine the range, depending on the initial conditions, at which the fluid is trapped in the vortex and moved along by the fluidic tweezers.

*Project Mentor: Dr. Longhua Zhao, Department of Mathematics, Applied Mathematics and Statistics*

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Upregulation of the Complement Pathway in Human Retinal Pigmented Epithelial Cells by 4-Hydroxy-7-oxo-5-heptenoic Acid (HOHA) Lactone at the Transcriptional Level

**Thomas I. Stiadle,** Department of Chemistry; Vasu Munjapara, Department of Biochemistry; Priyali Saxena, Department of Biochemistry

It had been previously established that oxidative cleavage of docosahexaenoate (DHA) in retinal pigmented epithelial (RPE) cells results in the formation of 4-hydroxy-7-oxo-5-heptenoate (HOHA) lactone. In turn, the metabolization of HOHA lactone causes oxidative stress on the RPE cells. This research is concerned with the activation of the complement pathway by HOHA lactone. There is compelling evidence that activity in the complement pathway contributes to age-related macular degeneration (AMD), which is a progressive loss of vision caused by damage to retinal cells. The effect of a low, physiologically reasonable concentration of HOHA lactone (0.1 uM) on the expression of various genes involved in the complement pathway in human RPE cells was determined through the use of quantitative PCR (qPCR). In particular, the relative expressions of these genes compared to a control were determined using double delta CT analysis. We find that HOHA lactone causes significant upregulation of Complement Factor 3 (C3), Complement Factor 5 (C5), Complement Factor B (CFB), and Complement Factor H (CFH) at the transcriptional level. Expressions of these genes around 1.5 times the base levels were shown to occur within two hours after the introduction of HOHA lactone to the RPE cells. A connection between the oxidative cleavage of DHA and the onset of AMD was thus established. Furthermore, substantial increases in expression were often observed prior to the two-hour mark, indicating that even at low concentrations, HOHA lactone is an efficient activator of the complement pathway.

*Project Mentor: Dr. Mikhail Linetsky, Department of Chemistry
Project Sponsor: Dr. Robert G. Salomon, Department of Chemistry*

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AplysiaNet: Aplysia Feeding Circuit Model

Shannon Stork, Department of Computer Science, Department of Cognitive Science; Tate Keller, Department of Biology; Jeffrey Gill, Department of Biology; Hillel Chiel, Department of Biology, Department of Neuroscience, Department of Biomedical Engineering

Artificial neural networks (ANNs) are inspired by biological neural networks. Even simple animals are capable of highly flexible behaviors and adapting quickly to their surroundings, and studying them can inform the design of novel ANNs. The feeding circuit of the sea slug *Aplysia californica* is an excellent model system because feeding is controlled by a relatively small number of large neurons and the circuit has been characterized through decades of research. In ingestion, the grasper, part of the organ called the buccal mass, protracts and seizes food before rotating back to pull food into the esophagus. This can be reversed in a process known as egestion to push food out if it is inedible. The muscles and their controllers switch between functions in response to environmental cues to ensure safe and effective feeding. Sutton et al. (2006) created a kinetic model of the grasper's muscles that lacks a neural mechanism for control. I will construct an network inspired by the biological neural circuit for controlling the kinetic model. The biological circuit includes chemical and mechanical sensors and a central pattern generator, or a set of neurons that produce an oscillatory pattern to drive rhythmic behavior like feeding. The user of my software will provide stimuli to model sensors through the user interface. Current will be passed between model neurons (Izhikevich 2003) through model synapses. Output will be passed to Tate Keller's implementation of model motor neurons, which will send output to the muscles of the kinetic model. Animations of the behavioral output of Tate's kinetic model will be displayed to the user. The behavioral output of the combined controller and kinetic model will be compared to biological data to validate the design of the ANN. The model will describe *Aplysia's* circuit for future research and further ANN development.

*Project mentor: Hillel Chiel, Department of Biology, Department of Neuroscience, department of Biomedical Engineering*

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Design of a Mouth-Like Mechanism for a Compliant Worm Robot

Matthew Stover, Department of Mechanical and Aerospace Engineering

Compliant worm robots developed within the Biologically Inspired Robotics Laboratory at Case Western Reserve University have historically served the purpose of applying peristaltic motion to a soft-bodied robot. The general trend for further development has been towards fewer rigid body pieces and sensory feedback systems that help the robot better move through its environment, but direct interaction with the robot's surroundings has not been fully addressed. A mouth-like attachment that provides the robot with a means of interacting with objects in its environment could make possible many new applications. The design of such a devise shall make it possible for the worm to bring in an object that is directly within its path and deposit it into the main body of the worm, within the first segment. In order to facilitate further future design for applications, FabricWorm was chosen as the primary platform for which the device will be designed for and implemented onto. The fully enclosed body of FabricWorm mimics the body of a worm in such a way that will facilitate the movement of objects through the worm using the same peristaltic motion the worm utilizes for locomotion once the object has been placed within the first, most frontal segment. The design, which is itself biologically inspired, attempts to mimic palps, a set of jointed appendages used by some insects to manipulate food, by utilizing the tubing and vertex pieces that the frame of the robot is constructed of. These palps were chosen as a basis for the design by providing a simple and effective means of pulling in an object that is directly in front of the robot while adding minimal weight and additional rigid pieces. An actuation scheme is being developed that will utilize the Robotis Dynamixel actuators currently in use on the robot for ease of integration into the system as a whole.

*Faculty Sponsor: Dr. Kathryn Daltorio, Department of Mechanical and Aerospace Engineering*
Modified Strandbeest Mechanism for Self-Powered Locomotion and Turning

Kristen Stultz, Department of Mechanical and Aerospace Engineering; Kevin Talbot, Department of Mechanical and Aerospace Engineering

A strandbeest is a multi-legged walking machine that normally is wind powered and locomotes only in a straight line. This project presents the design and build of a device capable of turning. Wind power will be simulated by an internal motor. Utilizing simple modular K'nex components, a modified and improved strandbeest mechanism is constructed. Gait-control motors on each planar leg pair actuate a segment of the leg that is directly connected to the crankshaft. The elongation of this segment increases the stride length unilaterally, which causes the strandbeest to turn. The segment length changes will occur while the leg is not touching the ground. Programming via Arduino ensures proper timing, coordinating rotational speed of the main motor with the leg motors. Customized gearing has been designed to integrate the motors with the modular K'nex components. Additionally, the modified strandbeest will have an added undercarriage to carry additional load. This design has applications as a children's educational tool about mechanical devices, and, if scaled up, as a mining transportation vehicle.

Project Mentor: Professor Richard Bachmann, Department of Mechanical and Aerospace Engineering

Myeloid-Derived Suppressor Cells Fail to Differentiate due to the Inability to Downregulate Serpin B10 Expression in the Presence of Psoriatic Cytokines

Hashim Syed, Department of Biology; Andrew Young, Department of Dermatology; Thomas McCormick, Department of Dermatology

Myeloid-derived suppressor cells (MDSCs) are immune cells that, when stimulated, can suppress inflammation. In psoriasis, an autoimmune disorder characterized by chronic inflammation, the amount of MDSCs circulating in the blood is drastically increased, due to a failure to differentiate into monocytes and/or macrophages. However, these psoriatic MDSCs are dysfunctional and fail to perform their suppressive functions. Also, prior research has found higher levels of Serpin B10, a transcription factor, in the MDSCs psoriasis patients. As MDSCs differentiate into monocytes and macrophages, the expression of Serpin B10 normally decreases. My ongoing project is to determine if cytokines associated with psoriasis, such as Interleukin (IL) 6, IL-17, and tumor necrosis factor, will prevent myeloid cells from decreasing their expression of Serpin B10 and express MDSC-like characteristics. I will do this by exposing monocytes to GM-CSF, a cytokine that differentiates monocytes into macrophages, with and without the psoriatic cytokines. If our hypothesis is correct, it will show that MDSCs will fail to differentiate under psoriatic conditions due in part to the failure of Serpin B10 downregulation.

Project Mentor: Dr. Thomas McCormick, Department of Dermatology
Faculty Sponsor: Professor Radhika Atit, Department of Biology

Intersections: SOURCE Symposium and Poster Session
Heating, Ventilation and Air Conditioning Controls Installation to Localized Panels for Individual and Wide Scale Building Control

Daniel Techman, Department of Electrical Engineering, Mores Mayonrime, Project Engineer,

Using the correct sections of the specifications and/or contract and a set of contract drawings to design local ATC control panels. The subway system spans eight miles long, which contains 26 buildings. The localized control panels help circulate and remove air from the tunnels, control temperatures, remove condensation and open and close dampers. This equipment falls under the heating, ventilation and air conditioning section of the contract. In order to simplify the controls, each building’s equipment is divided into small ATC panels to reduce the amount of panels while maximizing controlling capacity of each panel. Each building has one panel, which collects all data from the building and communicates via SCADA to a central controlling monitor.

Project Mentor: Mores Mayonrime, Project Engineer, Optimum Controls Corporation

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Developmental Changes in Femoral Neck Shaft Angle using a Historic Longitudinal Cohort

Danielle Thompson, Department of Biology; Dr. Ray Liu, University Hospitals

The femoral neck-shaft angle has previously been studied in older ages and disorders such as cerebral palsy, however, little research has been done on how the angle changes in developing children. The aim of this study was to determine the age and gender related changes in the femoral neck-shaft angle, by using serial radiograph measurements of developing children. Using the Bolton Brush Collection, which is a longitudinal historic collection of healthy children, 546 anteroposterior radiographs of the left hip of developing patients (263 female and 283 male), ranging from the ages of two to eighteen, were used to analyze the femoral neck-shaft angle. The measurements were performed on left neck-shafts using the program ImageJ, and 26 images were measured by two authors to confirm inter-relator reliability. The mean and SD of each year’s neck-shaft angle was obtained, along with the mean and SD of each change in neck-shaft angles from year to year. Inter-relator reliability demonstrated an intraclass correlation coefficient of 0.924. The results demonstrated that the mean neck-shaft angle, regardless of gender, remains mostly constant, decreasing only slightly with age.

In addition, the absolute mean value of the change represented the variability of the radiographs themselves, demonstrating a higher accuracy in older children’s neck-shaft angle measurements. Overall, neck shaft angle appears to change minimally after walking age, and variability in measurements is noted in younger children, likely due to difficulties in standardizing standing position in these young children.

Project Mentor: Dr. Raymond Liu, University Hospitals
Faculty Sponsor: Dr. Susan Burden-Gulley, Department of Biology

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A Kinase Inhibitor That Reverses Huntington’s Disease Phenotypes

Matthew Thompson, Department of Biochemistry and Department of Theatre; Di Hu, Department of Physiology and Biophysics; Xin Qi, Department of Physiology and Biophysics, Drew Adams, Department of Genetics and Genome Sciences

Huntington’s Disease (HD) is a fatal genetic disorder characterized by an expanded polyglutamine tract in the first exon of the huntingtin (Htt) gene. Accumulation of mutant Htt (mtHtt) leads to the death of medium spiny neurons (MSNs) in the basal ganglia, and as a result, HD patients suffer progressive motor and cognitive deficiencies, vision and speech loss, and an elevated suicide risk. Recent evidence suggests that mtHtt causes mitochondrial defects within affected neurons, causing decreased mitochondrial membrane potential (MMP) and oxygen consumption, and increased neuronal death. Despite our understanding of HD’s genetic and cellular mechanisms, current therapies merely alleviate HD symptoms but cannot halt or even slow disease progression. Our recent success in reversing HD-induced mitochondrial deficits via a peptide inhibitor led us to conduct a high-throughput screen to discover small molecules capable of mitochondrial rescue. Inhibitor 1 (which remains undisclosed for the purposes of future patent application), an Enzyme X inhibitor, emerged as a leading candidate capable of restoring MMP in HD striatal neurons. Follow-up studies showed Inhibitor 1 enhanced mitochondrial oxygen consumption and neuronal viability in vitro. In the R6/2 HD mouse model, Inhibitor 1 increased the density of MSNs and prolonged survival compared to a vehicle control. Subsequent mechanistic studies have shown that Inhibitor 1 likely does not modulate HD pathology through inhibition of its canonical target, Enzyme X, and we are currently working to determine its therapeutic mechanism. Ultimately, further optimization of Inhibitor 1 as an HD therapeutic and elucidation of its mechanism could open new avenues for HD drug development and provide much needed therapies capable of reversing disease progression.

