UNIVERSITY of ST. THOMAS

BUSH FOUNDATION PROGRAM GRANT:
COLLABORATIVE INQUIRY

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

Abstracts

Vol. 4
September 23, 2004

Introduction

The abstracts published in this volume reflect the value we at the University of St. Thomas place on faculty/student collaboration.

Students who have recently done collaborative work with a faculty member present that work in these abstracts and at this poster session for purposes of dissemination and scrutiny by their peers, their professors, and the academic public.

The University of St. Thomas expresses its deep gratitude to the Bush Foundation, who funded this event through a three-year Program Grant. The grant seeks to increase the use of inquiry-based teaching methods, so that students experience the real work of the professions, working on real problems often taken from outside the university, in the ways they will be called upon to employ their disciplines after they leave the university.

A second theme of the Bush Program Grant is to increase faculty/student collaboration. We believe that one of the very best ways to teach is to have professors work with students collaboratively. Students see how work is really accomplished in their chosen professions, and professors have the chance to share their work as it is being created.

We hope this event and this volume gives visibility and credibility to the ideas represented in our Bush grant

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As president of the University of St. Thomas, I am both pleased and proud to introduce the fourth poster session devoted to faculty/student collaboration projects developed as part of our three-year grant from the Bush Foundation, *Focus on Inquiry: Faculty/Student Collaboration at the University of St. Thomas*.

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. This 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

St. Paul, Minnesota
Minneapolis, Minnesota
Owatonna, Minnesota
Rome, Italy

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Breanne E. Anderson, Christina R. Bye and Tamara A. Johnson

ROLE OF TRANSCRIPTIONAL INFORMATION IN THE CIRCADIAN CLOCK MECHANISM OF *SYNECHOCOCCUS ELONGATUS PCC 7942*

Faculty Collaborator: Jayna L. Ditty

Central to models for animal and fungal circadian clock timing is negative feedback loops involving clock genes that negatively regulate their own expression. The single-celled cyanobacterium, Synechococcus elongatus PCC 7942, has a circadian pacemaker comprised of the products of at least three genes, kaiA, kaiB, and kaiC. The kai locus is expressed from two promoters, one upstream of kaiA (monocistronic message) and one upstream of kaiB (dicistronic kaiBC message), that are expressed in the same circadian phase in wild-type cells. Previous work has shown that KaiA is required for expression from the kaiBC promoter, and that overexpression of kaiA enhances expression from kaiBC, suggesting that KaiA is a positive activator of the kaiBC promoter. KaiC is required for normal levels of expression from its own promoter; however, overexpression of kaiC blocks expression from kaiBC, suggesting a role in negative autoregulation. These data were interpreted to be consistent with role of transcriptional control of the circadian clock in animal and fungal circadian timing models. Here, we have begun molecular and genetic experimentation to investigate the role of transcriptional controls in the cyanobacterial circadian clock model. Experiments are designed to determine specific kai promoter cis elements and identify trans acting factors involved in kai gene expression. Mutants of S. elongatus have been identified that change the phase relationship between kaiA and kaiBC expression without disrupting circadian timing, suggesting that the relative transcriptional activity of expression from the kaiA and kaiBC promoters is not important for generating circadian rhythms. Therefore, the timing of kai expression is being investigated by expressing the kai operons from heterologous promoters whose peak expression is 12 h out of phase from the norm (peak expression at dawn). Preliminary results suggest that the timing mechanism of the circadian clock in cyanobacteria may be based upon a post-transcriptional mechanism.

Neal Anderson

MARKOV CHAIN MONTE CARLO USING METROPOLIS-HASTINGS AND BACKWARD COUPLING

Faculty Collaborator: Dr. Arkady Shemyakin

My project is based on Markov Chain Monte Carlo, which deals with chains of values and trying to predict where the next value of the chain will be. We used two kinds of algorithms, the Metropolis-Hastings algorithm and the Backward Coupling algorithm, to make these predictions. Mathematica was used to design programs to quickly perform these algorithms. This allows us to come up with quick answers and allows us to run the programs hundreds of times in a row in a reasonable amount of time. This will allow us to come up with better values and averages, giving us an answer closer to our desired value. Each of these techniques have an integral that we can solve and give us what should be the correct answer. Knowing this answer allows us to come up with a sample set of values which can be used and compared to the correct value. The project also contains information explaining what Markov Chain Monte Carlo is and how it can be used. Acceptance-Rejection Sampling and Simulation are good tools used to help come up with and explain these chains. The chains we used contain values that are between zero and one and will either accept or reject a larger value based on a certain probability, all the while accepting every smaller value. This causes our average value of the points on our chain to be slightly less than one-half, specifically about 0.44. These chains will eventually converge to a single chain. We can't always tell exactly when they converge, but the Mathematica programs help. They use something called a burn-in period, which is a certain number of values that are discarded so that all of our data comes from the converged chains. This means that our data is much more accurate.

