



UNIVERSITY *of* ST. THOMAS

UNDERGRADUATE RESEARCH AND COLLABORATIVE  
SCHOLARSHIP (URCS) PROGRAM:  
COLLABORATIVE INQUIRY

Inquiry at UST:  
A Poster Session with the Results of  
Faculty/Student Collaboration  
at the University of St. Thomas

# Abstracts

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## Introduction

The abstracts published here summarize some of the sustained research and creative inquiry carried out in recent months across many disciplines by undergraduate students at the University of St. Thomas. In all cases, the student researchers have worked in close collaboration with faculty mentors who have contributed their time and talent to help our students dig more deeply into topics of the students' choosing and design.

Funded by the University of St. Thomas through its Undergraduate Research and Collaborative Scholarship (URCS) Program, this poster session allows our dedicated scholars an opportunity to share their work with larger audiences and receive the critical scrutiny of their peers, professors, and the general public.

We hope that you enjoy this event and invite you to engage our scholars in ways that will both challenge them and encourage them to continue their journey of the mind.



David Steele , Ph.D.  
Director, URCS Program



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September 2009

As president of the University of St. Thomas, I am both pleased and proud to introduce the fourteenth annual poster session devoted to faculty/student collaborative projects, sponsored by the Undergraduate Research and Collaborative Scholarship (URCS) Program.

I believe that one of the most effective ways for students to learn is through collaborative inquiry: students and faculty working together on research that can have real-world consequences. In fact, this was one of the major themes of my 2008 Academic Convocation address to our faculty. Active learning of this kind is completely in keeping with our mission as a Catholic university grounded in the liberal arts tradition. We strive to provide a high degree of personal attention in a challenging campus environment that is engaged with the complexities of our urban community and the world beyond.

Collaborative inquiry gives our students the opportunity to experience first-hand how their professors approach research questions in a given discipline. It also gives our faculty a better opportunity to understand how our students think, and helps them develop new ways of looking at research problems. Collaborative inquiry enables our students and faculty to experience their disciplines in action, deepening students' academic experience while simultaneously increasing career competency.

I heartily endorse this effort, and I hope this presentation of work accomplished to date will illustrate the importance of collaborative inquiry at St. Thomas.

Sincerely,

Reverend Dennis Dease  
President

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*Rachel Anderson*

## **PURIFICATION OF PRION PROTEINS FOR USE IN AN EXPERIMENTAL TREATMENT OF PRION DISEASE**

Faculty Mentor: Dr. Katherine Olson

Prion diseases are caused by misfolded proteins. They are lethal, communicable, and currently no treatment is available. Although they are capable of being transmitted through different species, a barrier exists that is still not fully understood. It is predicted that prion disease could be treated in one species by the introduction of healthy prion proteins, (proteins that have shown resistance to misfolding), from another species. This can be tested by the injection of hamster or rabbit prion proteins into scrapie-infected cells or scrapie-infected mice. In order to carry out the latter part of the experiment, which is being completed at the University of Minnesota, hamster and rabbit prion proteins must first be prepared. Hamster prion genes were available in an expression vector, while rabbit prion genes were subcloned into an expression vector. Each vector was then incorporated into bacteria and grown in a culture. The culture produced mass quantities of the desired prion proteins. The prion proteins were purified for use of injection into infected cells and mice. The purification consisted of affinity column chromatography as well as confirmation of the desired protein by light spectrophotometry and gel electrophoresis. The testing with cells and mice will be performed at the University of Minnesota. This aspect of the project is a necessary part of the whole investigation to find a treatment for prion diseases.

*Paul Armstrong*

## **2008 ECONOMIC STIMULUS: A GAME THEORY ANALYSIS**

Faculty Mentor: Dr. Craig Marcott

In response to the economic downturn, which began in 2007, Congress passed the Economic Stimulus Act, providing for a decrease in small business taxes and an increase in transfer payments to households. In determining what effect this economic policy will have, three discernable players must be taken into account: government, households and firms. Each of the three could act in the given situation in a variety of ways. Granted, the exact effects of choices made by the three may not be known for some time, yet neither were they known at the time that the act was passed: only projected results, based on the likeliness of players pursuing specific strategies could have weighed in on the decision of the policymakers to pass the act.

The options of the government player have been simplified to four discrete choices, passing no new legislation, decreasing business taxes, increasing transfer payments, or committing to both expansionary policies; in the latter three cases, historical values are used. However, both the household sector and the firm sector are allowed non-discrete strategies, reflecting the range of possible behaviors which those two sectors may choose to display. Households are able to change their marginal propensity to consume, as well as their income elasticity, while firms can modify their plant and equipment investment.

Using Ray Fair's US econometric model, specific, numerical predictions were made; moreover, coefficients are placed in the equations for consumption and plant and equipment investment, representative of the range of strategies which households and firms are able to pursue, respectively. In such a manner, numerical payoffs are generated, and it may be possible to find at least one scenario which is the mutual best response of all three players.

*Nikki Arola*

## **SPORTS PARENTS: ARE THEY DRIVING THEMSELVES NUTS?**

Faculty Mentor: Dr. John Tauer

This study investigates whether the high investments parents put into youth sports lead to higher expectations for their children and if this can explain why parental frustration in sports is becoming more and more common. Participants in this study were parents of campers at Johnny Tauer's Championship Basketball camp. This study utilized both a correlational and experimental design. In the correlational study, parents completed questionnaires measuring how their level of investment is related to their expectations and how the interaction between their investment and expectations relates to their satisfaction with their child's sport. The experimental study randomly assigned parents to one of eight investments and met vs. unmet expectations scenarios and asked them to rate their level of satisfaction with a number of factors. It was predicted that parents with high investments would have higher expectations than those with low investments. It was also predicted that parents with high unmet expectations would be less satisfied with their child's sport participation than parents with met or exceeded expectations. Analysis of data has provided support for some of these hypotheses. Results will be discussed. This study aims to help parents understand the frustration that they often feel from youth sports so that parental frustration does not lead to athlete burnout and parent/child interactions may be more positive.

*Richard Atherton, Eric Brost, Ann Ziegler, Dan Landberg, Jill Schleicher and Vy Tran*

## **DEVELOPMENT OF DATA ACQUISITION SOFTWARE FOR A CHAOTIC PENDULUM**

Faculty Mentors: Dr. Marty Johnston and Dr. Jeff Jalkio

Studying chaos can be accomplished with many physical systems, in our case we drove a pendulum in a sinusoidal fashion to create chaos. We designed an initial data collection program in LabVIEW using data acquisition hardware. In our pursuit to further classify this phenomenon we needed a more robust way of taking data. Data taking errors happened far too often to produce sufficient usable data sets. So this summer we set out with the goal of creating a program that was more stable than the previous program and one that would handle its own errors.

Other additions include a system file, and a way to initialize the motor. The system file lowers human error by storing all of the information that doesn't change. This has decreased the number of inputs required by an individual from about a dozen to just a couple. When the motor initializes current and voltage readings are taken, the eddy motor is centered and spun up to within .25% of a desired radial velocity. This allows for consistent starting conditions each and every run.

*John Balk*

## **THE ALLELOPATHIC OF RHAMNUS CATHARTICA LEAVES ON SIX NATIVE FLOWERING PLANT SPECIES IN MINNESOTA**

Faculty Mentor: Dr. Chester Wilson

The purpose of this experiment was to see if the leaves of *Rhamnus cathartica* inhibit the germination and growth of native flowering plants and if the decomposition of buckthorn leaves over the course of a winter increases or decreases the inhibitory effects. Six flowering plant species were chosen for the experiment. Each species was placed in a petri dish containing either weathered *R. cathartica* leaves which spent the winter outside or unweathered leaves that spent the winter inside. There was no significant difference in the germination between weathered and unweathered treatments, although in some species there was a significant difference in mass between the treatments and controls

and in others there was a significant difference in the germination rate between the treatments and the controls. This would conclude that there is, indeed, an allelopathic effect in *R. cathartica* leaves although there appears to be no difference in *R. cathartica* leaves that were subjected to a Minnesota winter and leaves that were not.

*Ellyar Barazesb, Mark Jadin, Patrick Persons, and Jennifer Woychik*

## **MODELING MULTIVARIATE FINANCIAL DATA**

Faculty Mentor: Dr. Arkady Shemyakin

The Black-Scholes Option Pricing Model is widely used in the financial sector to estimate the fair price of options (contracts that give the owner the right to buy or sell the underlying financial asset at a predetermined price). This model is based on the assumption that the underlying financial asset is normally distributed. A problem arises in the fact that most financial data is not normally distributed. Our current work is directed at determining a better fitting distribution for financial data using the Chi-Square goodness of fit test. The Black-Scholes Option Pricing Model may then be adjusted and incorporated into a Monte Carlo simulation and Markov Chain process to obtain a more accurate estimation of the fair option price.

*Stephanie Behrns, Kristina Meyer and Paul Nyombi*

## **APPLICATIONS OF MODEL-BASED CONTROL SYSTEMS**

Faculty Mentor: Dr. Christopher Greene

The goal of this project was to examine application tools used to implement different control systems. The first step was to model each process using the Matlab and LabVIEW environments. From the model a controller was developed. This controller was implemented using many different hardware and software tools. Some of these tools included microprocessors and Real-Time programs in Matlab and LabVIEW. The different implementation techniques were compared. The comparisons consisted of possible applications, strengths, and weaknesses. The conclusions found during this project make choosing an application tool easier and more educated for a wide variety of control systems.

*Jacqueline Marie Bernal*

## **A MOTHERS DICHOTOMY: A CATHOLIC RESPONSE TO THE GREAT DEBATE OF WORKING MOTHERS**

Faculty Mentor: Dr. John Buri

“The Family possesses its own specific and original social dimension, in that it is the principal place of interpersonal relationships, the first and vital cell of society”(Compendium of the Social Doctrine of the Church 211). While tragedy or sin can make for a less than ideal family life, each one of us is shaped and formed in one way or another by family. Many people today attack the traditional role of the family composed of a husband and wife devoted to loving one another until death do them part, with an openness to procreation, but it simply cannot be denied that good families make for a good society.

Furthermore, the role of parents in begetting and raising children remains one of the most important and vital aspects of family life. Both the father and mother play an indispensable and irreplaceable part in a child's life, educating, disciplining, instilling in them morals and virtues, and passing on the faith to their children. Within the

sphere of parenting, a mother has a particular role in the raising of children, and thus in the formation of society. So as our culture is witnessing great attacks a commitment must be made to renew society at large. My research this summer focused primarily on what a mother's role should be within this commitment to renewal and aimed at better understanding the Church's position on these issues.

*Elizabeth Bernhardt*

## **LONG-RANGE WAVE PROPAGATION THROUGH RANDOM MEDIA**

Faculty Mentors: Dr. Steven Tomsovic and Katherine Hegewisch, Saint Catherine University

We present an exploration of the stability of long-range wave propagation through random media. As a ray travels through a medium, it encounters variations which cause slight changes in velocity. Sound in the ocean, for example, propagates through varying temperature, salination, and pressure. Over long ranges, these variations cause the ray to become chaotic. In order to determine the behavior of the ray, the evolution of its stability matrix must be studied. Through creation of an adaptive step-size Runge-Kutta differential equations solver, we examined the stability matrices of several thousand rays to determine the transition with increasing propagation time between stable propagation and chaos. Our findings suggest that the timing of the transition is dependent on the initial kinetic energy in proportion to the average maxima and minima of the randomized plane potential. We would like to understand if rays with larger initial momentum tend to chaos as fast as rays with lower initial momentum. Our results relate to our understanding of the phenomenon of coherent branching of electron flow through quantum point contacts [1] and long range acoustic propagation through the ocean [2] as well as other physical contexts.

[1] Topinka, M. A., et al. (2001). Coherent branched flow in a two-dimensional electron gas. *Nature*, 410, 183-186.

[2] Colosi, J. A., et al., (1999). Comparisons of measured and predicted acoustic fluctuation for a 3250-km propagation experiment.

*Logan Bodnia*

## **ANALYSIS OF ALGAL TOXINS IN MINNESOTA WATERS**

Faculty Mentor: Dr. Tony Borgerding

Liquid chromatography coupled with mass spectrometry is a very powerful instrumental method. This method can be applied to detecting toxins from cyanobacteria, specifically microcystin-LR and anatoxin-a, found in various aquatic environments throughout the world. These toxins can cause disastrous effects to the environment as well as to humans. It is hard to detect these compounds sensitively and selectively using other common instrumental techniques. LC-MS allows for selective detection based on the mass of the ions from the toxins. There have been several studies of these compounds in parts of the US, but there have been no studies of microcystin-LR and anatoxin-a in the state of Minnesota.

*Brett Brakefield*

## **MINIMUM ROPELENGTH OF TORUS KNOTS (2,P)**

Faculty Mentor: Dr. Eric Rawdon

The ropelength of a knot configuration is the amount of "rope" needed to tie the configuration. By minimizing the ropelength within a knot type, one arrives at an idealized configuration. These configurations have been used to

predict the speed of knots in gel electrophoresis and predict the pitch of DNA helices. They have other applications in Biology and Physics as well. For my project I gathered and analyzed data on torus knots, that is, knots that can be drawn on a "doughnut". The data I collected regards the relationship between the number of edges used to create a knot and the resulting minimal ropelength. From this data I was able to generate an equation that will predict one of these values, given the other. Specifically, we were interested in determining a pattern in the ropelength of  $(2,p)$  torus knots.

*Eric Brost*

## **CHROMOSOME DISENTANGLEMENT AND THE UNKNOTTING NUMBER**

Faculty Mentor: Dr. Eric Rawdon

In knot theory, the number of passes needed to achieve the unknot, a circle, is known as the unknotting number. The topology of DNA is the twist knot, which has a characteristic unknotting number of one. In the supercoils of DNA molecules, the type II topoisomerase makes strand passes to disentangle the chromosome and ready the DNA for replication. To better understand how the protein operates, we will study the unknotting number in strand knots and other alike. In the past the unknotting number has been found through the knot signature and various other methods, but there has been no universal algorithm for finding the unknotting number. By studying the effects of different ways to unknot and make passes, we hope to find an algorithm for unknotting and better understand the type II topoisomerase.

