POSTER ABSTRACTS
Basic and Medical Sciences

1 A Feasibility of Small-Scale Hydroponics

Kevin Laverty, Gary Baker, Dane Elliot
Case Western Reserve University

A small-scale hydroponic setup was designed and fabricated. A wide variety of plants were chosen to show the flexibility of our simple hydroponic system. Basil was grown as a 'cash crop' since it goes for around $8/lb, kale was grown to show that the setup could produce nutrient-rich vegetables, and lettuce was grown to show that the setup could produce high volume edibles. The total cost and amount of time put into the project were tallied and the return on investment and feasibility were determined.

2 B Proton Exchange Membrane Fuel Cells

Randolph Cook
Cleveland State University *Dr. Orhan Talu , Mentor*

A fuel cell converts electrochemical energy into electricity. Proton exchange membrane fuel cells (PEMFC) can generate electricity through chemical reactions by combining hydrogen fuel with an oxidant, usually air. Fuel cells are a source of alternative energy, and with hydrogen being the most abundant of all the elements, harnessing it as a fuel may be a promising solution to energy crises. There are a number of factors that play a role in the efficiency of PEMFC's. Resistance, reaction rate, and gas transport (diffusion) are three key players that affect how well a PEMFC will operate. Chemical engineers play an important role in the advancement of fuel cells. By studying the effect of humidity, fuel, fuel cell temperature, and flow rates, chemical engineers may be able to maximize the power and potential of proton exchange membrane fuel cells. The first step of advancement of this technology is understanding how each of these factors affects fuel cells, then, through experimental development, these factors may be controlled, and new technologies may emerge as a result.

3 C Conservation of Linear Momentum In Chemical Reactions

Santino Bianco, Matthew Hamman, Maria Resendes, Taylor Santelle
Cleveland State University *Dr. Alla Zilichikhis , Mentor*

If two particles collide in a closed system the net momentum of the system is zero. This is known as the law of linear momentum conservation, and always holds true as long as the system is closed. The law can also be related to chemical reactions. Over the course of this poster the law of linear momentum conservation is proved using the law of conservation of energy, the law of conservation of mass, and Galileo Galilei's principle of relativity.

4 A Bio-printing

Lydia Fawzy, Kyra Rudy, Taylor Suchan, Grant Wethington
Cleveland State University *Dr. Stephen Duffy , Mentor*

3D bioprinting is the relatively new process of recreating living cells and tissues using a 3D printer. Although the use of bioprinting is still a long way from being hugely practical, the perfection of recreating these tissues would greatly advance the medical field in tissue engineering. Using cells from the patient so their body would not reject the printed bioprint, replacement tissue could be crafted and replace the defective cells in the patient. This has potential to result as a future substitute or even an improvement to original body materials. As of right, now surgeons and scientists have been able to implant a variety of engineered flat, tubular and hollow tissues into patients, including skin, cartilage and muscle. With more time and research these scientists hope to be able to print functioning human organs within the foreseeable future.

5 B Impacts of Ocean Acidification on Coral Ecology

Nadia Swit, Jordyn Stoll, Elizabeth Golias, Amelia Derevjanik
Cleveland State University *Dr. Julie Wolin , Mentor*

The purpose of this research is to explore how ocean acidification impacts various parts of an ecosystem, such as corals. Ocean acidification is the reduction of seawater pH worldwide as the consequence of the absorption of anthropogenic carbon dioxide by the oceans. Since the beginning of the Industrial Revolution, there has been a significant increase in acidity, which is detrimental to the ocean environment. Corals support marine biodiversity, because they are an important producer of biominerals. They are also essential for reef framework, and provide nutrients and homes for several living organisms. The increase in ocean acidity negatively impacts the presence of corals in the ocean, and it
also will intensify the effects of global warming. This research will further discuss what acidification is, how it affects coral and the environment, and examine what steps have been taken to combat the negative effects of ocean acidification. The effects are far reaching and impact not only the environment, but the human economy as well.

6 C The Nature of Poachers

Lisa Jorgensen
Cleveland State University *Aliyah Pandolfi, CEO Kashmir World Foundation, Mentor*

Wildlife reserves in South Africa have become war zones. Wildlife trafficking is the 4th largest illegal activity worldwide worth $23 billion US dollars per year. In 2014, 1,215 rhinos were poached in South Africa alone; approximately 100 African elephants are poached daily continent-wide. Conservationists and lawmakers are racing to keep up with, and get ahead of poachers, before it's too late. Conservation and ranger organizations are converting and recruiting former poachers. Gerard from Rwanda, and an anonymous gentleman from Tanzania talk about their life before and after poaching and what they think about the current crisis. In response to President Obama's National Strategy for combatting Wildlife Trafficking, Kashmir World Foundation founded the Wildlife Conservation UAV Challenge, which emphasizes the integration of sensors, embedded systems, and communications in a robust and high endurance, completely autonomous aircraft to aid rangers and combat poaching and trafficking.

7 A Regional Variation of Trabecular Bone Properties within the Post-Industrial Human Lumbar Vertebrae

Annie Bartosh
Cleveland State University *Dr. Anne Su , Mentor*

The internal structure of the human vertebrae is comprised of trabecular bone, a porous network of calcified bone known to strengthen with applied loading. Various habitual movements, such as unilateral upper limb use, are thought to asymmetrically distribute weight onto the lumbar vertebrae, affecting the strength of the spine while contributing to the prevalence of lower-back pathologies. Using a skeletal population of post-industrial males, the trabecular properties of the fourth lumbar vertebrae were quantified to determine the extent of lumbar asymmetry across various age and body-weight groups. Medical imaging, regional sectioning, and statistical analysis were then used to demonstrate that significant left-right differences do, in fact, exist within the lumbar vertebrae. As a baseline study for future, bone morphology research, this investigation attempts to provide a better understanding of the modern, lumbar vertebrae and the regional, weight-bearing properties of the lower back.

8 B Electron Charge to Mass Ratio

Nia Simmonds, Precious Adeleye, Destinee Battle
Case Western Reserve University

In this experiment we observe the effect of magnetic field on the path of an electron beam. The initial measurement of the radius of the electron beam produced by the apparatus was 3.7 ± .1 cm. This value is an average of the two values measured by each lab partner. With voltage at a constant 356V, we varied the coil current and found radius at the upper and lower limits to be 2.6 ± .1 cm at 1.99A and 4.1 ± .1 cm at 1.16A. With current at a constant 1.27A, we varied the voltage and found the radius at the upper and lower limit to be 4.5 ± .1cm at 357V and 4.5 ± .1cm at

309V. Our single best value for the charge to mass ratio was an average of the two values we calculated in regards to varying the coil current and the beam voltage. This value is (1.841608905 ± .02) *1012 C/kg.

9 C Expansion of "The Art Gallery Theorem"
Matthew Cremean, Kathryn Palmucci
Kent State University

The Art Gallery Theorem is a very intriguing and thought provoking idea. It's real-world application is very clear-cut and easy to explain. However, there are many ways to interpret or prove the theorem. It is known that the theorem has been proven by many mathematicians using various strategies. The objective of our poster is to depict various proofs by Chvátal, Kahn, Klawe, and Kleitman. The proofs display various techniques such as triangulation of polygons and quadrilateralization of orthogonal polygons. The poster will also demonstrate various expansions of the theorem, including application on three-dimensional objects and other quadrilateralization techniques. Overall, our poster is intended to explain and describe various ways to interpret the Art Gallery Theorem.

10 A Global Warming and The Effects on The Earth's Water System
Nancy Turner, Lisa Thomas, Johnicia Hicks, Asia Smith
Cuyahoga Community College *Cathleen Rossman and Brenda Stotesbery, Mentors*

We investigate the effects of global warming on the water system on our planet. We look to historical data to compare the changes in weather and in temperature for oceans and other major bodies of water. Significant weather changes include number of and length of droughts, hurricanes, and floods. We explore whether these events correlate with changes in water temperatures. We examine the effects of pollution and the greenhouse effect on global warming and water temperature changes over time. We conclude with examples each individual can contribute toward solutions to diminish global warming.

11 B Explaining the Theremin: A Physical Approach
Ericka Roy, Adam Morris, Morgan Miller
Cleveland State University *Dr. Jearl Walker, Mentor*

In 1927, Leon Theremin (born Lev Termen in St. Petersburg, Russia) invented the first ever non-contact musical instrument. Theremin's invention was termed the thereminvox, but is known commonly as the theremin. It has been used by many popular musicians, including the Beach Boys ("Good Vibrations") and Led Zeppelin. Theremins have also been used in the soundtracks of several Hollywood productions. The pitch produced by the theremin is a result of the capacitance change within the theremin that occurs as the player's hand moves in relation to the pitch antenna. Traditional theremins rely on a beat-frequency oscillator circuit to translate the capacitance change into an audible sound. Originally, theremins were analog in nature; today, modern theremins are often digital, which enables them to have a more linear octave range, attain higher pitch frequencies (at the expense of some lower frequencies), and be easier to operate.

12 A Sailing the Atlantic
Robert Crow
Cleveland State University

On my poster I will discuss how wind and ocean currents can affect a sail boat. First I will describe how a sail boat works and how the wind affects its speed with no outside forces other than the wind acting upon it. Next I will add how the currents of the ocean will affect the rate at which the vessel will move.

13 C Molecular DNA Cloning and Purification of DDX5

McKenzie Clapp, Abigail Fogle, Riley Brown, Spencer Boyd
Case Western Reserve University

DDX5, an RNA helicase, is an enzyme that unwinds double stranded RNA helices during cellular replication. Thus DDX5 plays an important role in cellular growth and division. Due to this role, DDX5 could have possible implications in cancer research. To begin analysis of DDX5, cloning of cDNA and purification experiments were carried out and successfully completed.

14 A The Comparison of Different Water Quality Characteristics along Yellow Creek, Northeastern Ohio.

Kayla Coldsnow, Nick Karousis, Justin Waldern
Youngstown State University *Dr. Carl Johnston , Mentor*

In Northeast Ohio, streams are subject to variations different from those in a deeper water ecosystem, which can cause sudden changes. This is due to factors such as a greater surface area of outside exposure to environmental conditions and the constant flow of the system. Changes in temperature or water volume can have large impacts on streams because the volume of water is low. This study examines spatial variation in water quality at three sites along Yellow Creek in Poland, Ohio. Water quality was determined by measuring temperature, along with other variables such as pH, conductivity, dissolved oxygen, fecal coliform abundance, along with multiple chemical ions. The hypothesis is that sites with similar physical characteristics that are subject to similar urban impacts will demonstrate similar corresponding changes in water quality characteristics. We also hypothesized that temperature and precipitation will have great impact on the multiple measured variables.