Molly Andreason

CALCIUM DIFFUSION IN ECOLOGICAL SYSTEMS

FacultyCollaborator: Dr. Paul Ohmann

Acid rain is an environmental problem that has garnered international attention for the past 30 years. One problem it causes is depletion of calcium in forest systems, leading to a decrease in soil pH levels. This has resulted in great losses of vegetation in some areas. However, not all regions have been strongly affected by calcium depletion; some have appeared to find alternative sources of calcium to counter these losses. One hypothesis as a source of calcium is diffusion from underground sources. Research has shown a consistency between the concentration of calcium in the soil and the possibility of replenishing lost calcium via diffusion from bedrock. This project examines the importance of calcium in forest ecosystems and evaluates one hypothesis to why certain areas were not direly affected by depletion—presumably via diffusion from bedrock levels. A computational model of calcium diffusion was constructed and results were applied to the Walker Branch Watershed in Tennessee—one specific region not strongly damaged by calcium depletion. Results of this project show a consistency between the experimental data and the proposed hypothesis.

Anne Bainbridge

DESIGN AND CHARACTERIZATION OF AN IMPROVED ARSLID FOR HIGHER TEMPERATURE DETECTION OF PAHS

Faculty Collaborator: Dr. Tony Borgerding

Improved detection of polycyclic aromatic hydrocarbons (PAH) would be valuable to the scientific community due to the toxic nature of the compounds. A diode-pumped micro laser emitting photons at 266 nm will selectively ionize PAHs after they have passed through a gas chromatograph. Our work this summer has been to improve the design of the aromatic selective laser ionization detector (ArSLID) so that higher weight molecules will remain in the gas phase after passing through the GC column. This was achieved by effectively heating the ArSLID. Compounds with boiling points as high as 300°C could be analyzed using the improved detector.

Lauren R. Becker

THE SYNTHESIS OF A NEW ANTIBACTERIAL AGENT: NOVEL ISOXAZOLINONE

Faculty Collaborator: J. Thomas Ippoliti

A new type of antibacterial agent, isoxazolinones have been found to treat bacteria normally resistant to antibiotics. This seven step synthesis is for a novel derivative of isoxazolinone. Two variations of this synthesis have been abstracted: a sulfur derivative and an oxygen derivative. Both synthesis are in progress, step two of the sulfur derivative and step four of the oxygen derivative have been completed successfully.

Adam Berland

USING GIS TO ANALYZE FISH POPULATIONS IN SHALLOW LAKES IN WESTERN MINNESOTA

Faculty Collaborator: Dr. David Kelley

This study used GIS to predict the presence or absence of fish populations in 18 shallow lakes in western Minnesota. Analysis was based on two geographic factors: lake size and connectivity. Connectivity was defined as the distance to the nearest permanent or semi-permanent body of water, including lakes, rivers, and intermittent streams. It was hypothesized that both larger lake area and increased connectivity are associated with the presence of fish populations. Minnesota Department of Natural Resources (DNR) GIS data formed the basis for this analysis, and secondary GIS

layers were created when necessary. Field sampling was used to determine the actual status of fish populations in each lake. Using statistical software, eigenvector analysis was incorporated to derive the probability that fish are or are not present in each lake. Further, the analysis was extended to predict the composition of fish populations in each lake, ranging from planktivorous minnows up to pisicivorous (fish-eating) species such as northern pike. The ability of the model to predict the presence or absence of fish proved to be quite accurate. The prediction of composition of fish populations was only slightly less accurate. This model may prove useful to the larger DNR landscape study under which it was created.

Jay Brecke

THE CONSTRUCTION AND CALIBRATION OF AN EXPERIMENTAL FACILITY TO TEST THE GAS ABSORPTION PROPERTIES OF MATERIALS AT CRYOGENIC TEMPERATURES

Faculty Collaborator: Dr. Camille George

With the energy crisis facing America today, alternative energy technologies are in need of development. Hydrogen is seen as a possible solution to our problems, however many technologies required for its use are underdeveloped, particularly hydrogen storage. The research project for this summer was to build an experimental facility to test specific materials for their ability to absorb and release gas at extremely low temperatures in order to advance hydrogen storage methods. Certain materials have been shown to absorb and release hydrogen gas very well at elevated pressures and temperatures, with this experimental facility built these materials could be tested at very low temperatures for possible use with liquid hydrogen. The project plan was to design the test facility, acquire the necessary equipment, assemble parts, and run calibration tests on the equipment to ensure it is functioning accurately. If time was then available the materials could be tested and the results analyzed. By the end of the three month research period several problems were encountered and the test facility was unable to be completely calibrated for testing, however with the experience gained a redesigned facility could be created to eliminate the remaining problems. The project is planned to continue into this school year as this research has been in part of a larger project to develop an advanced gas management system for a liquid hydrogen storage tank. The summer research has been an excellent learning experience and will prove to be very helpful for the continuation of this research.