Project Mentor: Dr. Drew Adams, Department of Genetics and Genome Sciences

Physical Properties of Coral Resilience

Christina Tian, Department of Biology; Jennifer E. Murphy, Department of Biology; Dr. Jean H. Burns, Department of Biology

Climate change has become a serious threat to natural ecosystems, in particular coral reefs. Coral species are especially important for the survival of marine species, as they exist as an underwater ecosystem. However, they are vulnerable to coral bleaching due to thermal stresses in the ocean water. This research considers both morphological qualities and habitat depth for coral resilience by focusing on 52 species in the coral genus Acropora. This study system includes the most abundant and species-rich group of corals in the world. The Acropora species are studied by their depth of habitat and their colony type, to determine how these factors may both individually increase coral resilience but also how they may interact to influence coral vulnerability. More resilient corals are hypothesized to have a specific morphology and inhabit areas deeper in the water. Phylogenetic comparative analysis methods were used for analysis of data and phylogenetic information. The GLS model using ape, picante, lmmtest, and phytools packages in R, confirmed that living deeper in the ocean offers somewhat of a refuge for Acropora species (P<0.01). The future of coral reefs is not looking too promising due to the changing climate, but with more research on the physical properties of resilient corals, long-term solutions can be found to save our reefs.

Faculty Sponsor: Professor Jean H. Burns, Department of Biology
Stability Assessment of a Hawkmoth-Inspired Micro Air Vehicle In Forward Flight Using the Forced Oscillation Technique

Daniel Tiffin, Department of Mechanical and Aerospace Engineering; Dr. Roger Quinn, Department of Mechanical and Aerospace Engineering; Kenneth Moses, Department of Mechanical and Aerospace Engineering

Flapping wings in animals and insects are being closely studied to understand and replicate their impressive stability and efficiency compared to fixed and rotor wing configurations. This research focuses on studying the hawkmoth, or Manduca sexta, and designing a flapping wing micro air vehicle (FWMAV) mimicking this animal. To assess the full flight performance of the robot, the dynamic stability will be quantified through the forced oscillation technique. This research is concerned with determining the feasibility of using forced oscillation to experimentally determine the dynamic stability of the FWMAV. A test rig has been designed and fabrication is underway. Once complete, this test rig will provide the first experimentally obtained forward flight data on a hawkmoth-inspired FWMAV. Potential applications are numerous and include tracking, monitoring, surveillance of unsafe areas, and search and rescue.

Project Mentor: Professor Roger Quinn, Department of Mechanical and Aerospace Engineering

New Mylodontid Sloth (Xenarthra, Phyllophaga) Specimen from the Middle Miocene in the Quebrada Honda Site, Bolivia

Elizabeth Tobin, Department of Biology

Teeth are crucial elements for understanding the taxonomy and paleobiology of a species. Three sloth molariform teeth were excavated in 2013 from the Quebrada Honda site in Bolivia, where four other species of sloths have previously been identified. The teeth are presumed to pertain to the family Mylodontidae based on their lobed shape and are from the late middle Miocene epoch (~ 13 million years old). Extensive literature comparisons and descriptions are being done in order to accurately determine to which genus and species the specimens belong. The teeth range from 18.5 – 26 mm in diameter at their occlusal surface, a moderate to large size compared to other Mylodontidae. Two of the teeth are lobate with flat occlusal surfaces, while the third tooth is more ovate with a raised occlusal surface. Giant ground sloths had very few teeth, and they were generally all of similar structure, unlike the teeth of most modern mammals; this makes identifying tooth positions challenging. The unique shape of one specimen suggests that it may represent a caniniform tooth. The other two likely represent second through fourth molariforms, as they are less lobate than most last (fifth) molariforms. Comparisons have been done with other taxa of similar age from La Venta, Colombia, where three mylodontid species have been identified. Brievabradyx laventensis from La Venta is significantly smaller, but Pseudoprepotherium confusum is comparable in shape and size. In addition to these comparative analyses, we studied the microwear on the surface of the teeth by scanning electron microscopy and traditional (“low-mag”) microscopy and compared patterns to other mylodontid sloths, finding that they are quite similar. This suggest that the Quebrada Honda sloth likely fed on browse such as leaves and shoots of woody vegetation.

Project Mentor: Dr. Darin Croft, Department of Anatomy
Conservation as Cudgel: The Saratoga State Reservation and the Protection of Private Interests

Rebecca Trickey, Department of History

As the popularity of Saratoga Springs, New York waned in the first decade of the twentieth century, companies began extracting carbonic acid gas from the town’s famous springs using mechanized pumps. What followed was the extraction of water and gas at a catastrophic rate; the resulting depressurization saw the quality and quantity of the remaining spring water diminish significantly. Those in the town’s tourism trade, which was built around the medicinal springs, believed their livelihoods were in jeopardy and formed the “Citizens’ Committee” bent on shutting down the gas companies. This meant there were two mutually exclusive financial interests pit against one another; on one hand, the gas companies, who wanted unfettered access to the gas the spring waters contained, and on the other, the Citizens’ Committee, who wanted to preserve the spring waters for their own economic benefit. Ultimately, the Citizens’ Committee emerged victorious with the passage of the 1909 Reservation Act that empowered the state to intercede in preserving the spring waters, and a United States Supreme Court ruling in 1911 that upheld the constitutionality of an anti-pumping ordinance. This paper argues that the battle between the Citizens’ Committee and gas companies is representative of a neglected strand of conservation history that explores the use of conservation law as a tool to protect a particular private financial stake in a resource. What is more, the existing literature in this category focuses on instances where companies in a single industry sought special extraction or construction privileges (as in the lumber and railroad industries), as opposed to companies in competing industries vying for the same resource, which was the case in Saratoga Springs.

Project Mentor: Professor Renee Sentilles, Department of History

Upgrades to an RF Coil Testing and Verification System

Alexander Trimbach, Department of Electrical Engineering and Computer Science

Abstract – Quality Electrodynamics (QED) is a company that develops advanced medical imaging technologies, such as radiofrequency (RF) Coils for Magnetic Resonance Imaging (MRI) systems [1]. In order to validate prototype RF coils and to verify finished products, QED evaluates its coils using various testboxes. These testboxes provide the RF coils with power and simulated input signals so that their performance may be properly evaluated. However, one of the testbox designs had several issues; overheating problems in the power supply unit (PSU) had an adverse effect on the unit’s ability to evaluate RF coils, and several components used in the testbox were on the verge of obsolescence, meaning that should a testbox break, it may not have been possible to repair it. This poster documents the co-op’s work over Fall 2017 to resolve both of these and other issues faced by the testbox. The co-op performed calculations on the device characteristics of the components used in the PSU, and compared these results with those obtained through thermal imaging in order to identify the greatest contributing factors to the overheating issue. Following this, the co-op designed a new PSU circuit schematic, utilizing new voltage regulator components that could better handle the load required of the system. In addition, the co-op assisted with the selection and validation of new RF switches to replace those going obsolete by both comparing the datasheets and performing experiments on their operation. Following this, the co-op redesigned some of the printed circuit boards (PCBs) so that these replacement components could be used in the testbox. Overall, this project was a success; a new design for the PSU was obtained, increasing the length of time that test could be run. In addition, the application of new components increased the operational lifespan of the testbox.

Project Mentor: Noah Deetz, Quality Electrodynamics
Synthesis and Surface Modification of Iron Oxide Nanoparticles for Plant Uptake Study Via Magnetic Relaxometry

Beoline Uwampamo, Department of Chemistry; Minseon (Stella) Ju, Department of Chemistry; Monica Navarreto-Lugo, Department of Chemistry; Anna Cristina S. Samia, Department of Chemistry

Iron oxide nanoparticles (IONPs) are widely investigated due to their tunable magnetic properties and promising applications in environmental monitoring and biomedicine. In this study, IONPs of varying sizes were synthesized through a thermal decomposition method for the purpose of evaluating its uptake and detection in the Lepidium Sativum plant. An EDTA-based ligand was used as a surface coating to render it hydrophilic for the uptake of the plant. The modified hydrophilic IONPs were characterized using transmission electron microscopy to analyze the shape and size distribution of the synthesized nanoparticles. The stability and magnetic performance of the surface modified IONPs were compared via magnetic relaxometry after their uptake in the Lepidium Sativum plant.

Project Mentor: Dr. Anna Cristina S. Samia, Department of Chemistry

Designing a Cost-Efficient Plastic and Paper Separation System for a Small-Scale Industrial Setting

Elizabeth Spila, Michaela Valenta, and Zachary Zimmerman, Department of Chemical Engineering; Dr. Daniel Lacks, Department of Chemical Engineering

Paper and plastic are two of the most widely used and least recycled materials. Together they contribute over 50 million tons of waste added to landfills every year. Many small industrial companies struggle with disposal of mixed paper fiber and plastic scrap waste; most pay expensive third-party services to handle their waste. This research is aimed at creating a paper and plastic separation process with a capital cost under $200,000, as it would be both more environmentally friendly and economically beneficial for many small-scale industrial companies. To that end, the research group is working in conjunction with a local company, Grafix Plastics, who is currently struggling with disposal of mixed paper-plastic waste. Grafix provided a representative sample of their mixed waste so that a viable separation scheme could be designed. The densities of each species in the waste sample were measured experimentally. Next, separation between high density species and low density species was attempted using air separation. To test this method, the team assembled a rudimentary wind tunnel. The behavior of the mixed scrap in the tunnel was observed under several conditions, and results were recorded to determine optimal design. Liquid separation was proposed to separate the paper and plastic in both the high density and low density groups. In the low density species group, paper materials absorbed water and sank, while the plastic floated. In the high density species group, the compressed paper fiber was too dense to absorb water, but not dense enough to sink, and so it floated while the rest of the plastic products sank. After experimental trials featuring several separation methods, it was determined that this two-step air and water separation process was able to successfully separate paper and plastic mixed waste. The hope is that, by refining a prototype of this separation process, the team will design an economically favorable way for small-scale industrial companies to increase the amount of paper and plastic they recycle.

Faculty Sponsor and Project Mentor: Dr. Daniel Lacks, Department of Chemical Engineering
Remote Sensing for Accelerator Applications

**Paula Van Rooy**, Electrical Engineering Major, Department of Electrical Engineering and Computer Science

The particle accelerator at the Los Alamos Neutron Science Center at Los Alamos National Laboratory supports civilian science research and national security research. This purpose of this project is to be able to remotely monitor accelerator component movement in the accelerator tunnel. This is especially useful because the tunnel is a high radiation area with limited personnel access to make mechanical measurements. Ultra-wideband radar provides a practical solution to long-term sensing in high-radiation environments associated with accelerator environments. The radar modules are small and easily portable, allowing for easy placement and arrangement. Three dimensional array geometries are used with sophisticated signal processing to provide resolution enhancement and multi-axis measurements with high precision.