*Eric Brost, Jill Schleicher, Ann Ziegler, Ricky Atherton, Dan Landberg, Vy Tran*

## **AN OVERVIEW OF METHODS USED TO STUDY A CHAOTIC PENDULUM**

Faculty Mentors: Dr. Marty Johnson and Dr. Jeff Jalkio

Over the course of the summer, our research team has taken further steps toward our goal of completely understanding the physics of a chaotic pendulum. Our scientific procedure starts with the collection of data from our experimental set up. It then follows with the analysis of data through use of several mathematical formulas. The mathematical methods include the correlation dimension, Poincare sections, Lyapunov exponent, bifurcation diagram, and the extraction of constants by minimization techniques. These formulas give us information on the data set that we can relate to the physics involved in the system. We use this information to generate a simulated data set from a theoretical model. With this theoretical model, we are able to error check the experimental results. Our eventual goal is to intentionally change the physics of the system and view the outcome through mathematical analysis. The first step toward this goal is the inclusion of a dipole to dipole interaction in the system. From the dipole-dipole results, we will be able to test our hypothesis.

*Jared Brown, Justin Falzone and Patrick Persons*

## **CROP INSURANCE**

Faculty Mentor: Dr. Heekyung Youn

There is a growing need for crop insurance products for farmers in developing countries. The majority of the world's poor are farmers who suffer periods of famine due to poor harvest. The situation can be improved dramatically if the farmers have access to high quality inputs, such as hybrid seeds and fertilizers.

Weather indexed insurance contracts were developed in 2007 for farmers in Malawi, Tanzania and Kenya by the International Research Institute for Climate and Society of the Earth Institute at Columbia University for World Bank's Commodity Risk Management Group. The insurance products were developed mainly to protect microfinance institutions against losses due to farmers, who received the loans to purchase higher quality inputs, defaulting on their loans when crop failure occurs.

We applied the same basic concept to study the cost of weather indexed insurance products for maize farmers in Kakamega, a western region in Kenya. We attempted to incorporate agronomic features of maize, characteristics of seed varieties, and timing of planting in relation to rainfall and to the lunar calendar. Our goal was to develop an insurance product that is affordable for farmers.

*Megan Brown*

## **IMPROVING THE SENSITIVITY OF MEASUREMENTS MADE USING MICRODIALYSIS AND GAS CHROMATOGRAPHY**

Faculty Mentor: Dr. Tony Borgerding

Gas-phase microdialysis sampling is useful in detecting volatile compounds in small environments. By coupling extraction probes with a carbon nanotube-coated trap and gas chromatography, we have increased the sensitivity of measurements made using microdialysis and GC by a factor of 10-100. To generate reproducible peaks, we constructed a heater that rapidly desorbs the carbon nanotube-coated trap in one second. Using this technique of rapid desorption coupled with microdialysis we have obtained distinct reproducible peaks for various concentrations as low as 1mM ethanol, 1mM isobutyraldehyde, and 0.1mM Toluene.

*Jeff Buchholz and Joe Maniaci*

## **CYPRESS WIND TURBINE**

Faculty Mentor: Dr. Greg Mowry

There are roughly 500,000 cell phone towers world-wide with approximately 10,000 towers being added annually. The majority of these cell phone towers are located in regions without immediate access to a power grid and consequently are powered by a combination of grid and diesel gensets. Unfortunately diesel fuel is expensive, as is the shipping of fuel and spare parts as well as genset maintenance. The power requirements of the cell phone towers vary from 400-3000 Watts, depending on the generation, making this an ideal application for a small alternative energy system. Such a system has the potential to be far more economical than the existing diesel genset technology.

The objective of this research project was to characterize and test the electronics of an existing vertical axis wind turbine system designed by Cypress Wind Turbine to power a cell phone tower. In order to characterize the existing wind turbine power system a dynamometer style test-bench was constructed and instrumented using a variable frequency drive to control an induction motor along with a variety of test electronics. The induction motor was directly coupled to the wind turbine generator and controlled as a means of simulating generator and electronic performance from wind power. During the course of the summer the generator and associated electronics were tested and characterized using the test-bed. Data will be presented showing the performance of the generator and associated electronics. The data that was collected will be used as a reference baseline for comparison with second generation generators and associated electronic designs.

*Katherine Cook*

## **EVALUATION OF AN OUT OF SCHOOL TIME PROGRAM: MEASURING STUDENT AND STAFF PERCEIVED IMPACT**

Faculty Mentor: Dr. Lisa K. Waldner

This research focuses on the self-reported effectiveness of Family and Children's Services after-school programs in place for at-risk youth in the Twin Cities. The origins of after-school programs date back to the start of the 20th century; however it has been during the last twenty years that there has been concentrated public interest in the concept. Family and Children Services, a community-based non-profit organization, has been providing neighborhood resources in Minnesota for over 130 years and in the past year have focused efforts on creating effective after-school programs. With research showing that "today's children participate in significantly more high-risk behaviors such as criminal activity, and alcohol, tobacco, and illicit drug use," grants and funding have been awarded to after-school programs shown to improve student behavior and attitudes towards school (Riggs, Greenberg 2004:177). The United Way awards funding to FCS after-school programs, provided that student participants are meeting designated outcomes. This research uses data in the form of surveys completed by both program staff and student participants to evaluate whether or not program goals are being met and to critically analyze how well current evaluation tools are performing. Analysis of the data with SPSS software indicates statistically significant improvement in student school attitudes and behavioral outcomes upon attending FCS after-school programs. Areas of improvement are also identified in regards to program design and evaluation tools. Given "that the choices that young people make about how to spend their afterschool time may carry long term effects which can be assessed at middle adulthood," this research is a crucial step to creating vibrant, successful communities for future generations (Woodland 2008:541).

*Gregory R. Crane*

## **QUANTITATIVE PCR ANALYSIS OF MRNA CONCENTRATIONS IN BRAIN CELLS OF TRANSGENIC ALZHEIMER'S DISEASE MICE**

Faculty Mentors: Dr. Katherine E. Olson and Dr. Pamela J. Skinner, Department of Veterinary and Biomedical Sciences, University of Minnesota

One way to distinguish between different neurodegenerative diseases (diseases which involve the degeneration of the nervous system) is by identifying proteins that are up or down regulated in a predictable manner among cells in certain tissues afflicted with the same disease, thus creating a unique, disease-specific profile of gene expression, a "protein profile." For this study, an attempt was made to form one such profile for Alzheimer's disease. Samples of mRNA were extracted from brain cells of both healthy and transgenic Alzheimer's disease mice raised at the University of Minnesota. Reverse transcription converted this into cDNA, and qPCR was used to quantitate the cellular concentrations of specific mRNA molecules. Results showed that concentrations of mRNA encoding for several proteins, including Hspa4, Hspa8, Hexb, H2-T23, Rtp4, and Usp18 are not altered in Alzheimer's infected brain cells when compared to wild type cells, whereas others like Cd68 and Gh are altered.

*Rob Crane*

## **TAKING A BREAK WITH BEAUTY**

Faculty Mentor: Dr. John van Ingen

In this paper I examine the shadowy role of consciousness in Kant's Critique of Judgment and its relation to the faculties necessary for making a judgment about beauty. My examination uncovers to what extent Kant's account of

judgments of beauty rely on the framework of cognition laid out in his earlier Critique of Pure Reason, and how consciousness attending to aesthetic judgments deviates from this framework. Kant is clear that the condition for the possibility of both judgments of beauty and normal cognition reside in the same faculties, but the extent that these faculties are employed in either case is vastly different. My analysis of these differences shows that judgments of beauty offer the possibility of the purest encounter with self-consciousness, which is manifest as a distinct break from non-aesthetic experience.

*Ben Czeck*

## **ANALYSIS OF PRE AND POST SETTLEMENT PHOSPHORUS LEVELS IN LAKE SEDIMENTS, SPRING LAKE, MN**

Faculty Mentor: Dr. Kevin Theissen

Humans have a large impact on the environment that surrounds them, including our lakes and waterways. I set out to find how people were affecting the phosphorus levels that were being introduced into Spring Lake, a hyper-eutrophic lake and part of a large watershed in Prior Lake, MN. Phosphorus is a limiting nutrient in most terrestrial and aquatic ecosystems. Though phosphorus is essential for animals and plants, excessive amounts can lead to eutrophication, which can be extremely harmful to lake aquatic ecosystems. To measure the amount of environmentally available phosphorus that was locked in the sediments I had to first use a multi-step acid digestion method that would essentially extract the phosphorus. I was then able to set up a method and run it through an ICP-AES (Inductively Coupled Plasma – atomic emission spectrometer) that uses complex optics to measure the intensity of light emitted at a given wavelength. These intensities correlate with a standards curve and give us a concentration. I also collected data on the total organic carbon and nitrogen concentrations and analyzed what made up the sediments under a microscope to get a better understanding of what type of environment existed at different time horizons as represented by the sediments. Our initial results yield an increased amount of both phosphorus and TOC in the cores and we believe that this represents the time of European settlement. In order to get a timeframe for the data that was derived we sent aliquots of the core to the Science Museum of Minnesota's St. Croix research lab for Pb-210 analysis. We are expecting dates that span from the past 200-300 years which should will help us understand how the phosphorus inputs have been affected in the past and get an insight in how we can change them for the better in the future.

*Caitlin Dado*

## **DEVELOPMENT OF A METHOD FOR MICROSCOPIC TITRATION**

Faculty Mentor: Dr. Gary Mabbott

One underdeveloped research area involves the uptake of drugs at the single cell level. In order to study the uptake of drugs at the single cell level, microscopic quantitative analysis methods are needed to analyze volumes on the sub-nanoliter scale. The goal of this project is to develop a microscopic titration technique that can be applied to individual biological cells. The progress of the microscopic titration was monitored using fluorescence measurements. Our first microscopic demonstration system used a solution of EDTA as the titrant and a solution of calcein, calcium, and KOH buffer as the target sample. Future demonstration systems will use fluorescently tagged antibodies as the titrant and protein covered beads and yeast cells as the target samples. The study of the uptake of the anti-cancer chemotherapy drug doxorubicin into single multidrug resistant cancer cells will be of interest in the future.

*Hans Drabek*

## **EVAPORATIVE COOLING FOR SEED POTATO STORAGE IN MALI**

Faculty Mentor: Camille M. George

The agricultural society in Mali, Africa has begun a pilot program to grow and develop 1 hectare of seed potatoes as an economic resource. Part of the growing process requires the seed potatoes to be stored at a low temperature and high humidity, around 50 C and 90% RH respectively. In order to reduce cost and environmental impact it is desired to develop a renewable structure, using locally available materials, to reach the desired specifications for seed potato storage. From research there is no proven method to achieve these specifications under the given constraints without using electricity or having a naturally occurring winter climate. Evaporative cooling is one of the few available methods to produce cooler than ambient temperatures without electricity. Evaporative cooling is a process whereby a liquid, usually water, absorbs the latent heat from its surroundings until it evaporates, essentially “drawing heat” from its surroundings. However the lowest temperatures attainable with evaporative cooling are limited by the ambient conditions. The purpose of this study is to understand the limitations and reaction of a structure designed to provide evaporative cooling. From numerous existing designs a brick structure, consisting of a half inch layer of sand as a foundation upon which a double walled chamber made from bricks is built with sand and water between the two brick walls, is chosen for its scalability and effectiveness. However, while there is extensive literature on this design, previous experiments have only proven that the general design is effective, which has been verified through internal preliminary testing of a brick evaporative cooler with an average thermal efficiency of 79%. Therefore, a designs of experiments (DOE) was developed to optimize the proven design. The four variables discussed in the DOE are the type of sand between the chamber walls, distance between chamber walls, height of the structure, and the cross section area of the chamber where the seed potatoes are stored. This DOE is ongoing with a tentative finish date in mid October of this year.

*Jonathan Estes*

## **ROMAN REGIONAL ECONOMIC SPECIALIZATION: A SEA ECONOMY IN DALMATIA**

Faculty Mentor: Dr. Ivancica Schrunk

The question of how the Romans dominated the Mediterranean area for so long has long been debated. One argument is how regional economic specialization within the Roman Empire was vital to its success and longevity. Whether it was through fishing, crabbing, or collecting salt the territories in the Mediterranean islands had economies that relied on the sea. Salt works are just a manifestation of this sea economy. The work I did in the salt works in Soline Bay on the island of St. Clement, Croatia, gave an insight into the purpose of the site and confirmed beliefs. Also it gave me a comparative look at other salt works in the area, which helped to fill in the context of the site. The regional specialization throughout the territory under Roman domination was the foundation of Roman longevity; the salt works on the island of St. Clement is a representation of that specialization.

*James Feeks*

## **SETTING UP THE UST OBSERVATORY**

Faculty Mentor: Dr. Gerald Ruch

The purpose of this project was to prepare the UST Observatory for research, class projects, and public viewing. In addition to assembling and automating the robotic telescope, an automated mirror cover was designed to prevent dust from collecting on the primary mirror of the telescope. The automation of the primary telescope allows for the

Observatory to be controlled remotely. The mirror cover presented challenges from a broad range of disciplines, including mechanics, circuit and electronic design, and materials science. Additionally, a separate, transportable telescope was modified for public viewing. A transport system and a mounting system were designed to transport and align the secondary telescope. Together, the two telescopes allow for an interactive viewing experience for students and the public.

*Sarah M. Fink*

## **SOLID-STATE HYDROGEN BONDING AND MOLECULAR PACKING: TWO “BRIDGE-FLIPPED” ISOMERIC CARBOXYLIC ACIDS**

Faculty Mentor: Dr. William H. Ojala

We designate as “bridge-flipped isomers” those molecules differing only in the orientation of a bridge of atoms connecting two major portions of the molecule. Examples are found among the benzylideneanilines, in which the isomerism is  $\text{Ar-CH=N-Ar'}$  vs.  $\text{Ar-N=CH-Ar'}$  ( $\text{Ar} = \text{aryl}$ ). Because isomers of this type assuming the same solid-state molecular packing arrangement might be co-crystallizable to form new solid materials, we are conducting a solid-state study of factors encouraging isostructuralism. Because these include similarity in H-bonding motifs, we have determined and describe here the crystal structure of a carboxyl-substituted benzylideneaniline to examine additional factors that cause it to assume a crystal structure different from that of its isomer. Our determination comes over forty years after initial cell data were first reported for this compound.