Cassandra Bueckers, Joel Demarais, & Nicholas Flier

ADOPTION OF INTERNATIONAL SIBLING GROUPS

Faculty Collaborator: Dr. Jean Giebenhain

This study focuses on international sibling group adoptions from the perspectives of: adoptive parents, adoptive sibling groups, other children in the family, and adoption agencies. Issues including pre-adoption experiences, relationships with family and friends, as well as cultural identity and adjustment issues are examined. If potential adoptive families and adoption agencies have more information about the effects of the adoption of international sibling groups, the entire adoption process may be improved. These results may also apply to other types of adoption, including domestic sibling groups, older international and domestic adoptees, and even foster care. In addition, if potential adoptive parents were properly informed about the benefits of sibling group adoptions, perhaps the rate of placement would be higher. Concerns about attachment disorder may also be minimized, because siblings remain attached to one another, whether or not they have a traumatic family background.

For this study, issues were explored by interviewing families who have adopted international sibling groups and by administering the Inventory of Parent and Peer Attachment (IPPA) and the Kvebaek Family Sculpture Technique (KFST). The IPPA is a 25 item self-report measure assessing children and adolescents' perceptions of the quality of their relationships with their parents and peers. The KFST is a self-report sculpture board which measures individual's emotional closeness between family dyads through creating spatial representations of family relationships.

Representatives from adoption agencies which place international sibling groups were also interviewed about the adoption process. Results and implications will be discussed.

Christina Bye

SYNTHESIS AND PURIFICATION OF THE ENZYME ALCOHOL OXIDASE FROM PICHIA PASTORIS FOR USE IN AN ELISA FOR ESTRADIOL

Faculty Collaborators: Dr. Kathy Olson, Dr. Tom Ippoliti

The yeast *Pichia pastoris* was grown on methanol to induce production of the enzyme alcohol oxidase (AOX). A culture of *Pichia* was successfully grown and the cells were lysed to release alcohol oxidase, which was subsequently purified and collected. The enzyme will then be linked to estradiol to function as a biological indicator.

Margaret Byro

INDUCTION OF HEPATIC DIFFERENTIATION BY VASCULAR ENDOTHELIAL CELLS

Faculty Collaborator: Dr. Glenn K. Sherer

The embryonic development of most organs involves a necessary interaction between two types of tissue. In the development of glandular organs the interaction occurs between a bud of epithelium and its surrounding mesenchyme (primitive connective tissue). Previous studies have indicated that in order to achieve successful liver development hepatic mesenchyme is necessary to interact with and induce the bud of epithelium, hepatic endoderm (hE), to differentiate into hepatocytes (mature epithelial cells specific to liver in structure, organization and function). Mesenchyme is composed of two distinct cell types; mesenchymal cells (MCs) and vascular endothelial cells (VECs) which are responsible for the formation of the blood vessels throughout an organ or body. However, it is unclear which cell type (MCs or VECs) is responsible for the induction of hepatic differentiation. Obtaining an answer to this question would provide a key link to understanding tissue interactions in organ development.

Circumstantial evidence has demonstrated that VECs are responsible for the induction of differentiation which hE experiences. To test this hypothesis, hE of quail origin was combined with VECs (also of quail origin) without the presence of MCs and grafted onto a host vascular system. Using a chick embryo as host allows for easy determination of organism origin when evaluating the graft tissue. One to five days after the graft is placed onto the host; it is removed, processed and prepared for evaluation. Results indicated that graft tissue did not survive beyond the first day however; signs show that differentiation may have occurred at day one. The results indicate that there may have been slight differentiation initiated by the VECs. While it is not clear that MCs are necessary for hepatic differentiation it is possible that MCs are necessary to increase the survival rate of the graft tissue.

Patrick M. Campbell

PHOTOELASTIC MODULATOR

Faculty Collaborator: Dr. Adam S. Green

This summer, we fully characterized a photoelastic modulator that will be used in high-speed, high-precision polarimetry experiments. We investigated the effects of temperature stability, tilt angle, input polarization, and lateral beam displacement on the time-varying intensity asymmetries in the output light. We built a proportional-integral-differential stabilization system to prevent temperature drifts, and we were nearly able to achieve the ten parts-per-million intensity stability required by our future research in biomedical optics.

Jay Christenson

SYNTHESIS OF A LEUKOCYTE ESTERASE SUBSTRATE

Faculty Collaborator: Dr. J. Thomas Ippoliti

A new, more stable, leukocyte esterase substrate has been synthesized in four steps. The product was tested, but proved to be too impure to produce any positive test results. The procedure is currently being repeated on a larger scale.

Daren Denker

ATTENTION PAID TO TELEVISION SHOWS AS A FUNCTION OF SHOW CONTENT

Faculty Collaborator: Dr. Gregory Robinson-Riegler

Television has become a major vehicle for people to receive information. Within one hour of television, a viewer can see as many as 20 advertisements, along with the show they are watching. Given that we are bombarded by so much information, one may start to wonder about how we process this information, and what factors influence our memory for it. Bushman and Bonacci (2002) conducted a study in which they measured participants' recall for advertisements embedded within television shows containing violent, sexual, and neutral content. They found that violent and sexual content had a negative impact on memory for commercials embedded within the programs including such content. These investigators propose that this is because of the tendency of violent and sexual content to occupy more of the individual's attention, leaving little available for the encoding of commercials.