*Project Mentors: Mark Prokop, Los Alamos National Laboratory, Professor David Kazdan, Department of Electrical Engineering and Computer Science*

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Purification and Neutralization of Two Industrial Waste Streams at General Electric Lighting

**Ryan Rice**, Department of Chemical and Biomolecular Engineering; **Kirsten Springer**, Department of Chemical and Biomolecular Engineering; **Richard Surdy**, Department of Chemical and Biomolecular Engineering; **Meghna Vij**, Department of Chemical and Biomolecular Engineering

The production of various GE Lighting phosphor products produce intermittent Hydrofluoric Acid waste, which are disposed of through a batch neutralization and dilution process. This process adjusts the pH of the stream to be permissible by the wastewater treatment facility that handles the output. The neutralization process was originally operated batch-wise, and the total waste capacity that the system can handle is projected to be at its limit in two years. As a result of this, General Electric is looking at methods to convert the existing equipment to perform continuously and dramatically improve the quantity of waste that can be treated. The addition of static mixers, valves, and other industrial process controls increases the theoretical maximum capacity by a factor of over 1300% due to the reduction of the transport limited reaction at an estimated cost of $25,000. Upon performing a safety analysis of the process, we also included a material feedback loop to provide extra protection against distributing waste that does not meet specification. This project contained community significance as the General Electric Lighting facility is located in a low income residential area. Any leaks or out of specification waste release to the environment would be detrimental to the surrounding area and has the potential to cause millions of dollars of damages along with potential loss of life. Additionally, the purification of an acetone waste stream was analyzed with intent to reach a purity of 99.9% acetone using Aspen. This purification enables GE to recycle acetone into their process and eliminates hazardous waste disposal costs while bypassing costly EPA fines for waste disposal. This project also carries a similar community significance as acetone is extremely damaging to the biological system.

*Project Mentor: Brett Beaugureau, GE Lighting; Uziel Landau, Department of Chemical and Biomolecular Engineering; Daniel Lacks, Department of Chemical and Biomolecular Engineering*
Investigating the Durability and Reliability of PERC Solar Cells with Microwave Induced Photoconductive Decay

Trey Wager, Department of Physics; Jennifer Braid, Department of Materials Science and Engineering; and Roger French, Department of Materials Science and Engineering.

Passive Emitter and Rear Contact (PERC) solar cells are a new type of photovoltaic cell first produced in 2012. They have demonstrated significantly higher efficiency than other similar silicon cells and could be a significant advancement in solar energy. While PERC cells are becoming increasingly popular, the durability and reliability of PERC cells have not been well established. The main objective of this project is to investigate the durability of the new PERC cells specifically in comparison to the similar aluminum back surface field (Al-BSF) cells using microwave induced photoconductive decay (μ-PCD). The passive dielectric layer introduced in the new PERC cells means that the recombination rate of the minority carriers will be determined by the bulk. When the minority carrier lifetimes are determined primarily by the bulk, the cell becomes more susceptible to light induced degradation (LID) specifically related to boron-oxygen defects. In this project, we will employ a stepwise procedure to expose both PERC and the more standard Al-BSF cells to accelerated weather conditions to simulate extended periods of degradation. Between each exposure, several parameters describing the degradation of the PERC and Al-BSF cells will be recorded and compared.

Project Mentor: Jennifer Braid, Department of Materials Science and Engineering
Faculty Sponsor: Professor Rolfe Petschek, Department of Physics

MedLok Fitting Design and Tool Head System

Danny Reifman, Department of Mechanical and Aerospace Engineering, Maren Waldner, Department of Mechanical and Aerospace Engineering

This project focuses on the MedLok fitting designed for use on gas lines in medical facilities. MedLok is an axially swaged fitting that can be installed as a cutoff or new installation for medical gas lines. The current production design of the MedLok fitting has a collar that is made of 440C, an expensive stainless steel that has issues with corrosion. The on site installation of the fitting also requires a tool head to perform the axial swaging action. This tool head is bulky, heavy, has issues interfacing with the tool gun used and also produces quality issues in the final swaged state of the fitting. Using CES Edupak, better material options for the collar of the fitting are researched that are more cost effective and have better corrosion resistance than the 440C without compromising the strength. FEA analysis is performed on the MedLok fitting using Ansys software to determine the viability of the researched collar material replacement options. Conceptual designs for the tool head are conceived for the purpose of redesigning the tool head that is used during installation to make it smaller and less bulky to better accommodate space constraints faced at medical sites the MedLok fitting is installed at. The tool is also redesigned with the intent of having the same axial swaging action performed but with better functionality to reduce fit and quality issues with the collet and collar finished installation. The FEA analysis also helps with this tool head redesign. The overall results of this will have the intent of accomplishing a better design for the fitting and tool head in order to decrease cost and improve functionality.

Project Mentor: Dr. Sunniva Collins, Department of Mechanical and Aerospace Engineering; Jesse Henning, Tylok
Faculty Sponsor: Dr. Robert Gao, Department of Mechanical and Aerospace Engineering

Intersections: SOURCE Symposium and Poster Session 127
Cytogenetic Nomenclature Translation Software

Janet Wang, Systems Biology; Thomas LaFramboise, Department of Genetics

Cytogenetic nomenclature is used to describe the results of karyotyping. Karyotyping is the analysis of chromosomes suspended in metaphase and stained using various banding techniques. Information on chromosome mutations present in a sample can be derived from karyotypes. Karyotyping typically uses band numbers on a chromosome to identify locations. More recently, methods have emerged to process genomic data using DNA sequencing. DNA sequencing uses a nucleotide base numbering system instead of band number. Sequencing uses genomic coordinates (chromosome, base number) to describe genetic material. The goal of my software is to convert annotation of loss and gain of chromosome material from cytogenetic nomenclature to genomic coordinates. Cytogenetic nomenclature has a variety of naming procedures including writing a long form and short form that causes the translation process to be complex. The guidelines for naming in cytogenetic nomenclature were determined from the International Society for Human Cytogenetic Nomenclature manual (ISCN 2016). Cytogenetic data from blood cancers were used to test the program. The program is written in R and is written to be an R package. The algorithm successfully processes autosomal mutations in roughly diploid cells.

**Project Mentor: Thomas LaFramboise, Department of Genetics**
**Faculty Sponsor: Christopher Cullis, Department of Biology**

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Quick Annotator

Aaron Cutright, EECS Department; Justin Lee, EECS Department; Ian Waldschmidt, EECS Department; Andrew Janowczyk, CCIPD; Yu Zhou, CCIPD; Anant Madabhushi, CCIPD

Recently there have been significant advancements made in the field of deep learning (DL), a type of machine learning that attempts to discover feature spaces and weights which maximize classifier performance on user-specified tasks. DL has already shown significant promise in the context of digital pathology (i.e., digitizing histology slides to produce high resolution images) as evidenced by a growing number of publications for histologic primitive segmentation (e.g., nuclei, tubules, etc.), disease detection, and prognosis prediction. One barrier in the application of DL to these types of tasks is the large amount of annotated data required for training DL models. Since DL is an unsupervised machine learning approach, the annotated training data represents the entirety of the domain knowledge available for inference generation on that particular task (e.g., detecting diseased tissue). In the case of digital pathology images, obtaining a sufficient quantity of primitive annotations (in this case represented by masks corresponding to the spatial location of the primitives) is often infeasible given that only a limited number of experts are qualified to assess the slide. This resource sparsity creates the demand for an annotation tool which prioritizes regions of the image for annotation which will most greatly improve the performance of the classifier so as to efficiently collect the expert’s knowledge. To address this need, the Center for Computational Imaging and Personalized Diagnostics (CCIPD) has been developing a deep learning-based annotation tool termed Quick Annotator (QA). In particular, by using the active learning paradigm, QA is able to indicate to the user which locations in the image will provide the most improvement to the classifier’s performance. By using this approach, areas of the image of low information value are avoided, strategically focusing the expert’s efforts on the most challenging areas. QA is thus positioned to facilitate the creation of large datasets for downstream DL applications. The undergraduate involvement in QA’s development consists of creating an intuitive frontend web interface that collects the user’s annotations, suggests regions of high information content to annotate, and displays the underlying classifier’s predictions.

**Project Mentor: Dr. Andrew Janowczyk, Center for Computational Imaging and Personalized Diagnostics**
**Faculty Sponsor: Professor Gregory Lee, Department of Electrical Engineering and Computer Science**

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Stiffness and Fatigue Testing for TWISTER: Toward Customizable Semi-Soft Robotic Mechanisms

Yanzhou Wang, Department of Mechanical and Aerospace Engineering; Chuanqi Zheng, Department of Mechanical and Aerospace Engineering

TWISTER is a unique origami-inspired mechanism that can generate linear contraction/extension, bending, and twisting. In the past, several versions of TWISTER were developed and used in robotic applications, such as a deformable wheel, a crawling robot, and a robotic arm. However, the functionality of this mechanism is highly dependent on the geometric configuration, design method, as well as material selection. As a step towards evaluating the different design options and materials, two different CAD models of TWISTER (i.e., Model-I and Model-II) were 3D printed using two different sets of soft and hard materials, resulting in four TWISTER samples to reflect different choices of design and material. Each sample’s stiffness and fatigue properties were tested using an Instron servo-hydraulic testing machine. The new design—Model-II—outperformed Model-I in overall stiffness, and the Agilus30 outlasted the previously used material, TangoPlus, in fatigue testing. A new robotic gripper is being developed using the best combination of the design and material, which is Model-II with Agilus30.

Project Mentor: Prof. Kiju Lee, Department of Mechanical and Aerospace Engineering

Personal Electric Vehicle for Short Range Commuting

Peter-Michael Webb, Department of Mechanical/Aerospace Engineering

Short-range commuting is a necessary part of life for most college students; in highly urban environments, the automobile can actually be a burden for primarily short-range commuters. This project is concerned with the design and build of a personal electric vehicle for short range commuting; the vehicle is built on the platform of a longboard. Preliminary research included an industry survey to define performance metrics and an ergonomic study of an existing longboard platform. Prototypes of the new drive system were built and tested to optimize power delivery. A full prototype of the new system was constructed for the purpose of additional ergonomic analysis and possible modifications. Electronic enclosures will be designed, tested, and validated.

Project Mentor: Professor Richard Bachmann, Department of Mechanical/Aerospace Engineering
Project Sponsor: Professor Robert X. Gao, Department Chair of Mechanical/Aerospace Engineering

Mobile Electroencephalography Device for epilepsy detection

Jonghyun Won, Department of Biomedical Engineering, Department of Electrical Engineering

Epilepsy is a neurological disorder whereby brief abnormal excessive or synchronous neuronal activity can result in seizures. Seizures can vary from uncontrolled jerking movement (tonic-clonic seizure) to momentary loss of awareness (absence seizure). Electroencephalography (EEG) is the method of choice to monitor brain activity during seizures but requires multiple channels and is not easily artifacts during sleep. The goal of this project is to build a simple and light electroencephalography device for home usage for detecting seizures. A channel electroencephalography device that can be worn at night was built and his currently being tested for its ability to record EEG with minimal artifacts.

Project Mentor: Dr. Dominique Durand, Department of Biomedical Engineering, Neuroscience and Electrical Engineering
A Wave Test Bed for Simulating Forces Experienced by a Crab-Like Robot in Surf Zone Conditions

Noah Napiewocki, Department of Mechanical and Aerospace Engineering; Justin Wong, Department of Mechanical and Aerospace Engineering

Ideas to create crab-like robots to explore surf zones have an advantage of mitigating overturning due to waves by gripping the ocean floor. Important features, such as size, and buoyancy are desired to optimize the movements of crab-like robots. By creating a wave system based on a theme park wave pool, a generation of one large wave by releasing specific volumes of water into the system is controlled. Different water depths for testing have been taken into account by creating multiple sized curves. After the completion of the test bed, basic experiments will be performed on neutrally buoyant objects to determine the approximate distances that can be achieved for different sizes of waves. Data obtained from these experiments will help to determine the general size and weight expectation for the current crab-like robot design.