*Maria Fischer*

## **TIGHTLY TWISTED TANGLES**

Faculty Mentor: Dr. Eric Rawdon

A particular set of tangled strings have been proposed as a model for determining quark masses. These configurations are to be in a tightened state according to this model, similar to what you get when you tighten your shoelaces. Solving for these configurations analytically is not possible with current theory and, until recently, numerical simulations were not even possible. We use the software RidgeRunner to tighten the configurations for testing this model.

*Jacob W. Forsman*

## **THE TRANSTHEORETICAL MODEL OF CHANGE AND SUSTAINABLE BEHAVIORS AT WORK**

Faculty Mentor: Dr. Elise L. Amel

The Transtheoretical model of change (TTM), initially developed by Prochaska and DiClemente (1983) to assess treatment programs for cigarette smokers, has since been adapted to fit many other problem behaviors, such as sun exposure, cocaine use, seatbelt use, and weight loss (Velicer, Prochaska, Fava, Norman, & Redding, 1998). Since the 1990s (e.g., Levesque, Prochaska, & Prochaska, 1999), organizational changes enacted using the model have ranged from quality improvement in healthcare organizations (Levesque et al. 2001), to employee health promotion

(Prochaska et al., 2008). The TTM is a temporally based model of intentional change including five different stages. Throughout the five stages are 10 processes of change, helping in the progression from one stage to the next.

With U.S. Industry linked to many environmental problems (e.g., producing more than 60% of all U.S. carbon emissions) and the average U.S. citizen spending a large portion of his or her life at work, performing a larger number of sustainable behaviors at work will be an important change. Continuing unsustainable behaviors can be likened to the problem behaviors that the TTM has previously addressed. Thus assessing and addressing the level of change in individuals at work regarding sustainability would benefit from using TTM tools. This would allow researchers to determine not only where it is that people fall on the stages of change, but also what processes are being used to either propel, or hinder, the amount of change a person initiates. To date, using the TTM to address workplace sustainability has yet to be examined.

Our research examines acting sustainably at work through the lense of the TTM. More specifically, we address how it is that a person's sense of self-efficacy and decisional balance influence the likelihood that they act sustainably. We also discuss the application of the model to specific sustainable behaviors.

*Alexandra C. Frank*

## **POLYMORPHS OF 2,3-DIPHENYLMALEIC ANHYDRIDE: TOWARD CONTROL OF THE PHASE TRANSITION BY CO-CRYSTALLIZATION**

Faculty Mentor: Dr. William H. Ojala

Polymorphism is the ability of a compound to crystallize in more than one distinct crystal structure (solid-state molecular packing arrangement). Different polymorphs of the same compound can manifest striking differences in properties such as solubility, hardness, melting point, and density. Upon heating, numerous solid organic compounds experience one or more transitions to different polymorphic phases before melting. We seek to control or influence the course of such transitions by co-crystallizing a compound that undergoes a polymorphic transition with a compound that does not undergo a similar transition. Isosteric molecules, molecules that are closely similar in size and shape, are known to co-crystallize most readily. We are currently investigating the isosteric pair diphenylmaleic anhydride and diphenylfuroxan. The two-fold disorder present in the diphenylfuroxan crystal structure provides this molecule with space-filling characteristics closely similar to those of the anhydride despite its having a different number of exocyclic oxygen atoms. On average in the solid, the molecules of these two compounds are isosteric, having a close atom-for-atom correspondence with regard to both atomic positions and van der Waals radii. The ultimate goal of our research is to determine the effect of co-crystallizing these two compounds on the solid-state polymorphic transition known to occur in diphenylmaleic anhydride. We intend to co-crystallize this pair of isosteric molecules to determine whether the temperature or the overall course of the phase transition can be controlled by co-crystallization of the anhydride with systematically varied amounts of the furoxan. Toward that end, we report here a comparison of the low-temperature crystal structures of the two polymorphs of diphenylmaleic anhydride and describe the results of preliminary co-crystallization experiments.

*Heather Gagnon*

## **ANALYSIS OF PHYTOREMEDIATION PROCESSES IN POPLAR SAPPLINGS WITH THE USE OF MICRODIALYSIS PROBES AND GAS CHROMATOGRAPHY**

Faculty Mentor: Dr. Tony Borgerding

Studies of phytoremediation and phytotransformation processes may lead to new information about pollution clean-up solutions and issues dealing with food contamination. This study of phytoremediation processes employs microdialysis probes to measure chemical up-take by poplars. Cuttings were grown hydroponically, and trichloroethylene was used to spike the water. Microdialysis probes were used to sample from various places where 1mm holes were drilled in the poplars. The small size of the probes allowed for non-intrusive, real-time measurements of the trichloroethylene as it was taken up and metabolized by the poplars. The chemical extracts taken with the probe were analyzed using on-line gas chromatography, an electron capture detector, and carbon nanotube-coated traps. This study shows the extent to which the probes can be used to sample from plants.

*Anthony L. Gerten*

## **SOLID-STATE CONFORMATION AND MOLECULAR PACKING: TWO BIS-SCHIFF BASES RELATED BY DUAL IMINO-GROUP REVERSALS**

Faculty Mentor: Dr. William H. Ojala

We are investigating the solid-state structures and molecular packing preferences of molecules we have designated “bridge-flipped isomers,” molecules differing only in the orientation of a bridge of atoms connecting two major portions of the molecule. Examples are found among the benzylideneanilines, in which the isomerism is  $\text{Ar-CH=N-Ar'}$  vs.  $\text{Ar-N=CH-Ar'}$  ( $\text{Ar} = \text{aryl}$ ). Isomers of this type that are isostructural might be co-crystallizable to form new and useful solids. As a result of a solid-state search for isostructural isomers of this type, we report here the crystal structures of two bis-benzylideneanilines both capable of assuming a centrosymmetric conformation. Their occupancy of crystallographic inversion centers might have encouraged their isostructuralism. Instead, we find that they assume different packing arrangements involving a striking difference in molecular conformation.

*Caitlyn Gomez*

## **MOTHER NATURE’S DAUGHTERS: AN EXPLORATION OF THE DISCONNECT BETWEEN THE MODERN WOMAN AND THE NATURAL ENVIRONMENT**

Faculty Mentor: Dr. Britain Scott

Although many ecopsychologists believe that our industrialized consumer lifestyle contributes to feelings of disconnection from nature, no published studies have explored how some causes of our disconnection may be gender-specific. We theorize that women’s connectedness to nature may be weakened by cultural beauty ideals which alienate women from their natural bodies and also discourage experiences in nature (because active, muscular, sweaty, and dirty bodies are considered unattractive and unfeminine; Choi, 2000; Dowling, 2001; West-Smith, 2000). In our sexually-objectifying culture, women learn to habitually adopt an observer’s perspective on their own bodies and to experience their bodies as objects on display, rather than as tools for engaging the world (Fredrickson & Roberts, 1997; McKinley & Hyde, 1996). In recent studies by UST students collaborating with Dr. Scott this self-objectification has been found to be significantly negatively correlated with women’s feelings of connectedness to nature. Disconnection from nature is related to less eco-friendly behavior and lower environmental concern (Clayton, 2003; Shultz & Tabanico, 2007). In the current study, we experimentally tested the relationship between connectedness to nature, self-

objectification, and environmental concern by assigning participants to either a natural or built environment condition. I hypothesized that those tested in the natural setting would report less self-objectification and more environmental concern in comparison to those tested in a built environment. I also hypothesized that there would be a negative correlation between connectedness to nature and self-objectification, and a positive correlation between connectedness to nature and items related to environmental concern. While I did not find support for the hypothesized difference in responses between conditions, I did find support for the predicted correlational relationships.

*Aaron D. Gronseth, JoJo A. Nemec, Abby H. Schutt*

## **TRICLOSAN RESISTANCE WITHIN BACTERIAL COMMUNITIES IN NATURAL WATERS: MICROBIAL DIVERSITY AND COMMUNITY COMPOSITION**

Faculty Mentor: Dr. Kristine H. Wammer

Selective pressure from triclosan, a common antibacterial agent used in many personal care products, is of concern in natural waters due to the potential risk of increased bacterial resistance to triclosan as well as cross-resistance to medically-important antibiotics. The goal of this project was to study effects on the community structure of Mississippi River bacteria exposed to low levels of triclosan by using Automated Ribosomal Intergenic Spacer Analysis (ARISA). ARISA is a method of community analysis in which PCR amplified DNA fragments of the highly variable 16S 23S intergenic spacer region (ISR) of the prokaryotic rRNA codon are separated using capillary electrophoresis. Here, we present efforts to correlate shifts in community structure with increases in observed resistance to triclosan.

*Mary Gustafson*

## **STRATIGRAPHIC VARIATION OF THE BITTER RIDGE LIMESTONE**

Faculty Mentor: Dr. Lisa Lamb

Between 14.5 and 13.2 million years ago, there was a lake in Southeastern Nevada. The limestone deposits that formed in this lake are now exposed in outcrop in almost continuous section in multiple places east of Las Vegas. By studying the extent and continuity of these deposits we can gain insights into what the lake basin was like; by studying the characteristics of the deposits we can learn about the environment of and around the lake. I defined and described six meso-scale units and traced them along the ridge to ascertain the complexity of the original basin structure. I also used facies interpretation to estimate the climatic conditions at the time. From this it appears that the lake the Bitter Ridge Limestone formed in was in a single basin and appears to have gone through several wetting and drying periods. Studying the BRL adds to our understanding of extensional basins by testing models, such as the low-angle model (Janecke 2009; Lister and Davis 1989). It also provides more information to our scanty knowledge of fossil lakes.

*Randy Hade*

## **ACTION RESEARCH FOR AURORA AVENUE COMMUNITY ENHANCEMENT**

Faculty Mentor: Dr. Lisa Waldner

The purpose of this paper is to present the project and analysis of action research around approximately 180 homes along Aurora Avenue in St. Paul, MN. The focus of the research is the creation of a neighborhood profile consisting of a combination of qualitative and quantitative data. The data gathered consists of already existing resources such as census data and local organizations' research as well as face to face interviews conducted with both qualitative and quantitative questions. This research is beginning part of a larger community oriented project called the Community Enhancement and Wellness project lead by the St. Paul, MN non-profit Community Stabilization Project (CSP). The goal of the action research and the project is to realign communities with their values. The completed research will be presented to the community with the intent that it will be utilized to create next steps towards improving the community.

*Kirsten Halstead*

## **MATHEMATICAL MODELING OF GROWING TISSUES**

Faculty Mentor: Dr. Magdalena Stolarska

Scientists have been trying to understand the details of how tumors grow for many years. Many scientists look into the biology of a tumor to find the answer but there are some that have instead thought about the mechanics of tumor growth. As described in an article by Gabriel Helmlinger and colleagues, a tumor of spherical geometry is placed into a cylindrical capillary, small in the axial direction when compared to the length. While inside the capillary tube, the tumor began to grow. However, instead of growing proportionally to its original spherical geometry, it grew more vertically following the length of the tube and less in the axial direction. The researchers showed that the symmetry breaking was from mechanical effects and not from effects of nutrient distribution, and as a result they concluded that mechanical stresses affect tumor growth.

My interest is to further understand tumor growth from a mechanical viewpoint. I decided to model tumor growth using methods learned in my Continuum Mechanics course. To do so, I needed to compose a system of nodes and springs to represent the capillary tube, the tumor, and the gel surrounding it. By applying forces and growth rates to the springs, I was hoping to see an overall expansion of the original tumor, as seen in Helmlinger's experiment, and determine the forces required to stop the growth of the tumor. From the research I did over this summer, I was able to investigate the qualitative parameters necessary to eventually seize the growth of the tumor over a length of time, which was something that was observed qualitatively in Helmlinger's experiments.

*Mary Hammer*

## **ANALYSIS OF ATRAZINE IN SHALLOW LAKES USING MS-MS**

Faculty Mentor: Dr. Tony Borgerding

Atrazine is a commonly used herbicide in the United States and it has accumulated in many lakes and streams. Atrazine samples were collected and concentrations were found using an internal standard, terbuthylazine. Atrazine was extracted from 500mL samples with 5mL of methanol in C18 cartridges. The extracts were analyzed using an MSMS triple quad with Q1 masses set to 216 m/z for atrazine and 230 m/z for the internal standard terbuthylazine. The Q3 mass for both compounds was set to 174 m/z. Atrazine concentrations were found to be from 0.1ppb to 5ppb.

*Kelsey Hofmeister*

## **PORTABLE GEN-2 BIODIESEL PRODUCTION SYSTEM**

Faculty Mentor: Dr. Greg Mowry

Last year, a team of engineering students designed, built and produced near ASTM grade biodiesel via a prototype biodiesel processor (Gen-1). The senior design project was a joint venture between Augsburg College, the University of St. Thomas and the SarTec Corporation. Biodiesel is produced using a revolutionary process called the MCGYAN process which uses no water and produces no waste. The goal of the research performed this summer was to develop a more efficient and cost effective Gen-2 system. The Gen-2 unit, when combined with a Lister diesel engine (another undergoing summer research project) will be used to generate approximately 4 kW of electrical power. The primary application for the Gen-2 system is to automatically provide biofuel for humanitarian (e.g. electricity) and agricultural applications (e.g. biodiesel fuel). The research focus was on designing, sourcing and developing more efficient and cost effective Gen-2 subsystems. Some of the subsystem work included:

- Designing a more efficient heat exchanger to maximize the use of heat energy
- Re-designing the reactor to properly use supplied heat
- Designing improved and low cost high pressure pumps with better specifications
- Oxygen removal without nitrogen sparging

My work also included contacting companies for quotes and questioning the specifications on certain components, which included pressure transmitters, flow meters, high pressure pumps, dissolved oxygen meters, and high temperature ceramic adhesives. Experiments using methanol and soybean oil were conducted for a better understanding and demonstration of the applicable chemical processes.

