Category **BE** **L01** Honey of Mystery Investigation

Abstract The purpose of this project was to determine whether electromagnetic radiation, emitted from a cellular phone has any effect on honey bees. My hypothesis was that the electromagnetic radiation would disorient the bees and disable their navigational skills that they use to find their way back to the hive when out foraging for nectar from flowers.

I created two terrariums with identical groups of honey bees , placing a cellular phone by one of the terrariums, and observed and recorded the behaviors of both "control" group (without a cell phone/ presence of electromagnetic radiation) and "subject" group (with a cell phone/presence of electromagnetic radiation). I monitored daily for any behavioral differences in the "subject" group from the "control" group and recorded any observations and data.

I found that the group of bees with the cellular phone showed agitated and abnormal behavior, forming small clusters and flying around in bizarre patterns. While the group of bees without a cellular phone showed to be more calm expressing a more normal behavior. They remained in one place in the terrarium, which was established as a sort of home base similar to a hive. They left to obtain food set up in the terrarium and returned to the "home base". These observations seem to indicate that the electromagnetic radiation emitted from the cellular phone does disorient the bees and overall bother them; but since my experiment was held in a short distance, controlled environment I could not test to see if the bees would be able to find their way back to their hive by placing a cellular phone by it.

I would conclude that the electromagnetic radiation disorients the bees; however further investigation is needed to determine whether the electromagnetic radiation would hinder them from finding their way back to the hive. Using a hive in the wild and placing a cellular phone by it while worker bees are out collecting nectar would show whether or not the bees would be able to find their way back to the hive. Maybe a tube or something to direct the path the bees have to take back that passes through or by a high level of EMR could be used.

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"Mobile Phones and Vanishing Bees" http://www.i-sis.org.uk/MobilePhonesVanishingBees.php (accessed Dec. 15, 2009)

Category **BE**   **L02**   Throwin' Heat

Abstract   I feel your size doesn't affect your velocity but your mechanics does. If a pitcher has a shorter arm, then he'll have a higher velocity fastball. I conducted an experiment to test my theory that arm length is irrelevant to the velocity of your fastball. My procedure was, find 15 guys, measure the length of their throwing arm from middle finger tip to shoulder, 18.4 meters from mound to plate, make sure the weather is very similar for each participant, have them throw 15 warm up pitches, record the next 10 pitches (only fastballs) with the radar gun, take the average of the ten pitches and record, make a chart with arm length on the x axis and speed on the y axis, analyzed my data, compared the data of speed from short arm pitchers to long arm pitchers and seen if there was a relation, wrote my conclusion proving or disproving my hypothesis.
Arm Lengt-h cm74 75 76 74 71 75 73 727874 76 74 72 79 76
Avera--ge velocity meters/sec30.085792 31.382208 30.890464 30.84576 31.382208 33.215072 31.82924834.019744 30.1752 29.459436 31.113984 31.2928 30.935168 30.532832 31.2928

My data proved that the length of your arm doesn't affect the velocity of your fastball. I was pleased with my results because I wanted to do an experiment that proved to myself and others that size doesn't play a role in pitching.

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Category **BE**   *L03*   Theory of Reciprocity on Donor Behavior

Abstract   When visiting Costco on a weekend it is possible to eat the equivalent of a meal without spending a dime. Why is this? Do Costco and its suppliers believe that after tasting a sample people will like it so much more they will buy it? Or are they counting on reciprocity, the feeling that if someone is given something, they must give something back.

The purpose of this experiment is to determine if the theory of reciprocity can have a positive effect on donations, specifically, in person donation solicitations. At some Salvation Army Red Kettle sites, some subjects will be offered a small token (a wrapped piece of candy) prior to being asked to donate, others will just be asked to donate. The ratio of subjects that donate when they receive a token versus those that donate without receiving a token will reveal the effectiveness of this approach.

Bibliography

Using MMORPG data to validate psycho-dynamics of collaboration

Abstract   Researchers have noticed that virtual environments such as EverQuest II serve as major mechanisms for socialization and learning. By observing various aspects within the virtual worlds, we can better understand behavior and interactions in the real world.

The purpose of this study was to analyze various datasets (provided by Sony Entertainment) containing information obtained from the game EverQuest II. Part of my analysis included placing the twenty-four available characters classes in clusters based on various factors including play time, grouping (collaboration), and the types of tasks completed in order to determine which classes are more similar and which classes advance faster or perform better.

Results of the grouping analysis show that certain collaboration improves task performance in the virtual world. It will further allow potential gamers to choose which character they should play depending on what kind of an experience they would like to have. Additionally, the results will provide Sony Entertainment with a tool that will allow the company to see whether or not the game is being played as expected. Researchers can use the game to simulate human interactions and to determine when collaboration is most effective in real world tasks.

Bibliography   http://everquest2.station.sony.com/gameinfo/classes

Category **BE** **L05** Preference of Facial Symmetry

Abstract The purpose of this experiment was to discover if a perfectly symmetrical face is the element that makes a person attractive, as well as to supply a statistical understanding of psychological behavior within a diverse population, consisting of gender, ethnicity and age. The objective of this experiment was to have at least 100 people anonymously fill out forms stating whether they found a symmetrical face more attractive than an asymmetrical face. In order to conduct this experiment, six sets of photos were created. Each set contained three facial pictures of the same person, in which 2 of the pictures were perfectly symmetrical and the third being asymmetrical. To generate a symmetrical image, the photograph was first bisected in half. Then a mirror image was made to both the right and left half of the face. When the mirror images were matched up to its original half, this resulted in two perfectly symmetrical faces, as well as the original face (which was asymmetrical). The collection data consisted of 112 people selecting one image per set which they found the most attractive. The completed form, including the six images they found the most attractive, consisted of the individual's age, ethnic origin, and sex. The overall analysis of the data resulted in an approximate 2 to 1 preference to an asymmetrical face verses both symmetrical faces. Even among the categories, such as gender, age, and ethnicity, an asymmetrical face was mainly the preferred version. This analysis of the experiment disproves that a perfectly symmetrical face is the main aspect that makes someone attractive.

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L06 Identifying Biophysical Properties of Iron Sulfur Cluster Assembly Proteins

Abstract Iron-sulfur proteins are important in cellular processes such as iron homeostasis and are also an integral part of our neurological functions. Iron sulfur clusters are found in all living organisms and serve as catalysts in chemical reactions, electron carriers in redox reactions, regulators of iron homeostasis, and stabilizers of protein structure. The aim of this project is to investigate biophysical characteristics and interactions of Fe-S proteins involved in the ISC assembly. The main focus lies on the essential role of Isu, the scaffold protein in the mitochondrial ISC construction, which combines the iron protein Frataxin and the sulfur protein NfsI. In this study, a mutant of the iron protein frataxin was isolated, purified, and studied to determine its binding ability with respect to Isu. Protein growth, isolation, and purification through Fast Protein Liquid Chromatography and gel electrophoresis were used in order to isolate Isu protein as well as Yeast and Drosophila Frataxin, the protein responsible for transporting iron to the binding site. The isolated and purified proteins were often concentrated through lyophilization, or freeze drying. After protein purification and concentration, activity assays were performed to test and confirm the role of Isu and Yeast Frataxin by comparing the amount of Fe-S clusters formed. In additional research, Isothermal Titration Calorimetry was also performed in order to learn more about the biophysical structure and binding affinity of each protein. The results of these tests confirm Isu's role as an essential protein in Fe-S cluster assembly. It also suggests that the Yeast Frataxin Mutant studied had only one iron binding site but still allowed for increased formation of iron sulfur clusters. These results can be used to better understand this constant and vital process of ISC assembly, which is thought to be among the earliest catalytic processes in the evolution of biomolecules.

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Category *BI* **L07** CACT and VNTR: Is There a Linkage

Abstract The purpose of this science fair project was to see whether there is linkage between VNTR and the deletion of CACT in Intron 8 of the CD72 gene. This is relevant because the deletion of CACT can be linked to kidney cancer.

My hypothesis for this project was that there is no linkage between VNTR and the deletion of CACT.

To do this experiment, polymerase chain reaction (PCR) was used to amplify DNA samples at the region of the deletion. Then, restriction enzymes were used to cut samples at the CACT sequence if it exists. In this way, DNA strands with CACT were shorter. Then, gel electrophoresis was used to sort DNA strands based on strand length. In this way, one can tell whether there is a deletion of CACT or not. To see if the samples have one or two repeats of the tandem repeat, the samples were amplified using PCR. As samples with two repeats are longer, gel electrophoresis was used to sort strands based on strand length to tell the number of repeats. Twenty-two samples were used in this experiment.

Statistical tests were used to analyze the data. a t-value of .,711 was derived from a correlation coefficient. Howevever, the critical value for a 95% confidence level is 2.2325. It was conclueded that there was no statistically significant linkage.

In the future,one could do this project with more samples. One might compare the probability to have a deletion of CACT in this intron between different groups of people for a future project.

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Category **BI**   *L08*   Effect of Various Antacids on the Digestion of Protein in Humans

Abstract   In order for protein to break down during the digestive process in humans, pepsin, an enzyme in the stomach, must be activated. This activation occurs at a pH level between 1 and 4. While hydrochloric acid provides the acidic environment in the stomach, pepsin breaks down the polypeptide bonds in the protein for digestion. However, antacids are used to soothe heartburns or upset stomachs by neutralizing the acid in the stomach, but make the break down of protein more difficult. The purpose of my experiment is to demonstrate which brand of antacid will most affect the digestion of protein. To test the effect of antacids, I created a solution similar to the stomach using hydrochloric acid and pepsin. I used pH paper to test the solution for a pH level of 1, an ideal pH level in the stomach. I then added albumin (protein in egg whites) and tested the pH level and the amount of protein not broken down in the solution at consistent time intervals using a spectrophotometer. This solution without antacids was the control. In a separate beaker, I recreated the same solution, but after adding the albumin, I also added an antacid and tested the amount of protein and pH level at the same intervals as the control. The antacids used were Tums, Maalox, Pepto-Bismol, and Rolaids.