15 B Lesser Celandine's (Ranunculus ficaria) optimal environment for bulbil germination and growth

Matthew Barr
Cleveland State University *Dr. Andrea Corbett , Mentor*

Nonindigenous or invasive species negatively impact bio assemblages across the entire world. Lesser celandine (Ranunculus ficaria) is presumed to display these invasive attributes. This weed was introduced into the United States in the 19th century and has spread rapidly throughout Northern America. Lesser celandine has begun growing rapidly within Rocky River Reservation, located near Cleveland, Ohio. This weed is capable of reproducing and dispersing very easily. In addition, lesser celandine, or the fig buttercup is capable of surviving in a wide variety of biomes varying from woodlands, wetlands, to commercial areas. An environment for optimum growth of the tuberous roots (the weeds main form of reproduction) of this weed has been established, however bulbil optimum germination and growth environmental preferences for lesser celandine have yet to be firmly established. Most discussion regarding fig buttercup bulbils is based on expert opinion and minimal studies backing these claims. A series of experiments were conducted to determine the optimal germination and growth for bulbils of Ranunculus ficaria. The first two studies focused on the depth bulbils are within soil and the amount of water provided and these two factors impacts. Zero bulbils in the first two experiments germinated or survived, regardless of soil depth insertion or amount of water provided. However, these results give direction for other environmental factors that could affect bulbil germination, such as sunlight exposure, temperature and temperature fluctuation between the day and night. The third experiment is still on going and focuses on light exposure instead of soil depth of bulbils and amount of water, and results shall be examined at a later time.

16 C How Different Diets Affect Earthworms and the Soil They Enrich

Jermaine Coleman, Briana Sealey
Case Western Reserve University

Approximately twenty Lumbricus terrestris will be used to determine what type of food this species of worm prefers to consume and how its food consumption affects the soil it reside in. L. terrestris will be measured and weighed, then paired off into separate plastic containers where each pair will be fed a variety of food, including wooden products, grass, and fruits and vegetables. After a few days, the weight and size of the worms will be measured to

determine how much the worms consumed over time and the quality of the soil. We predict L. terrestris will mostly consume fruits and vegetables, and results will show that better food yields better soil. Information gathered from this research can be used to determine the optimum food choice if one were to acquire a worm farm or desired to feed worms for gardening in the most effective way.

17 B Directing Neuroplasticity to Improve Rehabilitative Outcomes of the Upper Limb in Incomplete Quadriplegia

Daniel Janini
Case Western Reserve University *Dr. Ela Plow , Mentor*

After incomplete spinal cord injury (iSCI), cortical maps of stronger muscles overtake maps of weaker muscles. This pilot study assessed whether rehabilitation causes adaptive re-mapping, and whether brain stimulation via transcranial direct current stimulation (tDCS) enhances these changes. Subjects (n=5) were randomly assigned to receive rehabilitation of upper limb muscles with either tDCS or sham stimulation for 2 weeks. Brain stimulation resulted in greater improvement in function and strength. Transcranial magnetic stimulation was delivered to the brain as muscle activity was measured in order to map motor cortical representations of strong and weak muscles. Before therapy, maps of stronger muscles were larger ($p<0.01$) and more excitable ($p=0.015$) than maps of weak muscles. Excitability of strong muscle maps decreased following therapy. Patients receiving tDCS showed rearrangement of motor maps, with weaker maps re-establishing area. Thus, tDCS with traditional rehabilitation may result in improved functional recovery following a two week treatment window.

18 A Inhibition of Staphylococcus Epidermidis in the Case of Acne Vulgaris

Kaitlin Newcombe, Amelia Rivas, Erin Conway
Case Western Reserve University

The aim of this investigation was to explore the effects of topical prescription-strength antimicrobial gels and their ability to inhibit the growth of Staphylococcus epidermidis (S. epidermidis). In investigating this topic, it was necessary to test and understand how different active ingredients have different techniques for inhibition of S. epidermidis. The three topical gels chosen were Veltin™, Acanya®, and Epiduo™.

19 C Live Cell Imaging on Titanium Surfaces

Teisha Mullins
Cleveland State University *Dr. Joanne Belovich and Dr. Surendra Tewari , Mentor*

Titanium is a viable material for prosthetic implants due to its biocompatible surface which facilitates cell adhesion. In this study, titanium discs are used as a substrate for mesenchymal stem cells which have been genetically altered with Green Fluorescent Protein (GFP). Due to the reflective properties of the titanium discs, standard light microscopy could not be used for cell growth analysis. Thus, a fluorescent microscope and camera were used to record periodic images of live cell growth over trials seven to ten days in length. After the microincubator environment had been successfully optimized in my previous research, I will be performing the image analysis of the trials in order to extract meaningful data, such as cell area, cell travel, and instantaneous velocity. Whereas a previous graduate student focused on densely populated fields of view during the experiment, I will be focusing on less densely populated areas in an attempt to see if the cells behave or grow differently.

20 A Stimulants and Depressants Effects on Plant Growth

Kayla Merritt, Christine Katsaras, Rene Kizys, Hytham Nofal
Cleveland State University *Dr. Anthony Berdis , Mentor*

The experiment performed in this poster project, titled “The Effects of Stimulants and Depressants on Plant Growth”, explores the development of mung bean sprouts under the influence of caffeine and isopropanol. Furthermore, we will also investigate the effects of additional chemicals such as aspirin, Benadryl, Nyquil, and other over-the-counter drugs. We hypothesize that the addition of depressants will suppress sprout growth, while the stimulants will enhance plant growth. We intend for this experiment to be a model of the effects of pollution on

the environment in order to demonstrate the negative impact of improper disposal of chemicals.

21 C Molecular Detection of Penicillium marneffei in Insects

Kristin LaTessa, Jamielynn Doyle, Jason Gilmore, Sara Johnson
Youngstown State University *Chester Cooper , Mentor*

Penicillium marneffei is a pathogenic fungus endemic solely to Southeast Asia. The fungus infects humans, mainly those who have developed AIDS. The fungus is also found in bamboo rats, but there is no evidence to suggest that the disease is transmitted from rats to animals. In fact, the exact reservoir of P. marneffei is unknown despite decades of investigations. We hypothesize that insects may be the carriers of this infectious disease agent. To assess this hypothesis, we developed molecular methods to detect P. marneffei in insects based upon prior using previously published procedures. This assay is now being tested in wax moth larvae infected with P. marneffei. The results of the PCR protocol will be compared to traditional culture methods of identification.

22 B The Effect of Auditory Distractors on Stress-evoked Galvanic Skin Responses

Kaylin Camp, Rae'ven Crum, Christopher Leymarie, Thomas Rebracca, Tyler Tsangaris- Braatz
Youngstown State University *Johanna Krontiris-Litowitz , Mentor*

Environmental stimuli such images and music can have a profound influence on an individual's response to stress. Some studies suggest that certain environmental stimuli can serve as distractors and may reduce the physiological responses to stress. In this study we examine how an auditory distraction can influence a subject's response to stress as measured by the Galvanic Skin Response (GSR). Two auditory distractors were tested in this protocol, 1) an 8 min segment of a boring audio book, representing a minimal auditory distraction and 2) an 8 min segment of popular music, representing a moderate distraction. Twenty minutes of baseline GSR data was collected from 30 subjects. At the end of this period the The GSR for each event was evaluated and preliminary results reported.

23 C Transposon Mutagenesis of Stenotrophomonas maltophilia OR02

Vince Pilolli, Jeremy Borton, Angel Muns, Hayley Spalla
Youngstown State University *Jonathan Caguiat , Mentor*

A multi-metal resistant strain of Stenotrophomonas maltophilia OR02 (S. maltophilia 02) grows when exposed to toxic salts of gold and selenite. An E-Z Tn5 transposome was introduced into S. maltophilia 02. Approximately 880 transformants were replica plated onto plates containing gold chloride, sodium selenite and M-9 minimal salts medium to see if the transposon interrupted genes required for gold resistance, selenite resistance or growth on minimal media. Three transformants were sensitive to gold and selenite, three were sensitive to selenite, and 7 failed to grow on M-9 minimal salts medium. The transposon contains a kanamycin resistance genes and an R6Kγ replication origin. The genomic DNA from the mutants was purified, digested, ligated and transformed into E. coli. These transformants will contain new plasmids consisting of the transposon flanked by the interrupted genes. We expect DNA sequencing to identify genes involved in efflux, metal transformation (reduction and oxidation) and sequestration.

24 A Analyzing Variability in Cell Migration: Scratch Assay Wound Closure following Silibinin Delivery

Mikayla Smith, Aemilee Ziganti, Claire Holliday, Maggie Wong, Beoline Uwampamo, Tulibona Namulemo
Case Western Reserve University *Horst von Recum and Edgardo Rivera, Mentors*

Cancer is a leading cause of death, and while there are some, specific success stories, in general there is an ongoing need for better therapeutic strategies. Long dormant states and the body's defenses prevent tumor growth for a while, but in most cases the dormancy is not permanent and angiogenesis begins to occur. Appropriate delivery of anti-angiogenic drugs can therefore be valuable in preemptive cancer treatment. Using C166 endothelial cells to mimic in-vitro angiogenesis, a scratch wound assay was performed to optimize the parameters of the assay when treated with an anti-angiogenic drug, Silibinin. It was determined that low concentrations of dimethylsulfoxide

(DMSO) as a solubility agent; low assay cell density; and high concentrations of fetal bovine serum (FBS) were he optimal set of test parameters. Another scratch wound assay was then performed to determine the effects of varying Silibinin concentration. The expected S-curve was not completely clear. Variations can be accounted for in experiment design.