Project Mentor: Professor Kathryn Daltorio, Department of Mechanical and Aerospace Engineering

The Impact of Patient Attitudes and Practitioner Bias on Client Quality of Life in Hospice and Palliative Care

Khannah K. Wetmore, Department of Psychology

Hospice, palliative care, and end-of-life care are becoming increasingly popular choices for terminally ill older adults in the United States and other developed nations. This study will be a critical literature review of 30 studies that aims to determine how the use of hospice services impacts a patient's quality of life, as well as how palliative care health practitioners influence QOL in their patients. Qualitative and quantitative studies, case studies, and meta-analyses will be used as references within the literature review. This is a senior capstone. The project is ongoing and will be completed by the date of Research ShowCASE.

Project Mentor: Aloen Townsend, Jack, Joseph, and Morton Mandel School of Applied Social Sciences

Repair of the Intestinal Barrier by Indole-3-Propionic Acid

Manrong Wu, Department of Biology, Case Western Reserve University

Intestinal microbial metabolites have been proposed to modulate intestinal barrier function through a variety of poorly characterized mechanisms. We show that indole-3-propionic acid, a L-tryptophan derived microbial metabolite, restores the integrity of the intestinal epithelium by increasing transepithelial resistance in a model human cell culture epithelial monolayer. Xenobiotic receptor, pregnane X receptor (PXR) has been proposed as a potential target for this ligand due to its structural promiscuity. Many human colonic cell lines were tested for the expression of PXR protein, but none were identified. Therefore, the human epithelial cell, Caco-2, which forms reproducible monolayers, was stably transfected with a hPXR expression vector, constructed using Gibson assembly. Experiments are underway to determine the mechanism behind the restoration of the intestinal epithelial barrier by indole-3-propionic acid via the PXR receptor.

Project Mentor: Dr. Alan Levine, Department of Molecular Biology & Microbiology
Faculty Sponsor: Dr. Emmitt R. Jolly, Department of Biology
Collaborators: Caroline Tabler, Dr. John Tilton, Department of Nutrition
Two-Phase Flow Boiling in a Nuclear Thermal Propulsion Feed System

Nathaniel Wong, Department of Mechanical and Aerospace Engineering

NASA's current mission to Mars requires a method of propulsion that is powerful, feasible, and practical. Nuclear Thermal Propulsion (NTP) offers several key advantages over electric and chemical propulsion, being more time efficient than electric and more powerful than chemical. NTP works by using a nuclear reactor to heat a working fluid, usually hydrogen. This superheated gas is then expanded through a rocket nozzle to create thrust. NASA programs regarding this technology date back to the 1960's. During that time, the Nuclear Engine for Rocket Vehicle Application (NERVA) program developed enabling technologies that would allow a manned mission to Mars within reliability, safety, and trip length requirements. Further successful tests were conducted until loss of public support ended the program in 1972. Despite this cancellation, work has recently resumed on the development of this effective and efficient method of propulsion with the United States’ renewed interest in a Mars mission.

This poster will present current research being conducted at the NASA Glenn Research Center on the NTP system. Particularly, we are currently involved in designing an effective feed system from the liquid hydrogen (LH₂) storage tank to the nuclear reactor. The most critical aspect of this design is enabling the LH₂ to change phase to a gas along the length of the feed system. Heat transfer correlations regarding the liquid and gaseous phases are well-understood, but the existing correlations for heat transfer to hydrogen in its two-phase state have been shown to be prone to error. Our current research has shown a dependence of the heat transfer coefficient on properties such as mass flow rate and pressure as well as constants such as the Prandtl, Weber, and boiling numbers. Analyses of these correlations and data will help researchers and designers understand and define parameters for heat transfer to two-phase hydrogen to ensure the proper operation of this propulsion device.

*Project Mentor: Dr. Jason Hartwig, Department of Mechanical and Aerospace Engineering*

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Density and PH Control of Catalytic Coating

Adam Kolnik, Department of Chemical Engineering; Jonathan Krauss, Department of Chemical Engineering; Nathan Steinmetz, Department of Chemical Engineering; and Yao Xiao, Department of Chemical Engineering

Johnson Matthey works with catalyst production which are applied in fuel cell and methane reforming production. During the mixing procedure, dehydration and alkalization usually occur simultaneously. To ensure the quality of catalyst, the density and pH of the catalytic suspension will be controlled. A pH sensor is commonly applied; however, currently no efficient density sensor is available. Due to the lack of a density meter, we plan to design a density control system using light transmission across the catalytic suspension.

Our prototype will be composed of an impeller with a recirculation piping system. A black box containing a light sensor and LED array which measures the light intensity of catalytic suspension will be embedded in line with the recirculation pipes. The device will transfer signals of light into density while a PID controller will automatically control the water input to change the density of the catalytic suspension. Meanwhile, a pH sensor will be positioned on the side of the tank to measure the pH, while also transmitting the pH signals to another PID controller to control acid input. Should any of the measured parameters fall below the set points, both controllers will respond rapidly by adding water or acid and display notifications.

*Project Mentor: Dr. Daniel Lacks, Department of Chemical Engineering*
**Evaluation of a Novel Platform for CRISPR/Cas9 Mediated Gene Therapy**

**Rui Xin**, Department of Biomedical Engineering, Dr. Zhanhu Sun, Department of Biomedical Engineering, and Dr. Da Sun, Department of Biomedical Engineering

Gene therapy is a promising technique for correcting defective genes responsible for disease development. The CRISPR/Cas system, originated from a defense mechanism of bacteria, is an RNA-guided nuclease system for targeted introduction of double-stranded DNA breaks that are repaired by the cell’s own repair pathways, which provides a powerful tool for gene therapy. Since nucleic acids, especially RNA molecules, are not stable, carriers are desired for nucleic acids therapeutics.

Viral vectors were studied for a long time as carriers for gene therapy. They are usually stable systems with high transfection efficiency. However, using viral vectors raises several concerns, and the major one would be cytotoxicity. In addition, viral vectors usually have high production cost and limited cargo capacity. As result, non-viral vectors were developed to overcome these barriers.

Non-viral vectors have relatively low immunogenicity, and they provide unlimited cargo capacity at relatively low cost at the trade-off of relatively low transfection efficiency. Cationic lipid carriers fall into this category. Since they are positively charged, they have the advantage in forming particles with negatively charged nucleic acids and can facilitate cellular uptake when approaching the negatively charged cell surface. At the same time, the cytotoxicity due to the positive charges also needs to be considered and evaluated.

We hereby present the design of ECO, a multifunctional cationic lipid developed by our lab, and its modifications and evaluate the *in vitro* cytotoxicity and transfection efficiency of using these carriers to perform the CRISPR/Cas9 mediated GFP sequence knockdown from NIH 3T3 cells. Our hypothesis is by integrating a protonatable amino head group, polymerizable thiols, and hydrophobic tails, our carriers should be able to form stable particles with pCas9 protein and pgRNA, facilitate the cellular uptake, pH-sensitive amphiphilic endosomal escape, and reductive cytosolic delivery, and thus provide high transfection efficiency at low cytotoxicity.

*Project Mentor: Professor Zheng-Rong Lu, Department of Biomedical Engineering*

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**A Single-Use, Biosensor for the Detection of Alpha-Methylacyl-CoA Racemase (AMACR), A biomarker of Prostate Cancer**

**Jiwei Yao; Yuan Wang; Yifan Dai,** Department of Chemical and Biomolecular Engineering

Alpha-methylacyl-CoA racemase (AMACR), a metabolic enzyme, which has been proven to be a highly expressed biomarker in prostate cancer cell. This research project demonstrates that a single-use, cost effective micro-fabricated biosensor can detect alpha-methylacyl-CoA racemase (AMACR) in phosphate buffer saline (PBS) and undiluted human serum with very good sensitivity and selectivity. The effect on a redox couple reaction, $K_3\text{Fe(CN)}_6$ and $K_4\text{Fe(CN)}_6$ by the interaction between the AMACR antibody and antigen (the biomarker) was the bio-transduction mechanism used of this biosensor. The micro-fabricated biosensor was a three-electrode configuration: working, counter and reference electrodes. Chemical cross linking between the anti-AMACR antibody and the thin gold film working and counter electrode was accomplished using a thiol group bonding. Differential pulse voltammetry (DPV) electrochemical technique served as the transduction mechanism in this biosensor development. The lower limit of detection was 0.05 µg/ml in PBS solution and 0.5 µg/ml in undiluted human serum.

*Project Mentor: Professor Chung Chiun Liu, Department of Chemical and Biomolecular Engineering*

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The Cost of Primate Culture: Social Creatures have a Greater Risk of Infectious Diseases

Samantha Xu, Department of Biology; Dr. Jean Burns, Department of Biology; Jennifer Murphy, Department of Biology

A great amount of our understanding of the evolution of human culture stems from the observation of primate behavior. While behaviors such as innovation, extractive foraging, and social learning are mostly beneficial to the survival and advancement of primates, there are also costs: toxic substances in food, predation, injury, competition, and more. However, another potential cost of these behaviors that has not been widely studied involves the trade-off between social behavior and risk of infectious diseases of a parasitic nature. This study investigates the relationship between social and exploratory behaviors in primates and parasite variation within primate species. We test the hypothesis that greater social learning and exploratory behaviors are associated with increased risk of parasitic infections. We also hypothesize that the parasites of an infected primate species with a greater geographical range tend to exhibit greater phylogenetic diversity. Predictor variables include social learning and exploration behavior measured in richness and average geographical range of primate species for the latter hypothesis. Response variables include close and nonclose transmission (social and environmental transmissions) of parasite species richness and diversity of parasites, respectively. A Phylogenetic Generalized Least Squares (PGLS) test is used to identify the relationship between behavioral richness (BR) and parasite species richness (PSR) in primates using packages ape and phytools in program R, which demonstrated a positive correlation between PSR and BR. A Phylogenetic Diversity test is conducted to identify how parasite species richness correlates with the geographical range of primates. A phylogenetic signal test is conducted using the phytools package to identify any bias in behavioral richness between closely related primate species and also in primate habitat range between closely related parasite species. Overall, the data supports the hypothesis that social learning and foraging behaviors are associated with costs of increased parasitic infections, but exploration and social learning are independently related with their respective transmission modes. This study allows us to further understand how behavior is influenced in primates and opened doors to further exploring how social interaction affects our susceptibility to disease.

Project Mentor: Dr. Jean Burns, Department of Biology

Investigating the Financial Return Provided by the Taxpayer Subsidized Construction of Professional Sports Stadiums

Zachariah Zinserling, Department of Economics, Department of Physics

Many cities compete fiercely for the right to host a new sports team, building stadiums and providing copious tax breaks. Those same teams are liable to leave as soon as the stadium is a decade or two old, unless the city renovates or builds another multi-million-dollar stadium. Originally, back in the mid 1900s, stadiums were multipurpose. They would host football, baseball, soccer, concerts, municipal events, festivals, etc. These multi-purpose stadiums provided large amounts of positive externalities, and it made sense for the government to sponsor them. No single user would have been able to fund a multi-purpose stadium. Now, many stadiums are constructed for just one purpose and are sparsely used, at the lowest end being 7-10 football games a year. Recently, individuals and organizations have called into question the financial benefits provided by these sports stadiums, and whether cities and taxpayers are better off subsidizing them. In this paper, we investigate the financial return provided by subsidizing professional sports stadiums, along with how deals may be restructured to provide a greater financial return to the taxpayers.