Bibliography   http://biology.clc.uc.edu/courses/Bio115/pepsin.htm

Category **BO** **L09** The Electrical Influence on the Cultivation of Seeds and Growth of Oats

Abstract Plants are vital to our ecosystem as they provide food, which is extremely necessary in today's starving society. The purpose of this research is to study new non-reagent methods of intensifying the hydro-botanical growth process. In the experiment, the use of electrical variable frequency- modulated signals on water changes H2O's intermolecular structure, and ultimately creates fast and efficient growth of oats.

I started by putting the same number of seeds in six separate containers, each filled with water and either sand, soil or both combined. The sand was heated to 120 degrees Celsius to kill bacteria for a clean experiment. Three containers were placed in Faraday's cage that did not have a VFMS (variable frequency-modulated signals) generator (patented).

The other three were placed in a cage that did have a generator. I inserted a wire that connected to a VFMS generator into each of the three containers to send the electrical signals. The cages were connected to the ground to use the earthing system, which conducts zero voltage, so there were no outside influences.

I observed for eight days and measured the number of shoots grown and the length of their stems. The seeds grew in the sand best because the VFMS affected the water by creating less viscosity and a longer evaporation period. In conclusion, the influence of the VFMS on the water changed H2O's intermolecular structure and created sturdier and faster growing plants.

Bibliography

Category **BO** **L10** Effect of Salinity on Transpiration

Abstract In this project, the effect of salinity on the transpiration rate of corn plants was carefully investigated. Excessive accumulation of salt in the soil, which often occurs on cropland, creates drought-like conditions that impact the intricate functions of a plant. One of these important systems is the process of transpiration, closely associated with the ability to absorb moisture. I hypothesized that if the salinity of irrigation water for corn plants increases, then their transpiration rates will decrease.
An experiment was conducted, in which 20 corn plants were separated into 4 groups, one of them being the control group. The first experimental group received 0.1 gram of salt per liter of water for around 2 days. The second and third group received 0.2 and 0.3 gram per liter respectively. Due caution was taken to ensure that none of the solutions are in a concentration high enough to cause serious damage or death. Plastic tubes were placed over 2 leaves of every plant to collect the evaporated water. The amount of water transpired, the area of the leaves, and the time taken for transpiration are measured to calculate the transpiration rate for every level of salinity tested. The results showed little or no pattern of change in transpiration in the tested range of salinity. Further testing was done for a different range of salinity consisting of 0 to 3 grams per liter. A definite trend displayed a decrease in the rate of transpiration with increasing levels of salinity.

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Category **ME** **L11** Dendrimer-Dexamethasone Conjugates/Nanodevices for Targeted Delivery

Abstract Since the discovery and development of drugs is an expensive and tedious process, drug delivery systems are becoming increasingly popular. Dendrimers are repeatedly branched synthetic polymers with well-defined spherical structure, tailored surface properties, nanometer scale size (~5-10 nm), high degree of molecular uniformity, and ability to deliver drugs intracellularly. Since these surface functional groups can be used to covalently attach imaging agents, drugs, or targeting ligands for targeted delivery or controlled release, dendrimer nanodevices can be effective delivery vehicles.

The novel idea behind this study was to develop and characterize a small dendrimer-dexamethasone conjugate for delivery of dexamethasone in order to minimize systemic effects and increase efficacy at the targeted site. Dexamethasone, a synthetic member of the glucocorticoid class of steroid hormones and an anti-inflammatory and immunosuppressant drug, was conjugated to Generation 4 polyamidoamine (PAMAM) dendrimers using a coupling reaction with PyBOP as the coupling reagent. The synthesized conjugate was characterized using Nuclear Magnetic Resonance Spectroscopy (NMR), High Performance Liquid Chromatography (HPLC), and Matrix-assisted Laser Desorption Time-of-Flight mass spectroscopy (MALDI-TOF). Since it is often challenging to prepare delivery systems that can release the drugs within the target tissue in a predetermined manner, drug release mechanisms and profiles in conditions that these conjugates observe were understood to allow for a more accurate prediction of their in vivo efficacy.

Such an unique conjugate would serve as an optimal transport vehicle for delivering dexamethasone to specific tissues, thus providing treatments to the body in a predetermined fashion. This vehicle could eventually be utilized in patients with ocular diseases, such as macular degeneration or diabetic retinopathy, as well as potentially any other disease (including cancer and inflammation) in order that patients' lives would be significantly improved.

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The Effects of Progesterone in the Oxygen and Glucose Model of Ischemic Stroke

Abstract The purpose of this experiment is to determine if progesterone increases cell survival and decreases cell death in cortical neurons exposed to oxygen and glucose deprivation (OGD) in an in vitro model of stroke. Previous research has shown that progesterone decreases the amount of extracellular glutamate, inhibits the release of inflammatory cytokines, and increases mitochondrial function.

This experiment used cortical neurons from one day-old rat pups that were grown in culture to produce mature neurons with extensive processes. After seven days in culture, the neurons were deprived of oxygen and glucose for one hour to simulate the loss of nutrients that occurs in stroke. After one hour, progesterone was administered in six different concentrations to see if progesterone helped to increase cell survival and decrease cell death. Progesterone was not administered until an hour after the stroke to simulate treatment response to stroke since stroke cannot be predicted before hand. It is hypothesized that progesterone will increase cell survival and decrease cell death following ischemic stroke.

The results of this experiment support the hypothesis that progesterone increases cell survival in the oxygen and glucose deprivation model of ischemic stroke. The 1mM progesterone concentration provided the greatest benefit in terms of attenuating cell death, followed by the 10mM progesterone concentration. The 0.01mM and the 0.1mM concentrations of progesterone demonstrated no effect on the cells' survival. In addition, cytochrome oxidase staining demonstrated that all concentrations of progesterone inhibited mitochondrial dysfunction.

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Category **ME** **L13** Inhibition of tumor cell growth with capsaicin in hot peppers

Abstract Conflicting studies have debated whether hot peppers and their primary compound capsaicin are causes or inhibitors of cancer. With this is mind, my purpose for experimentation was to determine whether the level of "hotness," or capsaicin level, of a hot pepper would correlate to cancer cell killing activity in vitro. In order to test this, I made pepper extracts from ten different peppers varieties with different capsaicin levels, using ethanol to isolate the active compounds into a useable form. Extracts from both dried and fresh peppers were made because peppers for human consumption are commonly sold in both varieties. I used these extracts in carefully controlled concentrations to treat a variety of cancer cell lines and used multiple methods and assays to test cancer cell-killing and cancer growth inhibiting activity. Some of these methods included Trypan Blue assay to measure cell death, MTT assay to measure cell proliferation, VEGF assay to measure cancer metastasis, and Caspase 3/7 assay to measure apoptosis. The results showed that both fresh and dried pepper extracts were highly effective in killing cancer cells and inhibiting cell proliferation in multiple cancer cell lines including leukemia and breast cells in vitro. In addition, the extracts had little or no effect on non-cancerous control cells. Most interesting, however, was the fairly consistent and repeatable trend in which peppers with higher levels of capsaicin were more potent than peppers with lower levels of capsaicin. The results suggest that with further research, fresh and dried peppers or pepper extracts could eventually be effectively incorporated into anti-cancer drug treatments or preventive diets.

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Category **ME L14** High Cholesterol Impairs Water and Gas Transport in Red Blood Cells

Abstract High blood cholesterol is a major health problem, resulting in more than half a million deaths in the United States alone. It is well established that high levels of plasma cholesterol are causal to numerous diseases, including angina, diabetes, and cardiovascular disorders such as the development of arterial plaque, as a consequence of the long-term effects of high blood cholesterol. The most abundant molecule in a living cell is water (roughly 70%), which is critical to numerous life processes. Therefore, the precise and regulated transport and distribution of water in various cellular compartments is vital to life. Water can be transported slowly through biological membranes via an osmotic gradient, or rapidly transported through water channels called aquaporins (AQP). AQP1 was the first water channel to be discovered, and was first found in the red blood cell (RBC) membrane. Recent studies demonstrate the involvement of AQP1 in the transport of CO_2 as well as water through the RBC membrane. Reports further demonstrate the inverse relationship of membrane cholesterol on O_2 transport in RBC. In view of this, the immediate detrimental role of cholesterol on active water transport, and very likely on the CO_2 and O_2 transport in RBC was hypothesized, and tested in the present study. These studies were performed using isolated rat RBC, and real-time changes in RBC volume were determined using dynamic light scattering, following exposure to cholesterol and modulators of the water channel. Results from the study demonstrate that exposure of RBC to cholesterol is inhibitory to active water transport via AQP1 in the cell. In contrast, the removal of cholesterol from RBC membrane using methyl-β-cyclodextrin potentiates water transport. Recent studies suggest an increase in PLA2 activity in macrophages of coronary lesions prone to rupture, and high PLA2 activity in response to osmotic pressure in cholesterol-containing vesicles. In view of this, the role of PLA2 in RBC water transport was investigated. Surprisingly, the PLA2 inhibitor ONO-RS-082 was able to reverse cholesterol's inhibitory effect on water transport in RBC, suggesting its potential use in the treatment of complications resulting from elevated blood cholesterol levels. The present study demonstrates for the first time the immediate detrimental effects of cholesterol on RBC function, as well as its amelioration following ONO-RS-082 treatment. Results from this work are a major advancement in our understanding and treatment of the immediate detrimental effects of high cholesterol that likely precede angina, diabetes, and cardiovascular disorders.

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Category *ME* **L15** Does Sleep Apnea itself or the increased arousals in sleep cause Nocturia?

Abstract Many patients who have sleep apnea, snoring, restless legs at night (periodic limb movements) and pain have interrupted sleep with frequent mini arousals. Many of these patients , but not all, have nocturia (wake up to urinate in night). Available research in the sleep field of medicine shows some correlation between sleep apnea and nocturia. It was proposed that disturbances of abdominal pressure in sleep apnea, noise of snoring and interrupted secretion of antidiuretic hormone (ADH) from the hypothalamus contributes to nocturia. It is not clear why some have less nocturia then others for similar amounts of sleep apnea at night. This study is to prove the hypothesis that it is the extent of arousals that more directly correlates to nocturia. The sleep apnea, snoring, periodic limb movements indirectly correlate to nocturia, depending on arousals secondary to the individual's threshold for arousals. Those with higher threshold for arousal (in thalamic sensory gateway) are less disrupted in production ADH and less nocturia. Data will be gathered retrospectively. The data collected will be of adult patients who had overnight sleep studies for sleep disorders including sleep apnea, periodic limb movements, snoring and other causes of sleep disruption. Data collected will include number of nocturia, frequency of arousals, frequency of sleep apnea, frequency of periodic limb movements, frequency of snoring, associated arousals, total sleep time, quantity and ratio of slow wave sleep and REM sleep. Data obtained will be correlated to test the hypothesis.