25 B The Artificial Rainbow: Color in Modern Fireworks

Barnabas Brennan, Annelisa Monica, Quinten Hutchison, Sydney Tenaglia
Case Western Reserve University

In this experiment, we test the output color and efficiency of several pyrotechnic components in a controlled burn. Various metallic elements and compounds are used as colorants in a star, the section of a rocket that produces the brilliant colored light in a fireworks display. We here attempt to produce this effect in a low-pressure environment. Materials used in this experiment include strontium carbonate, sodium nitrate, copper acetoarsenite, calcium sulfate, potassium nitrate, barium nitrate, and aluminum powder, several of which can be found in everyday use. The colorants are combined with a range of propellant grades at different mixture ratios and tested in an open-air control site.

26 A Elucidation and Characterization of Commercially Produced CMA Road Deicer

Jennifer Miller, Matthew LaLama, Darian Wilson, Paije Kiraly, Samuel Dickson
Youngstown State University *Matthias Zeller, Mentor*

CMA (calcium magnesium acetate) road deicers have gained popularity in recent years as an environmentally friendly alternative to traditional rock salt. Despite its increasing commercial use, its exact composition and structure remain unknown, with subsequent problems in evaluating properties of commercial CMA. The purpose of this project was to elucidate the composition and structure of CMA using single crystal X-ray diffraction, SC-XRD. Attempts to grow crystals suitable for SC-XRD from aqueous solution failed due to formation of various calcium acetate hydrates. Crystals of a mixed metal calcium-magnesium acetate were eventually obtained under mostly water-free conditions from hot glacial acetic acid by slow evaporation of solvent. SC-XRD revealed CMA to crystallize in the orthorhombic space group Pnma with a formula of Mg2Ca(OAc)6 (OAc = acetate anion), with no water included in the crystal lattice. Analysis of commercial CMA by powder XRD, x-ray fluorescence, and SEM-EDS did match the results from SC-XRD.

27 C Testing the Efficacy of a New Anti-Cancer agent on an Animal Model

Casey Seol Kim
Cleveland State University *Dr. Anthony J. Berdis , Mentor*

Approximately 4,000 children in the United States are diagnosed annually with a brain tumor. Brain cancers are the deadliest of all pediatric cancers as they have survival rates of less than 20%. Although surgery and radiation therapy are widely used to treat adult patients, chemotherapy is the primary therapeutic option for children. One important chemotherapeutic agent is temozolomide, an alkylating agent that causes cell death by damaging DNA. In this project, we tested the ability of a specific non-natural nucleoside developed in our lab, designated 5-NIdR, to increase the efficacy of temozolomide against brain cancer. Cell-based studies and Microscopy results show that the combination of 5-NIdR and temozolomide causes cell death via apoptosis rather than necrosis and that that the combination of 5-NIdR and temozolomide kills more cells compared to treatment with either temozolomide or 5-NIdR used alone. These results are also supported by the animal studies using xenograft (nude) mice that evaluated the in vivo efficacy and safety of this drug combination against brain cancer.

28 B Removal of Pharmaceuticals from Water by Charcoal Filtration

Taylor Baum, Rachel Centofanti, Allison Guerrieri, Samantha Mock, Tayah Turocity
Youngstown State University *Dr. Nina V Stourman , Mentor*

Pharmaceuticals often contaminate waters which is a cause for concern because of the health effects these chemicals may inflict upon humans. In this study we tested whether water bottles with filters can remove pharmaceuticals from water. Two anti-inflammatory drugs, Tylenol and Aspirin, and two antibiotics, ampicillin and kanamycin, were tested. Solutions containing pharmaceuticals were filtered through three different systems: a BRITA water bottle filter, a BOBBLE water bottle filter, and a filter containing activated charcoal. For anti-inflammatory drugs, the amount of compounds remaining in the solutions after filtering was evaluated by High Performance Liquid Chromatography. Disc diffusion sensitivity test on bacterial plates was used to observe the removal of antibiotics. Our results show that in the removal of both Aspirin and Tylenol charcoal column was more efficient than the water bottle filters; however, neither the pure charcoal filter nor the water bottle filters effectively filtered out the antibiotics.

29 A Identification of Potent and Selective Tubulin Inhibitors against Human African Trypanosomiasis

Daniel Kulman
Cleveland State University *Dr. Bin Su , Mentor*

Human African Trypanosomiasis (HAT) is an endemic life-threatening disease caused by parasitic protozoan Trypanosoma brucei (T.brucei). The drugs being used for the treatment of HAT exhibit high toxicity to the hosts due to their poor selectivity against the parasite. There is a need for the development of potent drugs with efficient pharmacodynamics and high selectivity against the parasite over mammalian cells. Tubulin plays an important role in T.brucei cell growth because of their rapid rate of cell proliferation. In addition, microtubule within the flagellum of the parasite assists in locomotion, which is vital for their survival. The importance of tubulin in the parasite suggests the potential advantages of tubulin inhibitors against HAT. Based on the differences between mammalian and parasitic tubulin, a library of sulfonamide tubulin inhibitors was screened and evaluated using MTS assay on T. brucei. We propose to compare the anti-parasitic activity of the compounds to their activity against mammalian cells. The compounds with high potency and selectivity will be identified as drug candidates to move further in the drug discovery pipeline. Currently, we completed the proliferation assay with T.brucei cells and, the potent candidates against T. brucei are being screened for toxicity against normal mammalian kidney cells, HEK293. Overall, this study provides with the basis for further development of tubulin inhibitors that selectively targets T.brucei for the treatment of HAT.

30 C Synthesis of a Perylene-based Molecule to Exhibit Phosphorescence Due to the Heavy Atom Effect

Maria Tickerhoof, Alexzondria Carter
Case Western Reserve University

The presence of heavy atoms such as transition metals in or around large aromatic compounds may induce phosphorescence, a form of photoluminescence. The goal of this project is to remove the oxygen from a perylene-based alcohol and replace it with an iodine to create a heavy atom effect. This is done by adding a protecting group, toluenesulfonate, to the alcohol to make the oxygen a good leaving group, so iodine can take its place.

31 B Clash of Clans Defensive Base Strategies

Garrett Gustafson
Case Western Reserve University

This poster takes an in-depth look into the popular mobile game Clash of Clans and how to optimize your defense given your goals (i.e. protect resources or trophies). I will explain the types of attacks you can expect and how you can best construct your village to defend against them. Along with the description of attack types I will provide a

brief outline of the troops that can be used to raid your village. Given that different town hall levels provide different defensive options, I will explain different strategies that can be used and alternative methods for those with a lower town hall.

32C Correlation between Magnesium Concentrations in Drinking Water and Ischemic Heart Disease Mortality Rate in Ohio

Nicole Rodomsky, Ralph Roth, Amanda Seidler, Amanda Svenson, Lydia White
Youngstown State University *Alan M. Jacobs, Isam E. Amin, Nana Achiampong, Mentors*

Linear regression analysis was used to evaluate correlation between magnesium (Mg) concentration in drinking water (surface and aquifer sources) and incidence of ischemic heart disease in Ohio. Mg-concentrations were obtained for 69 of the 88 Ohio counties from: (a) public water treatment plants, and (b) the Ohio Environmental Protection Agency (OEPA). The results indicate a negative correlation (higher Mg yields lower ischemic hearth disease) with low R-squared values (0.33 to 0.50). The low R-squared values indicate that health factors other than imbibing magnesium also may affect the incidence of this disease. Other factors include: high blood pressure, high cholesterol, family history of heart disease, and lack of physical exercise.

33 A The Gender-specific Effect of S100a9 in the Development of Lupus-like Disease

Andres Alberto, Joana Dimo
Cleveland State University *Dr. Trine Jørgensen , Mentor*

An immunosuppressive population of myeloid origin has been characterised as MDCS (Gr1hiCD11b+) in a number of different cancer models, and shown to be tumour-promoting via suppression anti-tumour immune responses. A recent study has identified an increased population of myeloid-derived suppressor-like cells (Gr1hiCD11b+) in lupus prone male mice, imparting a protective effect on disease severity and development. Also in cancer models, MDSCs have shown to utilize S100a9 as a suppressive mechanism, but the mechanism utilized by MDSC-like cells in lupus prone mice is currently unknown. Based on the current literature, and our previous findings, we hypothesized that Gr1hiCD11b+ cells produce greater amounts of S100a9 as compared to females, which is somehow mechanistically involved in the suppression of B cell differentiation, T cell proliferation, glomerulonephritis, and the overall pathology of lupus. We found that male mice produce greater amounts of baseline S100a9, which correlates negatively with disease progress. Proteinuria, immune complex deposition, and spleen size increase in male mice lacking S100a9 to the female baseline. Thus, S100a9 may be be an effector molecule in systemic lupus pathology.

34 B Analysis of a Heat Transfer Mechanism for the Heat Melt Compactor

Daniel Gerges
Cleveland State University *Eric Golliher, NASA Glenn Research Center , Mentor*

The Heat Melt compactor is a current and ongoing research project at the NASA Glenn Research Center in Cleveland, Ohio. The Project aims to develop a device which will reduce the amount of space that astronaut trash consumes on the ISS and in addition to this, recycle any water waste which can be reused. This is to be accomplished through the creation of a compactor device that will crush all astronaut trash and reduce it to a disk shaped clump of waste. During the crushing process, excess water, found in the food wrappers and other daily consumables, will be squeezed out and extracted. In order to separate and recycle the water, a mechanism needs to be engineered to evaporate and collect the vapor in a micro gravity environment and condense it in a separate chamber. The aim of the presented work was to analyze and compare pre-identified mechanisms that may aid in the collection and condensation of the evaporate in micro-gravity. A selection and recommendation were made to the GRC facility after a through technical review of each candidate system.

35 C Cycling Efficiency

Stephan Kennedy, Benjamin Nimrod
Cleveland State University *Dr. Thijs Heus , Mentor*

The purpose of this poster is to see how effective the Newtonian physics laws of motion are in applications involving speeds significantly less than that of light. The application is to find out how fast the cars on the Blue streak roller coaster (an attraction from Cedar Point) go at various heights and check points along its track. Based on the Newtonian physics concepts of work, kinetic energy, potential energy, friction, and drag a theoretical calculation of momentary speeds will be compared with actual velocity data. Using calculus fundamentals and differential equations along with other documented approaches, the method of calculation will account for the friction between the cars, the track, and air resistance as well as with other related conditions. Results of these calculations also consider statistical error propagations from all data used in the calculation before being compared with the actual velocity data. The conclusion demonstrates the accuracy of these calculations through the percent deviation from the end condition data.