Though the rationale for this explanation is plausible, little research has been conducted on how sexual and violent television programming affects attention. This study attempted to assess how much attention is devoted to violent, sexual, and neutral shows as well as accompanying commercials through the use of a secondary task methodology. Participants watched a TV show with either violent, sexual, or neutral content; concurrently, they were required to listen for and respond to a tone presented at random times throughout the show, and reaction time was recorded

Results indicate that there was a relationship between show content and attention. Reaction times to the tones were slowest in the sexual TV show condition, and there was little to no difference between the violent-show and neutral show conditions. These results indicate that there may indeed be attentional differences between shows based on their genre/content, and these differences will have implications for cognitive performance.

Angela Donatelle

PETROGRPHIC CORRELATION OF VOLCANIC ASHES WITHIN THE BITTER SPRING QUADRANGLE, NEVADA

Faculty Collaborator: Thomas Hickson

Various geologic interpretations of the Bitter Spring Quadrangle in Nevada (Fig. 1) have been formed due to its complex structure. The area is cut by two large faults, creating three fault blocks. Each fault block contains series of rocks that some geologists believe to correlate, while others argue their differences.

Studying volcanic ash from each of the areas can help determine whether the three fault blocks correlate. Over 50 ash samples were taken from the field, with careful consideration taken to avoid altered ashes due to their ages (10-26 million years old). The ashes were examined in hand sample as well as petrographically. Each sample was made into a thin section and similarities between glass shards, crystal composition, size, and shape were used identify similar ashes that could match. This information allows an initial hypothesis about the correlation of the fault blocks to be made. With further data, including age data, it will be possible to see if the initial results in the study hold true and whether petrographic work on other altered ashes is useful.

Rachel Enns

THE ONTOLOGY OF GENDERHOOD

Faculty Collaborator: Dr. Siobhan Nash-Marshall

The topic of my research is the ontology of women. This is a particularly difficult and important topic to address. It is extremely difficult to define the nature of the ontological difference between men and women. Any attempt to claim that women and men are ontologically different in a significant way risks compromising the parity which one must assume women and men have, since men and women are both human. Any attempt to claim that women and men are not ontologically different, on the other hand, risks compromising an obvious set of facts. This difficulty has led many to forgo the attempt ontologically to define genderhood at all. I have attempted to do so.

This project is important in its own right, and in view of the role women play in philosophy generally. If there is a significant ontological difference between men and women, then one must assume that the philosophy developed by men and women would be different in some significant way. This point has many important consequences. Philosophy has been an essentially male field for the last two thousand years. Given the relation between genderhood and thought, one can assume that philosophy itself is not radically incomplete if and only if there is no significant ontological difference between men and women. If there is such a difference, however, then philosophy must by definition be radically incomplete. My project thus not only attempted to come to terms with a problem which is difficult in its own right. It also served to demonstrate why female philosophical thought is essential to the future of philosophy itself.

I was assisted in this project by working with Doctor Siobhan Nash-Marshall, who has not only written an important article on this matter,1 but is also a member of the board of women's studies – the *Forum d'Ateneo per le problematiche di genere e di pari opportunità* – at the University of Padova in Italy.

Eric Fazendin, Adam Rennaker, Mathew Toso, Benjamin Werner

BORGLE: DISTRIBUTED INTELLIGENT AGENT WEB HARVESTING AND SEARCHING

Faculty Collaborator: Patrick Jarvis

In the spring of 2004 our group implemented a web harvesting and searching application called Borgle. This application uses of a distributed environment of peers that coordinate and communicate both the harvesting of web content as well as the querying for search results. These operations are done concurrently in a distributed manner across all active peers. The peers form a collective using asynchronous message passing and dynamic load balancing to harvest the information from web sites with minimal duplication.

The messages passed from peer to peer act as intelligent agents. Having arrived at a peer, the agent determines the resources available on that peer and uses those resources to change the state of the peer before sending itself on to different peer. In this paradigm the peer is merely a resource server and the message the active intelligence, in contrast to a typical client-server environment in which the message is simply processed by the "intelligent" machine.

The use of intelligent agents allows the harvesting of new information to be done concurrently with the processing of search queries. In addition, when new peers are added to the collective, their agents locate existing peers and cause the new peers to be automatically and transparently assimilated into the collective.

Our implementation is an area of research that may lead to more efficient ways to store and harvest web content. This could also lead to more intelligent ways of searching the web than is currently being used by today's search engines.