Project Mentor & Faculty Sponsor: Professor William Mahnic, Department of Banking and Finance
Dynamics of a Feeding Pattern-Generating Circuit in the Marine Mollusk *Aplysia californica*

**Jingyi Yang,** Department of Biology; **Yu Huan,** Department of Biology; **Nathan X. Kodama,** Department of Electrical Engineering and Computer Science; **Dr. Roberto F. Galán,** Department of Electrical Engineering and Computer Science; **Dr. Hillel Chiel,** Department of Biology

Because of its large, identified neurons, the buccal ganglion of *Aplysia californica* is a model system for understanding the neural basis of feeding behavior, which provides insights into motivated behavior and multi-functionality. The majority of previous studies have focused on recordings from single neurons, or small groups of neurons. For instance, in previous work, our laboratory was able to monitor the activity of multiple key neurons in the neural circuit that controls feeding behaviors via extracellular nerve recordings *in vivo* (Cullins and Chiel, 2010). However, many interesting aspects of neural dynamics can only be understood by looking at large populations of neurons and their relationships to each other. To this end, we are now combining nerve recordings with recordings of neuron somata in the neural circuit using a two-dimensional, high-density (100 um pitch) microelectrode array (MEA, 120 electrodes). Our preliminary data suggests this approach will provide deeper insights into a pattern-generating circuit. In this project, We are recording from peripheral buccal nerves 2, 3 and radular nerve and I2 muscle simultaneously while recording the activities of neurons within the ganglion on the array. First, we are going to initiate the rejection pattern by stimulating the BN2a with current pulses and look for one-to-one relationship between the array and the nerve recording. Because the key interneuron B4/B5 project the biggest units on the buccal nerve 3, we can determine where the B4/B5 locates within the ganglion on the array. Then, we will bath the buccal ganglion with different pharmacological solutions and see how B4/B5 behaves differently within the neural network in each condition.

*Project Mentor: Dr. Roberto F. Galán, Department of Electrical Engineering and Computer Science*
*Faculty Sponsor: Dr. Hillel Chiel, Department of Biology*

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**Musicians for Hearing Health: Exploring Sound Exposure in the CWRU Music Department**

**Madeline Yankell,** Department of Music; **Ann Holmes,** Department of Psychological Sciences; **Ryan V. Scherber,** Department of Music

Crashing cymbals, blaring trumpets, and the roar of the timpani: these sounds, while musical, can come at a cost to the individuals making music. This project was designed to understand the noise levels experienced by music students at Case Western Reserve University. Students recruited from symphonic winds, jazz ensemble, and orchestra were asked to wear a personal noise dosimeter that measured their sound exposure over the course of a day. Students wore the dosimeter two times, once on a day of ensemble rehearsal and once on a day without rehearsal to serve as a baseline. The dosimeter records sound exposure levels as expressed in a percentage of allowable dosage set out by the Occupational Safety and Health Administration (OSHA). In addition to the dosimeter data, we collected interview data regarding the hearing protection practices and attitudes held by students and faculty in the music department. We sought to understand how important hearing protection is to individuals participating in musical activities and whether they are aware of potential risks due to sound exposure. We hypothesized that the sound levels experienced by students would not be above the daily allowable dosage of sound; however, sound exposure is cumulative and therefore the risk of noise-related hearing damage is compounded with all other noisy activities throughout the day. We hope that our project will, at a minimum, spark conversations in the music department about potential changes in facilities or personal hearing protection practices that may affect the long-term health of individuals’ hearing.

*Project Mentor: Dr. Ryan V. Scherber, Department of Music*
Dietary fructose increases oxidative stress in renal proximal tubules via angiotensin II

Nianxin Yang, Department of Biology

Fructose consumption has dramatically increased in the past 30 years due to the use of high-fructose corn syrup as a sweetener. Chronic consumption of fructose has been found to have many detrimental effects on the human body, including obesity, renal failure, and hypertension. A fructose enriched diet modifies metabolic parameters such as insulin sensitivity, uric acid production, and angiotensin II (Ang II) sensitivity. The last one may be related to the development of both renal injury and hypertension. Angiotensin II is an important regulator of renal proximal tubules (PTs) cells and through protein kinase C promotes production of reactive oxygen species (ROS). Enhanced ROS production leads to increased oxidative stress in the kidney. There are two pathways through which the ROS hydrogen peroxide is degraded, one through glutathione (GSH) peroxide pathway, and the other one through catalase pathway. In this project, I hypothesized that fructose-enriched diet impairs pathways through which ROS are degraded in PTs. I tested the effect of a low concentration of Ang II (10^{-9} mol/L) on total GSH and reduced GSH level and catalase activities in PTs from rats consuming normal (Control) chow and 20%-fructose (FRUC) chow. Without Ang II treatment, the total GSH level in Control group was 37.4 ± 2.5 nmol/mg PTs, and that in FRUC group was 33.7 ± 2.1 nmol/mg PTs (p > 0.05); the reduced GSH level in Control group was 23.5 ± 2.2 nmol/mg PTs, and the reduced GSH level in FRUC group was 22.2 ± 1.5 nmol/mg PTs (p > 0.05). With Ang II treatment, the total GSH level in Control group was 36.9 ± 2.3 nmol/mg PTs, and that in FRUC group was 30.2 ± 2.1 nmol/mg PTs; the reduced GSH level in Control group was 25.2 ± 2.1 nmol/mg PTs, and the reduced GSH level in FRUC group was 19.9 ± 1.8 nmol/mg PTs (p > 0.05). Also, the catalase activities in Control group was 13.5 ± 1.6 catalytic units/ug PTs, and that in FRUC group was 12.6 ± 1.5 catalytic units/ug PTs (p > 0.05). I concluded that dietary fructose diminished GSH pool in PTs through low concentrations of Ang II, and no effect of dietary fructose on catalase activities in PTs was found.

Project Mentor: Ulrich Hopfer. Department of Physiology and Biophysics
Faculty Sponsor: Susan Burden-Gulley, Department of Biology

Bringing Cognitive Approaches to Film Editing to Classroom Design

Preetham Yarlagadda, Department of Cognitive Science

While the extremely engaging nature of film and video to children has led to a lot of research worrying about the effect of screen time on childhood cognitive development, there’s also a lot of effort put into developing educational videos which take advantage of highly engaging images. The multimedia principle is the idea that deeper learning can occur when images and words are paired together instead of just words as this integrates one’s verbal and visuospatial thinking in their working memory. While it is clear that visual images are an effective tool for an educator, the applications of visual media have been underutilized in contemporary education curriculum and there are lessons that can be learned from other mediums such as film. Despite essentially being hundreds of thousands of individual frames, editing techniques allow filmmakers to develop a coherent narrative and effectively present information to the viewer. This poster will be a comprehensive literature review in cognitive psychology and film studies regarding the intersection of emotional involvement for viewers and editing techniques that emphasize spatial continuity. In particular, the cognitive principles behind techniques that emphasize both continuous and discontinuous editing, such as eye-line match cuts and hard cuts, will be explored. Finally, a sample lesson plan in an elementary science class will also be provided integrating these cognitive, filmic principles with pedagogical goals.

Faculty Advisor: Vera Tobin, Department of Cognitive Science
Flight Initiation Distance of Urban Birds in Response to Aerial versus Terrestrial Threats

Catherine Lange, Department of Biology; Kathryn Ryan, Department of Biology; Julia Westermann, Department of Biology; Ashley Yoon, Department of Biology

Flight initiation distance (FID) is defined as the distance at which a bird will begin to move away from an approaching threat. FID has been extensively studied for both applied and theoretical reasons, but mostly measured in the parameters of a human disturbance on the ground or by watercraft. Now, with the recent affordability and availability of remote-control drones, we are able to simulate bird’s FID in response to aerial predators. As a result, we can now explore the effects of aerial disturbances on birds and their ensuing escape behavior. This project aimed to compare urban sparrow (Passer domesticus) behavior when approached by a “terrestrial predator”, a human, and an “aerial predator,” a drone. FID was recorded, providing a baseline for differences in behavior, and video taken from each trial is being analyzed using WinAnalyze to determine how the sparrow groups disperse in response to each type of predator. We hypothesize that there will be a difference in FID and group dispersal patterns for threats coming from the air versus the ground. Threats can come from both places, but in nature, an aerial predator would call for a different type of response since a flying predator could maintain a chase after the bird takes off from the ground.

Project Mentor: Dr. Roy Ritzmann, Department of Biology

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Controlling for Surgical Variability in Intracortical Microelectrode Design Research

Noel Jeansonne, Department of Biomedical Engineering; Marina Yu, Department of Biomedical Engineering; Jen Paiz, Department of Biology; Dr. Andrew Shoffstall, Department of Biomedical Engineering

Neural microelectrodes have played a central role in brain-computer interfacing (BCI) technology by successfully reading and transmitting signals from the brain.Implanting these electrodes in the brain causes acute trauma to the blood brain barrier (BBB). Damage to the BBB can be measured using correlations in behavior and IgG as a histological marker. Early IgG staining matches well with rat behavioral tests in ladder crossings. For this reason, behavior testing can be used as a surrogate to measure the initial trauma to the BBB. This model can be used to better measure the chronic inflammatory responses of different implant materials, such as those developed by the Capadona lab to increase the longevity of implanted brain electrodes. In the long run, the foreign body response is believed to be the main component in the inflammatory response of the specific implanted material. Typically, clinical implants are expected to last 5-10 years, while our research is currently limited to 16 weeks due to constraints. The majority of the magnitude of the response is linked or amplified by the extent of the initial trauma. The chronic effects of an implant may be confounded by the acute trauma, increasing the variability of the histological results. The aforementioned variability means that large numbers of rat trials are required to achieve statistical significance, which is not feasible. This means that there is a need for a way of separating the acute and chronic effects and to develop better electrodes and techniques that reduce trauma caused by insertion. While the lab develops better insertion methods to battle the initial effects of trauma, we hypothesize that we may be able to use a ladder behavior test to decouple these effects for initial trauma from that of the overall inflammatory response to better compare these responses.

Project Mentor: Dr. Andrew Shoffstall, Department of Biomedical Engineering
Faculty Sponsor: Professor Jeffery Capadona, Department of Biomedical Engineering

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Quantifying Cells in the Embryonic Heart using Expansion Optical Coherence Tomography

Ragul Yuvaraj, Department of Biomedical Engineering; Yehe Liu, Department of Biomedical Engineering; and Michael Jenkins, Department of Pediatrics

According to the CDC, congenital heart defects affect around 40,000 births per year in the United States and are a leading cause of birth-defect associated illness and death. Abnormal embryonic cell proliferation, differentiation, and migration may contribute to the development of these defects. As such, there is need for a method that can count cells over a large field of view in embryonic heart tissue. Current imaging methods with sufficient resolution to see cells possess a limited field of view, making it very difficult to achieve cellular resolution throughout an entire embryonic organ. However, one solution may be to use optical coherence tomography (OCT) in conjunction with expansion microscopy. OCT is an emerging imaging modality that can image embryonic tissue over large field of view with micron-level resolution (~10 um). However, OCT still cannot achieve cellular resolution. To accomplish this, we use a technique known as expansion microscopy in conjunction with OCT. Expansion microscopy is a tissue processing technique used to improve effective resolution by using sodium acrylate to synthesize a swellable polymer network within the tissue. With a 10 μm resolution OCT system, expanding the samples by a factor of five increases the effective resolution to 2 μm, which is sufficient to resolve individual cells in the tubular heart. Although these methods complement each other, we will need to develop a protocol to allow them to be used together successfully. By combining OCT and expansion microscopy, we hope to provide a cell counting tool to quantify cell proliferation, migration, and differentiation patterns within cardiac tissue. Such a tool could allow for early detection of cardiac abnormalities and may one day lead to better treatment strategies in the clinic.