*Michael Hubn*

## **CUT-SETS AND CUT-VERTICES ON ZERO-DIVISOR GRAPHS**

Faculty Mentor: Dr. Mike Axtell

The goal of my research is to classify cut-vertices and cut-sets of zero-divisor graphs of finite commutative rings. Let  $R$  be a commutative ring possessing (non-zero) zero-divisors. There is a natural graph associated to the set of zero-divisors of  $R$  using vertices and edges. Each zero-divisor has an edge with each of its annihilators. I begin by classifying cut-vertices in the graph of  $Z_n$ , and apply these findings to cut-vertices of the graph  $Z_n \times Z_m$  first, and then of the graph of  $Z_{n_i}$ . The third section classifies cut-sets of by examining cut-sets of  $Z_n$  with specific values of  $n$ . The final section accomplishes the goal of classifying cut-vertices and cut-sets on zero-divisor graphs of finite commutative rings with identity using what we discovered in the previous sections. The section begins by classifying cut-vertices in the graph of  $R$ , where  $R$  is isomorphic to  $R_1 \times R_2 \times \dots \times R_n$ , and go on to classify cut-sets of the graph of  $R$ . Then elements of cut-sets of the graph of  $R$  are classified, and finally we classify cut-sets of direct products of local rings and fields.

*Matthew Humbert*

## **GAS PHASE MICRODIALYSIS EXTRACTION: A VERSATILE TOOL FOR THE EXTRACTION OF VOLATILE COMPOUNDS INTO THE GAS PHASE**

Faculty Mentor: Dr. Tony Borgerding

Gas phase microdialysis probes are small (200 $\mu$ m x 3mm), fast (response time <5 sec), and sensitive means of extracting volatile compounds from solution. Gas phase microdialysis probes have been interfaced with a chemiluminescence detector to measure aqueous nitric oxide with limit of detection of 5  $\mu$ M. The probes have also been interfaced with a proton transfer reaction mass spectrometer to dynamically monitor products and reactants of the oxidation of n-butanol, as well as measure aqueous H<sub>2</sub>S at 14.7 mM.

*Renee Huset*

## **UNDERSTANDING MINNESOTA'S CARBON LANDSCAPE**

Faculty Mentor: Dr. Paul Lorah

The current state of the environment has launched the concept of a Carbon footprint—the total Carbon emissions made by a party in a given timeframe—into the mainstream. This project focuses on a closely-related concept known as Carbon offsetting, which involves replacing Carbon present in the atmosphere back into the Earth. One of the many ways to offset Carbon emissions is through reforestation, as trees naturally store Carbon as they grow. The state of Minnesota is heavily forested, but given its unique geography there are many places in which this approach to Carbon offsetting could be particularly advantageous and other regions where reforestation is simply not a viable option.

This project was focused on finding which areas are best-suited for Carbon offset projects via reforestation by using Geographic Information Systems (GIS) technology and statistical regression. To target areas with the greatest potential for Carbon absorption we created a model that best predicts aboveground Carbon deposits in currently-forested land using both physical and human variables. By applying the same model to deforested land we were able to calculate the amount of Carbon that should be found in the landscape according to our model and target areas in which there is considerably less Carbon present in the landscape than is expected. We then applied our findings to the concept of Carbon offsetting in regard to both the state of Minnesota as a whole and the University of St. Thomas.

*Nick Huynh*

## **ACTIVATION OF THE SIRT1 DEACETYLASE AS A NOVEL STRATEGY TO TREAT T CELL HYPERACTIVATION DURING HIV INFECTION**

Faculty Mentor: Dr. Melanie Ott, Gladstone Institute of Virology and Immunology, University of California San Francisco, and Jill Manske

Immune activation is a hallmark of HIV-1 infection and HIV-1 Tat protein plays an important role in immune hyperactivation in HIV-infected T cells. NF- $\kappa$ B, a critical regulator of immune responses, has been linked to Tat-mediated immune hyperactivation. The activity of the prototypical NF- $\kappa$ B complex (a heterodimer of p50 and p65 subunits) can be regulated by acetylation of the p65 subunit by the histone acetyltransferase p300. SIRT1 deacetylates p65 subunit and suppresses the transcriptional activity of NF- $\kappa$ B. We find that the HIV-1 Tat transactivator promotes hyperactivation of T cells by blocking the NAD<sup>+</sup> dependent deacetylase SIRT1. Tat directly interacts with SIRT1 and blocks the ability of SIRT1 to deacetylate the p65 subunit of NF- $\kappa$ B. Because acetylated p65 is more active as a transcription factor, Tat hyperactivates the expression of NF- $\kappa$ B-responsive genes, including interleukin-2. Based on these findings, we hypothesize that activators of the SIRT1 deacetylase activity can counterbalance the Tat-

mediated T cell hyperactivation. To test this hypothesis, we infected purified human CD4<sup>+</sup> T cells with a lentivirus expressing HIV-Tat protein and GFP along with a control GFP virus. In parallel, a lentivirus carrying shRNA targeting SIRT1 was utilized to suppress endogenous SIRT1 expression. Infected cells were reactivated with anti-CD3/CD28 antibodies in the presence of either DMSO or resveratrol. Our primary experiment showed that IL-2 production was not increased in Tat expressing CD4<sup>+</sup> T cells. Surprisingly, the resveratrol treatment enhanced IL-2 expression in a SIRT1 independent manner. We believe that further optimization of experimental setting and repeats are required to draw conclusion.

*Emma M. Jindra and Bisrat A. Fekadu*

## **ESTROGENIC ENDOCRINE DISRUPTORS IN THE CHICAGO AREA WATERWAYS**

Faculty Mentor: Dr. Dalma Martinovic

The Chicago Area Waterways (CAWs) comprise numerous natural and man-made passages. The wastewater effluents are one of the main sources of endocrine disrupting chemicals (EDCs) in aquatic environments. These EDCs are potentially impacting the health of fish populations in the aquatic environment by interfering with their hormonal system. There have been no studies to date that have investigated the occurrence/impact of endocrine disrupters on the fish populations in the Chicago area. In this study an Enzyme Immunoassay (EIA) was utilized to quantify the levels of estradiol in concentrated water samples (n=30) from Chicago. The samples were concentrated using solid phase extraction and shipped to the University of St. Thomas for processing and analysis. Estradiol was detected in all of the analyzed water samples (excluding the negative controls—distilled and well water). It was also found that estradiol levels were higher in sites closer to the reclamation plants than levels further downstream. This suggests that the wastewater treatment plants (WWRP) are the main source of estrogens in Chicago waterways.

*Samuel Johnson*

## **LEARNING ELECTRONIC WITH PLAY-DOH: FUN, COLORFUL, MALLEABLE, AND CONDUCTIVE**

Faculty Mentor: Dr. AnnMarie Thomas

For many individuals, learning electronics is a particularly difficult thing to do. In fact, engineering concepts, in general, are not easily grasped by many people. Visual and playful learning are two of the best teaching methods that allow students to develop a genuinely deeper understanding of these concepts. The development of conductive, and insulating, molding compounds apply these learning techniques to basic electronics, an otherwise intuitive subject. With the use of this innovative, fun, safe, and low-cost learning tool, students can effectively learn the basics of electronics and circuit building while engaging with a tangible medium and building creativity. One aim of this project was to develop both conductive and insulating molding compounds for use as an effective tool in electronics education. The other aim was to construct a preliminary method to successfully implement the use of this tool in a basic electronics, or circuit building, curriculum.

*Melissa Joyce*

## **A COMPUTATIONAL STUDY OF $\text{TiH}_5^+$ AND $\text{CH}_5^+$**

Faculty Mentor: Dr. Joseph Brom

An interest in three-center-two-electron bonding leads to a study of  $\text{CH}_5^+$  and  $\text{TiH}_5^+$ . The electronic structures of  $\text{TiH}_5^+$  and  $\text{CH}_5^+$  were examined using GAMESS (General Atomic Electronic Structure System). Full-valence MCSCF (Multiconfiguration Self Consistent Field) calculations for both  $\text{CH}_5^+$  and  $\text{TiH}_5^+$  have been completed.  $\text{CH}_5^+$  was analyzed using a 6-311 G(d) basis set. For  $\text{TiH}_5^+$  a 6s4p4d2f basis set was employed for titanium, and a 5s2p was employed for the hydrogens. The Cs point group resulted in two conformations for  $\text{CH}_5^+$  and three conformations of a completely different structure for  $\text{TiH}_5^+$ . One of the conformations found for  $\text{TiH}_5^+$  is a  $\text{TiH}(\text{H}_2)_2$  complex. Three-center-two electron bonding was found in  $\text{CH}_5^+$  while this particular type of bonding was not seen in the  $\text{TiH}_5^+$  species.

*Godino Kalungi*

## **ANALYSIS OF PFCS IN FISH SAMPLES FROM LAKE JOHANNA AS PART OF AN AQUATIC FOOD CHAIN STUDY**

Faculty Mentor: Dr. Tony Borgerding

Perfluorochemicals (PFCs) were analyzed in fish from Lake Johanna as part of a larger food chain study. The PFCs were extracted from fish by solid phase extraction (SPE) using methanol, and then analyzed using the liquid chromatography with mass spectrometry detection (LC-MS/MS). The concentrations of PFCs in fish were between 0.4 to 1000ng/g. Generally, the acids showed a higher concentration than the sulfonates with the highest concentration of 1000ng/ml and 218ng/ml respectively. On average, bigger fish such as northern pike had high PFC concentration than small fish such as bluegill. The fish results are being compared to PFC concentration in bugs, water, plants and sediments from the same lake.

*Luke Kassekert*

## **DEVELOPMENT OF A NANOPORE FOR PROTEIN CHARACTERIZATION**

Faculty Mentor: Dr. Gary Mabbott

The overall goal of the project was to create a nanometer scale pore with a size selectable aperture. The pore may act as a gate that allows particles below a predetermined size to pass through. Our approach is based on casting a pore in PDMS using an electrochemically sharpened tungsten needle to define the pore. As particles pass through the opening they can be counted from the pulses that they create in the electrical resistance of the pore (Coulter principle). These pulses are proportional to the size of the particle and directly related to the translocation of particles. Experimental results will be applied towards the characterization of nanoparticles by size and quantifying antibody/antigen reactions.

*Emily Kawesa-Bass*

## **IDENTIFYING FABRIC DYES USING NEGATIVE ION MODE ESI MASS SPECTROMETRY (QTOF2) FOR FORENSIC SCIENCE PURPOSES**

Faculty Mentor: Dr. Gary Mabbott

The goal of this research project is to be able to simply and accurately identify a dye molecule by interpreting negative ion spectra obtained from a QTOF2 mass spectrometer. For the sulfonated dyes in this study, the base peaks were easily identifiable as the parent molecule minus a hydrogen or a sodium. The observed base peaks, isotope peak ratios and mass fragment calculator helped in identifying the molecules. In terms of analysis of fibers in forensic science this protocol will save forensic scientists time and enable positive identification of the dyes in the fibers collected.

*Albert Kertho*

## **ANALYSIS OF PERFLUOROCHEMICALS (PFCs) IN SEDIMENT SAMPLES FROM LAKE JOHANNA**

Faculty Mentor: Dr. Anthony Borgerding

The concentration of selected perfluoroalkyl sulfonates and acids were determined in sediments to investigate the fate of PFCs in aquatic environment. The sediment samples were collected from a core and surface points on Lake Johanna. Extraction was done by solvent extraction with methanol. The analytes were then identified using liquid chromatography tandem mass spectrometry (LC-MS-MS) system. The concentration of sulfonates and acids ranged between 2-3400ng/ml and 2-5400ng/ml, respectively. Surface has slightly higher concentrations of PFCs except in PFHxS, PFHpA and PFOS. The concentration of PFOS increased with the depth of the core. PFOS and PFOA were the major PFCs detected. The sediment values are also being compared to water, fish, plant and bug data from the same lake ecosystem.

*Laura Kolar*

## **VICTORIA AND ALBERT: MARRIAGE AND MONARCHY**

Faculty Mentor: Dr. Alexis Easley

In 1837, at the age of 18, Victoria became Queen of Great Britain, and with her beloved husband Albert at her side, went on to rule the largest empire the world had ever known. Yet the reign of Victoria and Albert was not always a fairytale story. In fact, in the early years of Victoria and Albert's marriage, many doubts were raised by English subjects about Victoria's passionate, naive ways and Albert's foreign manners and affiliations. How, then, did they become the most influential and iconic married couple of the nineteenth century?

I argue that Victoria and Albert are an intriguing case study of a political marriage, for they model a political partnership based on a companionate marriage. Both wielded their own type of power, resulting in a successful marriage and monarchy. Privately, Victoria and Albert's relationship depended on their love and the ability to encourage the other in their strengths, which they learned to balance throughout their marriage. Publically, in securing the empire, Victoria and Albert relied on the circulation of mass media to project their image of domestic harmony to the public. By extension, the entire royal family was instrumental in creating the spectacle of virtuous home life that gained public support. Through this spectacle, the public was made aware of the royal family, and by identifying with them, lent whole-hearted support.

My interpretation of Victoria and Albert's marriage differs from the views of many modern biographers. Rather than viewing Victoria and Albert's marriage as an example of gender based oppression, I look at it as a success of the partnership between a man and a woman that succeeded regardless of any presumed power struggles and dominance. Victoria and Albert were not two independent leaders living together, but through their complementarity, they worked together for a single purpose.