This is a retrospective study of data gathered from routine clinical patient records after deidentification of all personal information. All privacy requirements of HIPPA will be adhered to under supervision of the HIPPA officer of the Sleep Center. There will be no effect on any patient's care or health due to this study.

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Abstract   The purpose of my investigation was to show how to make antacids or use of antacids less risky to people with pre-existing health conditions, such as Milk-alkali Syndrome and Hyperkalemia.

My hypothesis was that antacids can be made safe for people with pre-existing health conditions, such as milk-alkali syndrome and hyperkalemia by regulating either amounts or types of antacids used.

I setup containers to use as my "stomachs" which contained my simulated stomach acid (diluted hydrochloric acid). In each of my experiments I added to the stomach acid one type of antacid. I then tested for ph, calcium and magnesium levels. Following each antacid experiment I recorded my observations and data. I used 4 different antacid medications. I was sure to safely handle and store all chemicals; and I properly disposed of waste.

I observed as I was testing, that sodium bicarbonate and magnesium (which also had sodium in it) were the fastest neutralizing and safest antacid. I believe that antacids with sodium are more likely to neutralize the acidity, and I found that they had no calcium, when I was testing. I found that the famotidine had very high levels of Potassium. Together my data showed which antacids could reduce acidity and produce safe levels of calcium for those who suffer from Milk-alkali Syndrome and Potassium for those who suffer from Hyperkalemia.

In conclusion, the testing and data that I have collected has helped determine Magnesium and sodium bicarbonate antacids are the fastest for neutralizing stomach acid, and most importantly, they are the safest antacids for those with both Milk-alkali Syndrome and Hyperkalemia.

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Category *ME* *L17* Alcohol Consumption During Pregnancy and Facial Dysmorphology in Offspring

Abstract Fetal Alcohol Syndrome (FAS) is a permanent birth disorder that results from alcohol ingestion during pregnancy. Children with FAS have mental and behavioral impairments, as well as facial and growth abnormalities. The existence of FAS facial features may suggest significant brain and nervous system damage. In this study the facial features of children who weren't exposed to alcohol and those that were were compared by evaluating pictures using the FAS Facial Photographic Analysis Software. The data was correlated to the quantity of alcohol they were exposed to during fetal light.

The goal for this study was to objectively measure the facial features of children born to women who consumed alcohol during pregnancy. The hypothesis for this study was: the morphogenic features, birth weight and getational age of children born to women who used alcohol during pregnancy is associated with amount of alcohol ingested. Furthermore, gender may be a moderator of prenatal alcohol such that different effects may be seen in male and female offspring.

At the Fetal Alcohol Research Center of the Wayne State University, pregnant women were screened for alcohol use as part of an existing study. The offspring of these women were followed into childhood. Standardized photographs meeting certain minimum criteria were obtained at 6-7 years of age. De-identified photographs were evaluated as part of this project. Three key diagnostic features that characterize the FAS facial phenotype were evaluated: small palpebral fissures, smooth philtrum, and thin upper lip. This data was analyzed after receiving maternal alcohol consumption data from the parent study.

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Proteasome Inhibition and Apoptosis by DSF-analogue #39 in MDA-MB-231 cells

Abstract Copper is one of the most crucial elements in tumor cell growth because it is required for several molecular processes in angiogenesis, which is essential for tumors to spread and metastasize. It is known that there are higher concentrations of copper in cancer cells than normal cells creating a differentiation between these cells, which provides a mechanism of using copper to target only cancer cells as an anticancer strategy. In recent studies, it has been found that Disulfiram (DSF), a clinically used medicine for the treatment of alcoholism, is able to bind to copper forming a potent DSF- Cu conjugate that inhibits proteasome activity and induces apoptosis in human breast cancer cells. However, clinical use of DSF for the treatment of cancer is limited because of its toxicity to normal cells. As well, DSF irreversibly inhibits aldehyde dehydrogenase and other enzymes, causing toxicities, which makes it a disadvantage considering its anticancer effects. In this study, I am trying to investigate whether a variety of DSF analogues are able to bind to copper and form a complex that produces apoptotic cancer cell death through the inhibition of the proteasome, as well as have less toxicity to normal cells.

MDA-MB-231 breast cancer cells were cultured, and incubated with different concentrations of the DSF analogues coupled with copper. MTT assays were taken to determine the effects of the compounds and copper to the proliferation of the breast cancer cells. A Western Blot Analysis was conducted to determine proteasome inhibition, followed by a Proteasomal Chymotrypsin- like activity assay demonstrating the effects of the DSF analogues-copper mixtures on the proteasome. A cellular morphology analysis was performed as well.

It has been demonstrated that designated DSF analogue #39 with copper was the most potent compound-copper conjugate with ~100% inhibition of MDA-MB-231 cells at concentrations of 1 um – 10 um, even stronger than DSF-Cu, which was used as a positive control. For breast cancer cells treated with #39-Cu, there was inhibition of the proteasomal CT-like activity, and through Western blot an accumulation of ubiquitinated proteins and PARP cleavage was seen. Preliminary tests also showed that the DSF analogue #39 has similar toxicity to the MCF-10A normal breast cell line as the DSF-Cu complex.

In Conclusion, the designated DSF analogue #39 with copper had potent anti-proliferation effects through the inhibition of proteasome activity in cultured breast cancer cells even greater than the DSF-Cu complex, while it had similar toxicity to normal cells. However, since DSF has multiple toxicities, further toxicity studies of #39-Cu should be conducted using a different model. Overall, the data presented here suggests that the DSF-analogue #39 after coupled with Cu, is a promising complex for further tests to be a useful anti-tumor drug.

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Category *ME* **L19** GCNT2 Gene Expression Influences Breast Cancer Metastasis and Promotes an EMT

Abstract Breast cancer is the most commonly diagnosed cancer affecting women today, and its metastasis has become the hallmark of breast cancer mortality. There is increasing evidence which identifies metastasis as a multifaceted process with many steps regulated by numerous genes. Recent studies have identified genes which concurrently enhance cancer metastasis and promote an epithelial-mesenchymal transition (EMT), a cellular program normally occurring only during embryogenesis in which epithelial cells morph into a mesenchymal phenotype. This study focuses on the glucosaminyl (n-acetyl) transferase 2 (GCNT2) gene. It was isolated through gene expression array analysis and its expression was found to correlate with breast cancer cell metastatic ability. Furthermore, ectopic expression of GCNT2 in Madin-Darby Canine Kidney (MDCK) and Immortalized Human Mammary Epithelial (HMLE) cells found it to be localized in the cell cytoplasm, but showed no difference in cell proliferation or colony formation. GCNT2 did, however, cause a profound increase in cell migration in vitro and promoted an EMT. Interestingly, GCNT2 selectively suppressed epithelial markers rather than affecting both epithelial and mesenchymal markers. Also, GCNT2 suppression in 4T1 breast cancer cells showed marked morphology changes and significantly down-regulated cell migration and invasion. These findings collectively suggest that GCNT2 is a novel gene that is probably involved in breast cancer metastasis, setting the ground for further studies of this gene which may lead to effective strategies and novel therapies against breast cancer metastasis.

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Category *MI* **L20** Multidrug Resistance: C. albicans Gene IPT1 Affects Gene Expression

Abstract Candida albicans is the most commonly isolated yeast in human disease; it acutely impacts immunocompromised patients. Furthermore, C. albicans resistance to antifungal drugs is escalating. The purpose of this investigation was to determine which C. albicans genes in the target pathways of the antifungal drugs: aureobasidin, rapamycin, and fluvastatin are affected by transformation with high copy number plasmids containing the gene IPT1. The two transformants and the controls were cultured and tested on ten antifungal drugs at five concentrations, and the transformants were proven resistant to nine of these drugs. RNA was isolated from the transformants at 4 time intervals with exposure to three drugs and no drug. Total mRNA was reverse transcribed into cDNA, which was then quantified by real-time PCR. Levels of transcription of IPT1 and of genes known to affect drug resistance were determined, including AUR1 (aureobasidin A), HMG1 (fluvastatin), and TOR (rapamycin), and known drug efflux genes (CDR1 and MDR1). Data indicated that expression of the cloned IPT1 was not necessary for resistance, suggesting that DNA sequences are directly altering phenotype, perhaps by sequestering regulatory proteins. Genomic DNA agarose gel analysis revealed that one plasmid had a rearranged version of IPT1 and both plasmids had an insert. The observed changes in expression likely cause the multidrug resistance and occur because of integrative disruption of chromosomal IPT1 by the homologous sequences in the plasmid. Multidrug resistance suggests that there are regulatory links between unrelated pathways that can be utilized for drug development.

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Category **MI**   **L21**   Effects of Ibuprofen on H. littoralis Feeding Reflex

Abstract   Regulated water treatment and disposal makes water safe for drinking. However, because not all contaminants are regulated, water may not be purified relative to those contaminants. Common unregulated contaminants that can be found in a water supply include over-the-counter drugs. I investigate how an over-the-counter drug may affect a littoral ecosystem. I specifically examine the effects of ibuprofen on the feeding behavior of H. littoralis, a common freshwater species. I hypothesize that ibuprofen should interfere with this species' ability to feed and that its feeding reflex would be noticeably slowed. Hydra rely on glutathione emitted by their prey to capture and consume their prey. Ibuprofen is a non-steroidal anti-inflammatory drug that reduces glutathione production. Ibuprofen may interfere with this link.