Project Mentor: Dr. Michael Jenkins, Department of Pediatrics

Analyzing the Internal Structure of Bulk Metallic Glasses Through X-Ray Absorption Fine-Edge Structure (XAFS) Spectroscopy

Hanyu Zhang, Engineering Physics Major, Department of Physics; Jennifer Carter, Department of Materials Science and Engineering; Harold Connamacher, Department of Electrical Engineering and Computer Science

Bulk metallic glasses are solid metallic structures with their atoms arranged in a non-crystalline random fashion. Due to their glassy structure, these materials have superior strength when compared to their crystalline counterparts, and are as shapeable and moldable as plastics. In this project, we test our current understanding of these materials by comparing computer simulated structures and their real-life counterparts. This is achieved by analyzing the accuracy of current molecular dynamics (MD) simulations to predict the amorphous structure of metallic glasses as characterized by x-ray absorption fine-edge structure (XAFS) experiments. The influence of composition and processing techniques on the final structure is being tested on bulk metallic glasses made from Ni, Co, Ta, and Nb. This project utilizes LAMMPS, a MD software, to build the structures and the Larch Python package for data analysis. We are analyzing how closely the computer-generated structure matches with its real-life counterpart through the comparison of real and simulated x-ray spectroscopy spectra.

Project Mentor: Dr. Jennifer Carter, Department of Materials Science and Engineering
Faculty Sponsor: Professor Rolfe Petschek, Department of Physics
The Safety-Check Point Queueing Model via Gillespie Algorithm

Yijia Zhang, Department of Mathematics, applied Mathematics and Statistics

The purpose of the project is to simulate the flow of the security checkpoint process and identify the bottlenecks of the system by a Gillespie algorithm.

Queueing models constitute an important topic in stochastic processes. They have lots of practical use, e.g., in helping reduce the operation costs while maintaining the efficiency of service. Previous studies on this topic include M/M/1 and M/M/c models which assume the consumers' coming rate follows a Poisson distribution and the serving rate follows an exponential distribution. However, the above models assume there is a single service process, i.e., consumers exit the system after being serviced, but in practice, many systems like the safety check point have several processes to pass. After entering the system, a passenger enters a line and waits for the document check; after this, he/she enters another line to wait for the body check while his/her belongings pass the x-ray check. To study this process, we need to extend the original M/M/c model. The main algorithm used in this paper is the Gillespie process which is frequently used to simulate chemical reactions. The two main advantages of our simulation is that any mechanisms of the safety checkpoint could be easily added in the simulation and the waiting time for each passenger could be tracked. This project has been arranged as follows: the first section will explicitly introduce how the Gillespie algorithm is applied in our simulation. The mathematics behind our simulation are essentially covered. At the same time, it compares our simulation with tradition M/M/c model and explains our motivation of this new simulation. The second part of this paper focusses on the assumptions we made and the construction of the algorithm. In this section, Pseudo is provided so that readers can better understand how our simulation is computed. The third part gives an experimental result of our simulation. One important result is that in most circumstances, the waiting time is independent from the passengers' coming rate. Also, combined with other calculations the experimental results show the validity of our simulation. The fourth part adds the TSA pre-check system in our originally simulation, and the results are discussed. This section shows how additional mechanisms could be easily added to the original system.

Project mentor: Prof. Somersalo, Erkki, department of Mathematics

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Carbon-based Additions for Improving Electrical Conductivity of Directly Written Silver Traces

Jessica Zhou, Department of Polymer Science and Engineering; Anton Salem, Department of Mechanical Engineering

This study focuses on the effect of carbon-based additives on the resistivity of silver paste. Highly conductive carbon-based additives may be able to enhance silver paste, potentially yielding resistivity values equal to or better than that of copper wire. For example, graphene's large aspect ratio and extreme geometry can facilitate its ability to form conductive networks at low filler content. Because large contents of conductive fillers are difficult to process, a low percolation threshold is highly desirable. Carbon Nanostructures, Graphene, and Carbon Black, with varying weight percentages, are added to silver paste then compared and analyzed in order to explore this effect. By attaining lower resistivity values for these slurries and utilizing additive manufacturing methods to achieve new motor designs, we may have the ability to create electric machinery with higher power densities and efficiency while eliminating the need for high labor conventional manufacturing.

Project Mentors: Michael C. Halbig, NASA Glenn Research Center; Dr. Mrityunjay Singh, Ohio Aerospace Institute
Perceptions of Others’ Reasons for Religious Beliefs: Effects of Ethnicity

Yuxuan Zhao, Department of Psychological Sciences; Nick Stauner & Julie J. Exline, Department of Psychological Sciences

Past research had studied how religious groups view non-religious groups as minorities. However, little research had studied how non-religious groups view religious groups. This study explores non-religious people’s perceptions of religious people’s reasons for having religious beliefs. Since religious groups are diverse, this study will focus on how different ethnicities in religious groups affect non-religious people’s opinions. The topic is being investigated using an online survey. Participants rate 13 reasons they think that a hypothetical person with a randomized ethnicity is religious. Ethnicities include Africans, Asians, Asian Indians, Latinos, Native Americans, and non-Hispanic whites. Participants are undergraduates from Case Western Reserve, Bowling Green State, and Florida State Universities. The survey includes measures of demographic information, including religious affiliations. Nonparametric analyses will be used. Hypotheses follow: if the target religious person is African, participants will more often attribute their religious beliefs to lacking analytical thinking; if the target religious person is Native American, participants will more often use ethnic background as an explanation; for Latino targets, participants will more often endorse reasons based on family or community background. Confirming these hypotheses would imply that people use ethnic stereotypes while inferring others’ reasons for being religious, reflecting illusory correlations with ethnicity. In addition, the study will investigate whether religious and non-religious participants view reasons for being religious differently. Hypothetically, religious participants will more often attribute others’ religious beliefs to personal experiences, including having supportive religious or spiritual experiences, strange experiences that they could not explain without religious beliefs, or stressful or traumatic experiences. Conversely, non-religious participants will more often attributes others’ religious beliefs to lack of analytical thinking. Confirming these hypotheses would imply that religious participants emphasize situational reasons for being religious, and non-religious participants emphasize intellectual deficit-based reasons, possibly reflecting positive ingroup and negative outgroup attitudes.

Project Mentor: Nick Stauner & Julie J. Exline, Department of Psychological Sciences

Phenotypic Variation in Response to a Hyperoxic Environment

Aemilee Ziganti, Department of Biology; Dr. Elizabeth G Damato, Department of Nursing; Dr. Michael J Decker, Department of Physiology

A hyperoxic environment is one that exposes inhabitants to a higher than normal partial pressure of oxygen, such as the cockpit of a U.S. Air Force or Navy aircraft. The effects of hyperoxia have yet to be determined but are believed to be the cause of Unexplained Physiologic Events (UPEs) that have been a primary focus of military research the past few decades. This research is concerned with investigating the effects of hyperoxia on cerebral blood flow, cognition with specific regard to reaction time, respiratory patterns, carbon dioxide levels, and Electroencephalogram (EEG) patterns. Individuals complete cognitive testing in the form of the Microcog, Arterial Blood Gases (ABGs), and Arterial Spin Labeling (ASL) MR Imaging while breathing room air and 100% oxygen to allow for direct comparison. All of these measures were completed under the monitoring of 64-channel high density EEG (HD-EEG) with respiratory rate monitoring throughout the MR scan. Through comparisons within and between subjects, specific phenotypes have emerged, suggesting response to hyperoxia can be categorized and perhaps predicted. This phenotyping can be applied to the military setting and utilized to reduce the incidence of UPEs and provide a basis for future research into hyperoxia and its effects.

Project Mentor: Professor Michael J Decker, Department of Physiology
Faculty Sponsor: Professor Radhika Atit
Raman Signatures of 3C-SiC and h-BN Thin Films

Vivian Zhou, Department of Electrical Engineering; Dr. Yanan Wang, Department of Electrical Engineering; Dr. Jaesung Lee, Department of Electrical Engineering

Rapid developments in quantum computing technology have incentivized the study of reliable qubits, specifically defect centers in diamond. Because diamond qubits can be initialized, manipulated, and measured at room temperature, this allows quantum computing without super cooling. There has been a roadblock so far, since high quality diamond cannot be easily produced and processing techniques are still premature. Other wide-bandgap materials as silicon carbide (SiC) and hexagonal boron nitride (h-BN), on the other hand, are available in high-quality single crystals, thus they are promising platforms to examine defect centers at room temperature. In order to appreciate the advantages of SiC and h-BN and utilize their properties for emerging quantum applications, it is desirable first to understand the molecular structures and quality of the materials. In this study, we employed Raman spectroscopy and carefully extracted useful information on SiC and h-BN such as disorder, lattice strain/stress, defects and doping concentration. We will be working specifically with one polytype, 3C-SiC, on this study to demonstrate the reliability of Raman spectroscopy as an optical method of SiC characterization. We will be also measuring Raman signals of the h-BN thin films. In addition, Raman mapping will be used to detect defects in both materials. This study will contribute some fundamental understanding to the quantum emission on both materials.

Project Mentor: Professor Philip Feng, Department of Electrical Engineering
Faculty Sponsor: Professor Gregory S. Lee, Department of Electrical Engineering

An Analysis of Sandwich Generation Caregivers’ Stressors, Health Outcomes, and Perceptions through a Sociodemographic Lens

Emily Leung, Department of Psychological Sciences; Dr. Kathryn Perry Rothenberg, Department of Psychological Sciences

Throughout recent decades, declining birth rates and longer life expectancy have resulted in a growing aging population which is cared for by their children. In addition to caring for older family members, adult children hold other responsibilities such as having professional careers and raising their own children who are living at home for longer periods of time (Riley and Bowen, 2005). This described cohort, termed “sandwich generation,” is caught between the competing demands of caring for children, assisting older relatives, working, and taking care of personal needs. This research paper examines the accumulated stress that sandwich generation caregivers (SGC) experience which often manifests into higher risks for poor physical and emotional health. The subjective well-being of this population is further examined through a sociodemographic lens (e.g., socioeconomic class), in order to reveal differences explained by contextual situations. Future recommendations for interventions and coping support are discussed at the paper’s conclusion.

Project Mentor: Dr. Kathryn Perry Rothenberg, Department of Psychological Sciences
A Portable Neonatal Hypothermia Device to Treat Neonatal Hypoxic Ischemic Encephalopathy

Keith Dona Department of Biomedical Engineering, Rebecca Haley Department of Biomedical Engineering, Vanitha Raguveer Department of Biomedical Engineering, Ashley Rein Department of Biomedical Engineering, and Mike Yang Department of Biomedical Engineering

With the high incidence rates of birth asphyxia and subsequent neonatal hypoxic ischemic encephalopathy, the need is clear for a portable, low cost hypothermia device to be developed. This project aims to design a cooling apparatus that accurately lowers the temperature of an HIE patient to the ideal treatment temperature of 33-34°C. in a cost-effective and easily transportable system that could be widely implemented with current transport protocols. This lessens cortical and nuclear injury by slowing the development of irreversible brain damage until the body is no longer in a state of asphyxia. Current Neonatal Hypothermia Systems cannot be transported, and are inaccessible for low-income or resource areas. Therefore, there is a clear need for a system which can accurately and efficiently treat the HIE patient in conjunction with current transport protocols in low-resource settings.

This design has the potential to meet these needs via Peltier cooling. The system consists of the copper plate, Peltier plates, fans, the overall crib build, and temperature monitoring system.