*Lindsey Lee*

## **A DETAILED LITHOFACIES ANALYSIS OF BITTER SPRING CARBONATES; POSTULATES FOR MIOCENE TECTONIC EXTENSION AND PALEOCLIMATE IN NEVADA**

Faculty Mentor: Dr. Lisa Lamb

The Bitter Ridge carbonates are rocks that formed in a lake from 13-14million years ago. The suite of rocks is exposed in the southwestern USA and was sampled from outcrops in eastern Nevada. These rocks record the development of the major phase of extension experienced in the American southwest and a well-defined climatic optimum that has been studied by other geologists. The project consisted of doing a high-resolution analysis of the central Bitter Ridge Limestone, seeking to delineate facies changes through time. The two main goals of the project were to first, better define the different carbonate facies according to changes in texture, color and structures. Second, through the use of hand sample and microscope observation, to understand the microscopic changes that influence how the facies change in outcrop. In other words, the rocks change through time and I worked to determine why, what environmental variations occurred throughout the deposition of this rock sequence of the basin. After interpreting the sedimentary and microbial structures, presence of shell fragments, variations in pore space, energy levels and level of sub-aqueous exposure, I came to conclusions about 1)the evolution of the Bitter Ridge Lake through time and 2)possible tectonic versus climatic signals within the rock sequence. I made detailed hand sample and thin section observations on 6 lithofacies, however 17 principle lithofacies were identified. A sufficient majority of the principle lithofacies formed in a fairly shallow, saline to hypersaline, evaporative lake. By observing how the lithofacies plotted through time, as well as reading the stable carbon and oxygen isotope data, 7-8 episodes of wetting and drying were identified, some of which appear to correlate with the 100,000 year Milankovich eccentricity cycles. Though the isotope data was roughly interpreted, there is still more research to be done on how to interpret the data in an evaporative, saline lake.

*Amanda Louiselle*

## **ASSESSING THE REACTIVITY OF A FUNCTIONALIZED POLYLACTIC ACID**

Faculty Mentor: Dr. J.T. Ippoliti

The goal of this research was to determine if the functional group on an initiator for polymerization was reactive. An initiator was found that has two alcohol groups with the ability from which to grow polylactic chains as well as, a reactive carboxylic acid group located off the quaternary carbon. Various methods were attempted to utilize the carboxylic acid group's reactivity to attach the polymer chains to two different sugar molecules, which are useful in aiding the degradation rate. Also, various methods were used to extend the reactive carboxylic acid group away from the quaternary carbon as this gave potential to make the group more reactive.

*Nicole Lucca*

## **THE INVASION OF WONDERLAND: A POST-COLONIAL READING OF LEWIS CARROLL'S ALICE BOOKS**

Faculty Mentor: Dr. Alexis Easley

When Lewis Carroll's Alice books were first published, works of children's literature were regarded as entertaining stories unworthy of academic study. During Carroll's lifetime, the Alice books received little if any serious critical attention, but by the 1930s critics began to interpret the stories as complex literary works. Because the Alice books are full of provocative ideas and adult themes, they should not be viewed merely as escapist fantasy written exclusively for children. They tell the adult reader a great deal about Victorian ideology, particularly attitudes toward colonized peoples. During the Victorian era, children were special targets of imperialist discourse because they were considered the future rulers and guardians of the Empire. This paper examines how imperialist ideology was communicated to children through children's literature, with a focus on Carroll's Alice books.

*Tristan Lunde*

## **QUALITATIVE AND QUANTITATIVE CHEMOTACTIC RESPONSES OF PSEUDOMONAS PUTIDA STRAINS TO FURAN MOLECULES**

Faculty Mentor: Dr. Jayna Ditty

Chemotaxis is the process by which bacteria are able to facilitate movement in response to some environmental stimuli. Sensory signals are picked up by transmembrane receptors that initiate a signal cascade within the cell. These signals are processed by the bacteria and trigger rotary flagellar movement toward or away from the stimulus depending on whether the chemical is beneficial or toxic for the bacteria. Typical attractants include chemicals that the bacteria can use as a source of carbon or energy. Carbon sources used for this experiment were 2-furoic acid and 5-hydroxymethyl furfural. There was interest in determining if *Pseudomonas putida* Fu-1 and A3 strains, which are known to degrade furan compounds, would also detect and respond to these two industrially important compounds which act as fermentation inhibitors when crops, such as grapes, are pretreated with acid and heat to release fermentable sugars. To determine the chemotactic response to furan carbon sources, qualitative observations were made by analyzing swarm plates and performing agarose plug assays. Swarm plate results showed that both *P. putida* strains were attracted to either the furan molecules or a metabolic intermediate. Agarose plug assays determined that each *P. putida* strain was attracted to the furan molecule itself. To quantify the response, capillary assays were used to determine the intensity of the *P. putida* Fu-1 response to 2-furoic acid. It was determined that the Fu-1 strain was best attracted to a  $5 \times 10^{-3}$  molar concentration of 2-furoic acid. It was also determined that the response to 2-furoic acid was inducible.

*Kati Lundell*

## **THE DEVELOPMENT OF CHARITABLE INSTITUTIONS WITHIN ST. PAUL**

Faculty Mentor: Dr. Tom Mega

During the late 19th and early 20th centuries, the city of St. Paul began to see a dramatic population increase. Thousands of settlers were attracted by the new opportunities offered in the emerging businesses of the city. As St. Paul began its transition into a profitable economic center, how did this affect the formation of non-profit institutions within the city? My goal in researching this subject was to understand the development of St. Paul from a different perspective. Although the growth of St. Paul was heavily based on the emerging industries, the creation of charitable

organizations further propelled another aspect of development. I wanted to connect how St. Paul business effected the formation of community-oriented non-profit organizations and thus a more completed city.

*Matt Luong, Billy McKee and Gary Vu*

## **DYNAMIC SYSTEM ANALYZER**

Faculty Mentor: Dr. Chris Greene

In this poster we developed a Dynamic System Analyzer (DSA) using LabVIEW, which is a program, developed by National Instruments specifically for the applications in engineering and science. A DSA is used to analyze the dynamic motion of mechanical and low frequency systems and is also used to model and understand the behavior of the system through the changes of sinusoidal signals. With these changes from the generated signal and the output signal it allows one to determine characteristics of the unit that is being tested. Normally the market price of a DSA goes for around \$20,000. Through this project a software version of a DSA functions just as commercial DSA would and a number of variations that were changed to better display the information as well as increase the capabilities of the instrument.

*Rae Lyons*

## **PETS AS PURSES: TREATING PETS AS ACCESSORIES AND ITS INFLUENCE ON HUMAN CONCERN FOR THE NATURAL ENVIRONMENT**

Faculty Mentor: Dr. Elise Amel

This study explored the “pet as accessory” trend and its influence on concern for the natural environment. Previous research had not investigated the effects of this recent trend. One hundred and forty five college students read a narrative and viewed a photo describing a human-pet relationship where the human treated the pet as an accessory, a family member, or nature. Participants then completed the Environmental Motives Scale with three dimensions: egoistic, altruistic and biospheric concern, and completed the New Environmental Paradigm Scale to determine general environmental concern. The original hypotheses were not supported in that no significant differences were found between conditions on either scale. However, evidence for sex differences on scales and the validity of the scales was found.

*Kevin Mahoney*

## **EXECUTIVE STOCK OPTION COMPENSATION AMONG U.S. FAMILY CONTROLLED BUSINESSES**

Faculty Mentor: Dr. Mary Daugherty

With executive pay steadily climbing, and management repeatedly cashing in on stock options even amidst economic turmoil, many people have begun to question these current compensation practices. This paper evaluates the stock option grant process in order to establish if there is a substantial difference between the practices of Family Controlled Businesses (FCBs) and Non-Family Controlled Businesses (NFCBs). This study examines stock options grants of FCBs versus NFCBs for the period 2000-2008 and discovers that FCBs use fewer stock options than other companies, which helps lead to improved financial performance. This study also evaluates the 2005 option expensing rule change and finds that both FCBs and NFCBs significantly decreased their option grants after the rule was instituted.

*Jascha Marchuk*

## **USING ELISA ASSAY TO DETECT PRESENCE OF TESTOSTERONE IN RURAL AND URBAN WATERWAYS**

Faculty Mentor: Dr. Dalma Martinovic

Waste water treatments plants are a known source of endocrine disrupting chemicals (EDC's), such as testosterone that can have adverse effects on the organisms they come in contact with. The goal of this study is to determine if two different waterways, the Redwood River System in Minnesota and the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC), are being affected by increased levels of testosterone from their respective waste water treatment plants. The water samples were collected by the University of St. Cloud and shipped to the University of St. Thomas where they were concentrated with C-18 Solid Phase Extraction (SPE). The sample extracts were then used in an enzyme immunoassay (EIA), Free Testosterone Assay (ALPCO Diagnostics). It was found that the urban Chicago waterways had much higher concentrations of testosterone than the rural areas of Minnesota on average. The majority of the Minnesota samples were less than 0.001 ng/ml testosterone while the Chicago samples ranged up to 0.05 ng/ml testosterone. In the Minnesota samples, the effluent water clearly had the highest source of testosterone followed by the sites impacted by the runoff from the feedlots. The feedlot sites were probably higher in testosterone due to hormonal implants and/or naturally produced hormones in cattle. In the Chicago samples, Salt Creek wastewater treatment plant effluent had higher testosterone levels than the downstream sites. In the other two waterways, the highest sources were not the reclamation points. This indicates that there may be other sources of testosterone or that testosterone may be accumulating in the riverbed sediment.

*Ryan Markwardt and Kayla Pocquette*

## **SIGNALS LAB USING SIMULINK WATERWAYS**

Faculty Mentor: Dr. Chris Greene

The main objective of our summer research was to design a lab for the Electrical Engineering course Signals and Systems (ENGR 340) that would encompass several of the main topics covered in class. This was accomplished using the MATLAB application Simulink in conjunction with Xilinx's System Generator, where we were able to design a digital filter using block diagram system models. The digital filter was then programmed onto a Digilent Spartan3 board and, with the use of analog to digital and digital to analog converter chips, we were able to input analog test signals into our system and view the effects of our filter on an oscilloscope. The lab, when completed, will require students to construct the Spartan3 signal processing system and program it with their own custom digital filter.

*Rory Mattson*

## **A CHANNEL TO DESTINY AND ITS EVOLUTION IN SOCIETY**

Faculty Mentor: Dr. Steve Hoffman

In 1986 Congress formally recognized the Mississippi River as both a nationally significant ecosystem as well as a nationally significant commercial navigation system. Throughout the United States of America's history the Mississippi River has been a focal point for transporting goods, a gateway for settlers and a freeway for commerce, however at a substantial expense to its ecosystem. In recent years, society has begun to recognize the Mississippi River as a unique and irreplaceable ecological system. Central to this evolution is the manner in which the tensions between ecology and economic development are presented to the public. The media play a crucial role in prioritizing social ideals. This research will explore the framing of this debate by the media, the public perception regarding the debate and whether it is possible to reconcile two contradicting purposes for the Mississippi River.

*Anna Meyer*

## **VASCULOGENESIS OF THE AVIAN EMBRYONIC LIVER: AN ANGIOCIRCULATORY HYPOTHESIS**

Faculty Mentor: Dr. Glenn Sherer

Vasculogenesis in the early embryo has been shown to occur both angiographically (Schultz 2008) and angioblastically (Sherer 1991). The former is dependent upon the recruitment of vascular endothelial cells (VECs) from an external, established vasculature; the later, upon the in situ differentiation of mesenchymal cells intrinsic to the vascularizing organ, which develop into VECs. This investigation proposes and provides evidence for a third vasculogenic mechanism, which we have termed angiocirculatory, by which VECs and/or their precursors, angioblasts, are obtained from circulating blood. We have tested this hypothesis in liver harvested from interspecific chimeras. Whole chick and quail embryos, whose cells are distinguishable by means of antibody staining, were co-cultured in ovo and in shell-less culture to form parabioses. Quail VECs were found to contribute to the formation of the sinusoids of parabiotic chick livers, suggesting that the cells that form these capillary level vascular structures are acquired from circulating blood. Surprisingly, most VECs of these livers were of quail origin, suggesting the possibility that the mechanism proposed here may even be the predominant means of vasculogenesis.

*Anna Meyer*

## **HEPATIC MORPHOGENESIS IN MAMMALS AND FOWL: TWO PATTERNS FROM ONE MECHANISM?**

Faculty Mentor: Dr. Glenn Sherer

The miracle of embryonic development is the transformation of a single, fertilized cell into a myriad of cell types and tissues that comprise a functional organism. This process is controlled in part by tissue interactions: relationships between two proximate tissues in which one (the inducer) either causes or allows the second (the responder) to attain its mature form. The formation of every organ in vertebrates is a consequence of these interactions, which generally involve a mesenchymal tissue as the inducer and an epithelium as the responder. This project explores these interactions with regard to the livers of mammals and birds (fowl), each of which has a distinctive morphology. When mammals and birds diverged 65 million years ago, the livers of these two classes took on distinguishable patterns of organization. This project investigates whether this structural difference may be traced to the liver's epithelium or its associated mesenchyme, and how the interaction between these tissues changed over evolutionary time. Epithelium and mesenchyme from the rudimentary livers of two different species, mouse and quail, were combined, and the resulting structural patterns of the developed liver analyzed.

*Andrew Michel*

## **THE SYNTHESIS OF A THIADIAZOLE FUNCTIONALIZED OXAZOLIDINONE**

Faculty Mentor: Dr. J. Thomas Ippoliti

Bacteria continue to mutate, multiply, and gain multidrug resilience, therefore new antibiotics need to be explored and synthesized. Oxazolidinones are a class of synthetic antibiotics proven to combat these resilient bacteria. An Oxazolidinone functionalized with a thiadiazole group was successfully synthesized in six steps and tested for antibacterial properties. 2-amino-5(4-methoxyphenyl)-1,3,4-thiadiazole is reacted with benzyl chloroformate in base to form an amide linkage. This product is then reacted with R(-)-glycidyl butyrate and lithium bis(trimethyl-silyl) amide to produce the oxazolidinone ring with an alcohol side chain. The alcohol is then converted to a sulfonate,

creating a good leaving group for the following reaction with sodium azide. This azide intermediate is reduced to the amine. Finally the amine is turned into an amide to create the final product.