My experiment focused on H. littoralis' feeding reflex, which was measured by timing the duration between capture and ingestion of Artemia. Baseline feeding reflex of H. littoralis was recorded for a month. The group of hydra were then chronically exposed to specific concentrations of ibuprofen. Low levels of ibuprofen (20 mg/L) were not immediately detrimental to the H. littoralis, but gradually slowed its feeding reflex. Exposure to 40 mg/L of ibuprofen resulted in an immediate slowing of feeding reflex; by the third day of testing, H. littoralis stopped feeding. My results supports the hypothesis that ibuprofen interferes and slows the feeding reflex of H. littoralis. More slowing was correlated to increasing concentrations of ibuprofen.

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Category *MI* *L22* How Light Emitting Diodes Affect the Activity Level of Drosophila Flies

Abstract Fruit Flies intrude the homes of millions of Americans each year. Imagine a new, innovative way to get rid of those pesky insects once and for all. Experimenting on how LED's affect the activity level of fruit flies could be a step towards this new invention. Using four different colors of LEDs, (red, amber red, green and yellow), the fruit flies (kept in a plastic flask) were tested with a different color each day for eight days. The flies were tested in 24-hour cycles, and a CPO timer was used to keep track of the count number. After averaging out both trials, the flies' activity level was greatest when tested with the green LED.

Bibliography

Category *MI* **L23** Don't Sweat the Small Stuff

Abstract The purpose of this experiment was to determine which odor eliminating spray killed the most bacteria that were extracted from a previously worn shoe to determine whether the sprays successfully killed the bacteria or simply masked the odor. Oust, Febreeze, and Dr.Scholl's odor eliminating sprays were tested on the shoe bacteria. It was originally hypothesized that Dr. Scholl's would kill the most bacteria, but it was later hypothesized that Oust would kill the most bacteria after several tests. To test this experiment, filter paper was sterilized in an autoclave for thirty minutes and placed in a shoe during exercise. The filter paper was then cut into 1 cm by 1 cm pieces, sprayed with each odor- eliminating sprays, and diluted in water using sterilized equipment. The diluted water was applied to three triptych soy agar dishes per spray with a graduated pipette and placed in an incubator for twenty-four hours. After the twenty-four hours, the samples were placed in a refrigerator until ready to be observed. The number of bacterial colonies that formed on each of the agar dishes was counted, compared, and averaged to determine which spray had the least amount of bacterial growth. Oust proved best effective in killing the sweat bacteria, and Febreeze proved to be the least effective in killing bacteria. This experiment accurately proves that though air fresheners and odor eliminators may have a pleasant aroma and say that bacteria is killed through the use of the spray, most do not actually kill the bacteria that is the cause of the foul smell.

Bibliography

Category **ZO** *L24* Mitochondrial DNA Phylogeny of the Family Alligatoridae

Abstract Despite the prevalence and importance of the family Alligatoridae throughout the Americas and China, few large-scale studies including most taxa at the species and subspecies levels have been conducted. Due to conflicts between genetic and morphological characterizations and a lack of resolution in studies of phylogenetic relationships, the systematics of the family remain ambiguous. In this study, we constructed a complete phylogeny of almost all taxa within Alligatoridae using mitochondrial DNA sequences from cytochrome oxidase c subunit 1 and cytochrome b in order to resolve these ambiguities. We used sequences of DNA amplified by polymerase chain reaction (PCR) from individuals of the species Caiman latirostris, C. yacare, Melanosuchus niger, Paleosuchus palpebrosus, and P. trigonatus, and many sequences from NCBI, to construct high-resolution maximum likelihood and Bayesian inference trees, and calculate percent divergences for each gene. Our results were generally consistent with currently accepted taxonomies, but with many additional findings. We found evidence that the C. latirostris lineage diverged from Caiman soon after the divergence of Caiman from its common ancestor with Melanosuchus, suggesting that M. niger may be more closely related to C. latirostris than to other members of Caiman. Individuals highly divergent from their species were identified in both C. latirostris and P. trigonatus, which may represent distinct evolutionary lineages. We also found support for indications of hybridization between C. c. chiapasius and C. c. fuscus in northern Mesoamerica and confirm a specific clade of C. c. crocodilus identified by Venegas-Anaya et al. (2008) as being worthy of special conservation concern. Finally, we found evidence for possible admixture between C. crocodilus and C. yacare and indications that relations between them are highly complex. We advocate further research in alligatorid systematics using techniques such as microsatellites, and support efforts toward the conservation and sustainable management of crocodilians.

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Category **CH P01**   Analyze This: Aspirin Content in Powder Form and Tablets

Abstract   Aspirin is an analgesic and anti-inflammatory agent that is widely used all over the world. There are different analytical methods that could be used to detect the content of Aspirin powder or its concentration in pharmaceutical preparations. In this experiment, three different methods of analysis were tested for accuracy and practicality. The three analytical procedures are the USP method of Acid-Base Titration, UV Spectroscopy, and Reverse Phase HPLC. The Acid-Base Titration showed accurate results but was somewhat cumbersome and tedious to use on consistent basis. UV Spectroscopy and Reverse Phase HPLC showed both accurate results and more practicality for everyday use. To test a more real-life example, three different commercially available preparations containing known amounts of Aspirin were tested for their concentration of the drug using UV Spectroscopy and Reverse Phase HPLC. Percent error and statistical analysis showed that the actual concentration of Aspirin in these preparations varied somewhat from the stated concentration depending on the brand. In conclusion, although all analytical methods seem to be accurate, UV Spectroscopy and HPLC are more practical for drug analysis and quality control, which is an important process to monitor different commercially available brands containing the drug.

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Abstract Purpose: The purpose of this experiment is to determine whether the type of food and the method of preparation of food are factors that vary the food's levels of free radical emission, or the food's antioxidant properties.

Hypothesis: Foods that are grilled will have higher levels of free radicals than foods that are baked, boiled, or microwaved, and foods that have more complex chemical compositions will have higher levels of free radicals than foods with simpler chemical compositions. Foods that are unprocessed and that have simpler chemical compositions will have greater antioxidant properties.

Procedure: 1) Prepare samples of one type of food (i.e. potatoes) prepared four different ways- baked, boiled, microwaved, and grilled.
2) Put samples in capillary tubes and put tubes into the Magnetic Resonance Spectrometer (machine using magnetic fields to excite electrons, causing free radicals, which are unpaired electrons, to emit signals that a computer records).
3) Run tests on Spectrometer to determine amount of free radicals, as well as type of free radical emission (more homogeneous or heterogeneous), from the samples. Also run comparative tests to determine the Lorentzian and Gaussian line widths of the free radical emission in each sample, comparing these values in each sample.
4) Put samples in capillary tubes with stable free radical and put tubes in Spectrometer to observe antioxidant properties (which will be based on the diminuation of the free radical signal that the stable free radical sample is emitting).
4) Repeat this procedure with foods from all the major food groups- grains, vegetables, fruits, dairy, meat, and oils.
2) Carbonize one sample of each type of food to determine differences in chemical structure between samples.

Data Analysis: According to the results of the tests run on the Spectrometer, it will be determined which type of food and method of preparation will have the greatest levels of free radical emission. The initial tests will record the emissions the samples give off when they are excited in a magnetic field, and using Baseline Correction and Lineshape Simulation programs will produce graphs of free radical emission from each sample that can be easily compared to each other. These tests will also be used to determine the antioxidant properties of the samples. Carbonizing samples will enhance these graphs so that they convey an idea of the simplicity or complexity of the chemical composition of the various samples.

Conclusions from this analysis will determine recommendations for the optimal mode of food preparation, as well as the best types of foods to consume, in terms of free radical absence and antioxidant levels.

Bibliography

Category **CS** **P03** Optimizing the Deflation Strategy of a Divide and Conquer
Eigensolver

Abstract A classic problem in numerical linear algebra is the calculation of the
eigenvalues of a symmetric matrix. These eigenvalues are useful in
calculating critical frequencies in many systems, such as vibrations in
mass spring systems ([1] page 254). Not much research has been done
on the deflating criteria in the divide and conquer eigenvalue algorithm.
My hypothesis is that a better deflating criterion than the currently used
constant threshold exists, and that the deflating threshold will be a
function of the size of the matrix. A genetic algorithm is used to search
for this better function. The genetic algorithm (GA) in 12 out of 18 runs
(on 100 random matrices) showed that a logarithmic function is better
than a constant function. A quadratic fit yielded a logarithmic deflating
function that was optimal for general matrices, not just the 100 random
matrices used in each run of the GA. Data collected with this new
function showed acceptable errors (1.73 accurate digits versus the
average 1.88 computed with the GA). With this function, the divide and
conquer method yielded 2.61 accurate digits on larger matrices. In
conclusion, the hypothesis was correct, and the new logarithmic deflating
function is better than a constant function.

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Category **CS** **P04** Stimulating Protein Synthesis Using Java Applets

Abstract Throughout the years, many forms have been used to model protein synthesis. Most biology related classes, especially in high schools, haven't been able to get past colored construction paper labeled with the four bases of DNA and diagrams to help students grasp the process of protein synthesis. The purpose of this project is to use java applets to model protein synthesis, to allow the users to enter any combination of DNA bases from the start and watch how the polypeptide chain forms from the very bases they entered. From transcription to translation, users are able to watch protein form and grasp a better understanding of the concept. Using a java compiler, implementing the Runnable interface and importing java packages/classes, simple code such as if-else statements are used to configure DNA bases to form Messenger RNA to form protein and draw figures on the screen. The final animation of protein synthesis will enable students to not only take part in the making of protein, but to understand the way it forms. Programs like this one can provide students and users with a better comprehension of complex processes such as protein synthesis throughout numerous classrooms and demonstrations, upgrading form the traditional construction paper and diagrams.

Bibliography

Category **CS** **P05** How do Pitch and Speed Affect Voice Recognition?

Abstract The purpose of this experiment was to find out how much the speed and pitch of a voice would have to be changed until the voice could no longer be recognized by computer speech recognition software. The voice was recorded speaking a command for the computer using Audacity digital audio editor. Windows speech recognition was used; it is a program where you can speak into a microphone and it interprets your voice and carries out the computer command your voice is speaking. The voice was then sped up and slowed down and tested for accuracy in carrying out the command at different percents above and below the normal speed. The voice was also raised and lowered in pitch and tested. The variables of pitch and speed were then both changed at the same time and tested. The data for the combination of variables was plotted on a success/failure graph. The results showed that the voice was recognizable up to 17% increased speed, 21% decreased speed, 27% raised pitch, or 20% lowered pitch. When the variables were combined, as the pitch was raised, the speed needed to be lowered for the voice to be recognized and vice versa. From this we can conclude that speed has a greater impact on the recognition of a voice than pitch and that speed and pitch of a voice are inversely related.