Amy Gaviglio

THE EFFECTS OF RAP1 ON THE SMALL G PROTEINS RAC AND CDC42

Faculty Collaborator: Dr. Jennifer Cruise

The small G-protein Rap1 is closely related to Ras, which has been shown to play a role in a variety of cancers. Most interactions and functions of Rap1, however, are still unknown. Recent research has suggested that Rap1 may interact with a subset of Ras downstream effectors, in particular the Rho family proteins Rac1 and cdc42. Using various Rap1 expression vectors, we found that the overexpression of active Rap1 in cells caused a decrease in the levels of both Rac1 and cdc42. This phenomenon was reversible when cells were transfected with a dominant-negative form of Rap1. The pattern of reduction and activation also implies that cdc42 may itself activate Rac1. In addition, knocking down levels of active Rap1 caused a loss of adhesion in epithelial cells, suggesting that all three proteins, Rap1, Rac1, and cdc42 may be necessary for the maintenance of cell attachment. These results suggest a potential mechanism of action for the small G-protein Rap1 and may lead to a better understanding of cell motility, adhesion, and proliferation.

Anthony Giang, Danielle Peterson, and Amy Reineck

EFFECTS OF VARIOUS LIGHT INTENSITIES ON THE SENSITIVITY OF THE CIRCADIAN SYSTEM IN MICE

Faculty Collaborator: Dr. Dwight Nelson

Circadian rhythms can be found in most animals, many plants, and even some bacteria. In mammals, these endogenous rhythms are controlled by the suprachiasmatic nucleus in the hypothalamus of the brain and can be reset by altering the natural light/dark cycle. Many previous studies have focused on examining the influence of light on animals after long durations in constant darkness. Conversely, this experiment sought to test the effect of various light intensities on an animal's circadian system after only one cycle in constant darkness. Specifically, 81 mice were entrained to a 12 hour light/dark cycle. They were then released for one cycle into constant darkness and given light pulses at varying intensities for 60 minutes to determine whether they exhibited a change in the sensitivity to the light or a change in the maximum response as indicated on a stimulus (dose) response curve to the light pulse. Results indicated that the maximum response to light is smaller immediately following release into darkness, but the sensitivity to light is relatively unchanged. Light levels less than 1 lux did not induce shifts, while light stimuli from 1 – 10 lux induced increasing responses to light. Pulses greater than approximately 10 lux induced a saturating response to light – approximately 85 – 100 minutes.

Meghan Gibson

PUBLIC PERCEPTIONS OF TODAY'S MEDIA

Faculty Collaborator: Dr. Wendy Barger

Today's media outlets are becoming increasingly controlled by fewer hands. This started with the 1996 Telecommunications Act and has continued with a 2003 proposal by the Federal Communications Commission to further relax media ownership rules. This deregulation may be good for business and the bottom line, but the concern is that corporatization and conglomeration threaten the media's role as a free marketplace of ideas where the diverse voices of a community can be heard.

This project explores public perceptions of media ownership, specifically whether members of the public are aware of trends in media ownership; whether they feel ownership rules have an impact on their lives; and – if they do oppose current trends – whether they feel their voices can be heard and their activism can make a difference.

A series of five focus groups with individuals throughout the Twin Cities revealed the following trends: Most participants were not aware that the majority of what they see, read, and hear in the media is controlled by a handful of conglomerates. Upon learning this, however, participants expressed concern and fear with this trend, but most also

agreed that the media are a business, and the bottom line drives many actions. The media' public service function came secondary for most participants, if at all. In addition, most participants more readily conceptualized themselves as consumers of media rather than citizens in a society with a democratic, free press. Finally, after learning more about media concentration, many participants expressed concern that ordinary citizens are unaware of media concentration issues. They expressed the need for media literacy education directed toward children as well as adults.

Jeff Goeden

TITLE: STRUCTURAL ANALYSES OF THE BITTER SPRING QUADRANGLE

Faculty Collaborator: Dr. Lisa Lamb

The Bitter Spring Quadrangle in Nevada had never been mapped in detail and has had different views concerning the deposition and deformation of the area. Due to this, I worked on trying to unravel some of the questions concerning the structure. To do this we went back out to the Bitter Spring Quadrangle in early June to collect more data. The data was then used to create a geologic map and analyzed further with the use of cross-sections and stereonets. Several questions and hypotheses' were brought up though those processes and will be used later to create a geologic history once we get our dates back from our ash samples. This work was done in collaboration with other faculty and students working on different parts of the Bitter Spring puzzle to help shed a little light on the bigger picture of understanding the processes that created Basin and Range.