*Valerie Milazzo*

## **SYNTHESIS OF AN IMIDAZOLE DERIVATIVE**

Faculty Mentor: Dr. J. Thomas Ippoliti

The organic molecule 1-(1H-imidazol-2-yl)-N-methylmethanamine was synthesized due to its potential commercial applications when in combination with metal ions to create Metal Organic Frameworks (MOF). These applications include storage, molecular separation, and catalysis, among others. The synthesis of the organic molecule was achieved by using methylamine and reacting it with the aldehyde functionality of imidazole-2-carboxaldehyde to perform a nucleophilic addition of the amine and an elimination of water to yield an imine. This intermediate imine was then subjected to sodium borohydride in order to perform a reductive amination and produce the secondary amine 1-(1H-imidazol-2-yl)-N-methylmethanamine. The reductive amination was also performed in one pot by adding the sodium borohydride directly into the solution containing the amine and aldehyde and heating. This one pot method gave the product in a more pure form and in better yields.

*Katie A. Miller*

## **NITROGEN HOMEOSTASIS IN THE INVASIVE ARGENTINE ANT, LINEPITHEMA HUMILE**

Faculty Mentors: Dr. Thomas C. Marsh and Dr. Adam D. Kay

Homeostasis of macronutrients is vital to the success of many organisms including social insects such as ants. Insects, in general, respond physiologically to different macronutrient ratios but most of the studies in this area have focused on nitrogen and phosphorus as limiting macronutrients. This study investigates the effects of varying the ratio of nitrogen to carbon in the form of defined protein:carbohydrate diets provided to laboratory colonies of the Argentine ant, *Linepithema humile*. When carbon is a limiting macronutrient, colonies experience an increased mortality rate among workers, workers have lower lipid content and the colony has decreased viability. To gain a better understanding of the underlying biochemical cause of the increased mortality rate, the levels of total nitrogen and the nitrogenous waste product, uric acid, were measured. It was hypothesized that the consumption of the excess nitrogen puts an increasing burden on the limiting pool of carbon due to increased uric acid production. Measurement of total nitrogen by flash combustion gas chromatography revealed that the total percent nitrogen increased as the ratio of protein to carbohydrate increased in a colony's diet. Quantification of uric acid content per colony showed a similar trend as nitrogen became more prevalent in the diet treatments.

*Lindsay Morgenstern*

## **CLONING AND EXPRESSION OF PUTATIVE CHEMORECEPTORS OF FROM PSEUDOMONAS PUTIDA F1**

Faculty Mentor: Dr. Jayna Ditty

The organism of interest was *Pseudomonas putida* F1 because it becomes attracted to toluene within its environment where toluene serves as its energy and carbon source. In *E. coli*, it is known that environmental chemicals attach to methyl-accepting chemotaxis proteins (MCP's), which are receptors for these molecules. Once a chemical is attached

to a MCP receptor, an intracellular cascade begins that tells the bacteria to orient itself towards the attractant. Using bioinformatics, 27 different potential MCP genes had been identified, and previous work showed that mutations in each of these genes led to a wild-type response in toluene experiments. In order to study how individual MCP proteins relate to toluene chemotaxis, it was necessary to look at MCP overexpression. In this project, one possible toluene MCP gene was used (2091) and used for cloning into an over-expression vector. Successful cloning was accomplished though successful sequencing is in progress. By identifying the toluene MCP gene scientists could improve chemotaxis of *Pseudomonas putida* F1 to facilitate bioremediation efforts.

*Liz Motz and Cristen Bonz*

## **WAVELET PACKETS AND IMAGE COMPRESSION**

Faculty Mentor: Dr. Pat Van Fleet

Image compression can be done by many different routines or methods. In order to store an image, each pixel of the image uses 8 bits of storage space. Image compression allows for the amount of storage space needed per pixel to be decreased. In this project, ideas from the FBI Fingerprint Compression method will be used to construct an image compression routine for a set of homogeneous images of the same dimension. The homogeneous images are of matchbox cars because, like fingerprints, they also have similar characteristics such as mirrors and windows that are consistent in location from car to car. The basic algorithm for image compression used is to first take an image. Then the image must be normalized. Next, the image must be transformed and quantized. Finally, the image must be encoded. In order to view the compressed image, the inverse of this algorithm must be performed. The image needs to be unencoded and dequantized. Following these steps, the image must undergo the inverse wavelet packet transform and be denormalized. The combination of the algorithm for image compression and inverse image compression will result in a new, compressed image.

*Natalie Neish and Rachel Lytwyn*

## **THE DIETARY PREFERENCES OF EARTHWORMS AND MANAGEMENT IMPLICATIONS OF EARTHWORM FEEDING BEHAVIOR IN THE CONTEXT OF THE RELATIONSHIP WITH RHAMNUS CATHARTICA**

Faculty Mentor: Dr. Chester Wilson

Earthworm activity has been shown to affect all kinds of ecosystem processes. The breakdown and consumption of leaf litter is one activity that has been shown to affect all levels of an ecosystem. Earthworm feeding activity can alter plant species composition and biodiversity at the community level. The relationship between exotic earthworms and invasive European buckthorn is one that has been examined within this context. Previous studies have shown that the invasion by buckthorn and invasion by exotic earthworms facilitate each other, creating a positive feedback loop of invasion. This objective of this study was to examine if earthworms developed diet preferences that would affect foraging choices related to this unique relationship with *Rhamnus cathartica*. Over a period of one month, earthworms were exposed to three different diets: *R. cathartica*, *Acer saccharum*, and *Acer platanoides*. Leaf litter loss was measured to see if a diet preference was present among the diets. Our results found that overall, earthworms prefer *R. cathartica* over both *A. saccharum* and *A. platanoides*, and that dietary preferences were not influenced by the earthworms' previous diet, but instead corresponded to the current leaf litter available. These findings have significant implications for the application of management strategies to control both invasive exotic earthworms and invasive buckthorn populations in these invaded woodland areas.

*Jo Jo Nemec, Aaron D. Gronseth and Abby H. Schutt*

## **TRICLOSAN RESISTANCE WITHIN BACTERIAL COMMUNITIES IN NATURAL WATERS: A SURVEY OF EXISTING RESISTANCE LEVELS**

Faculty Mentor: Dr. Kristine Wammer

Triclosan is an antibacterial agent that has been reported present in low concentrations in many natural waters. There are concerns that exposure to triclosan could lead to higher levels of resistance within the bacterial communities due to a selective pressure. The main objective of this project is to obtain a survey of existing resistance levels in bacterial communities from a variety of water sources in order to determine if there is a correlation between potential human impacts and current resistance levels. Bacteria were grown on solid media with varying triclosan concentrations. Growth measured as percent of control (no triclosan in the media) was used as the measure of resistance. To date, we have seen no evidence of elevated resistance in human-impacted areas.

*Joseph R. Nesbitt*

## **RESEARCHING, DESIGNING, AND BUILDING BETTER COMMUNICATION DEVICES FOR OLDER ADULTS**

Faculty Mentor: Dr. AnnMarie Thomas

I designed and built a wireless, battery-powered device that is capable of monitoring refrigerator activity. The device sends an email, text message, or posts a Twitter update when the refrigerator opens. This could be useful to families of older adults who may have trouble remembering to eat, or completing other day-to-day tasks. Families are able to monitor the older adult in a passive and non-invasive manner. Devices like this could contribute to helping older adults continue to live in the comfort of their own homes.

A personal notification device that functions similarly to the previously mentioned device was also developed. This device allows an older adult to check in with a friend or family member by simply pressing a button. This method allows the older adult to inform the friend or relative of their current health state without the fear of bothering that person. As with the refrigerator-monitoring device, notifications can be through emails, text messages, or Twitter updates. We currently have a Patent Pending for this device.

*Linda Nininahazwe*

## **ISSUES INVOLVED IN CREATING A PHYSICAL SCALE MODEL OF A MECHANICAL ASSEMBLY USING RAPID PROTOTYPING TECHNOLOGY**

Faculty Mentor: Dr. Michael Hennessey

The purpose of this research was attempting to understand issues involved in creating a physical scale model of a mechanical assembly using (primarily) Rapid Prototyping (RP) technology. That said, due to strength of materials issues, cost, and other limitations of RP, other traditional manufacturing processes were used selectively as well. Scale models are useful as easily transportable demonstration aids. The assembly used in this project is a previously designed hand-powered breadfruit shredder of modest complexity (i.e. about 60 total parts and assemblies). The methodology used was to start from: (1) the CAD files that describe the geometry of the assembly to characterize all of the essential features and dimensions and (2) the assembly liaison diagrams. They are then transformed into the CAD files and the liaison diagrams of the scaled version of the original assembly assuming use of a nominal scale factor (1:2.5). In the

process a table that documented the transformation was created and it only focused on scaling issues. The process turned out not to be as simple as applying the nominal scale factor to all relevant dimensions, and the scale factor was not uniform throughout the entire assembly. The transformation process included adding special scaling features such as ribs and additional material, such as for thickening, to ensure adequate strength and enhance the view of salient features. In one case, a subassembly (the frame assembly, a “weldment”) was melded together into a single part, suitable for 3D printing on a RP machine. The final step was to create the physical scale model using mostly RP with several minor changes noted. To summarize, this research explored the main issues encountered during the fabrication of a scale model of an assembly, and the methodology developed serves as a paradigm for that process, of use to mechanical designers.

*Ashley Patraw*

## **A COMPUTATIONAL STUDY OF “BRIDGE-FLIPPED ISOMERS”**

Faculty Mentor: Dr. Joseph Brom

This is my abstract: In this work, we study the effects of intermolecular interactions in “bridge-flipped isomers” by use of computational chemistry. In particular, the aim was to learn the nature of intermolecular interactions in bridge-flipped isomeric benzylideneanilines. Geometry optimization calculations were carried out on monomer and dimer structures using restricted Hartree-Fock (RHF) theory with the 6-31G\* basis set. Intermolecular interactions examined are between halogen atoms, nitrile groups and ring hydrogen atoms.

*Alexa Pflaum*

## **SYNTHESIS OF QUATERNARY AMMONIUM SALTS FOR THE PRODUCTION OF ZEOLITES USING REDUCTIVE AMINATION**

Faculty Mentor: Dr. Tom Ippoliti

Zeolites, microporous rock-like structures determined by the crystals in which they’re formed around, are commonly used as catalysts in the petrochemical industry, for storage of fuel molecules and as sieves to selectively separate certain molecules. Synthesizing complex crystals allows the zeolite to be uniquely selective in terms of the size and shape of molecule it can accommodate. Using reductive amination, a process that can either require the reduction or bromination of the desired starting ketone, quaternary ammonium salts could be formed as a basis for zeolite production. Once the desired ketone, in this case cyclohexanone, had been reduced by sodium-triactoxyborohydride, it could be coupled with pyrrolidine and then butylated to form 1-butyl-1-cyclohexylpyrrolidinium iodide. An alternate pathway, and also one that was more cost effective, was to first brominate the ketone, in this case, dibenzosuberone, couple it with 1-methylpiperazine, and then methylate the resulting product.

*Dustin Potter*

## **FACTORS INFLUENCING FISH COMMUNITY COMPOSITION IN SHALLOW MINNESOTA LAKES**

Faculty Mentor: Dr. Kyle Zimmer

The number of fish species present in lakes (species richness) is driven by both colonization and extinction variables. Colonization variables (can a species get there) include horizontal and vertical distance to other lakes, while extinction variables (can the species persist through time) include lake size and lake depth. Research in deeper lakes has shown

colonization variables are more important than extinction factors, but variables driving fish richness in shallow lakes (less than 5 m deep) are presently unknown. We studied 104 shallow lakes in 5 different eco-regions throughout the state of Minnesota and we looked at the factors that drive fish community composition in these lakes. Depth and percent of agriculture surrounding a lake were found to not be a significant factor in shaping fish richness in Minnesota lakes as no linear relationship was found ( $R^2 = 0.0017$  for depth and fish richness, and  $R^2 = 0.0065$  for percent agriculture and fish richness). Lake area was found to be a significant factor in shaping fish richness throughout the 5 eco-regions ( $R^2 = 0.3696$  for lake area and fish richness). Furthermore, it was found that the eco-region that had the lowest fish richness also had the lowest lake area average (Itasca state park average area = 0.712621 and fish richness = 0.362182) and vice versa (Chippewa average area = 1.39663 and fish richness = 0.752376). Connectedness showed to have a slightly significant effect as lakes that were connected had a higher fish richness compared to those that were not connected ( $p = 0.0883$ ). These results suggest the importance of connectedness and lake area on fish richness on Minnesota shallow lakes, and these results show that lake depth and the percent agriculture may not be enough in predicting fish richness in Minnesota shallow lakes.

*Annemarie Rodriguez*

## **NATURE, GOD, AND SELF-ACTUALIZATION IN ISABELLA BIRD'S A LADY'S LIFE IN THE ROCKY MOUNTAINS**

Faculty Mentor: Dr. Alexis Easley

Although written earlier in her career, *A Lady's Life in the Rocky Mountains* (1878) was one of Isabella Bird's most revealing books. Yet few scholars have written on this book, choosing instead to focus on her later work. Unlike the polished books of her later years, this book includes emotional descriptions of her surroundings written with an air of sincerity. I explored how the natural surroundings become Bird's means in achieving self-actualization and spiritual health. Applying Ralph Waldo Emerson's Transcendental thought, I demonstrate how his influence prompt Bird to overcome physical and gender obstacles to immerse herself in nature's sublimity, achieving both a physical and spiritual transformation. However, I assert that despite these accomplishments and her subsequent happiness in this new world, Bird maintains her imperialist desire to conquer and yields to the constrictions of the Victorian publishing industry. Thus, on one hand, Bird's journey is one of spiritual renewal influenced by the Transcendental thought of Ralph Waldo Emerson, yet on the other hand her narrative depicts a woman in conflict between achieving self-fulfillment and complying with the societal norms of Victorian Britain. Unlike other books that wholly conform to Victorian Britain's societal norms, I demonstrate how Bird's book alludes to the sense of double standards and contradiction present in many Victorian texts that are also travel narratives. *A Lady's Life* becomes a fascinating case study for its ability to mediate between these two seemingly opposing ideas.