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Category **CS** **P06** Optimizing Health Care Resources Allocation Using Data Mining Approaches

Abstract The goal of my project is to use a systematic approach to segment patients based on predictive morbidity indices such as the Charlson Index. Individuals do not know their exact score on the Charlson Index and determining this score exactly can be very time consuming and resource intensive. Through data analysis and data mining techniques, I was able to determine some of the factors that can very accurately predict the patient's score. The benefit is that scarce medical resources, such as vaccines that are in short supply and attention can be directed towards people with higher scores, which will ensure that such resources get applied effectively in preventing spread of epidemics.

To perform data mining, I used a tool called SQL Server on data that was made available by a prime insurance company. The medical claims data gave information regarding member profiles, health indicators of members, and the member's severity of illness at that point. All the medical conditions as well as their demographic profiles were used as features to predict the Charlson Index.

Different data mining techniques were used in this process. After inputting the different features that determined the severity of illness, the data mining tool created a decision tree which predicted one or more discrete variables, based on the other attributes in the dataset. There were two different analyses done: one, using only health indicators to predict the severity of illness and another, using member demographic details, such as age and gender, as well as health indicators to predict the severity of illness. For each analysis a dependency network of attributes was created and decision tree evaluation was done. Accuracy charts and lift charts were created for validation.

My project proves that a small number of specific health related data is a better predictor of the Charlson Score and that health care providers should use these elements rather that traditional demographic measures such as age and gender to make decisions regarding allocation of scarce health care resources.

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Category **CS** **P07** Finding Efficient Shellsort Sequences Using Genetic Algorithms

Abstract Shellsort, discovered by D. L. Shell in 1959, is a sorting algorithm whose performance depends on the increment sequence chosen. Even though many attempts have been made to find an optimal sequence to allow Shellsort to reach the lower bound of $O(n \log(n))$ for comparison sorts, no such sequence has been discovered. This paper presents a method to find efficient increment sequences through the use of genetic algorithms and compares the performance of Shellsort with these sequences to merge sort and Shellsort with other known remarkable sequences. It is concluded that the sequences found through genetic algorithms perform exceptionally compared to merge sort and Shellsort with other sequences even though they do not reach $O(n \log(n))$ performance.

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Abstract   This experiment tested which setup of a geothermal heating and cooling system maximizes the effectiveness of that system. A geothermal heating and cooling system accesses the renewable resource of the Earth as the constant production of thermal energy being produced inside the Earth is tapped to heat or cool buildings to a near constant year round temperature. This heating and cooling system is extremely cost effective over a long period of time and this experiment can discover which setup maximizes the system's effectiveness as a heating and cooling system to add to the already high cost effectiveness.

This experiment was conducted by creating a device to simulate the conditions of a geothermal heating and cooling system which works by running a liquid through piping that uses the soil as a heat source or a heat sink. This device was used to test the effectiveness of four different soil types with varying sediment sizes which were clay, sand, fine gravel, and coarse gravel. The device was also used to test the effectiveness of three tubing sizes which were 2.54cm, 3.175cm, and 3.81cm in diameter. These variables were tested in four different environments, each with a different temperature, for twenty minutes and the change in water temperature as well as the change in soil temperature was calculated.

The hypothesis was if the rate of temperature change of 60 mL of distilled water is tested in different tubing sizes and different soil types in four different environments, then the 2.54 cm tubing and clay will be the size of tubing and type of soil that maximizes the effectiveness of a geothermal heating and cooling system will be found.

After conducting this experiment, the results do not support the hypothesis completely as the clay soil was the most effective soil type however the 3.81cm tubing was the most effective. These results can show a setup that will make an already cost effective heating and cooling system perform at a higher level functionally.

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Category *EN* *P09* Alternative Energy: Wind vs Water

Abstract This experiment tested wind energy against hydroelectricity. A wind turbine and a water wheel were built and tested at wind speeds of 5 mph and 10 mph, while the water was tested at heights of 1M and 0.5M. Waters overall voltage was almost double the winds. In conclusion water energy is more efficient and more practical to use in the Flint area.

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Walking on the Wild Side: Designing a Robot to Traverse Varied Terrain

Abstract

In the experiment "Walking on the Wild Side: Designing a Robot to Traverse Varied Terrain," a robot was designed and constructed which harbored insect-like qualities; namely, six jointed legs, and a tripod gait in which three legs were lifted simultaneously and moved, while the other three remained stationary. The hope was that the robot, in its final state, would be capable of traveling long distances across fields of different physical construction without the interference of a second, human, party.

Aluminum was chosen to be the material which would compose the frame of the robot, in light of its weight, strength, durability, and relative cost. The robot's drive train, which was intended to transform the electrical energy provided to the device via sunlight or stored battery power into mechanical motion, consisted primarily of servo motors (which contain DC motors but also possess the circuitry needed to control specific speeds and degrees of rotational movement) and gear motors (which are constructed with a lightweight, internal set of gears in order to increase motor torque), assisted by thin metal tubing and connector actuators. Pushbutton switches were also installed, so as to inform the robot when its feet were and were not in contact with the ground.

The microcontroller which was chosen for this particular project was the Arduino Mega, whose programming software can be downloaded onto a Mac OS X computer. The Arduino Mega functioned as the robot's brain, sending signals to the servos and gear motors controlling its legs and prompting changes to the course of the device after analyzing the data it had obtained in the field.

The hypothesis stated that if a robot was designed and constructed in the manner described above, it would be able to traverse varied terrain independently of its creators and would be able to maneuver around obstacles effectively enough to make its way from the designated point "A" to the designated point "B," whatever they might be. The robot's ability to navigate its surroundings was to be tested in snowy conditions, sandy environments, grasslands, and areas of steep incline. The hypothesis has been challenged, since it has been determined that the drive train system initially chosen for this project is not adequate, and that the gear motors which were originally supposed to lift the legs up and down should be replaced with servo motors (which offer more frictional resistance during moments of apparent stillness).

The research and experimentation associated with this project were completed in the hope that one day a similar device would be occupied with duties associated with disaster relief, or even extraterrestrial sample collection. In a continuation of the experiment, the robot would be equipped with solar panels for power, tilt sensors for balance, a camera for more accurate data collection, and a sample collection system to be employed in real-world scenarios.

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Williams, Karl. Insectronics: Build Your Own Walking Robot. © 2003 The McGraw-Hill Companies, Inc., New York, NY.

Category *EN* **P11**   High Efficiency High Power Factor Electric Vehicle Battery Charger

Abstract   Electric vehicles are the future of our transportation system. Electrical vehicles are much more efficient than gasoline powered vehicles, have zero carbon emissions, and reduce our dependency on fossil fuels. One of the biggest obstacles to widespread electric vehicle usage is our inability to build high efficiency multi-kilowatt battery charging systems. Because high power battery chargers necessitate high power factor, current charging systems incorporate active power factor correction circuits. These lower the overall efficiency of the charger. In this project, I present a new charger design that can maintain both high power factor and high efficiency.

The main challenge to a unity power factor charger is that the voltage of the battery itself nullifies charging voltage less than the current battery voltage. This only allows the battery to be charged in a very narrow band around the peak of the input voltage, and this distorts the current waveform and reduces power factor. Previous methods of achieving unity power factor have utilized boost converters in series with the main H-bridge DC/DC converter. While this does give excellent power factor, it adds the loss of the boost converter onto the loss of the system. This is the result of the boost converter operating continuously independent of input voltage, even if the input voltage is sufficient to charge the battery. This particular implementation of the boost converter reduces the overall efficiency of the system and increases production cost, for the high power boost converter is large and expensive. My project presents a new design in which the boost converter can be intelligently turned on and off based on the instant input voltage, and is only activated when the charging voltage multiplied by the transformer turns ratio slips below the battery voltage. This new design has the following advantages:

1. The boost converter only activates a small portion of the time, and only delivers about 18% of the charger's total power, reducing both cost and size.
2. Because 82% of the power passes solely through the H-bridge converter, the efficiency of the system is raised.
3. The boost converter only requires simple software algorithm to control.

A thorough mathematical analysis of the relationship between the conduction angle of the battery charging current (the percentage of time in which the battery is actually receiving power) and the resulting power factor was conducted. Fourier analysis of the charging current was performed to calculate the power factor.

A computer simulation of this system using the electronic simulation tool Powersim was conducted. Both simulation and theoretical examination of this design have yielded up to 98% power factor and 94% charging efficiency.

Bibliography

Helius: A Solar-Tracking Mechanism for Efficiency Max. Of
Photovoltaic Modules

Abstract   Photovoltaic modules are generally plagued with a common dilemma, lack of efficiency due to their immobility. One solution to this dilemma can be found in one of the vast wonders of our environment, the sunflower. This American native plant possesses a characteristic that could possibly increase the efficiency of photovoltaic modules, when properly applied. The mystery behind this solution is the process known as heliotropism, the diurnal motion of plant parts (flowers or leaves) in the response to the direction of the sun.

To apply this concept to the modern field of technology, this project will attempt to mechanically mimic the heliotrophic characteristics of the sunflower at its bud stage. Although the original design of the project was in the form of a mechanical sunflower, the main focus will be centralized around the control, or the head, of the sunflower. Four photovoltaic panels will be attached to each other to accurately track the location of the sun. The motion of the device will be powered by the Arduino Duemilanove microcontroller, which uses the Atmel ATmega328 and must be programmed with C++ language, and the OWI-535 Robotic Arm Edge for arrays, which was assembled along with the rest of the project.

The methodology behind this project is fairly simple. Apart from the C++ coding, cross-partitions are implemented to ensure that the cell panel is always perpendicular to the direction of maximum illumination. If the panel is off-axis, one cell in a pair will be in partial shadow, so its output voltage will fall. The circuitry of the Arduino measures the voltage difference between the cells and turns on the appropriate drive motor to move the panel in the direction that will make it perpendicular again, when the shadow is eliminated.