36 B Experimentation of Heat Transfer using Lumped System Analysis

Jodi Turk, Grace Gaeckle, John Liggett, Michael Sutadji
Cleveland State University *Dr. Kiril Streletzky , Mentor*

Through this experiment lumped systems will be explored. There will be three different types of bottles used in this experiment: aluminum, plastic, and glass. These bottles will be cooled in a refrigerator and then allowed to warm up by sitting out at room temperature with a thermometer attached to the side of the bottle. The rising temperatures will be recorded and analyzed. The results for each of the different bottles will be calculated and then compared to each other. The results will be graphed with temperature versus time.

37 A Light Shutter with Dichroic Dye and Photosensitive Chiral Dopant

Kelsey Darrah, Paul Palumbo, Aditya Malik, Enrique Luevano, Wilmel Cosme
Case Western Reserve University

Transmittance through a liquid crystal cell with dichroic dye can be controlled by the liquid crystal lecture. Using a photosensitive, high helical twisting power (HTP) chiral dopant, dichroic dye, and nematic liquid crystal, a light shutter can be created by photo switching of sample between a bright and dark state. After laser relaxation, the cell had 46% light transmittance and after UV excitation the cell had a transmittance of 8%. Switching times were .8 seconds for excitation and 1.91 seconds for relaxation. We tested the cell under direct sunlight. We were able to swtich the cell between bright and dark states with UV excitation and laser relaxation to create a light shutter.

38 C Modern Physics

August Wright, Mark Bowling, Rani Hannawi
Cleveland State University *Dr. Jearl Walker , Mentor*

Blackbodies are objects that absorb all incident electromagnetic (EM) radiation, or light. They are also excellent emitters of thermal radiation. Cavity Radiation uses a cube with a hole, or cavity, on one side to approximate ideal blackbody radiation from the opening. We measured the levels of infrared radiation emitted by various surfaces on each side of a heated cube and compared those levels to light reflected by each side. The goal is to experimentally simulate the function from Planck's Radiation Law, which ultimately sparked the birth of quantum mechanics.

39 B Large Scale Automatic Photovoltaics Manufacturing on Mars

Michael Baker, Nicholas McGuigan, Martin Strong
Youngstown State University *Donald Priour , Mentor*

The remote exploration of Mars has been of enormous profit from a scientifically, but has also come at great expense due in part to the costs of sending payloads to Mars. Common to all craft exploring the Martian surface is a

need for a robust energy source, supplied in many cases by on board photovoltaic cells. To reduce payload weights and make exploration more economical, we examine the possibility of an automated onsite factory with the robotic manufacture of solar cells to replace damaged solar panels on existing rovers, to outfit probes en route to Mars, and to power the factory itself. We examine the feasibility and discuss principal challenges associated with the remote manufacture of Solar cells (i.e. purity constraints in refined silicon and implementing a self-management scheme), and we consider optimal geographical placement on Mars given the available data on the availability of raw materials on the Martian surface.

40 C A Classical Analog of a Kerr Black Hole

Connor Hetzel
Youngstown State University *Michael J. Crescimanno, Ph.D. , Mentor*

By examining the orbits around a black hole, cosmologists have known that Kerr black holes (those with angular momentum, but no charge) have certain characteristic multipole expansions. These multipoles exhibit a key dependence on the angular momentum itself. From relativity, we know that the angular momentum is bounded. We simulated a classical mass distribution whose far-field matches these characteristic multipole expansions. We then numerically perturbed the angular momentum to approach and exceed the relativistic bounds. By finding classically unphysical situations in the mass distribution, we found that classical physics may imply bounds more strictly imposed by relativity.

Engineering and Technology

41 B Determining Viscosities of Motor Oils at Various Temperatures

Jesse Saluga, Mike Craver, Kyle Bryan, Justin Getz
Youngstown State University *Dr. Suresh Sharma , Mentor*

The intention of our project is to determine viscosities of different motor oils at varying temperatures. Through our research, we concluded that the viscosity of engine oil directly affects the efficiency of the engine. In our testing, we used 5W-30 for a gasoline engine, and 15W-40 for diesel engines. In general, as the temperature had a direct effect on the viscosity of each oil that was used. The results obtained from our experiment will show how engines react in different climates.

42 A Design of an Industrial Water Treatement Process

Eric Schubert
Youngstown State University

The real-world design process for water treatment can be performed very quickly by an experienced Engineer in the field. However, the task contains extensive regulatory forms, decisions, and calculations that should be expected with any project. This design project is to design an industrial water treatment process for a proposed bottling facility. Along with several standard governmental forms, this project very closely simulates the process that would be followed by an Engineer in order to develop a solution to satisfy the given criteria.

43 C Up-and-coming Technologies

Michael Hinton, Jacob Katzenmeyer
Cleveland State University

We are all aware that technology is constantly changing and improving. One day, you buy a new gadget, and the next week, something better becomes available. Twenty years ago, no one would have predicted that society would be as advanced as it is today. This research poster will essentially be a “World of Tomorrow” type of research, displaying technologies that are currently being developed, with the possibility of some of them becoming widely used in science or being released to the general public.

44 A Automated Brewing System

Patrick Bollinger
Youngstown State University *Dr. Jalali , Mentor*

In this project we are researching, designing, developing, and testing an automated beer brewing system. The purpose is to explore and follow an engineering design process. We analyzed the market for an automated beer brewing system, designed several concepts, chose one concept, and developed said concept. As a result, we have a working automated brewing system that meets surveyed customers' needs.

45 B An Extreme Green Approach to Worldwide Implementation of a Self-Sustainable Renewable Ecosystem

Anita Whitlow, Kristina Blue, Muna Jarik, Aminat Adebayo
Cuyahoga Community College *Dr. Bilal Bomani and Dr. Clarence Johnson, Mentors*

The three most important global resources are water, food, and energy. We are investigating an eXtreme Green solution optimizing water and food resources. eXtreme Green is a concept developed at NASA GRC's GreenLab Research Facility where renewable, alternative, and sustainable techniques are researched and implemented. We are conducting a six-week feasibility study optimizing a portable self-sustainable renewable ecosystem by evaluating up to five plant species. We are using Poecilla species fish (Mollies) as a natural fertilizer to provide nutrients for the plants. Our goal is to develop a portable self-sustainable renewable ecosystem that can be implemented worldwide. We present the results of our six-week study and our recommendations for adapting our ecosystem concept into STEM classrooms across the United States.

46 C Personal Bar Tap

Zachary Abraham, Dominic Sikora
Youngstown State University

The goal of this project is to design and fabricate a fully functional bar tap that cools beer from a keg in a reduced amount of time. Current keggerators utilize ambient air in order to cool down the entire keg in the refrigerated space. This design utilizes a double pipe heat exchanger in such a way that cools the beer as it is tapped from the keg. The cooling system is placed on the keg and refrigerates the beer to desirable temperatures as it flows through the system. The system is placed on a modified dolley with all the needed power sources attached to it, as well as a CO2 tank that keeps the carbonation of the beer intact. The system is controlled through the use of various valves and sensors to keep the system regulated, accurate, and consistent.

47 A Solar Source

Neil Feldman, Zachary Kahl, Mitzi Fernandez
Case Western Reserve University

We present the design and construction of a cell-phone case with solar panels to charge the phone on the go.

48 B SunTrac

John Elmo, Alexander Shimek
Case Western Reserve University

We present the design of the mechanical assembly for a dual axis solar tracker.

49 C Energy Backup for St. Joseph's Hospital

Tyce Gall, Anthony Hill, Jason Huey, Jennifer McAnallen, Justin Stellmar, Blake Walker
Youngstown State University *Dr. John H. George , Mentor*

The goal of our project is to find the most effective ways to conserve energy at St. Joseph's Hospital as well as backing up the facility's critical load. With the help of our partners at the National Electrical Contractors

Association's YSU student chapter, we are in the process of finding a way to integrate a backup system into the hospital's micro grid. The purpose of the backup system is to take on the load in the event of a power failure to give time for the backup generators to come online. In addition to backing up the facility, we plan on retrofitting the hospital's lighting in order to make it more energy efficient.

50 A Reusable Rockets

Tyler Kaptain, Lucas Kuhns
Cleveland State University *Dr. Woodrow Whitlow , Mentor*

Space travel is extremely expensive but companies are testing methods to dramatically reduce that cost. One such method is to reuse spacecraft and launch vehicles. By reusing the spacecraft, the cost per kilogram to low earth orbit (LEO) could be reduced by 95%. Currently it costs about $10,000 per kilogram to LEO but some companies, SpaceX for example, would like to reduce that cost to well under $1,000/kg. This dramatic reduction in cost could accelerate scientific research and space exploration. The purpose of this research is to evaluate the history of reusable launch vehicles and look at some of the current designs and technologies that are undergoing testing.

51 B Turbochargers Vs. Superchargers

Fadi Abas, Wayne Gyorgak, Christina Pope
Cleveland State University *Dr. Michael Adams , Mentor*

Since the creation of the internal combustion engine people have searched how to make it better. The most common idea was to force as much air and fuel into the given space as possible to create more power. From this thought two different approaches emerged: the turbocharger and the supercharger. We shall try to give those who are curious the knowledge on the difference between the two forms of charging and how they work. Then with research we intend, if possible, to name a superior of the two methods.

52 C Automation of Semi-Trailer Landing Gear

James Schuster
Youngstown State University *Mark Jeffrey , Mentor*

The shipping industry primarily relies upon hand operated trailer jacks, typically referred to as the landing gear, to raise and lower the semi-trailer. This cranking process takes time and effort from the driver. Utilizing an electrical power source to raise and lower the landing gear significantly reduces the time required to raise and lower the trailer jacks. Also, it could potentially eliminate the injury and risk associated with manually cranking the landing gear up or down. A unit was designed that operates the landing gear using both speeds of the existing gear box located on the trailer, while also retaining manual operation of the landing gear system in case of an electrical failure of the semi-trailer or truck. The automated unit was then installed on a trailer and tested in real world conditions to confirm that all aspects of the design operate as desired.