*Jillian Schleicher, Ann Ziegler, Eric Brost, Daniel Landberg and Richard Atherton*

## **MAGNETIC DIPOLE MOMENT AND ITS ROLE IN DETERMINISTIC CHAOS**

Faculty Mentors: Dr. Marty Johnston and Dr. Jeff Jalkio

Our research is part of a larger project involving the analysis of a chaotic pendulum. In order to further test our understanding of chaotic attractors, we added a magnetic interaction in the pendulum system. This changes the potential energy well of the system from one dependent solely on gravity, to one involving magnetic fields as well. Part of the analysis of the pendulum involves modeling the system using a differential equation, and adding this magnetic interaction requires the addition of a term in the equation to account for it. In order to properly model this, we needed to develop a method of experimentally determining the magnetic dipole moment of the magnets added in the system. We used two methods to collect data and calculate the correct value for the magnetic dipole moment of

neodymium magnets. Our results confirmed that when magnets are stacked on top of one another, the value of their dipole moments are added together.

*Mark Schreck*

## **PARALLEL COMPUTING: BUILDING A BEOWULF CLUSTER**

Faculty Mentor: Dr. Marie Lopez del Puerto

Many research projects require minimal processing power, which can easily be handled by most desktop computers. In physics, however, the questions proposed require a significant amount of processing power, which requires finding precise numerical approximations for very complicated systems of differential equations. Luckily, most of these problems can be broken up into smaller pieces, and worked on one part at a time, and then put back together. This method for finding approximations for these systems can be efficiently implemented on a cluster of computers working in parallel. A cluster is made of several nodes, which are individual computers, that all work on the same task at the same time. A parallel cluster differs from a distributed computing cluster, in that the nodes of a parallel cluster can all work together on the same task, while a distributed computing cluster only allows one task per node. A Beowulf cluster is a specific type of parallel cluster that is built from off the shelf computer components. My project was to build an eight processor Beowulf cluster that can aide in the research of students and faculty, by providing the processing power required by these projects. This cluster will be primarily used for research in the physics department, but it will also be available for use by faculty and students at St. Thomas.

*Daniel Schupp*

## **THE OPTIMIZATION OF SOFT PROCESSORS IN A GATE ARRAY FABRIC**

Faculty Mentor: Dr. Jeff Jalkio

Extensive guidelines exist for the optimization of traditional microprocessors, including tradeoffs between speed and size. However, in recent years there has been growing use of field programmable gate arrays in which speed and circuit size are tightly related. In this project we hoped to evaluate the applicability of traditional design rules and find optimal designs for processors.

Two papers were written on the findings, due to the large amount interesting results. The first paper covers the optimization of the implementation of a module called a Floating Point Unit (or FPU for short). The second paper covers the optimization of the processor with respect to utilization of chip resources and the effects of certain peripherals on maximum clock frequency.

The findings of this project were particularly interesting, and often flew in the face of conventional wisdom regarding processor development. The odd results have even caused another research group to declare that the Floating Point Unit hurts performance. Our research found that this is untrue, but the difference between improper and proper implementation results in several orders of magnitude difference in performance. Above all, this research cemented an important concept to the sciences: applying classical guidelines in brand new frontiers can lead only to confusion and faulty behavior.

*Abby H. Schutt, Aaron D. Gronseth and Jo Jo A. Nemeč*

## **TRICLOSAN RESISTANCE WITHIN BACTERIAL COMMUNITIES IN NATURAL WATERS: SELECTION FOR RESISTANT BACTERIA DUE TO LONG-TERM EXPOSURE**

Faculty Mentor: Dr. Kristine H. Wammer

Triclosan warrants investigation as it is the active ingredient in many personal care products. The aim of this study is to investigate the effects on environmental bacteria caused by long-term exposure to the antibacterial. Environmental bacteria were collected from natural waters and maintained in chemostats, where they were subjected to known triclosan concentrations in a controlled setting. Weekly resistance tests were performed where bacteria from chemostat effluent were grown on elevated concentrations of triclosan (10 M and 50 M) in liquid media. The optical density at 600 nm was measured to observe bacteria growth in the presence of triclosan with respect to a positive control. Prolonged exposure was shown to produce selection for resistant bacteria; however, the concentrations used are higher than those currently found in environmental waters.

*Daniel Sjolund*

## **PHOTO-INDUCED ELECTRON TRANSFER AND REDUCTION OF PYRROMETHENE 567 WITH TMPD IN TRANSIENT ABSORPTION SPECTROSCOPY**

Faculty Mentor: Dr. Joseph Brom

This project is primarily concerned with obtaining the UV-Visible absorption spectrum of the Pyrromethene 567 (PM567) radical anion. Photo-induced electron transfer reactions of PM567 have been investigated with transient absorption spectroscopy. In order to perform transient absorption spectroscopy, one utilizes a laser-generated burst of photons directed through a sample containing PM567 and a suitable electron donor species such as N,N,N',N'-Tetramethyl-p-phenylenediamine (TMPD). This technique, in conjunction with appropriate instruments, enables the observer to determine whether the photo-induced reaction products of interest were generated. This project focuses on developing reproducible methods for generating ground electronic state PM567 radical anions, and employing transient absorption spectroscopy to record the absorption spectrum.

*Nathan Skemp*

## **THE EXTRADITION OF TERRORIST SUSPECTS: A COMPARATIVE STUDY OF U.S. AND U.K. APPROACHES IN A POST 9/11 WORLD**

Faculty Mentor: Dr. Susan Marsnik

My research examines the legal and ethical issues concerning the law of extradition in two powerful world leaders which have recently faced terrorist threats: the United States and the United Kingdom. My research explores the law and policies of extradition including the relevant treaties, the international norms of handling terrorists, and how human rights documents impact treatment of suspected terrorists. Comparing of U.S. and U.K. extradition, focusing on post-2001, practices of suspected terrorists illuminates key issues, such how the government interpret complex treaties, the rights of suspects, Guantanamo Bay, and capital punishment.

*Matthew Slattery*

## **ANALYSIS OF THE ANTIBACTERIAL PROPERTIES OF TETRACYCLINE AND ITS PHOTOPRODUCTS**

Faculty Mentor: Dr. Kris Wammer

In this study the photo-degradation of tetracycline under environmentally-relevant conditions was examined to determine the environmental significance of its photoproducts. Tetracycline is known to degrade by direct photolysis into at least 7 different photoproducts under varying conditions. Water hardness and pH are two characteristics of a natural environment that can alter the decomposition pathway of tetracycline. Here, the growth of the bacterial strains *E. coli* DH5 and *Vibrio fischeri* was measured by UV-vis spectrophotometry (600 nm) in the presence of varied concentrations of both photolyzed and unphotolyzed tetracycline to determine the potential antibacterial activity of its photoproducts in diverse waters and conditions. In all cases studied to date, we have determined that the photoproducts retain no significant antibacterial activity.

*Ryne Smith and Ryan Maciej*

## **A CONTINUUM-DISCRETE HYBRID MODEL FOR THE MOVEMENT OF SINGLE CELLS**

Faculty Mentor: Dr. Magdalena Stolarska

The movement of individual cells is vital in various biological processes including immune response, embryonic development, and the spread of cancer. Since both intracellular biochemistry and cell mechanics affect single cell motility, and therefore these biological processes, it is important to understand cell motility from both of these viewpoints. In this poster, we present a continuum model of the signal transduction pathway that affects the chemotaxis, (Bagorda et al., 2006), i.e. movement in response to a chemical signal, of the cell type *Dictyostelium discoideum* (Dd), and we couple this model to a discrete model of cell mechanics. The governing equations for the intracellular biochemistry are solved using the finite element method, and the underlying triangular element mesh is used as framework for the series of nodes and springs that are used to calculate the displacements and force distribution within the cell. This continuous-discrete hybrid model provides a streamlined and effective computational tool that allows us to investigate the interplay between intracellular biochemistry and cell mechanics. While our preliminary simulations focus on understanding the experimentally-observed oscillatory “C-to-spot” formation of the contraction-inducing intracellular species myosin (Koehl and McNalley, 2002), the goal of the model is to better understand the fundamental biochemical and mechanical processes that are necessary to observe extension of the leading edge of Dd and the contraction of its rear, both of which occur in a highly coordinated periodic manner. A. Bagorda, V.A. Mihaylov, and C.A. Parent. Chemotaxis: moving forward and holding on to the past. *Thrombosis and Haemostasis*, 95:12–21, 2006. G. Koehl and J.G. McNally. Myosin II redistribution during rear retraction and the role of filament assembly and disassembly. *Cell Biology International*, 26:287–296, 2002.

*Christine Spampinato*

## **EFFECT OF SUBSTANCE P IMMUNOMODULATION ON ESTABLISHMENT AND GROWTH OF EL4 LYMPHOMA**

Faculty Mentor: Dr. Jill Manske

Substance P (SP) is an eleven amino acid neuropeptide that has been shown to have a regulatory role in the immune system. This regulation includes an interaction with both the proinflammatory and anti-tumor mechanisms of the

immune system. Depending on the tumor model, SP has been shown to have either stimulatory or inhibitory effects on tumor growth. Most recently our lab found the K1735 mouse melanoma was inhibited by SP, while in the past SP has been linked to stimulating growth in human glioma and childhood acute lymphoblastic leukemia. In this study, SP's effect in vivo on the establishment and growth of EL4, a mouse lymphoma model, was found using both a subcutaneous and intravenous model. In the subcutaneous model, mice receiving SP grew tumors at a significantly slower rate than the control mice. Though this is a contradictory trend than was expected, this could be due to the murine immune system being "primed" by the exogenous SP, thereby negating the result of any direct SP-EL4 interaction.

*John Stark*

## **BIO-DIESEL GENSET**

Faculty Mentor: Dr. Greg Mowry and SOE Mr. Roy Jenson

Modern diesel engines place very demanding requirements on the diesel fuel that they consume. In particular, parameters such as viscosity, particulate and cetane number are critical for the proper performance of the modern diesel engine. In developing countries it is very difficult to guarantee diesel fuel quality hence engine maintenance becomes an issue. This in turn often makes modern diesel gensets (diesel engine – generator = 'genset') unreliable and prone to failure in developing countries. Hence in situations where a reliable source of electricity is needed, one cannot depend on 'power-on-demand'. This is particular troublesome for medical applications. Traditional (or antique) style diesel engines are not significantly affected or constrained by these problems and are capable of running reliably on a wide range of fuels; e.g. from kerosene, vegetable oil to biodiesel and petrel diesel.

The goal of this summer project was to convert a 6 hp 1920's style diesel engine, a Lister, into a 4 kW genset. The Lister diesel engine has a historic reputation of being incredibly reliable, able to run on almost any fuel that can ignite by compression, and is still available to this day. The project required taking a raw, unprepared and 'not broke in' engine block that had been shipped from India to UST and completing the entire engine design, construction, assembly and testing in order to produce a working genset that ran on biodiesel fuel produced by the MCGYAN process.

The presentation will outline the work required to successfully accomplish the project goals. This prototype, Lister based genset, will serve as the core building block for a future electronic project that will have the goal of producing well regulated electrical power for use in a wide variety of critical applications in developing countries.

*Chris Stefonowicz*

## **IDENTIFICATION OF MCPS RESPONSIBLE FOR TOLUENE RECOGNITION IN PSUEDOMONAS PUTIDA F1**

Faculty Mentor: Dr. Jayna Ditty

Many different types of bacteria are known to be chemotactic, that is they have a physical attraction to specific chemicals in their environment. The attraction is usually driven towards chemicals that the organism is able to metabolize and harness as energy. This phenomenon is controlled by protein receptors located on the surface of the cell that recognize either energy changes or certain chemicals that are of particular interest to the cell. Once an energy change or chemical is detected, these receptors generate a series of biochemical reactions that lead an organism to swim towards that chemical. Pseudomonas putida F1 is a common bacterium found in the environment that displays chemotactic behavior towards the toxic aromatic hydrocarbon, toluene; a common environmental contaminant. Unique from many other organisms, P. putida F1 is able to utilize toluene as an energy source. Currently, it is not

known what receptors are used by *P. putida* F1 to detect toluene in the environment. We hypothesize that *P. putida* F1 has a specific set of genes on its chromosome that encodes for the ability of *P. putida* F1 to detect toluene in the environment and subsequently affect the biochemical changes to make the bacterium swim towards toluene. If we are able to identify the specific set of genes that code for the chemotactic protein receptor, it could lead to a better understanding to how bacteria respond to toxic chemicals in the environment and possibly provide some solutions for the degradation and clean-up of chemical toxins in the environment.

*Amanda M. Stemig*

## **ANTIBACTERIAL ACTIVITY OF PHARMACEUTICALS TREATED WITH POTASSIUM PERMANGANATE**

Faculty Mentor: Dr. Kristine H. Wammer

If pharmaceuticals are not removed in wastewater treatment plants, they will eventually end up in the environment when the effluent is released into natural waters. The overall goal of this project is to determine if a current water treatment technique, that uses potassium permanganate, will be effective in removing selected pharmaceuticals from the water. This portion of the project studies the antibacterial activity of three antibiotics used to treat bacterial infections in humans (ciprofloxacin, trimethoprim and lincomycin) both before and after degradation with potassium permanganate. We have found that the degradation products of these drugs have little to no activity when compared to the parent compound. Thus, this technique shows promise for removing these compounds from wastewater or drinking water without creating undesirable byproducts.

*Jake Sundberg*

## **ENROFLOXACIN AND THE ANTIBACTERIAL ACTIVITY OF ITS PHOTOPRODUCTS**

Faculty Mentor: Dr. Kristine Wammer

Enrofloxacin, a drug from a class of antibiotics known as fluoroquinolones, has been widely used on domestic animals for its activity against a broad spectrum of bacteria. Previous work in our lab has shown that enrofloxacin breaks down by direct photolysis, yielding a variety of photoproducts. Selected photoproducts were isolated using HPLC equipped with a preparative column and were manually collected. Antibacterial activity testing was performed by measuring the growth of *E. coli* DH5a exposed to varying concentrations of enrofloxacin or its photoproducts. Testing was performed over six hours and measured using UV-Vis spectrophotometry at 600nm. Through antibacterial activity testing, one of the photoproducts of enrofloxacin was found to be biologically active. LC-MS and NMR were used to help identify the structure of that photoproduct.