Faculty Sponsor: Dr. Colin Drummond, Department of Biomedical Engineering

Reflectance Based Pulse Oximeter for Use in Pediatric Care in Low Income Countries

Daniel Fabiniak Department of Biomedical Engineering, Nathan Boldt, Dennis Chan Department of Biomedical Engineering, Colin Curtis Department of Biomedical Engineering, Luke DiFrancesco Department of Biomedical Engineering

In 2015, over 900,000 child deaths (approximately 15 percent of the total pediatric deaths) worldwide were caused by pneumonia. Many of these deaths could be avoided if these cases were diagnosed properly in the early stages of the illness. An important tool in the diagnostic process for pneumonia is the pulse oximeter, which helps not only diagnose, but also determine the severity of the disease. In low-income countries, such as Uganda, the availability of pulse oximeters that can be used both repeatedly and without electricity is very low due to economic and technological barriers, such as the price of maintenance of current designs. Many of the current pulse oximeters on the market are not designed for pediatric use in low-income countries, which can result in misdiagnoses and over or under treatment. The creation of a cheap and durable pulse oximeter designed for pediatric use could greatly aid in the battle against pneumonia in low-income countries, possibly saving thousands of lives through improved diagnostics. The current technology employs transmittance based sensing, which often fails due to misalignment of the emitter and detector. Our design employs reflectance based sensing to detect oxygen in the blood, which eliminates these risks of misalignment. We have incorporated the sensor into a watch-like casing, negating the problems caused by the wide range of digit sizes in children that a traditional finger clip design may have. The product is also made of materials that can be sanitized with alcohol wipes, removing the need for more complicated cleaning methods between uses. These factors lead to a novel device that aims to make the pediatric diagnosis process of pneumonia safer, easier, and more affordable.

Project Mentors: Dr. Colin Drummond, Dr. Matthew Williams; Department of Biomedical Engineering, Case Western Reserve University

Intersections: SOURCE Symposium and Poster Session
Design of a modular hip flask with an external cellular charger

Michael LaFramboise, Department of Mechanical and Aerospace Engineering; Dr. Sunniva Collins, Department of Mechanical and Aerospace Engineering

A person bringing their own alcoholic beverages to various social gatherings, bars or parties risks their drinks being spiked, and is often required to purchase overpriced drinks. This goal of this project is to facilitate safety while drinking by introduce a hip flask with a combined cellular charger. This project will ride the rise in popularity of external cellular charging batteries to bring about an increase of hip flask usage. A custom designed, machine washable hip flask with a magnetically connected charging module is currently designed by using the SolidWorks software package. The current design has a capsule containing the charging module magnetically connected to the underside of the flask. This module will be able to charge, discharge and display a battery level. The targeted drinking volume is 3 - 5 oz, which should be comparable with other small flasks. The battery selected has a 2,200 mAh capacity and should be enough for one smartphone charge.

Project Mentor: Sunniva Collins, Department of Mechanical and Aerospace Engineering

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The influence of visual cues on the odor plume tracking behavior of Manduca sexta moths.

Kathryn Ryan, Department of Biology & Department of Evolutionary Biology; Parthasarathy Kalyanasundaram, Department of Biology; and Mark Willis, Department of Biology

Male Manduca sexta moths display a side-to-side zigzagging behavior while tracking plumes of attractive odors, such as female pheromones or the scent of night-blooming flowers, upwind. As the males approach the source, they narrow their flight path as the odor plume changes predictably with distance from the source. Optic flow, defined as the apparent motion of all objects in a visual scene as perceived relative to a moving observer, is another important source of information utilized by animals during flight. The objective of this research was to determine if and how M. sexta males use optic flow information to control their altitude and center their flight with respect to lateral obstacles while tracking odor plumes. Using a projection system, visual stimuli consisting of alternating light and dark band patterns of various widths were displayed on the walls of the wind tunnel. An odor plume was established in the wind tunnel, and the odor plume-tracking trajectory of each moth was captured using a real-time SciTrackS video system. These data were analyzed to investigate how different visual stimuli affect how straight the moths fly, their flight speed, and how centered their flight trajectories are.

Project Mentor: Professor Mark Willis, Department of Biology

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Intersections: SOURCE Symposium and Poster Session 142
HvZ Optimized Nerf-Style Blaster

Adam Doros, Department of Mechanical Engineering; Korey Otani, Department of Mechanical Engineering

The foam blaster toy market has evolved to include a significant hobby group surrounding it. Recently, several hobby grade blasters have entered the market from individual sellers focused on attaining maximum performance. These products are poorly optimized for gameplay at closer ranges where these high levels of performance could pose safety hazards. In addition, these products are often sold at a price above what the average consumer is willing to pay. This project is tasked with designing and prototyping a hobby grade blaster that better meets the needs of players of game types such as Humans versus Zombies (HvZ). It will also attempt to do so at a price point below that of its major competitors in the hobby grade blaster market. This blaster will utilize lithium-polymer powered flywheels to accelerate standard Nerf-style darts to a velocity of roughly 120 feet per second, with a revolving cylinder system to allow easy reloading and more reliable functionality. Optimally this product could go to market within the year and could serve as the basis for a shift in the hobby grade market towards leaner manufacturing practices.

Project Mentor: Dr. Robert Gao, Department of Mechanical & Aerospace Engineering
Faculty Sponsor: Roger Quinn, Department of Mechanical & Aerospace Engineering

Investigating the Pre-Synaptic & Post-Synaptic Roles of Frazzled/Netrin in Drosophila

Dallas Eckman, Department of Neuroscience; Heather Broihier, Department of Neuroscience, Kelsey Herrman, Department of Neuroscience

The ligand-receptor pair, Netrin and Frazzled (DCC, Deleted in Colorectal Cancer, in vertebrates), has demonstrated roles in axon guidance in both the central nervous system and the motor neurons of the periphery. Netrin, a secreted protein that can act as a chemotropic axon guidance cue, pairs with its receptor Frazzled in wild-type Drosophila. In the guidance of Drosophila photoreceptor axons, Frazzled has been shown to be required not in the photoreceptor neurons but instead in their targets, demonstrating that Frazzled also has a non-cell-autonomous function. The action of Frazzled at the postsynaptic side of the neuromuscular junction (NMJ) of the periphery, however, remains unexamined. In this project, we investigated the postsynaptic roles of Frazzled in synapse assembly at the Drosophila NMJ, particularly as it relates to the active zone complex structure. Utilizing the UAS-Gal4 system and immunohistochemistry, we investigated Frazzled mutants in the third instar stage of development to demonstrate non-cell-autonomous functions of the ligand-receptor pair at the NMJ, particularly as they relate to bouton quantity and active zone complex assembly.

Project Mentor: Heather Broihier, PhD., Department of Neuroscience
Serotonin (5-HT) is a neuromodulator that regulates a wide variety of physiological and behavioral functions in the central nervous system. Dysfunctional 5-HT signaling has been linked to depression, anxiety, and autism, among other disorders. *Lmx1b* is a transcription factor that regulates serotonin neuron terminal differentiation by activating a 5-HT gene battery. However, *Lmx1b* continues to be expressed after 5-HT neurons are differentiated, suggesting possible other functions later in life. We hypothesize *Lmx1b* regulates genes that control 5-HT axon growth and the development of axonal architecture. This is supported by evidence that conditional knockout (*Lmx1b*<sup> KO </sup>) mice, mice with the genotype *Lmx1b*<sup>fl/fl</sup>*fCrePet-Cre:TdTom*, show almost no 5-HT innervation in distal forebrain regions as compared to control mice. Our data suggest *Lmx1b*<sup> KO </sup> mice still have 5-HT neuron cell bodies in similar numbers to control mice, supporting the hypothesis that the loss of axons is not secondary to loss of cell bodies. Thus, we conclude that *Lmx1b* controls 5-HT neuron axonogenesis. We performed a Cre efficiency test using RFP-labeled TdTomato and GFP-labeled *Tph2* to determine how many 5-HT neurons are affected by the Cre injection. Almost all RFP-labeled cells in the *Lmx1b*<sup> KO </sup> did not show *Tph2* labeling. This reflects the true knockdown of *Lmx1b* because we know *Lmx1b* controls *Tph2*, the synthesizing enzyme of 5-HT. An alternate marker that targets 5-HT neurons is channelrhodopsin-yellow fluorescence protein (ChR2-YFP), whose expression is driven from an adeno-associated viral vector injected into the hindbrain. This marker allows us to visualize the labeled serotonin neurons and compare the presence of axons in the forebrain of the control mouse versus the *Lmx1b*<sup> KO </sup> mouse. Preliminary evidence suggests ChR2-YFP effectively labeled the axons in the control and confirmed the severe loss of axonal innervation in the *Lmx1b*<sup> KO </sup>.

*Project Mentor:* Dr. Evan Deneris, Department of Neuroscience  
*Faculty Sponsor:* Dr. Susan Burden-Gulley, Department of Biology

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**Testing Cre Efficiency, Cell Body Loss, and Channel Rhodopsin Labeling**

**Madelyn Szilagyi-Jones,** Department of Biology; **Lauren Donovan,** Department of Neuroscience; **Dr. Evan Deneris,** Department of Neuroscience
A Correlational Study: Investigating the Association Between Zinc Intake & Colorectal Cancer Risk

Jennifer Ibarra, Major: Medical Anthropology, Department of Biology; Dr. Li Li, Center for Community Health Integration; Ashutosh Sheth, Center for Community Health Integration; Dr. Robin Snyder, Department of Biology

The purpose of this study is to determine a correlation between dietary zinc intake, zinc supplementation, and colorectal adenoma incidences. This research study builds on the Iowa Women’s Health Study's findings, which correlated high dietary zinc intake with reduced colon cancer risk. However, the study does not determine the mechanism through which this protective effect takes place and used a homogenous group of postmenopausal women for its study. Given this, and the fact that adenoma incidences are associated with increased colon cancer risk, this study aims to investigate zinc's role in this relationship using a diverse population.

Through collaboration with the Department of Gastroenterology of University Hospitals and the Center of Community Health Integration at Case Western Reserve University, men and women undergoing screening colonoscopies were admitted to the study to determine their polyp status and associate it with lifestyle and behavioral factors. Each participant is between the ages of 30 and 80, was screened for (1) no history of adenomas over the past 10 years, (2) no personal or family history with Lynch Syndrome (HNPCC) or Gardner Syndrome (FAP), (3) no history of cancer (with exception to skin cancer), (4) no history of major bowel surgery or resectioning, and (5) no history of inflammatory bowel disease. Demographic and dietary information was collected using standardized interviews and questionnaires, and analyzed for statistical significance to achieve the study’s aim. By investigating the influence of gender, race, body mass index (BMI), and age, the results of this study will add corresponding evidence that further clarifies the relationship between colon adenoma risk and dietary zinc intake.

Project Mentor: Dr. Li Li, Center for Community Health Integration, CWRU SOM
Faculty Sponsor: Dr. Robin Snyder, Department of Biology, CWRU
April 20, 2018

The Celebration of Student Writing and Research showcases undergraduate student writing projects from across the university. The celebration encourages students to (re-)present and display their research and writing in formats other than conventional word-processed documents. Some students create video projects; others produce poster presentations or read aloud portions of their writing; still others design models or digital illustrations that present their writing projects in new media. The event receives assistance from the following academic centers:

The Writing Resource Center (WRC) at Case Western Reserve University provides writing consultation to students across the university in Bellflower Hall, in four other campus locations, and online. More than 40 full-time Writing Program faculty, graduate students, and undergraduate students staff the WRC. Each year, WRC consultants hold more than 5,000 individual sessions with approximately 1,500 individual students ranging from first-year writers to graduate students and faculty. The WRC also conducts a campus-wide workshop series and sponsors other writing-focused events.