53 A Design and Installation of a 2 Ton Jib Crane

Christopher DeChellis, Benjamin Tadla
Youngstown State University *Chad Thorne , Mentor*

A jib crane is an ideal mechanism used to lift and transport various materials from one location to another. These jib cranes are often found in numerous shops and manufacturing facilities. The primary dilemma faced for the capstone project was that a jib crane was needed in an industrial shop with a minimal concrete base. The main goal addressed by the team was to build this jib crane in compliance with CMAA (Crane Manufacturing Association of America), AWS (American Welding Society), and AISC (American Institute of Steel Construction). In this study of a semi free standing jib crane, stress and strain analysis was performed on all members and at critical joints. These members and critical joints consisted of the jib, mast, secondary mast, derrick legs, base plate, pin, bushings, and welds. Following the analysis, it was then given to a professional engineer to be checked and signed off for construction.

54 B Design and Prototyping of an Application Specific Hydraulic Component

James Lake, Ryan Sepesy, Phillip Scheanon, Matthew Canestraro
Case Western Reserve University *Mark Nandor , Mentor*

We present the design of a custom hydraulic component for a medical exoskeleton. The project consists of the entire design process, from the initial definition of the requirements and deliverables through the concept design, driving equations and material selection, computer assisted design, finite element validation, manufacturing, and testing.

55 C How to Throw a Shirt

David Solomon, Christian Gundlach, Ashley Briskey, Brian Klements
Case Western Reserve University

My team has been tasked with creating a t-shirt launcher for use by RP+M at their conferences. We have the use of their rapid prototyping capabilities and we are trying to make it as unique and eye catching as possible with the limited time allotted to us. Dardanelles is a one of a kind pressure cannon with a rotary magazine.

56 A Teaching Children Circuits at Oh Wow! Science Center

Eduardo Bustillos, Michael Kunzer
Youngstown State University *Hazel Marie , Mentor*

One way to increase scientific and technological literacy in young kids is to take a hands-on approach. One way to help kids learn circuits is the use of “Circuit Blocks.” To build a set of circuit blocks, we took small blocks of wood and nailed or soldered basic electrical components, such as power sources, LED lights, resistors, DC motors, etc. Once nailed and soldered, different blocks can be connected with small jumper wires, thus completing a circuit. In addition to Circuit Blocks, modeling clay (Play-Doh) is electrically conductive and can be used to make circuits. To achieve better results, two batches of homemade clay were made; one batch that was more conductive than conventional Play-Doh and one that was more resistive. By using wires to connect clay with different components, circuits can be made. Using this approach, kids can really use their hands and imagination, all while learning about circuits.

57 B CollaMesh: An Innovative Material for Stress Urinary Incontinence

Rachel Hammond, Tyler Densmore, Haley McAllister
Case Western Reserve University

Stress Urinary Incontinence (SUI) affects roughly 40% of all women. Slings are the current method of treatment, but due to their non-resorbable nature, they erode nearby existing tissue. Using a pure collagen mesh-CollaMesh, we hope to eliminate this issue.

58 C Property Analysis and Applications of SMP Using 3D Printing

Sam Cappelli, Antonio DiSalvo, Kelly Kovaceich, Dan Martin
Youngstown State University *Dr. Pedro Cortes , Mentor*

Shape Memory Polymer (SMP) is a material that contains properties comparable to Shape Memory Alloys (SMAs). The property of focus as well as the polymer’s namesake, is the ability to have its shape manipulated/altered at room temperature, then when heat is applied, it will revert to its original form. Essentially, the SMP/SMA can be bent, twisted, smashed, etc., but “remember” what its past shape was and can return back to it after being exposed to heat. This research analysis involves extruding SMPs into 3D printable wire to be used to print specimens for research and study. Potential applications of printed SMPs were discovered, including specimens composed with SMA wire.

59 A Improving the Low Temperature I-V characteristics of Molybdenum Di-Sulfide (MoS2) on Hexagonal Boron Nitride (h-BN) Devices

Vipul Malik
Case Western Reserve University *Philip Feng , Mentor*

This project involved measuring the low temperature I-V characteristics of Molybdenum Di-Sulfide (MoS2) and hexagonal Boron Nitride (h-BN) devices. The MoS2/h-BN devices were fabricated in the lab and tested to study the interface between the two 2-dimensional materials.

60 A Incommensurate modulation and phase transformation in a zinc tri-thiadiazol complex

Kristen Hernandez
Youngstown State University *Dr. Matthias Zeller , Mentor*

The complex of zinc nitrate with 5-(methylthio)-1,3,4-thiadiazol-2-amine crystallizes in a monoclinic setting, space group P21/n, as the tri-thiadiazol complex [(C3H5N3S2)4(OH2)2Zn](NO3)2, with the water molecules in the apical positions of the pseudo-octahedral complex. At room temperature, the structure is characterized by large thermal libration and disorder of the thiomethyl groups, the nitrate counterions and also of one of the zinc coordinated water molecules. Upon cooling to less than 200 K, disorder and thermal libration reversibly transition to incommensurate modulation, with a q-vector of 0.337 a + 0.460 b and space group P21/n(a0g)s. At 100 K satellites up to second order are visible, and disorder and libration is completely replaced by pronounced modulation. Using second order satellites, ADP values may be reasonable refined in higher ADP orders. Phase transformation, refinement strategy and parameters and modulation functions used will be presented.

61 B Mobile Security - Your Personal Data At Our Fingertips

Nick White, Brandon Sinkovic, Matt Lysyj
Cleveland State University *Dr. Wenbing Zhao , Mentor*

Is your wireless on? The answer is most likely. The vast majority of Smartphone users utilize the WiFi technology prevalent in most modern devices, but with this feature comes a number of consequences. Per the RFC (Requests for Comments) documentation, client devices (your smartphone) send out PRQs (Probe Requests) which look for networks to which the device had previously connected. With this in mind, the focus of the research here was to exploit this technology and develop a distributed tracking and data interception framework capable of analyzing and interpreting collected data. The purpose of the software would be to track (in both real-time and a historical mode) the devices operating within range of the host device, and to track the people who own them. Each Snoopy drone collects every observed probe-request, and uploads it to a central server (timestamp, client MAC, SSID, GPS coordinates, and signal strength). On the server side client observations are grouped. Using these observations, we can potentially geo-locate network SSIDs to GPS coordinates.

62 C Design and Construction of an Operational Multwii Quadcopter

Kyle Spickler, Matthew Pilch, Patrick Hyden, Brennen Morrison, Austin Snovak
Youngstown State University *Dr. Salvatore Pansino and Professor Kin Moy , Mentor*

Unmanned Arial Vehicles (UAV's) have been evolving to suit a variety of applications, where piloted aircraft is unsatisfactory. The combination of weight restrictions, untethered communications, and harsh environments pose design challenges that require unique solutions. A quadcopter is a UAV which utilizes four counter-rotating propellers to provide adequate thrust for stabilizing and accelerating the onboard power supply, receiver module, body weight, and any auxiliary attachments. The team goal is to design and build a quadcopter with optimal thrust and battery life for various applications through the use of rapid prototyping and experimental data feedback. The quadcopter will be operated via remote control or based on preprogrammed GPS coordinates. Applications associated with a quadcopter comparable in size include: video surveillance, payload delivery, automated rapid charge capabilities, and various methods of control. General quadcopter parameters can be modified through

changes in the control program, or physical adjustments to the motor and propeller.

63 A The Internet Lock

Brandon Mirto
Youngstown State University *Jason Zapka , Mentor*

The Forget Me Lock' describes the development and implementation of a door lock controlled through the internet. By utilizing a raspberry pi 2, various electrical ciruit components, and a simple door lock I developed a motor driven lock that will also monitor the status of the lock (i.e. locked or unlocked). I used python to program the circuit and it's monitoring capabilities. Then by using the android design suite I was able to connect the raspberry pi through the internet to an android application to monitor and control the lock. Whether it's because you think you forgot to lock the door to your house or you forgot your key to get back in the house, 'The Forget Me Lock' can take the worry out of life keeping you both calm and safe.

64 B Going Green Saves Green – An optimization study utilizing Wind and Solar Technologies

Steven Fairley, Silvia Cortez, Khawaja Mahwood, Actavius Mills
Cuyahoga Community College *Dr. Bilal Bomani and Dr. Clarence Johnson, Mentors*

The three most important global resources are water, food, and energy. We are conducting a six week energy study, researching a Micro-Grid concept at NASA GRC's Green-Lab Research Facility. We aim to determine the feasibility of utilizing Wind and Solar Energy Technologies as a 100% clean energy concept with a goal of implementing this concept in modern day or new construction homes. The NASA GRCs Green-Lab Research Facility is powered, in part, by using alternative and renewable energy from solar and wind technologies. This reduces the reliance on current on-the-grid electricity sources. The main goal of this study is to optimize the wind and solar energy devices utilized by the Green-Lab to achieve 4 to 6 hours of "free" energy per day. We present historical Green-Lab clean energy data, cost-benefit analysis and recommendations for future implementations.

65 C Study of Effects on Production Economics using 3D Printed Sand Casting Molds

James Limperos, Dakesha Jordan, Matthew Manna, Dylan Pflager
Youngstown State University *Dr. Guha Manogharan and Dr. Brett Conner, Mentors*

Sand casting is one of the oldest manufacturing processes used to produce components of varying sizes for several applications ranging from an engine block to complex manifolds. The basic principle of sand casting is the pouring of molten metal into a 'cavity' with the desired shape in a sand mold and solidification. Complex part designs which have internal cavities require molds with cores which are very expensive and time-consuming for each casting run. Additive Manufacturing has revitalized the traditional sand casting through 'binder-jetting' to produce the molds directly without patterns, cores, etc. This study presents the economic advantages of using binder-jetting to produce complex parts. A case study is presented to develop decision criteria for traditional molds and additive manufacturing molds.

66 A Using 3D Printing to Understand Customer Engagement during Active Customization

Ashley Martof
Youngstown State University *Dr. Brett Conner and Dr. Kerry Meyers, Mentors*

Additive manufacturing also known as 3D printing is an emerging technology. Additive manufacturing can displace traditional manufacturing when products have high levels of complexity and/or customization. Today, most consumers have little experience in actively customizing a physical product. The goal is to put the word "custom" back into "customer" by making individuals comfortable in actively designing a product. In order to get a clear understanding of how customers respond to active customization, a survey was designed, disseminated, and the results were analyzed. Individuals were allowed to customize a product in three different ways: Selection Only, Mentored Customization and Self-Directed Customization.