Two pairs of cells, two orthogonal drive motors, about 90 degrees of movement in each axis, produces more than enough solid angle of movement to track the light. The smart bit is making the measurements differential rather than absolute. If we just measured the illumination and used that as a guide, then the tracker would be fooled every time the Sun went behind a cloud. This way, if the panel is at right angles to the Sun, then the difference between the cells will be zero, no matter how bright the Sun is. Also, the tracker will eventually be configured to power itself, as well as supply an ample amount of energy for storage.

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Category **EN** **P13** Trebuchet Trajectories

Abstract The purpose of my experiment is to determine which variables produce the greatest range for a trebuchet. By building a trebuchet and altering the arm length from the fulcrum to the weight, the mass of the weight, and the angle of launch, I can measure changes in distance and predict what combination of these variables would result in the greatest range possible for my trebuchet. The procedure is as follows: load one marble into the sling and pull back the counterweight. Release the marble with fingers on the side so as not to disturb the path it follows. Record the distance the marble travels. Next change the arm length by moving the fulcrum to a hole 2 cm closer to the weight; repeat for six holes. Return the fulcrum to the original position. Stack books underneath the base to vary the angle. Place weight on the base to prevent rocking. After testing the change in angle remove the books and add a discrete mass to the weight, keeping it balanced. Record the results, then add the same discrete weight and balance. The data collected showed a steady increase with distance as arm length and angle of launch increased, yet distance decreased slightly as mass weight increased from second heaviest to heaviest. I can conclude that the greatest range is attainable with maximized arm length, a weight of 353 grams, greatest launch angle and allowing for the trebuchet to rock back and forth, utilizing its momentum.

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Testing the Structural Integrity of Concrete Using Alternate Methods of Reinfo

Abstract Concrete is a hard and porous composite of cement, sand, aggregate, and gravel. Concrete cement is a very compressively strong material after proper component mixture and curing. It has a compressive strength 15 times greater than its tensile strength. Because of the lack of tensile strength, reinforcement is needed.

Steel rebar is the most common method of reinforcement used in building concrete structures. Steel can rust and corrode over time and leave structures compromised. The purpose of this project is to test different methods of reinforcement to determine if there are plausible alternatives to steel rebar for the purpose of reinforcing concrete.

It is believed that changing the method of reinforcement will also change the structural integrity of the concrete. Although steel rebar is the most widely used reinforcement, it is expected that the carbon fiber strip reinforcement will be stronger than the traditional rebar.

After extensive testing it was found that the fiberglass was the weakest reinforcement used as it crumbled at an average force of 1220.79 N which was less than the unreinforced concrete. The steel rebar began cracking at an average force of 1675.90 N. The next strongest material was the steel mesh which cracked at an average force of 1724.08 N. The carbon fiber strips and threads both held up under the maximum capacity of my scale before breaking, therefore the force needed to crumble them is listed at the maximum of 500 lbs, 226.75 kg or 2223.66 N.

The hypothesis was supported by the experimentation. The carbon fiber strips and the carbon fiber threads held up under the maximum force that could be measured, higher than any of the other materials being tested.

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Category **EV** **P15** Does exposure to different climates affect the pH of a body of water?

Abstract In this experiment, I tested the effects of temperature on the pH of a body of water. I used water from the Huron River to conduct my experiment. Using a digital pH meter, I took the pH of the water as collected at 20 degrees celsius. Then I exposed it either to a warm temperature environment or cool temperature environment. After the temperature of the water returned to 20 degrees celsius, I took a second reading and identified the difference. I found that the pH of the water that had been exhibited to warm temperature rose, while the water that had gone through the cold temperature decreased slightly.

I collected water samples from three sites, the Huron River at Gallup Park, the River Rouge at Edward Hines Park, and Fleming Creek at the Botanical Gardens. When the water temperature 20 degrees celsius, I took the pH. All three sites had a pH of about 8.2 or 8.3.

To expose the water samples to a warm temperature climate, I heated them over the stove to 99 degrees celsius. To expose them to a cool temperature climate, I cooled them in a freezer to -10 degrees celsius. I used Newton's Law of Cooling to calculate how long it would take for all the water samples in the freezer to reach -10 degrees celsius.

Next, I left all the samples in a room that was 20 degrees celsius. Once the temperature of the cups returned to 20 degrees, I took the pH. The pH of the warm climate water was about 8.7 to 8.9, while the pH of the cool temperature water was about 8.1 to 8.3.

I concluded that the exposure to warm temperature climate will raise the pH of a body of water. Also, the exposure to a cool temperature climate will slightly lower the pH of a body of water.

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Category *EV* **P16** Shut the Front Door

Abstract The purpose of this experiment is to design and build a model door which will produce energy. The procedure starts with the design. After the design was created, then materials were gathered. The actual building of the door included cutting wood into a base, door, and door frame pieces. The door was set into the base with a pivot. At the top of the door frame, a crank flashlight with the crank removed was placed and an all thread was connected to the flashlight crank housing. The turbine inside the flashlight turned with the motion of the door as the all thread worked as the crank creating energy. The data for the project involved finding the time period when the doors at my school were in use the most. I found there was an average of 29.38 minutes per day where the doors opened and closed consistently as students entered and exited the school building. Using the consumer packaging information, I learned one minute of cranking was equal to ten minutes of light. Therefore, the motion of the door would create about 5 hours of energy with the flashlight. I concluded the motion of the door could create energy to power the exit signs in the building.

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Heavy Metal Veggies: The Effect of Soil pH on the
Phytoaccumulation of Lead

Abstract   Lead is found naturally in the environment. However, high concentrations of lead, particularly in foods, can be harmful to human health. Oftentimes, vegetables and other edible plants are grown inadvertently in soils of high lead content. Through phtyoaccumulation (a specific form of bioaccumulation in which plants absorb substances from the environment), lead present in soil can be collected in the edible tissues of these plants. Many possible solutions may remedy this common problem of lead phytoaccumulation; one of which is the increase of soil pH to immobilize lead ions thus preventing the uptake of lead particles by plants.

In the experiment, the effect of soil pH on the bioaccumulation of lead in plants is analyzed. To contaminate, a large sample of neutral soil was treated with a lead(II) nitrate solution to achieve a lead level of 700 ppm by mass; this is considered unsafe for use in gardening and vegetable growing. (Rosen) The soil was then separated into 18 groups and each group was individually treated with unique solutions of aluminum sulfate and calcium carbonate to vary soil pH. Each of the 18 soil samples was then placed into an individually labeled soil tray, and another two soil trays were filled with neutral, unmodified soil. The twenty soil trays were then separated into two sets: the spinach set and the mustard set. Each set contained 9 contaminated soil trays of varying pH: 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, and 9.0 and a final neutral, uncontaminated soil tray. 25 spinach (Spinacia oleracea) seeds were planted in each of the soil trays of the spinach set and 25 mustard (Brassica juncea) seeds were planted in each of the soil trays of the mustard set. After a growing period of 50 days, various tissues of the plants, namely the leaves, stems, and rootstalks, of each soil tray were harvested. The collected samples were then desiccated, powdered, weighed and suspended in individual solutions of water. Enzyme solutions were then added to the solution samples to digest and break down organic matter. After filtration to remove organic debris, a solution of potassium iodide was then added to each of the solutions to produce a precipitate of lead(II) iodide. The precipitate was then isolated, dried, and weighed to obtain the mass of lead(II) ion present in each of the plant samples. With this mass of lead(II) ion and the mass of the dried plant sample powders, the amount of lead accumulated by each group was calculated in parts per million.

According to the World Health Organization, ingestion of more than 254 micrograms of lead per day can be dangerous for adults (Bassuk) and even less for small children. High concentrations of lead that collect in produce through phytoaccumulation poses a serious health hazard. The amounts of lead calculated in the experiment indicate trends of lead levels in edible foods grown in contaminated soils as soil pH changes.

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Category **EV** **P18** Optimal Deicer Combination for Performance, Cost and Enviromental Impact

Abstract This project was inspired by watching salt being spread during the winter to melt ice and wondering whether there was a more efficient and balanced combination of deicers for the roads. The purpose of this research is to find the optimal combination of commonly available commercial products for deicers; rock salt (NaCl), Magnesium Chloride ($MgCl_2$), Calcium Chloride ($CaCl_2$), Calcium Magnesium Acetate (CMA). Three criteria were considered for this project; deicer cost, melting time efficiency and environmental impact. The first experiment was conducted by making fifty-six different combinations of deicer to obtain the melting time of constant amounts of ice. Six levels with fifty-six runs and three trials of Design of Experiment (DOE) were set up and analyzed to understand the main effect and interaction effect with respect to the criteria. The regression was constructed and an optimization was performed to determine the most favorable deicer combinations for the criteria of cost and time. Lettuce seeds grown in solutions of different deicers were used to represent the environmental impact. Ten lettuce seeds were grown in plates which consisted of the different combinations of a constant concentration. The length of the root grown from the seeds was used to determine the best and worst combinations of the environmental criteria. From this project, the model can be used for county roads and environmental departments to make knowledgeable decisions in support of their winter deicing budget and the reduction of potential environmental concerns.

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Category **EV**   **P19**   The Impact of Soil Thermal Diffusivity Fluctuation on Geothermal
                                 Heating

Abstract   The prices of fossil fuels are running rampant, the adverse effects and
             damage on and to the global environment are compounding, and a
             solution is needed. Geothermal heating could be a major step in the right
             direction, yet it is hobbled by a substantial installation fee and large
             quantity of requisite space. If the buried piping grid were to be bedded in
             a thermally diffusive soil, the "hobbles" on this infinite energy source
             could be removed. And to make this concept into a marketable, viable,
             variable plan of action, a model and accompanying computer program
             will be developed, incorporating the thermal diffusivity of a spectrum of
             soils with varying percentages of mineral composition, humidity, grain
             size, and crystal lattice structure and totality. A Dual-Probe-Heat-Pulse
             utilizing high-resistance wire and a thermocouple will be used to measure
             the thermal diffusivity and volumetric heat capacity, from which the
             thermal conductivity can be calculated. This data will be formed into a
             differential equation that can be refined into a model depicting the
             aforementioned variables' effect on a soil's thermal diffusivity.
             Homeowners will have a graded scale of various soils, describing their
             thermal diffusivity and the accompanying price tag. The more thermally
             diffusive the soil bed, the smaller the system size, and the greater its
             power and efficiency. These soil bed options will be easily compared to
             the local soil, and its thermal properties, allowing for simple cost-benefit-
             analysis up front. A final result of this all will be a supercharged,
             miniaturized system that will be now available to countless homeowners
             with either too little room for the previously large systems or whose
             residences are in an environment not diffusive enough to be feasible.