The Center for the Study of Writing was established in 2008 to facilitate research and scholarship on writing at the University and in the world. It serves three distinct but interrelated roles at the University: to support writing and research by resident and visiting students and scholars; to facilitate exciting new courses and curricula on writing; and to provide an array of practical writing and publishing support services to the University and University Circle communities. For more information, see http://www.case.edu/writing/csw.
Since 2009, the Center for the Study of Writing has been sustained by generous gifts from Marilyn McCulloch (FSM ’50); from Edward S. Sadar, M.D. (ADL ’64, SOM ’68) and Melinda Melton Sadar (FSM ’66); from Sharon Schnall (MBA ’87) and Dr. R. Drew Sellers (EMBA ’08); from Eric Winter, M.D. (CWR ’98, GRS ’91, MD ’98); from Jackson McHenry (ADL ’52); Dixon Long, Ph.D. (Dean Emeritus, Western Reserve College; Professor Emeritus, Political Science, CWRU); and from an anonymous donor.

The Celebration of Student Writing and Research is additionally supported by the SAGES Program and the Department of English.

Courses and Organizations:

CWRU Writing Programs & The Writing Resource Center

Director: T. Kenny Fountain

Assistant Director: Martha Shaffer

Essays by the winners of the 2017 University Essay Prizes and the First Seminar Essay Prize are available in booklet form. Stop by the WRC table and pick one up!

Student Group: Writers Writing Words

Group Advisor: Barbara Burgess-Van Aken

Students: Anna Anders, Connor Baumler, Sanchi Kalra, Won Hee Kim, Herman Rincon, Sidney Wilson

Choose your own adventure with Writers Writing Words! The creative writing club presents its experimental text-adventure stories.

Course: FSCC 100: First Seminar: International Students' Wellness

Course Instructor: Mary Assad

Students: Section 100: Weihao Fan, Yuanhang Fu, Yunzhi Lin, Shuaiyu Tu, Linxuan Xie, Alex Yang, Andrew Yang, Yuedong Yang, Yifeng Yu, Anna Zhang, Shengjie Zhang, Xinyu Zhou, Yifu Zhou

Section 102: Runqiu Chen, Ziyi Chen, Andy Sui, Gaozheng Wang, Krystal Wang, Yikun Wang, Ruiying Xu, Jingming Yang, Zeyang Zhang, Ruyuan Zuo
We will be presenting the results of original research that our class conducted on the CWRU campus. We received IRB approval for a 48-question survey administered to undergraduate international students in March 2018. Our goal was to address a research gap in existing scholarship on college health, which has investigated numerous issues related to college students' health but devoted much less attention to health concerns of international students, specifically. Students each researched a different aspect of health in their individual projects, drawing from our primary research data as well as secondary sources. For the culmination of their work in FSCC, students are producing IMRaD research articles and delivering presentations in our class symposium on wellness (to take place at Guilford House the week of April 23). Students’ CSWR posters will present this research to the campus community to share what we have learned from our primary research on campus and make connections with existing published research on college health. In addition, our CSWR display will feature comic books that students created earlier in the semester on various aspects of wellness to reach a target audience of fellow CWRU students. Since research shows that wellness directly affects students' academic performance while in college, we are hoping to educate students, faculty, and administrators about health concerns that affect international students’ campus experiences. Our broader goal is to initiate further conversations about possible solutions to the problems uncovered in our research.

**Course:** USNA 204: The Evolution of Scientific Ideas  
**Course Instructor:** Barbara Burgess-Van Aken  
**Students:** Divya Jasthi, Trevor Watson

These two nominees will present excerpts from their semester-long research on a scientific question for which there are competing theories:

**Divya Jasthi:** Leading Theories on the Primary Causes of Obesity  
**Trevor Watson:** The Cause of the Dinosaur Extinction

**Course:** USSY 284: The Art of Madness  
**Course Instructor:** Barbara Burgess-Van Aken  
**Students:** Esther Kim, Ray Lui, Taylor Moon, Megan Murphy

Using a New Historical Lens as our theoretical basis, this class explores the history of the beliefs about mental illness as reflected in literature. Students today will present excerpts from their group project on changing perceptions of mental disorders in the postmodern era and from their individual research on interpretations of Robert Louis Stevenson’s *The Strange Case of Dr. Jekyll and Mr. Hyde.*
Course: USSO 286L (Section 100): Exploring Nonprofit Organizations

Course Instructor: Barbara Clemenson

Students: Jake Galiatsos, Bao Ho

The two nominees from this class will present excerpts from their semester-long research.

Jake Galiatsos: The Programs and Effectiveness of the Greater Cleveland Food Bank
Bao Ho: The Programs and Effectiveness of JumpStart

Course: USSO 286L (Section 101): Exploring Nonprofit Organizations

Course Instructor: Barbara Clemenson

Students: Tom Liu, Cassandra Lopez

Students from this class will share their investigations of local nonprofit organizations.

Tom Liu: The Programs and Effectiveness of LAND Studio
Cassandra Lopez: The Programs and Effectiveness of Frontline Service

Course: USNA 288N: Engineering Water

Course Instructor: Sunniva Collins

Students: Cassie Candel, Tapan Darji, Haocheng Du, Nathan Ewell, Keith Ethan Hill, Jared Jacknow, Abby Lindsay, Eric Liu, Stephen Liu, Takaaki Miki, Connor Nally, Keely Newson, Hiep Pham Bui, Sierra Vo, Lauren Walters, Thomas Zapadka, Tony Zhang

Take the Water Tasting Challenge! In an effort to raise awareness about bottled water consumption and water scarcity issues, we will host a blind taste test of various waters to demonstrate how typical perceptions of bottled water v. tap might not always hold true. Do you drink bottled water? Do you have a favorite brand? Do you think you can tell the difference between tap and bottled water? Stop by and give it a try! We will be tracking responses and sharing information about tap water and bottled water.
Course: USSY 286X: The Future of News
Course Instructor: Bill Doll
Students: Ozgur Bolat, Abby Bukovinszky, Rohan Chandrasekhar, John Dorow, Zhife Gu, Jeffrey Heferle, Gregory Horn, Monica Karam, Karena Kett, Karley King, Zehua Li, Adam Poltrack, Ethan Straight, Zane Varner, Guosheng Wang, Ryan Yoo, Tianyi Zhang

This century has seen an explosion of new digital news sources, from Vice, to Vox, to Buzzfeed to ProPublica and Infowars. Some are fun. Some are mean, and some are expanding the hard work of strengthening democracy. Our exhibit explores how the media has changed and how it has not.

Course: USSO 291V – 100: Political Corruption in America
Course Instructor: Michael Halberstam
Students: Joseph Dinko, Allison Kennedy, Kiera Olson, Victor Xie, Grace Howard, Katherine Toledo

Americans increasingly believe that their politicians and political institutions are corrupt. They believe that elections are rigged, elected officials would sell their votes for gifts or campaign contributions from rich donors, and corporate lobbyists typically get their way in Congress. But how serious a problem is political corruption in our political system? And how do we think about what corruption means?

Course: USNA 287K: Human Research Ethics
Course Instructor: Michael Householder
Students: Serena Lai, Hannah Messenger, Abigail Moss, Jessica Mu, Rebecca Mu, Maria Pawluk, Nova Qi, Rachel Robertson, Jackson Routhier, Ioanna Skubas, Alena Sorensen, Kimberly Steele, Alexis Thornburg, Esther Yoo, Sara Young

In this course, students examined how academic researchers violated the trust of members of the Havasupai Indian tribe, on whom they were doing genomic research. For their final papers, students researched a variety of proposals for how researchers could avoid such problems when doing research on Native Americans and others when doing research that may lead to privacy violations or other kinds of harms to individuals and groups.
Course: FSCC 100: Educational Equity

Course Instructor: Shaofei Lu

Students: Section 106: Yuru Chen, Yuliang Ding, Po Hu, Peifeng Hu, Tianxin Jiang, Zhuoyi Li, Tingyi Liu, Tianzhe Lu

Section 107: Tingrui Ma, Ruiyu Mao, Hongxu Zhao

Section 108: Xinfeng Wu, Yajie Xu, Shizhe Yang, Tomcheung Zhang

This course examines equity issues in education. Students will display comic books that they designed to explore problems such as micro-aggression, racial discrimination, and gender inequality.

Course: USNA 249: Restoring the Great Lakes

Course Instructor: Glenn Odenbrett

Students: Harper Case, Yash Goswami, Catherine Kaminski, Anthony Monczewski, Alexander Mullarkey, John Peralta

Team 1: At the request of the Cuyahoga County Board of Health, student teams in consecutive semesters of USNA249 have been investigating the Lake Erie fish consumption habits of subsistence anglers to determine how aware they are of the toxicants these fish contain and the health risks associated with consumption of these fish in excess of recommendations contained in public fish advisories. Students will present the outcome of subsistence angler interviews as well as plans for signage at locations where these anglers frequently fish along Lake Erie and its tributaries in the Greater Cleveland area.

Team 2: At the request of a member of the Cuyahoga County Council, a student team is developing an outreach strategy to increase support for passage of a new County ordinance. The ordinance would establish a modest carry-out fee for plastic bags provided for merchandise purchased by consumers at local commercial establishments.
Course: USNA 287H: Plants in Medicine
Course Instructor: Erika Olbricht
Students: Thanvi Vatti, Muriel Hook, Branden Kraus, Kobe Wanko, Samuel Berman, Hannah Weaver, Sanay Mohile, Bambi Zellers, Peter Yang

This SAGES class investigates the medicinal properties of plants, both historical and current. Each student has researched a plant of their choice, and will be present to discuss their findings. We will display examples of plants and their associated products at our table.

Course: USNA 289E: Medieval Robots
Course Instructor: Brie Parkin and Greg Lee
Students: Mingda Chen, Sissi Chen, Astra Nicole Driscoll, Connor Gaffney, William Huang, Alan Kao, Elise Kim, Joshua Mehler, Ethan Liaw, Sean Liu, Elizabeth Mahoney, Kimberly Meifert, Monica Oh, Joseph Recchia, Ke Ren, Michael Ritchey, Emily Young

The students are making automatons based on the medieval reading from the class. We’re going to show them off!

Course: USNA-289A-100: Antibiotics: from Miracle Drugs to Superbugs
Course Instructor: Marianne Pusztai-Carey
Students: Francine Espana, Annie Hu, Amogh Iyer, Kayla Kim, Michael Miller, Julianna Mulligan, Timothy Park, Raghav Ramraj, Jordin Sirody, Medha Srigiri, Trey Starshak, Emily Tisza, Callie Wang, Gabrielle Watson, Sarah Yu, Ryan Zimmerman

During the 1950s-1970s, the Golden Age of Antibiotics, resistance to antimicrobial drugs was of little concern to the drug industry and there was little research into this topic as the focus was solely on curing infections. Soon, researchers began experimenting with livestock and discovered that giving antibiotics to animals would make them grow faster and larger and therefore making them more profitable as the farmers could produce more animals in a shorter amount of time. However, due to the rampant use of antibiotics in human and livestock medicine, antibiotic resistance has spread all over the world breeding a new and dangerous class of bacteria called superbugs. Now, as antibiotic resistance is coming to the forefront of the world’s attention, we have begun to grasp the grave reality that changes need to occur in order to stop the spread of resistance. In an effort to preserve the efficacy of antibiotics, unnecessary usage needs to be reduced, new drugs need to be created and more research conducted on course of treatment.
Student Group: Discussions: The Undergraduate Research Journal of CWRU
Advisor: Sheila Pedigo
Students: Torrey Guan, Sierra Cotton

*Discussions* is the undergraduate research journal of CWRU. We publish two to three issues each year and feature research in all disciplines in order to promote undergraduate exploration in the sciences and humanities. For one of our recent issues, we received over twenty submissions from various undergraduate institutions across the nation. If you are interested in assisting us in the publication process or if you wish to submit an article to *Discussions*, please stop by our table or visit our website at www.case.edu/publications.
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