Matt W. Gorman

FISH COMMUNITIES VERSUS WATERSHED USE AS DRIVERS OF ALGAL ABUNDANCE IN SHALLOW LAKES

Faculty Collaborator: Kyle Zimmer

Past research has shown that nutrient loading from agricultural activities in the watershed can strongly influence the abundance of algae in deeper lakes. However, this relationship has never been tested in shallow lakes. I measured turbidity (an index of algae abundance) in 18 shallow lakes in western Minnesota during the summer of 2004. I also sampled the fish communities in each lake to determine the type of fish community present, or whether the lake was fishless. Lastly, I acquired data on the percent of the lake's watershed that was used for agriculture from the Minnesota Department of Natural Resources. My results showed that the presence/absence of fish in shallow lakes explained 29% of the variance in algal abundance, and was thirty times more effective in predicting algal abundance compared to the proportion of the watershed used for agriculture. My findings indicate that management on Minnesota's shallow lakes should expand beyond the current focus on anthropogenic effects on watersheds and include the management of fish in these systems. Installation of culverts and ditches that connect shallow lakes and increase the distribution of fish will likely influence the water quality characteristics of these ecosystems.

Mitchell D. Haustein

EFFECTS OF VARIABLE FISH COMMUNITIES ON AQUATIC INVERTEBRATES IN MINNESOTA WETLANDS

Faculty Collaborator: Kyle D. Zimmer

Island biogeography predicts that species richness is positively related to lake size. This notion has found strong support in studies examining terrestrial islands in aquatic habitats. This hypothesis can also be tested in lakes, which can be considered aquatic islands in a terrestrial habitat. The objective of my study was to test the island biogeography hypothesis in shallow lakes. I sampled fish and invertebrate communities in 18 shallow lakes located in western Minnesota in the summer of 2004, and I determined fish species richness and invertebrate taxon richness of each lake.

I also determined lake size from data provided by the Minnesota Department of Natural Resources. Results showed a significant positive relationship between fish species richness and lake size, as predicted by island biogeography. In contrast, invertebrate taxon richness showed a significant negative relationship with lake size, opposite the prediction of island biogeography. A one-way analysis of variance indicated invertebrate taxon richness was significantly lower in the presence of fish compared to fishless sites, regardless of the fish community present. My results indicate fish have strong influences on invertebrate communities in shallow lakes. Historically, management of shallow lakes in Minnesota has focused on connecting shallow lakes and preserving only the largest lakes, likely increasing the distribution of fish and negatively influencing aquatic invertebrates. My results indicate that management should also strive to maintain small, isolated shallow lakes in order to maintain high invertebrate taxon richness in some lakes

Justin Herold

INTEGRIN SIGNALING IN CELLULAR ADHESION

Faculty Collaborator: Dr. Jennifer Cruise

Cellular adhesion to extracellular matrix proteins, or to other cells, is crucial for many cells to carry out functions such as gene expression, apoptosis, and proliferation. Integrins are known to be the primary proteins involved in the process of adhesion to extracellular matrix molecules, and also are known to be involved in cell signaling pathways. Cell adhesion to the extracellular matrix proteins fibronectin and collagen was investigated in ECR-CHO epithelial cells and MRC-5 fibroblasts. Transfection and over expression of either active of dominant-negative forms of Rap1, a G-protein known to be crucial in many cell signaling pathways, was used to determine its effects on cellular adhesion. A dye-release adhesion assay was optimized to allow observation of losses or gains in cell adhesion. Results show that inhibition of ap1 activity decreased adhesion of ECR-CHO epithelial cells to fibronectin and to collagen, but that over expression of Rap1 had little or no effect. Dominant-negative Rap1 in fibroblastic MRC-5 cells caused a slight loss of adhesion to fibronectin and collagen, but had much less profound effects than it did in epithelial cells. These results suggest that suggest that Rap1 is involved in the cell signaling pathway that Integrins are involved in, and that inhibition of Rap1 in epithelial cells causes the loss of integrin adhesion to extracellular matrix proteins fibronectin and collagen.

Nell Herrera

FLUORESCENT PROBES FOR DETECTING CARBON DIOXIDE INSIDE A CELL

Faculty Collaborator: Dr. Gary Mabbott

Preliminary test for detecting carbon dioxide inside a cell has been developed. This project is based on Fluorescence Resonance Energy Transfer (FRET) between Rhodamine B (fluorescent dye) and Bromothymol Blue (pH indicator). Rhodamine B and Bromothymol Blue were dissolved in an Octanol solution in order to prevent any polar molecules from interacting with these dyes. These mixtures of dyes were isolated in aragose gel and coated with polystyrene in order to prevent leaching. The fluorescence was measured by using a spectrofluorimeter. So far, FRET does occur between Rhodamine B and Bromothymol Blue. However, polystyrene did not protect the dye from polar molecules. These probes have not been introduced inside a cell, because of problems concerning the dye mixture.

Chaillee Hogan

HOW MUCH IS TOO MUCH? THE EFFECTS OF CHALLENGE ON INTRINSIC MOTIVATION IN COMPETITIVE AND COOPERATIVE SETTINGS

Faculty Collaborator: Dr. John Tauer

This study investigated how the level of challenge in competitive and cooperative settings affected intrinsic motivation. Intrinsic motivation refers to an individual's desire to engage in a task because the task is enjoyable. This unique type of motivation is correlated with persistence and performance. Participants were drawn from an instructional youth basketball camp. Participants were randomly assigned to one of nine conditions in a 3 (competition, cooperation, and intergroup competition) x 3 (easy, moderate, difficult) experimental design. In each condition, participants shot ten free throws and received feedback regarding their performance. They then completed a questionnaire measuring task enjoyment, our primary dependent measure.