Bibliography

Category *EV* *P20* Diet and the Ecosystem

Abstract The purpose of my investigation was to see how reptiles' dietary preferences positively affect an ecosystem.

My hypothesis was that my test subjects would prove that reptiles' dietary preferences can help an ecosystem where an invasive species or pest is a problem.

First, I ordered a collection of insects and recorded those that would be used in this investigation, and where they are commonly found. Next, I separated "reptile subject" 1 (a leopard gecko) and "reptile subject" 2 into two separate (proper and safe) living habitats. Then, I offered each "subject" a choice of two different insects at feeding time. Using two subjects helps to determine that the preference is uniform, that it is not an individual preference. I offered this same set of insects 2-3 different times for stronger results. I recorded observations and data. I repeated this for the other sets of insects, marking and recording observations in a "preference table".

I observed that the geckos showed certain dietary preferences.
I concluded that reptiles' dietary preferences can positively affect an ecosystem that has an invasive species or pest.

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Category **EV**   **P21**   Comparing the Efficiencies of Solar and Wind Energy

Abstract   The purpose of this experiment is to compare the efficiencies of solar and wind energy and to determine which form of energy is more efficient. This experiment also covered more extensive topics such as finding the time of day in which a solar cell delivers the most energy. The hypothesis that was formulated prior to experimentation states that if the efficiencies of solar and wind energy are compared, solar energy will be more efficient than wind energy.

Two solar cells were purchased and charged in the sun for a set amount of time. After the solar cells were removed, they were connected to a digital multimeter to check the voltage (in millivolts) that was being put out and also the current (in microamperes) running through each cell at that point in time. Knowing these two values helped to determine the amount of power that was being put out as a result of the solar cells being charged which then allowed the efficiency of the solar cells to be calculated.

A pinwheel was used to model a wind turbine absorbing wind to create wind energy. A hair dryer was used in this experiment to model wind blowing into a wind turbine. A pen was attached to the rear end of the wind turbine and the wind absorbed by the pinwheel raised the pen upward. The time in seconds it took for this to happen was recorded as well as the distance it raised. Through an extensive series of calculations, the efficiency of the wind turbine was also calculated.

The results show that a solar cell is most efficient around 2:00 P.M. Also, while neither form of alternative energy is very efficient, solar energy is far more efficient than wind energy. This experimental outcome supported the hypothesis made, and solar energy is, in fact, more efficient than wind energy.

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Category   **EV**   **P22**   The Pyrolytic Synthesis of Biochar and Biofuel from Biowatse

Abstract   The purpose was to produce biochar from biowaste, determine if the biochar can amend the soil improving quality, improve plant growth, and can be produced during the pyrolysis process used to make the biochar. The hypothesize was that biochar will amend the soil improving the soil quality which will encourage the plants with the highest concentration of biochar to grow tallest, and that biofuel will be produced during the process that can be captured.

Biochar produced was rich in nitrogen, low in phosphorus, and moderate in potassium. The pH levels were acidic with an average of 4.7. Initial elemental analysis of the samples with Biochar added by ICP shows that the soils were amended by the addition of the biochar. After the addition of Biochar the levels of nitrogen and phosphorus appeared to be in the optimal level however the potassium was on average low. The soybeans planted in the Biochar treated clay and sand samples did not germinate. Biochar treated top soil samples did germinate and grew. Syngas was released during both the initial research with the kiln pyrolysis and with the pyrolysis apparatus made in the lab. The syngas released could possibly have enough energy to cycle the process. The liquid that was produced during pyrolysis was captured and showed that it had a boiling range of 34C –186C. In conclusion, results did support the hypothesis. The soil quality not the growth of the plants was not dependent upon the concentration of Biochar added. The hypothesis on the biowaste ability to produce a fuel and capture it was supported. It is clear that Biochar has amending potential. Optimizing the production and growing technique will prove this to be a viable source of fuel and food security.

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Category **EV** *P23*   Researching a Relevant Remedy to Repair Riparian Residences

Abstract   Purpose: To determine if Ceratophyllum demersum and Lemna valdiviana are capable of absorbing quantities of nitrate from freshwater sources

Hypothesis: Ceratophyllum demersum and Lemna valdiviana will absorb quantifiable amounts of nitrate; Ceratophyllum demersum will absorb a greater quantity of nitrate than Lemna valdiviana. The plants will absorb an increasing amount of nitrate comparable to the increased concentration of nitrate until the concentration absorbed resembles a logistic curve.

Procedure: Pour 2 L of Artificial Lake Water into empty distilled water jugs. Enrich the ALW with nitrate so that seven jugs have a concentration 17.6 PPM; 8.8 PPM; 4.4 PPM; 2.2 PPM. Place 6 grams of Ceratophyllum demersum into three jugs of ALW with nitrate concentrations of 17.6 PPM; 8.8 PPM; 4.4 PPM; 2.2 PPM; 0.0 PPM. Place 6 grams of Lemna valdiviana into three jugs of ALW with nitrate concentrations of 17.6 PPM; 8.8 PPM; 4.4 PPM; 2.2 PPM; 0.0 PPM. Leave one jug of ALW with a nitrate concentration of 17.6 PPM; 8.8 PPM; 4.4 PPM; 2.2 PPM; 0.0 PPM. Test each jug of ALW for nitrate concentration every day for 14 days.

Conclusion: Ceratophyllum demersum and Lemna valdiviana absorbed quantifiable amounts of nitrate. Ceratophyllum demersum absorbed nitrate more quickly than Lemna valdiviana, but Lemna valdiviana progressively absorbed nitrate while Ceratophyllum demersum absorbed nitrate only after immediate immersion in ALW.

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Category **EV** **P24** Silicone versus EVA: Comparing Two Methods of Solar Cell
Encapsulation

Abstract The purpose of this experiment is to compare the Quantum efficiency,
actual efficiency, and power output of silicone and EVA photovoltaic solar
cell encapsulants in order to determine which of them should be more
frequent in commercial use.

The common element used in the industry today for encapsulation is
Ethylene Vinyl- Acetate, or EVA. This organic copolymer comes in sheets
and is relatively easy to use. The problem with EVA is that, since it is
organic, it needs stabilizers to prevent from browning. The stabilizers
absorb all UV light, which on the solar spectrum, in 0 nm to 400 nm. That
is a considerable amount of light that is not even allowed to get to the
cell. A possible solution to this problem is to replace the EVA encapsulant
with silicone, a polymer of silicon that includes carbon, hydrogen, and
others. Silicone comes in a gel and does not require the use of
stabilizers. This means that UV light can reach the cell and be used.

The hypothesized result is that the silicone encapsulation will have a
greater performance than the EVA when tested.

3 Cells of each category (Silicone-encapsulated, EVA-encapsulated, and
bare) were tested multiple times for quantum efficiency, actual efficiency,
and power output before and after encapsulation and differences were
measured and charted.

In conclusion, the hypothesis was supported by the data. Silicone did in
fact out-perform EVA overall, which leads to the assumption that silicone
should replace EVA as the popular PV cell encapsulant. This also leads
to thoughts about the future. Silicone has a higher performance and also
lasts longer, which suggests that it is most definitely the ideal material
and will pay for itself in years to come. In the future, it would be beneficial
to look at selective vs. homogeneous emitters as well as back contact
cells.

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Category **MA** **P25**   Converging logarithmic spirals on the complex plane

Abstract   The logarithm of a complex number in the form a+bi can be complicated
to find and is volatile when graphed on the complex plane; however,
continuously taking the logarithm of a complex number and taking the
logarithm of the answer eventually gives a unique spiral that always
converges to the same constant value. I started my project during the
summer of 2009 with the help of Professor Jerold Grossman from
Oakland University. He suggested many books and websites for me to
use in order to research my problem. Since operations with complex
numbers get really complex, I bought a mathematics program called
Maple 13(used by many universities and college students). With the help
of the program, I gathered data as proof of my findings. I created tables
where I showed the patterns of my mathematical operations and used
Maple to create plots that visually showed these numbers. To further my
research, I went on to prove that my function does converge for many, if
not all, values in the form a+bi. My proof includes the use of the Cauchy's
convergence theorem along with some unique proofs of my own.

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Category *PH* *P26*   A Magnetic Linear Accelerator Made from Magnets and Steel Balls

Abstract   Linear particle accelerators are used in medicine for various purposes. In cancer treatment, they are used for targeting x-rays at a tumor without damaging surrounding healthy cells. For these reasons, I was interested in learning about the physics behind this device. Using a ruler, strong magnets and steel balls, I assembled a magnetic linear accelerator (MLR) – otherwise known as a gauss rifle. My report describes the experimental procedures I created to determine the most optimal design that maximizes the traveled distance and velocity of the final ball. I conducted experiments both with 1) a predictive mathematical tool I created based on the physics of the MLR, and 2) the actual MLR.

To create such a design, I wanted to know which of the following design variables would have the most influence on the fired ball's velocity: ball mass, ball size, spacer size, friction, spacing between magnets and strength of the magnets. I hypothesized that to increase the velocity, the ball mass, ball size and friction should be decreased, and the strength of the magnets increased. I also hypothesized that the spacer size and the spacing between magnets will have minimal influence.

In addition to comparing the traveled distances and velocities of the fired ball, I calculated the predicted kinetic energy and compared it to the measured kinetic energy. I discovered that the measured kinetic energy was slightly less than my calculations predicted. Possible reasons for this are discussed.

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Category *PH* *P27* Comparing Methods of Determining the Acceleration of a Roller Coaster

Abstract This experiment was created to compare the acceleration found on a computer simulation (the NoLimits Roller Coaster Simulation) and the acceleration calculated from a mathematical formula. Using this program, a model of the Serpent, a roller coaster in Saginaw, Michigan, was constructed. A mathematical equation was also created based on the measurements of the first hill of this roller coaster. It was hypothesized that if a mathematical calculation of the acceleration on a roller coaster is computed, then the acceleration found by the simulator will be accurate within a factor of 10%.