67 B Dispersion of Polymer Functionalized Gold Nanoparticles in a Novel Liquid Crystal Block Copolymer Matrix

Nick Hampu, Justin McMahon, Colter Flynn, Matthew Hively
Case Western Reserve University *Russel Composto (University of Pennsylvania) , Mentor*

Thin films composed of liquid crystalline polymers and gold nanoparticles were prepared in order to gauge the extent of NP dispersion in the matrix. AuNP were grafted with PS brushes and dispersed into PNBCB12 and PNBCB12-b-PNBPEO matrices and observed with SEM and UV-Vis. The resulting SEM images show well-dispersed NP, which corresponds to the lack of a blue shift in the UV-Vis spectra for these films. Both AuNS and AuNR remain well dispersed in both annealed and unannealed films, indicating that the dispersion is a structurally driven rather than thermally driven process. The low α ratios for both the homopolymer and BCP films allow for the matrix to wet the PS brush coating on the AuNP to enable the repulsive forces necessary for this type of dispersion.

68 C FARO Inspection of Edge Forgings Prior to Hot Forming

Joe Novak, Abdallah Rahmy, Faraaz Hussain, Matthew Szigeti, Ogoegbunam Okolo
Case Western Reserve University

Modern turbofan engines have begun using carbon-fiber composite fan blades in some applications. In many cases, a titanium edge forging is required to allow the blades to cut through any debris which the engine may encounter. After forging, these parts often have bow and twist issues with significant variation that precludes them from being measured using traditional inspection equipment. This project documents the use of a FARO Edge laser scanner to inspect parts prior to a hot forming operation. The resulting data can allow engineers to make adjustments to the hot forming press that will minimize the number of hot forming operations needed to bring the parts into conformance.

69 A Autonomous Glider

Kevin Candow
Cleveland State University *Dr. Dan Simon , Mentor*

A radiosonde is a small telemetry package that measures temperature, pressure, wind speed and humidity at various altitudes using a weather balloon. Over 200 radiosondes are launched daily by the national weather service, however less than 20 percent of radiosondes are recovered. This project designs a Microchip PIC-based flight navigation computer to guide a glider with a 300 gram radiosonde payload to a predetermined destination using GPS. In practice, this glider will save the National Weather Service thousands in radiosonde costs. The PIC microcontroller calculates current heading and desired heading towards the landing position from the GPS coordinate, and sends a pulse width modulated signal to the rudder servo to adjust the current heading to align with the desired heading. A Condic procedure is implemented in C language to calculate the inverse sin function. The success of the design is measured using a simple closed loop flight simulator application that reads the PWM output for the rudder and adjusts the change in GPS coordinates proportionally to the PWM duty cycle.

70 B Design of an Engine Air Particle Separator for Unmanned Aerial Vehicle Applications

Jason Wolf
Cleveland State University *Dr. Majid Rashidi , Mentor*

This project seeks to explore the effectiveness of an Engine Air Particle Separator (EAPS) for situational use on Unmanned Aerial Vehicles (UAVs). An objective of the Air Force Research Laboratory (AFRL), the development of a EAPS with greater particle separation efficiency is necessary for the increased performance of UAV's that are routinely deployed to remote areas in support of military, civilian, and humanitarian efforts. The EAPS will mount onto a UAV engine air intake and act as a pre-filter to an already existing inlet barrier filter, thus increasing the operational life and performance of the UAV. This paper explains the design of an EAPS that employs an Inertial Particle Separation (IPS) technique and focuses on separating particles in the 10-200 micron range. Several IPS design geometries and flow simulations were explored using SolidWorks 2014 Education Edition to maximize

separation efficiency while considering other performance parameters such as weight and pressure drop before initial component testing is performed.

71 A How Technology has Improved Car Engines

Luka Komljenovic, Jeremy Harper, Robert Piskura, Jonathan Wright
Cleveland State University *Dr. Jon Negrelli , Mentor*

We will be creating a poster about the topic of automotive engineering. We will be talking about how car engines are becoming more efficient and more powerful compared to as how they performed several decades ago. Different types of technologies have been developed that help increase performance while maintaining fuel economy if not improving it. Some types of technologies include turbochargers and superchargers that work to compress the cylinders causing them to use less gasoline but produce more power. For example Ford has implemented EcoBoost into many of their vehicles and how Volkswagen has become heavily reliant upon turbocharges for running their cars. Hybrids have also become more common in today's world ranging from economic cars like the Prius all the way to high performance cars like McLaren P1. These topics will be the general basis of our poster which correlates to smaller more efficient motors.

72 C Baja Car Suspension

Zack McCarthy, Nick Lees
Case Western Reserve University

This project was focused on the design and manufacturing of the front and rear suspension for a baja car. The car is supported by a double A-arm style independent suspension. Testing was done on previous models during the design process in order to establish the most practical convention for construction. A majority of the manufacturing was completed in the Bingham shop at Case Western Reserve University.

73 A Integration of Prosthetic Hands and DC Motor Control

Antonio Guglielmi, David Pendleton
Cleveland State University *Dr. Dan Simon , Mentor*

Prosthetic hands have been in development for many years; however, with the recent uprising of 3D printers, it has become possible to make modular, cost effective, and efficient prosthetics. Although prosthetics can be used without aiding electronics, many prosthetic hands gain higher levels of functionality when paired with electric motors, microprocessors, and various electromechanical systems. Modular hand designs consist of different motor configurations ranging from a simple design that controls all fingers at once, to a more complex design that simultaneously controls and monitors the movement of each finger individually. Regardless of the configuration, DC motors require proper control to allow the hand to open and close at the proper rate, to apply correct pressure to pick up objects, and to ensure the safety of the end user. All motors will be controlled by a microprocessor, similar to those found in an Arduino development board.

74 B Baja Car Body Panel Attachment

Richard Ferry, Alex Fitzgerald, Carmen Marinucci
Youngstown State University *Dr. Hazel Marie , Mentor*

Our group was assigned to work with the Baja Car team. Focusing on the attachment method for the body panels, the main purpose of the research project was to reduce the total weight of the car to make it faster. We researched multiple methods, but also had to consider SAE safety and regulation constraints. Attachment methods such as metal ring clamps or zip ties are extremely light, but do not meet these requirements. We determined that welding short segments of 3/32'' diameter carbon steel rod to the frame of the car was comparable to the strength of the fastener tabs that are normally used, but significantly lighter. This is demonstrated on a small test frame that we welded together to represent the frame of the car.

75 A Coefficient of Friction Testing Machine

Dakota Joy
Youngstown State University *Dr. Solomon , Mentor*

To meet the need of local company Delphi, a friction testing machine was redesigned for more accurate friction coefficient testing of different materials without vibration interference and a more controlled testing speed. Plastics and elastomers were the main focus in material selection to more accurately determine the forces need to assemble connectors during the manufacturing process.

76 B High Strain Rate Response of Polymethylmethacrylate

Nicholas Bi, Veronica Rivard
Case Western Reserve University

In many engineering applications, materials are subjected to high strain rate loading, or impact loading. Under these conditions, the mechanical properties of many materials are not fully understood and can vary significantly from its accepted quasi-static behavior. In this project, the Split Hopkinson Pressure Bar (SHPB) technique is used to test Polymethylmethacrylate (PMMA), also known as Plexiglas, under strain rates in the range of 1000-2000 1/s. The data is then interpreted as a stress-strain curve of the sample at a given loading rate.

77 C Innovation Of Proximal Interphalangeal Finger Joint

Nick Buffa, Ian Schantz, Rana Abu-Hashim, Matthew Hetzel
Youngstown State University *Dr. Jae Joong Ryu , Mentor*

The purpose of this project was to design and innovate a Proximal Interphalangeal Joint for use in replacement surgery. Our goal was a 2 piece design which allowed biaxial movement. The model was then brought to life using 3D printing and modified until our goal was achieved.

78 A Valveless Pulse Detonation Engine

Tim Shreeve, Mike Bestic, Zach Bromley, Sam Faykus, Mike Savopolous
Youngstown State University *Dr. Ganesh V. Kudav , Mentor*

Valveless Pulse Jet Engines are a primitive means of propulsion that are simple to manufacture and operate at a low cost. There earliest application was as the engine for the German V1 Rockets. They utilize a vacuum created by the geometry of the jet and the ignition of gas. While pulse jets are a fairly simple machine, there was room for design and some interesting analysis. The initial aim was to design a pulse jet engine utilizing references available online and any analysis obtained with the aid of software. To cool the pulse jet, it was initially believed a water jacket would yield the best performance. However it became evident that a water jacket would remove the productive energy of the jet. Upon further inspection the realization was reached that a series of radiation shields to contain the heat would make the pulse jet safe for operation without reducing energy output.The purpose was to prove that a pulse jet can be a useful method of propulsion, if the wasted heat can be contained utilizing radiation shielding.

79 B Literal Moon Shot: Is it practical?

Paul Billig
Kent State University

In Jules Verne's fictitious novel "From the Earth to the Moon", the setting is New England just after the civil war. A group of artillerymen, who no longer know what to do with themselves, decide that they are called to conquer the Earth's closest relative, the moon. A cannon of incredible proportions is constructed in Tampa, Florida, and it is fired, sending an aluminum round into outer space. This book was written in 1865, but with the best scientific information of the age. So, how far have we come? How close to possibility was Jules Verne? What would it take to make an actual "Moonshot" cannon, and may it actually be feasible? This project researched all of these questions.

80 C Using 3D Printing to Integrate Thermal Management into High-Altitude Flight Vehicle Structure
Caitlyn Rodomsky, Lauren Rodomsky, Michael Seifert
Youngstown State University *Dr. Brett Conner , Mentor*

The CubeSat, a small and cost-effective satellite alternative for aerospace education and innovative prototyping, was developed by California Polytechnic University and Stanford University in 1999. This project aimed to fabricate a CubeSat using additive manufacturing processes in the structure to increase structural efficiency and thus increase available space or power for payload. The satellite will also collect data and video. Since the manifest process for rocket launch to orbit takes many years, the team chose to use a high altitude balloon for flight to the near-space environment. The vehicle used an Arduino board to record video, data, and control operations; and used 3d printed materials for the structures. All operations and parameters were tested on the ground before the balloon flight to increase confidence of operation during flight.