*Zack Thielke*

## **MAPPING FARMERS' MARKETS: PASTURE TO PLATTER**

Faculty Mentor: Dr. Catherine Hansen

This summer, I distributed a survey at the New Hope and St. Thomas More (St. Paul) farmers' markets, asking where market participants (customers and vendors) came from. After collecting vendor and customer addresses, I mapped those locations to determine where the closest 70% of the markets' customers and vendors were coming from.

Then I created drive time polygons around the markets to measure how long people had to travel by car to get to the markets. One market was open on Friday afternoons and the other was open on Saturday mornings, so I also mapped nearby metro-area farmers' markets that shared their hours of operation, to see if people were choosing the market closest to them during the given market hours.

Finally, I analyzed how close a markets' customers and vendors were to the nearest competing metro-area markets, to gauge how far out of their way people chose to go relative to the closest market.

By showing the geographic trade area of farmers markets, we can see the spatial boundaries of these markets' communities, and demonstrate how far away they are able to pull participants who could have patronized a closer market.

*Vy Tran*

## **VERTEX DISTRIBUTIONS IN FAMILIES OF SIX EDGE POLYGONS**

Faculty Mentor: Dr. Eric Rawdon

The topology of polymers often influences their chemical behavior as well as how they interact with the environment around them. For long chain polymers, their topology often includes knotted conformations. The type of knots formed and nature of the knotting influence the overall structure of the polymer. For viscosity and flow calculations, the average shapes and sizes of these polygons are of interest, and these properties have been studied under a variety of conditions. In a thermally agitated environment, randomly generated polygons are used to model the conformations of polymer chains. To better characterize these polygons, we looked at the family of six edge polygons, separating them by knot type, and we also looked at 6 edge open chains. For each of these families, density plots were created showing the distribution of vertices. These plots characterize the polygon families and provide a way of determining their average structure.

*Jonathan D. Tschiggfrie*

## **TOWARD A SYNTHESIS OF STEAM CALLIOPE TECHNIQUE ON THE INLAND WATERWAYS**

Faculty Mentor: Dr. Sarah Schmalenberger

The primary goal of this study was to continue musicological research into the steam calliope tradition as it developed on Western Rivers steamboats in this country. The scope of the research in the summer of 2009 involved documenting steam calliope performance practice with the best possible technical accuracy and historical authenticity. As recordings were made and different styles were analyzed, it became evident that the study's focus needed to be narrowed further. Special attention was given to one particular steam calliope style that was most prevalent well into the 20th century and that has informed many of today's performers. Combined with interviews and artifact collection, a more complete understanding of the riverboat steam calliope technique has been created through this study.

*Brandon Turek-Krengel*

## **A STUDY OF THE ENGINEERING DESIGN PROCESS IN P-12 PROGRAMS**

Faculty Mentor: Dr. AnnMarie Thomas

Recently industry, universities and precollege educators have expressed an increase of interest for the inclusion of engineering science principles in precollege curriculum. Generally, when engineering science is presented to this field of students it is presented in the form of an engineering design project and its associated design process. This process is commonly considered necessary for most engineering practices. When taught in schools the engineering design process can allow for students to learn a systematic approach to solving problems, what is often beneficial to a student regardless of their career interests. Unfortunately, the process of engineering design is often considered to be hard to learn and still harder to teach to most students, despite their age. The following study was performed with the intent to motivate and facilitate the teaching of engineering design and its process to P-12 students. Through research of engineering design programs currently used in P-12 systems and other pedagogical publications on engineering design, we have consolidated some of the information found and use it to present a definition of engineering design and a rationale for the inclusion of engineering design in P-12. The seven programs included in this report were selected to determine the degree to which engineering and engineering design is included in their curriculum. As later noted these programs present the projects through different types of activities and teach engineering design to varying degrees of emphasis.

*Joseph Tursich*

## **GENERATING TWISTED CLASPS**

Faculty Mentor: Dr. Eric Rawdon

Our goal is to find the least amount of rope necessary to compute different types of clasped structures. The first step is to create model structures from which other software can be used for the tightening. I will detail software I wrote to generate twisted clasps using the C++ programming language.

*Jessica R. Urban*

## **PSYCHOLOGICAL IDENTITY OF COLLEGE STUDENTS AND ITS RELATIONSHIP TO MORAL IDENTITY**

Faculty Mentor: Dr. Tonia Bock

Adolescence, for many, has become an extended period of time, allowing college students to explore and make commitments regarding their ideological, interpersonal, and moral identities. As no one has explored the links between identity developmental concepts and moral identity, I examined the following hypotheses: (1) individuals in an achieved or foreclosed identity status will have a stronger moral identity than those in a moratorium or diffused status, and (2) individuals who have identified with their commitments and explored their commitments in depth will have a stronger moral identity than individuals who have not identified with their commitment and have only explored their commitments in breadth. Undergraduate students ( $n = 57$ ) from a Midwestern, Catholic university completed four paper-and-pencil questionnaires assessing their ego identity status, identity development, moral identity, and moral self-concept. Though the results showed trends in the hypothesized directions, statistical significance was not achieved.

*Andy Van Alst and Erica Gathje*

## **NUTRIENT REGULATION IN TETRAMORIUM CAESPITUM WHEN GIVEN FOOD VARYING IN NUTRIENT CONTENT AND CONCENTRATION**

Faculty Mentor: Dr. Adam Kay

All animals must obtain a balanced intake of nutrients because different nutrients, including carbohydrates and proteins, play distinct roles in an organism's functioning (Lehninger 2005). Animals can obtain an appropriate balance of nutrients by selectively collecting resources rich in the nutrients they need (Kay et al. 2006). This regulation of nutrient intake is also more complicated (and more interesting) for social animals that must work together to collect food. For ant species, this challenge to work together to feed the colony is prominent. In this study, we investigated patterns of nutrient regulation in colonies of the pavement ant, *Tetramorium caespitum*. It was hypothesized that pavement ant colonies would regulate their protein: carbohydrate intake ratio around a common target when given foods differing in nutrient balance and overall nutrient concentration. Ant colonies were given paired foods that differed in protein: carbohydrate ratio and total nutrient level in order to test their level of regulation. Over a period of several weeks, the colonies were given each of the six food pairings and data was taken on the amount of food eaten in one hour on two days of exposure. Contradicting the hypothesis, it was found that the pavement ant colonies regulated their balance of protein: carbohydrate ratio but did not regulate the amount of food they consumed. However, ants were observed surrounding the food squares and crawling up onto them, indicating that the colonies were not being fed enough. Therefore, the colonies were most likely eating as much as possible and were unable to regulate their overall intake of food.

*Vladimir Vinnik*

## **A NOVEL BIS-SULFIDE EN ROUTE TO THE SYNTHESIS OF 4,4-BIPYRAZOLYL**

Faculty Mentor: Dr. J. Thomas Ippoliti

A new synthetic route to 4,4-bipyrazolyl, a molecule potentially useful toward the research of metal-organic frameworks, was the original goal of this research. The synthetic route to 4,4-bipyrazolyl starts with the reduction of Dimethyl-3,4-furandicarboxylate to the diol. The next step was a modified Swern oxidation of the diol to the dialdehyde, furan-3,4-dicarbaldehyde. The oxidation step was done using sulfur trioxide pyridine complex in dimethyl sulfoxide and triethylamine. It was in the optimization of the reaction conditions for the oxidation that an interesting discovery was made which led to the isolation of a novel bis-sulfide that was characterized via NMR and X-ray crystallography. The synthesis was finished by hydrolyzing the dialdehyde to the tetraldehyde, 1,1,2,2-Ethantetracarboxaldehyde, which was subsequently reacted with hydrazine to form 4,4-bipyrazolyl.

*Kelly Ward*

## **ROBERT E. LEE AND LOST CAUSE MYTHOLOGY**

Faculty Mentor: Dr. Joseph Fitzharris

The American Civil War raged between the Union and the confederacy from 1861 to 1865 claiming the lives of many and immortalizing the lives of a few. Robert E. Lee, a Confederate General, was one such "Immortal." Admired in life, his stature grew and flourished after his death. This project explores the cult following of Robert E. Lee and his place in the Lost Cause mythology of the Confederacy. I examine Robert E. Lee; his public image from the Mexican War to the 1920's and his place in the greater context of the Lost Cause mythology of the Confederacy. My primary research materials are letters and memoirs from Confederate and Union soldiers and newspaper and journal articles from 1861 to 1880.

*Carmen Weaver*

## **ADVANCES IN THE SYNTHETIC ROUTE OF A NOVEL OXAZOLIDINONE**

Faculty Mentor: Dr. J.T. Ippoliti

Since the development of antibiotics, the evolution of antibiotic resistant strains of bacteria have caused many problems in the medical world. Ground-breaking research in this area has become very important due to the necessity to keep up with continuously mutating strains of bacteria, such as methicillin-resistant *Staphylococcus aureus* (MRSA). Oxazolidinones are the most recent class of antibiotics to be shown to be effective against resistant gram-positive strains of bacteria. Linezolid, branded Zyvox is currently the only commercially available oxazolidinone. Previously, Dr. Tom Ippoliti and his students have synthesized novel antibiotics utilizing an oxazolidinone ring. In order to improve its effectiveness, thiazole and thidiazole groups were used in replacement of the fluorobenzene of Zyvox because they also have independent antimicrobial properties. In continuation of the research regarding these two antibiotic components, an azide compound was synthesized, two steps short of achieving the ultimate goal of synthesizing a combination of the two antibacterial agents of an oxazolidinone and a thiazole group accompanied by an electron donating phenyl methoxy group as a substituent. Ideally, this will create an oxazolidinone that will be effective against new strains of MRSA, and also a broader spectrum of gram-positive bacteria than previously released Zyvox. The effectiveness of the final product will be tested against methicillin-resistant *Staphylococcus aureus*.

*Jenny Xiong*

## **THE EFFECT OF AN IMBALANCE IN DIETARY CARBON AND NITROGEN ON THE ENTERIC MICROBIAL COMMUNITIES OF *LINEPITHEMA HUMILE***

Faculty Mentors: Dr. Thomas C. Marsh and Dr. Adam Kay

The Argentine ant, *Linepithema humile*, is an invasive species that rely primarily on carbohydrate-rich, nitrogen-poor liquids from exudates and honeydews. Generally, insects that have nitrogen poor diets typically host bacterial flora in their guts that assist in the upgrading of nitrogenous compounds to essential amino acids and enzymatic cofactors. Because the ants depend on the microbial communities for recycling and upgrading nitrogenous wastes, we hypothesized that changing the *Linepithema humile*'s dietary ratios of carbohydrates to proteins would change the diversity of the microbial communities the species hosted. To determine the diversity of the microbial communities, whole DNA from ant gasters were extracted which were amplified, specifically the bacterial 16S-23S intergenic region, and analyzed using both agarose and denaturing gradient gel electrophoresis. The collected data revealed that the different dietary ratios of carbohydrate to protein affected the diversity of microbial communities in this specie. The colonies treated with a 1:1 ratio of carbohydrate to protein had a diminished minimum apparent diversity of microbial communities compared to colonies provided with a 6:1 ratio of carbohydrate to protein. An interesting correlation between the enteric microbial diversity and previous work on the dietary effect of nutrient imbalance on behavior and colony fitness was observed. Colonies provided a high carbohydrate rich diet had greater fitness compared to diets that had an equal or greater amount of protein. Future work will entail identifying what the specific species of bacteria are present in the different colonies and how they may contribute to worker health and overall colony fitness.

## **SYNTHESIS OF A FUNCTIONALIZED POLYLACTIC ACID**

Faculty Mentor: Dr. J. T. Ippoliti

There has been increased use and interest in the application of polymers in the biomedical field. One such example is the use of polymers to coat medical devices, specifically polymer-coated stents. Polylactic acid, a known biodegradable polymer, does not have functionalized side chains in which to attach itself to the stent. The overall goal of this project was to synthesize a polylactic acid that was capable of post-polymerization functionalization with 3,4-dihydroxyphenolalanine (Dopa). An amino acid, 3,4-dihydroxyphenolalanine (Dopa), has recently been found to be present in mussel proteins, which plays some role in mussel adhesion to various surfaces and substances. A DOPA substituted polymer would overcome many of the obstacles associated with PLA, such as the use of adhesion promoters. In order to make the functionalized polymer, functionalized cyclic lactides, or monomers, were needed. *O*-benzyl-L-serine was converted to its  $\alpha$ -hydroxy acid and used to synthesize the monomers. 3-methyl-6-benzyloxymethyl-1,4-dioxane-2,5-dione, 6-benzyloxymethyl-1,4-dioxane-2,5-dione, and 3,6-dibenzyloxymethyl-1,4-dioxane-2,5-dione were synthesized. Prior to polymerizing the substituted-lactides, lactic acid lactide was first polymerized using an organocatalyst, triazabicyclodecene (TBD). A preliminary ring-opening polymerization of 3,6-dibenzyloxymethyl-1,4-dioxane-2,5-dione using TBD did show promising results. The protected, functionalized polymer will then be conjugated with Dopa, an amino acid found in mussel proteins that is known to play some role in mussel adhesion to various surfaces, both organic and inorganic. This functionalized polymer can then be applied to medical devices, such as stents, without the use of adhesion promoters.

*Ann Ziegler, Jillian Schleicher, Eric Brost, Daniel Landberg and Vy Tran*

## **UTILIZING LEAST SQUARES METHOD TO DETERMINE SYSTEM PARAMETERS IN DETERMINISTIC CHAOS**

Faculty Mentors: Dr. Marty Johnston and Dr. Jeff Jalkio

In order to accurately model any system certain parameters must first be known. In the case of a physical pendulum these parameters are determined experimentally. The traditional experimental methods are insufficient to determine system parameters with the desired precision. We solve this by employing a very elegant piece of math that utilizes the least squares method to take raw numerical data from a pendulum chaotic trajectory and extract the system parameters. Once we have obtained more accurate parameters we are able to better model the system. In order to test our method we applied it to three chaotic attractors: Lorenz Attractor, Rossler Attractor, Pendulum Attractor. This method was successfully used on our system in both theoretical and experimental analysis.

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