The simulated method was tested on the simulator by measuring the acceleration that riders experienced during the first hill of the Serpent for every tenth of a second. The calculated method was developed by identifying the times when the roller coaster was parallel to the ground as roots on the first hill, and then creating a velocity graph using these roots. This velocity graph was converted into a position graph to emulate the vertical position of the roller coaster over time. Then, the derivative of this equation was taken twice to find a function modeling the acceleration of the roller coaster.

The simulated roller coaster showed that the acceleration decreased slightly during the first 0.5 seconds, and then increased dramatically as the roller coaster reached the bottom of the hill. Then, when the roller coaster traveled upwards, the acceleration decreased again. The calculated function showed similar data, but did not show the leveling out of the acceleration at either end. Therefore, while the percent error was within 10% during a central interval, the error ranged from 20% to 800% everywhere else. In conclusion, the mathematical equation derived only from the maximum and minimum vertical altitudes of a hill on a roller coaster did not describe the acceleration experienced throughout the hill with a 10% margin of error when compared to acceleration determined by a computer simulation.

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Category **PH** **P28** Effects of Sterilization using One Atmosphere Cold Plasma

Abstract The basis of this study was to analyze the sterilizing effects of cold plasma in non-pathogenic bacteria. Plasma is very similar to a gas, and is naturally created during storms when lightning strips the electrons off atoms at extremely high temperatures. Another way of creating plasma is with an enormous flux. Flux is the change in magnetic field, and a large enough flux can influence any charged particle, even electrons. By generating a large flux, the electrons from atoms in the air can be stripped off, thus creating a cold plasma. This can be done with a 24 volt DC power source and a circuit which converts it to 15,000 hertz AC. Next, the voltage must be stepped up to several thousand volts and run through a wire. While in the wire, this high voltage, high frequency current emits a flux which is strong enough to strip the electrons off nearby air particles. To test the sterilization effects of the plasma, two strains of non-pathogenic bacteria, Micrococcus luteus and Escherichia coli strain K12, were exposed to the plasma. Next, the growth of each bacteria strain was observed over several days and compared to that of a control dish. Data concerning the growth of each strain was acquired, quantified, and analyzed using two different methods. For the first method, pictures were taken of each dish everyday, and a computer program, written in Matlab, was used to count the number of pixels in a certain range of hues and compare that number to the total number of pixels. The second method involved streaking each plate for isolation, so that each proceeding quadrant had diminishing concentration of bacteria. The number of quadrants showing growth was then noted, and a two sample T-Test comparing growth in control dishes to growth in dishes exposed to plasma was used to analyze the data and test for significance.

Bibliography

Category **PH** **P29**   The Effects of Waxes on Downhill Skis

Abstract   The purpose of this investigation was to find what wax makes skiers go faster if is was Swik Ski and Snowboard wax, if it was Alpine Ski wax, just an ordinary candle wax, or Turtle car wax. All four of these waxes have different textures and different ways of being applied, and what was trying to be shown was, if you added a weight to the wax, the block will go faster. All this shows is when a skier goes down the hill they will got that much faster because there has been more weigh added. The investigation was done by, making a slope and waxing four sets of boards for each wax, all four tracks were interchangeable. The experiment was seeing how fast a block of ice went down the track, weighted and a just a normal block of ice. The normal not weighted time that was the fastest was the alpine ski wax with an average of 2.71 s. and the fastest weighted wax was the candle wax with the average time of 2.456 s. The hypothesis for this project was proven correct, because the hypothesis was when sliding an ice block down a plank of wood if the wax is more slippery in texture, then the wax will be faster and more efficient. In conclusion both either the Alpine Ski Wax or the Candle wax are the way to go if you want to go the fastest on the slopes!

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Fly Casting Analysis: The Effects of Varying Rod Action and Line Length

Abstract   The purpose of this experiment was to examine the mechanics of the fly cast by looking for performance differences in different aspects of the fly cast that might be seen between fly rods with two different actions, or different flexibilities. I utilized an electronic fly casting analyzer to obtain quantitative measurements of the fly cast, which include peak speed, stop speed, rod load, smoothness ratio, deceleration rate, and symmetry of the cast (dependent variables).

In this study I analyzed casts with a slow action rod (flexible rod) and a fast action rod (stiff rod) while varying the amount of line being cast (independent variable). The length of the rods was held constant. The goal was to find out what effects rod action had on the cast stroke when varying line length, and apply what was learned to fishing in nature.

I hypothesized that as line length increased, so did the casting arc and peak speed of the cast. I also hypothesized that the slow action rod would have a higher rod load than the the fast action rod.

Casts were made outside in an environment where weather was not a factor. I would stand next to the caster while holding the casting analyzer and record the casts while the caster cast the fly rod. Four casts would be done for each combination of line length and rod action.

To conclude, all of my hypotheses were proven correct. As line length was increased, the arc and peak speed of the casts both increased. The slow action rod had higher rod loads than the fast action rod. I found that it took more energy to cast the slow action rod than it did to cast the fast action rod when casting longer lengths of line.

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Category *PH*   **P31**   Solar Sails: Which Design is Best?

Abstract   With today's growing use of satellites and other spacecraft for exploration, much research is being done to develop faster, lighter, and more efficient space vehicles. One of the avenues being explored involves the use of large reflective "solar sails" to propel a spacecraft using thrust from sunlight. James Clerk Maxwell proposed in 1873 that the photons which make up sunlight exert force on objects. This was confirmed in the early 20th century by the experiment of Nichols and Hull. Today, multiple countries are developing solar sails; NASA hopes to launch its NanoSail-D in 2010. However, no solar sails have been successfully flown so far. Over the course of solar sail history, different configurations have been tested to develop maximum efficiency. This experiment was formulated to research the ability and efficiency of flat, concave, and convex sails to propel a payload. The three sail types would be tested with a light source shining directly on them, and then at a forty-five degree angle. Thus, the best sail for sailing directly away from the sun, and the best for sailing at an angle would be determined. Ray tracing was performed for each sail in an attempt to predict which sail would perform the best for each part of the experiment. It was hypothesized that, if the force on the sail was great enough to be measured, the flat sail would perform best when struck directly, followed by the concave and convex sails. When struck at a forty-five degree angle, the convex sail would be most effective, followed by the concave and flat sails. To perform the experiment, a device based on the one Nichols and Hull used was constructed. A sail was placed in the device, and a bright LED spotlight was shone on it. However, no movement was detected which could be attributed to the light, even when modifications were made to increase the sensitivity of the device. The torsion coefficients of various fibers were calculated to determine a more sensitive material and a laser-based measurement system was devised in order to further increase the sensitivity. It was concluded that the light force was not significant enough to be measured in this manner. However, the experiment did not disprove the existence of this force, but only demonstrated that it is very small indeed. A very large sail would be needed to propel a small mass. This experiment was enjoyable, though, as well as being educational about the principles behind solar sailing.

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Category **PH** *P32* Effect of Ultraviolet Light on Different Fabrics and Their Colors

Abstract Of all cancers, skin cancer is the most commonly diagnosed type in the United States. For most cases, ultraviolet radiation is the culprit. Protection against this form of electromagnetic radiation from the sun is essential for avoiding skin cancer and maintaining healthy skin. This project deals with determining which fabric (polyester, wool, or cotton) and color (black, green, or white) is most effective in disrupting the ultraviolet rays from coming in contact with the skin. A black, green, and white sample of each of the three fabrics was needed. The hypothesis was that black would dominate amongst the colors in terms of absorption of light, and polyester would be most protective, then wool, and cotton last. The hypothesis was constructed based on the investigation of the strength of the bonds within the molecular structure of the fabrics. A UVB probe was used to measure the amount of ultraviolet light that the fabrics would absorb in the experiment. Ultraviolet B is the most dangerous form of UV that humans, or other organisms, are exposed to, and it is the main cause of sun burn and cataracts. Using UVB as a standard for ultraviolet in this experiment is beneficial towards providing information regarding protection on a harsher level. An ultraviolet light (UVB) was then attached inside a black box which was impenetrable to light. Next, the light emitted ultraviolet to one of the nine samples of fabric at the bottom of the box. The probe, placed below the box, would measure the amount of ultraviolet absorbed by the specific fabric. The results would determine the fabric that would absorb the most ultraviolet, therefore blocking it from the skin and providing protection for Americans and others around the world under the sun.

Bibliography

Category **PH** **P33** Effect of Car Design Parameters in Protection of Passengers in Car Crashes

Abstract Over the last 5 years, there have been nearly 6,420,000 auto accidents per year on an average in the United States. Millions of people are injured and over 42,000 are killed each year. How do we mitigate the injury to the victims? Does a stronger vehicle cushion the force of the impact and enable passengers to fare better? What is the role of seat-restraint in mitigating the force of the impact? What is the role of air-bags? These important questions are addressed in this project by designing crash impact experiments involving these variables and analyzing the results and more importantly using laws of physics to explain the results.

The project uses a impact ramp (courtesy Ford Motor Corporation) to simulate the impact of car crashes with a number of pertinent variables. Firstly, I designed "front ends" to simulate "stiff" (strongly built) cars, "soft" (lightly built) cars and intermediate strength cars. Effective ways to simulate seat restraints and air-bags were also designed. Initially, the crash impact to the passenger was measured by conducting experiments varying the velocity and acceleration. This was done by adjusting the length of the impact ramp. For each length, the results of the impact for a "stiff" car, "soft" car, and an intermediate car were measured. By these steps I established, the car design that offers the best "raw" impact protection.

In the next stage of the experiment, I measured additional impact protection afforded to the passenger by seat restraint systems and airbags. This experiment was conducted on the car design that offered the best "raw" impact protection. The impact results were measured for no restraints, seat restraint only, air-bags only and with both seat restraint and air-bags. The data collected was the impact observation and the "crush"distance of the fender.

Finally, I utilized the laws of physics to calculate, validate and explain the results obtained.

Bibliography Physics by Holt, Rinehart, Winston