Mathematics, Statistics, and Computer Science

81 A Interest Theory
Rebecca Finley, Alana Kemp, Jaime Eiben
Kent State University *Morley Davidson , Mentor*

Our project is based on the best situations to use different types of interest such as Simple Interest, Compound Interest, and Nominal Interest. It explains when it is best to use in any time frame from fractional periods into years and what some equivalent rates of interest would be accordingly.

82 B Efficiently Generating Network Links for Bluetooth and Other Mobile Networks
Jenna Wise, Sasha Monroe, Tyler McVicker, Kevin London
Youngstown State University *Richard Goldthwait , Mentor*

A computer algorithm has been implemented that quickly calculates a network configuration for a network with a large number of wireless computing units (or “nodes”.) The algorithm, based on the calculation of a minimal weakly connected dominating set (MWCDS), requires as input the distance from each “node” to each of the other nodes. One of the team previously wrote a computer program that implements an algorithm for finding the MWCDS. Two team members focused on writing a graphical user interface (GUI) that allows the user to “see” the network that has been computed by the main program. The other two team members applied our program to simulate network creation in Bluetooth networks.

83 C Simulated Organic Light-emitting Diode Optimization
Michael Skowrons, Michelle Waugh
Kent State University *Dr. Bjorn Lussem , Mentor*

The optical properties for an organic light-emitting diode (OLED) are modeled by the transfer matrix algorithm. Using the commercially available software package SimOLED, we adjusted the dimensions of the organic layers of the OLED to achieve the optimal optic properties for a red OLED. We also studied the underlying model the program uses for its calculations, and how it can be used to determine the emission of the OLED at different wavelengths and viewing angles.

84 A Cryptography
Robert Hurley, William Ivancic, Michael Min, Matthew Stewart
Cleveland State University *Dr. Luiz Martins , Mentor*

Our poster will explore the history and evolution of cryptography from its early stages into what it is today. While

early encryption involved simple and often easy to break ciphers, such as substituting each letter with the next in the alphabet (cipher wheels), modern encryption uses complex mathematical algorithms and protocols that can only be done with modern technology.

85 B Euclid's Algorithm

Alex Phipps, Sudeshna Chakraborty, Mark Heller
Cleveland State University *Dr. Ivan Soprunov , Mentor*

In mathematics relationships between numbers have always been extremely important. One relationship is the greatest common divisor (GCD) between two numbers. The GCD is the largest number that divides both numbers without leaving a remainder. One way to find this number is to list out all the factors of the numbers and match them up. This works well for small numbers but can become quite tedious for large numbers. In approximately 300 BC a Greek mathematician named Euclid came up with an algorithm to quickly find the GCD. It uses the principle that the GCD does not change if you replace the larger number with the difference of the original two numbers. This algorithm is used today in cryptography for securing internet communications as well as breaking them. We will use Java to demonstrate this algorithm and demonstrate the possible runtimes.

86 C Use of Prime Numbers in Cyptology

Lisa Stelmarski, Leon Bykov, Daniel Arraj
Cleveland State University *Dr. Luiz Martins , Mentor*

Our project focuses on the use of prime numbers in encryption. Encryption is the process of encoding information, such as text, so that only authorized parties are able to access the information. This allows information to be delivered safely by requiring a key to decrypt the message and staying hidden otherwise. An effective technique in encryption is using very large prime numbers, which are hundreds of digits long. Our poster will highlight the history of encryption, the math behind it, how it developed into what it is today, and where it could be going in the future.

87 A Increasing Retention of Math Skills

Mitch Gillespie, Ronan Keane
Kent State University *Dr. Andrew Tonge , Mentor*

More and more people are enrolling in higher education than ever before. As a by product of higher education, most students will take more math classes, with increasing difficulty. More often than not, students have received appropriate math instructions prior to college, but are not retaining vital information that future math courses add on to. Can classes be taught in a way to help students retain more information? This project first addresses theoretical approaches in the literature before considering a case study conducted at Kent State University. In the study, sections of remedial math classes were divided into control and experimental groups taught by the same instructor. The experimental groups received no extra class time but were required to spend extra in-class time reviewing. The study suggests that compulsory review will increase total student mastery.

88 B ISBN Numbers

Erik Fogwell, Nicole Fogwell
Kent State University *Artem Zvavitch , Mentor*

The method behind creating ISBN numbers, their significance, and how they can be checked and used.

89 C Hackenbush Blue and Red

Morgan Snyder, Taylor Thomas, Anna Lombardo
Kent State University *Corey Lyons , Mentor*

Hackenbush Blue and Red is a two-player partizan game that is not a game of chance, but instead has a calculated predetermined winner. This poster is designed to go deeper into the mathematics behind Hackenbush Blue and Red

in order to explain how to determine the winner by finding the game values using the simplicity rule.

90 A Drafting Running Backs
Stanley Zalewski, Matthew Grissom
Kent State University

In the multi-billion dollar industry that is the National Football League, draft picks can hold the keys to a successful franchise. Historically, some of the greatest draft picks of all time have been running backs. But what distinguishes a seventh round All-Pro from a first round bust? This project tackles this yearly dilemma that faces general managers across the league.

91 B Sparse Recovery via Basis Pursuit
Zachary Emrich
Kent State University *Dr. Benjamin Jaye , Mentor*

My project investigates the use of subgaussian matrices and the discrete Fourier transform matrix for sparse recovery via basis pursuit.

92 C An Exploration in Intervals of Simpson's Paradox
Julian Sobieski, Raymond Gontkovsky
Kent State University *Dr. Darci Kracht , Mentor*

There exists specific scenarios in which two individual entities are evaluated and compared in two categories and one entity maintains a higher average in both given categories, while the other entity maintains a higher average overall; this occurrence is known as Simpson's Paradox. The discrepancy between the intuitive understanding of averaging averages and the correct method in adding averages leads to the paradoxical nature of Simpson's Paradox. With our project, we aspire to identify which conditions must be present for Simpson's Paradox to occur. First, we will define a model for Simpson's Paradox. Second, we will explain an applied example of Simpson's Paradox. From there, we will present our research in classifying interval restrictions which allow Simpson's Paradox to occur or prevent it from occurring entirely. Finally, we seek to apply our findings to 3-,4-, and n-category based models.

93 A Security Measures for File Sharing in a Cloud Environment
Joseph Gantz
Youngstown State University

Data storage is an appealing service of the Cloud to modern users. The primary concern included with this service is the necessity to trust that one's data is not manipulated by the service provider. In this poster, we explain how both commutative and fully homomorphic encryption schemes can provide the user a way to securely store data on the Cloud while maintaining the ability to share among other permitted users. We also examine the Shamir Three-Pass Protocol and introduce a scheme based on the RSA protocol to allow multiple users to share files on an untrusted server.

94 B Sudoku Solver Program Utilizing Logical Solving Techniques and Recursive Backtracking
Jonathan Boyd, Emily Hoopes
Kent State University *Dorothy Klein , Mentor*

The Sudoku solving program operates on a 2-dimentional array of classes, which contain the given or assigned values for each cell, as well as the candidates of possible numbers for these cells. With this structure the program can operate on and update the cell's candidate values, allowing it to utilize the more advanced solving techniques such as 'Linked Doubles' and 'Swordfish'. In addition to these solving techniques the program also contains a function that demonstrates a recursive backtracking solution. The recursive backtracking function tests possible

candidates for a cell and continues to check values for subsequent cells until it either finds the solution or runs into unresolvable problems and backtracks to a previous cell to try another number.

95 C Concurrent Face Routing for Vehicular Ad Hoc Networks

Essien Cobham
Kent State University *Mikhail Nesterenko, Ph.D. , Mentor*

Given the inherent potential for improvement in road safety, traffic management, and passenger convenience, Vehicular Ad Hoc Networks (VANETs) have garnered significant research interest in recent years. However, high node mobility combined with a lack of infrastructure and stability on such a network renders routing-table based schemes nonviable. Geometric routing protocols provide an attractive solution to the routing problem on VANETs due to their scalability and statelessness. Thus, we apply Concurrent Face Routing (CFR), an asymptotically optimal geometric routing algorithm achieving improved path stretch relative to other known geometric routing algorithms. We consider possible reduction in packet overhead during transmission sessions with the addition of a Backtracking algorithm (CFR+B). Furthermore, we compare CFR+B against other popular routing algorithms such as GPSR, GOAFR+, AODV, DSR, and flooding via simulation with parameters including node density and session length.

96A Detecting and Correcting Errors in Finite Arbitrary Length Code Words

Wayne Fincher
Kent State University *Dr. R. Aron , Mentor*

In this work, we shall investigate error detection and correction in binary messages of finite arbitrary length. This is an important area of research because of the increasing reliance on digital communications, which are based on digital messages. We build on the work of Richard Hamming who contributed the Hamming distance which is a method for measuring the difference between two segments, i.e., words, of a message. Assuming errors only change one component of a code word into some word, the following are three questions we seek to answer. How many detectable code words can be packed into a space with words of length n? What is the least efficient packing of detectable code words? How many correctable code words can be packed into a space with words of length n?

97 B Predicting Protein Subcellular Location

James Munyon
Youngstown State University *Drs. Andy Chang and Jack Min , Mentor*

Proteins perform many functions within the cells of organisms, and these functions are closely related to their subcellular location: where in a cell they reside. Protein sequences are entering databases faster than their subcellular locations can be empirically measured, so there is a need for predictors that can accurately predict protein subcellular locations. One numerical representation of the amino acid composition of proteins is called Pseudo Amino Acid Composition, turning a long string of amino acids which make up a protein into a length 20 (or greater) vector (whose first 20 values are the normalized occurrence frequencies of the 20 "standard" amino acids). Through this transformation, initial methods of Random Forests, Adaboost, and SAMME will be applied to protein data to establish "baseline" predictive performance results, and then many prediction methods found in the literature such as Support Vector Machines and the Covariant Discriminant Algorithm will be applied as well.