The data will be analyzed using analysis of variance (ANOVA). We predict that task enjoyment will be greatest in the intergroup competition condition compared to the cooperation and competition conditions because intergroup competition provides the social support and encouragement of cooperative situations as well as the excitement and intensity of competitive situations. We also predict that task enjoyment will be greatest in the moderate challenge condition compared to the easy or difficult conditions. In situations that present a challenge that is too difficult or too easy, participants may disengage due to anxiety or boredom; for this reason, conditions of moderate challenge may facilitate greater task enjoyment. Finally, we predict an interaction, such that when the challenge level is difficult, task enjoyment will be greatest in the cooperation conditions. However, when the challenge level is easy, task enjoyment will be greatest in the competition conditions. It is our hope that these findings will increase our understanding of how activities should be structured and how goals should be set so that task enjoyment is optimized. Data are currently being analyzed and will be discussed in terms of motivational theory.

Sara Holter

USING GAMMA RAY AND INDUCTIVELY COUPLED PLASMA OPTICAL EMISSION SPECTROMETRY (ICP-OES) TO EVALUATE ELEMENTAL SEQUENCES IN CAP-CARBONATES AND CAP-LIKE CARBONATES OF THE DEATH VALLEY REGION

Faculty Collaborator: Dr. Kevin Theissen

The Snowball Earth theory of Hoffman et al. (1998) proposes dramatic post-glacial chemical weathering as large concentrations of carbon were removed from the atmosphere. This would result in a large input of terrigenous material into the oceans; hence, we might expect that carbonates formed under these conditions would demonstrate elevated K, U, Th levels in comparison to carbonates formed under more typical conditions. In January of 2004 we collected spectral gamma data (K, U, Th) and hand samples from cap carbonates (Noonday Dolomite) and cap-like carbonates (Beck Spring Dolomite) of the Death Valley region in order to explore elemental changes in post-snowball Earth oceans. Based on our spectral gamma results, Th/U ratio trends suggested variations in the oxidation state of the Precambrian ocean. We pursued further investigations of trace elements to ascertain the reliability of these results by using ICP-OES. A suite of 25 trace elements was measured, most notably including U and Th. The ICP-OES data not only allow us to compare elemental changes between cap-carbonates and cap-like carbonates, but they also allow for a comparison of optical emission spectrometry and hand held gamma spectrometry methods. Both methods show similar trends in U and Th values for both the cap-carbonates and cap-like carbonates.

Emily Horth

COMMUNICATION SYSTEM ANALYSIS: WHO IS DOING WHAT WITH ASTHMA IN RAMSEY COUNTY?

Collaborators: Dr. Melissa Lamb: UST Geology Department, Deborah Carter McCoy-Environmental Health Educator: Saint Paul Ramsey County Public Health Department-Environmental Health Sector, Cathi Lyman-Onkka- Supervisor: Saint Paul Ramsey County Public Health Department-Environmental Health Sector

I conducted a "communication systems analysis" of Saint Paul Ramsey County's Public and Environmental Health Department's (SPRCPHD) work being on the issue of asthma. The SPRCPHD is a large government organization with many employees, and many different teams or sub-departments working on individual projects. This has led to confusion on how asthma is currently being addressed within the county. The main objective of this analysis was to improve communications within the SPRCPHD, by determining which Ramsey Co employees are working on projects about asthma, what those projects entailed, and what tools, materials, connections would be beneficial in addressing asthma in a successful manner. In order to do this, I interviewed employees within SPRCPHD, as well as outside resources such as individuals from the Saint Paul Public School system, The American Lung Association, and the Minnesota State Data Unit. After all the interviews had been conducted and all data collected and analyzed, a report was written stating recommendations for the direction of work being done on asthma within the county. The recommendations that will be presented at a meeting this fall to Ramsey county include addressing the lack of connection between environmental issues and human health problems. It is recommended that Ramsey County take a multi-disciplinary approach to the issue at hand. This entails a pro-active response to creating awareness to the connection between health and the environment on both a public and employee realm. This will be mastered through educational programs and materials, as well as programs containing environmental interventions.

Kathryn Hoy

MICROSPECTROPHOTOMETRY FOR FORENSIC PURPOSES

Faculty Collaborator: Dr. Gary Mabbott

Visible Spectroscopy is being explored to determine the dyes used to color fibers. This process should allow us to determine colorants in a non-destructive manner. By first mounting the fibers on a waveguide and using the waveguide to direct the incoming light of a monochromator to illuminate the fibers, a camera can capture a series of photographs—five to ten nanometer increments between photos—that contain the entire visible spectra of the fibers. This series is then downloaded into a computer program, Igor Pro Carbon©, that is able to construct a graph of the absorbance of the fibers. This graph is compared to a traditional absorbance spectrum of the extracted dye in order to affirm a match of absorbance spectra.