98 C ID Numbers and What They Really Mean

Matthew Waaland, Corey Bryant, Rebecca Leppelmeier
Kent State University *Jenya Soprunova , Mentor*

An in-depth explanation of methods to decode identification numbers and pull information out of them. Shows examples of information that can be pulled from the sequences, including names, birthdates, sex, and eye color, as well as how to derive this information. Also will show how check digits can be found, which are important to checking the validity of identification numbers.

99 A Linear Transformations in Computer Graphics

Benjamin Wilson, Jonathon Mudrinich, Steven Schiffhauer
Youngstown State University *Dr. Padriac Taylor , Mentor*

In this project we researched the use of linear transformations, matrices, and homogeneous coordinates in computer graphics. The transformations researched include translations, rotations, shearings, and scalings. We created a program in MATLAB that allows us to animate an object using these transformations.

100 B Markov Chains in America's Pastime

Drew Saluga
Youngstown State University *Tom Wakefield , Mentor*

I studied occurrences of America's pastime (baseball) to see if any characteristics, trends, appearances, or tendencies could be explained mathematically. After close examination of the game, I made a Markov Chain model of the game, namely the Cleveland Indians' 2013 season, to model the number of runs scored in an inning, a game, and across the entire season.

101 C Snail Population Dynamics in Seasonal Habitats.

Gavin Brown, Kristin Kirkland, Whitney Miller
Case Western Reserve University

Snail species are intermediate host for Schistosomiasis transmission, with parasite circulating between human and snail hosts via larval stages. Clearly, snail population dynamics and infection plays important role for accurate prediction of Schisto transmission and control. Field data from Kenya used in our study, shows snail populations and their habitats undergo strong seasonal variations, following rainfall. In this study, we developed dynamic snail population model in such habitats. Snail populations are described by spatially distributed densities of its two stages (young-adult). The basic mechanisms in our system include population biology, as well as snail mobility in response to changing habitat. The model has two components (i) dynamic habitat driven by precipitation and loss (evaporation); (ii) dynamic snail populations competing for resource. The model was calibrated and validated using field data collected in Coastal Kenya, where seasonal rainfall is the principal driving force of changing and snail growth.

102 A Winning the Game

Andy Manka, Ryan Adamek, Abigail Kramer
Kent State University

Making decisions in strategic games is often considered to be obvious but is there proof that one decision is actually better than another? Can games be simplified to show that certain strategies are always more effective. In this study three types of games were studied, tic-tac-toe, a simple child's game, Euchre, a card game, and Risk a board game. In tic-tac-toe it was studied if the opening moves could determine the outcome of the game. The initial conditions that lead to a guaranteed win in Euchre were calculated. The likelihood of victory with varying numbers of die in Risk was also investigated. In all three of these games by neglecting human error after a certain point it was found that the outcome of certain moves was highly predictable. With this data any similar games can be won by following simple moves.

103 B Public Key Encryption: The RSA Algorithm

Lynne Cheravitch, Jillian Gaietto, Jessica Pugliese
Kent State University *Dr. Gang Yu , Mentor*

Over the past decade, the frequency and sophistication of intrusions into U.S. government, private industries, and personal databases has grown exponentially. As the scale of cybersecurity threats tips to threaten national, economic, and personal security, the need for layered and sturdy defenses to protect vital networks and

infrastructure is growing. One of the most successful public key encryption methods is the RSA Algorithm, which utilizes the mathematical difficulty of factoring the product of two prime numbers. Our goal is to provide interested parties with an understanding of how the RSA Public Key Algorithm works, and how it benefits and protects our information technology-dependent society. Our combined knowledge was extracted from declassified written materials, consultation with our supervising professor Dr. Gang Yu, and experience working with government agencies.

104 C Properties of the First Hurwitz Equation

Josiah Banks
Youngstown State University *Jacek Fabrykowski , Mentor*

A Hurwitz Equation is a diophantine equation of the form $x_1^2 + x_2^2 + x_3^3 + \cdots + x_n^2 = ax_1x_2x_3 \ldots x_n$ where a and x_i are positive integers for each $i = 1, 2, \ldots n$. This equation has been studied by many great mathematicians. In this talk we present original research on the Hurwitz Equation with $a = 1$ and discuss divisibility properties as well as operations to generate an infinite number of solutions. Other aspects looked at include: the solution space forming an infinite group and fixed divisors of the orbits of the group. Lastly, we will present unproven conjectures formed in the process of research.

105 A Hearing the Shape of the Universe: A Correlation Matrix Search for Oblique Torus Topologies

John Dulin, Lucas Flowers, Hunter Overstreet
Case Western Reserve University *Glenn Starkman , Mentor*

Recent attempts to discern the shape of the universe, particularly its topology or “connectedness”, have expanded to examine the full CMB sky for telltale correlated patterns of intensity. While helping to constrain the universe's possible topologies, these hunts have not discovered the universal shape. This project aims to extend that investigation to a broader set of topologies, including some deformations of known spaces using the known correlation function comparison method. These deformations include the oblique rectangular and hexagonal prisms, as well as their associated twisted spaces. As the correlation function comparison utilizes the full CMB sky, we build numerical tools to generate the CMB sky’s correlation matrix, which quantifies the statistical correlation of the intensity of every pixel of CMB light data with that of every other. The ultimate goal of these generalizations is to detect the unique discreteness of waves in a cosmologically non-trivial (topologically interesting) space. To apply this idea to the three-dimensional space of the universe and its two-dimensional CMB, we will be tiling the 3D universe at the surface of last scattering with the eigenmode solutions of the Laplacian operator on candidate topologies. From these models, we will then compare the observed CMB anisotropy with the expected radiation emitted from our set Laplacian solutions, with the goal of finding a single statistically significant correlation between one of the possible topologies and the observed CMB.

Case Western Reserve University

Cleveland State University

Abas, Fadi	51	B
Alberto, Andres	33	A
Arraj, Daniel	86	C
Barr, Matthew	15	B
Bartosh, Annie	7	A
Bianco, Santino	3	C
Blatnik, Marie		A
Bowling, Mark	38	C
Bucey Leopold, Rachael		A
Bykov, Leon	86	C
Candow, Kevin	69	A
Chakraborty, Sudeshna	85	B
Cook, Randolph	2	B
Crow, Robert	12	A
Derevjanik, Amelia	5	B
Dimo, Joana	33	A
Fawzy, Lydia	4	A
Fienberg, Jeffrey		A
Gaeckle, Grace	36	B
Gerges, Daniel	34	B
Golias, Elizabeth	5	B
Guglielmi, Antonio	73	A
Gyorgak, Wayne	51	B
Hamman, Matthew	3	C
Hannawi, Rani	38	C
Harper, Jeremy	71	A
Heller, Mark	85	B
Hinton, Michael	43	C
Hurley, Robert	84	A
Isabella, Christopher		A
Ivancic, William	84	A
Jorgensen, Lisa	6	C
Kaptain, Tyler	50	A
Katsaras, Christine	20	A
Katzenmeyer, Jacob	43	C
Kennedy, Stephan	35	C
Kinn, Jenna		A
Kizys, Rene	20	A
Komljenovic, Luka	71	A
Kramer, Zachary		A
Kuhns, Lucas	50	A
Kulman, Daniel	29	A
Lange, Eric		A
Liggett, John	36	B
Lysyj, Matt	61	B
McCarthy, Julia		A
Merritt, Kayla	20	A
Miller, Morgan	11	B
Min, Michael	84	A
Morris, Adam	11	B
Mullins, Teisha	19	C
Nimrod, Benjamin	35	C
Nofal, Hytham	20	A
Oryszak Ley, Tristan		A
Pendleton, David	73	A
Phipps, Alex	85	B
Piskura, Robert	71	A
Pope, Christina	51	B
Resendes, Maria	3	C
Roy, Ericka	11	B
Rudy, Kyra	4	A
Santelle, Taylor	3	C
Seaman, Jaclyn		A
Seol Kim, Casey	27	C
Sinkovic, Brandon	61	B
Stelmarski, Lisa	86	C
Stewart, Matthew	84	A
Stoll, Jordyn	5	B
Suchan, Taylor	4	A
Sutadji, Michael	36	B
Swit, Nadia	5	B
Tarnay, Jonathan		A
Toth, Christina		A
Turk, Jodi	36	B
Wethington, Grant	4	A
White, Nick	61	B
Wolf, Jason	70	B
Wright, August	38	C
Wright, Jonathan	71	A
Zak, Elizabeth		A

Cuyahoga Community College

Adebayo, Aminat	45	B
Blue, Kristina	45	B
Cortez, Silvia	64	B
Fairley, Steven	64	B
Hicks, Johnicia	10	A
Jarik, Muna	45	B
Mahwood, Khawaja	64	B
Mills, Actavius	64	B
Smith, Asia	10	A
Thomas, Lisa	10	A
Turner, Nancy	10	A
Whitlow, Anita	45	B

Kent State University

Adamek, Ryan	102	A
Augustine, Courtney		B
Billig, Paul	79	B
Boyd, Jonathan	94	B
Bryant, Corey	98	C
Cheravitch, Lynne	103	B
Cobham, Essien	95	C
Cremean, Matthew	9	C
Eiben, Jaime	81	A
Emrich, Zachary	91	B
Fincher, Wayne	96	A
Finley, Rebecca	81	A
Fogwell, Erik	88	B
Fogwell, Nicole	88	B
Franjesevic, Adam		B
Gaietto, Jillian	103	B
Gillespie, Mitch	87	A
Gontkovsky, Raymond	92	C
Grissom, Matthew	90	A
Hoopes, Emily	94	B
Keane, Ronan	87	A
Kemp, Alana	81	A
Kramer, Abigail	102	A
LaDuke, Donovan		B
Leppelmeier, Rebecca	98	C
Lombardo, Anna	89	C
Manka, Andy	102	A
Palmucci, Kathryn	9	C
Pugliese, Jessica	103	B
Shumay, Jeffrey		B
Skowrons, Michael	83	C
Snyder, Morgan	89	C
Sobieski, Julian	92	C
Thomas, Taylor	89	C
Waaland, Matthew	98	C
Waugh, Michelle	83	C
Zalewski, Stanley	90	A