Adam Huss

EXCITED STATE LUMINESCENCE QUENCHING OF TRIS(2,2'-BIPYRIDINE)-RUTHENIUM(II) BY ELECTRONIC ENERGY TRANSFER TO NILE BLUE

Faculty Collaborator: Joseph Brom

The excited state luminescence quenching of a common donor-quencher system was studied in the aim of determining the mechanism of quenching. Fluorescence intensity vs. time data was measured for Tris(2,2'-bipyridine)ruthenium(II) (Rubipy2+) and Nile Blue solutions in acetonitrile. The fluorescence of Rubipy2+ was shown to be quenched and the data was analyzed via the Stern-Volmer collisional quenching model. Sensitized fluorescence of the quencher was also observed and the fluorescence quenching was tentatively attributed to short-range (collisional) energy transfer. Concerns over various properties of the data are presented and future work relating to an electron transfer quenching model is discussed.

Andrea Johnson

IS THERE A ROLE FOR RAP1 IN THE MAMMALIAN CELL CYCLE?

Faculty Collaborator: Dr. Jennifer L. Cruise

The small GTPase Rap1 has been linked to a number of signaling pathways involved in the cell cycle, but its exact role is unknown. To help determine the effect of Rap1 on the cell cycle, DNA synthesis assays measuring BrdU incorporation were conducted on two different cell lines, MRC-5 fibroblasts and EcR-CHO epithelial cells. Baseline experiments were conducted to characterize the normal response of each cell line to stimulation with fetal bovine serum at different concentrations. MRC-5 cells showed low levels of DNA synthesis in serum-free conditions; the percentage of cells that had undergone S phase was around 10%. In media with serum at a concentration of 2.5%, DNA synthesis increased to 80-85%, and to 96% in 5% and 10% serum. EcR-CHO cells demonstrated a high level of DNA synthesis, about 75%, even in serum-free conditions. This increased to 99% in 0.5% serum conditions and 100% in all higher concentrations (up to 5% serum). These results suggest that despite a 24-hour serum starvation period, EcR-CHO cells were not growth arrested prior to stimulation with serum. Preliminary data from MRC-5 cells transfected with active Rap1 showed a drastic decrease in DNA synthesis in comparison to untransfected cells. This suggests that active Rap1 may inhibit the cell cycle, but further experimentation is necessary to confirm this hypothesis.

Erik Johnson

NON-LINEAR DYNAMICS: EXPERIMENTAL CHAOS

Faculty Collaborator: Marty Johnston

During the summer we spent a large amount of time studying the dynamics of a non-linear pendulum. Under the right circumstances with precise control settings the motion of the pendulum can be considered chaotic. We also attempted to create a computer program to model chaos. The ultimate goal of the summer was to use the computer model to generate a chaotic Poincare plot identical to that of the physical apparatus whose equation of motion and initial conditions were the same as the ones used in the model. Before any theoretical chaos modeling could take place, we had to secure out ability to gather experimental chaos data.

The entire project began with a lab class during the spring 2004 semester. Our goal for the semester was to find chaos in our system. Given a "chaos apparatus" we were to design a circuit to run the driving motor, write computer programs to: read data from the apparatus, convert the data file into a user friendly format, sample and display the results and further analyze the data to confirm chaos. At the same time we created a computer model for chaos using the equation of motion for our apparatus. Within the equation of motion are various constants representing forces acting on the pendulum that vary between both experimental runs in individual systems and from apparatus to apparatus. As we continued with the project we had to experimentally determine these constants to plug them into the model.

The poster focuses on the experimental aspects of the project. Information regarding the driving of the system, the computer programs necessary to run the experiment and the gathering of the constants are included as well as some background information on non-linear dynamics and chaos. This is the first in a three poster series.

Melissa Jones

AN *IN VIVO* SAMPLING TECHNIQUE TO MONITOR NITRIC OXIDE NEUROTRANSMITTERS USING CHEMILUMINESCENCE

Faculty Collaborator: Dr. Tony Borgerding

Nitric oxide (NO) has been shown to be an important neurotransmitter; however, it has never been directly measured or quantified. Our objective of this experiment is to develop and in vivo sampling technique to selectively and rapidly extract and detect nitric oxide from neurological environments. Extraction is done using "side by side" probes with membrane cover fabricated in-house with fused silica capillaries. Membranes were developed combining the properties of microdialysis membrane fibers and filling the dialysis pores with a synthetic polymer membrane Nafion. By using capillaries and microdialysis membranes, the size of the probe is small (approximately 200 mm at the tip), which is important for minimizing the damage caused when probe is inserted into the brain. Probes were tested for their effectiveness of extracting ethanol, showing that it took 5-10 seconds for ethanol to permeate the membrane. Probes were also shown to withstand backpressure of at least 75 p.s.i without leaking. Detection of the NO is done using gas phase chemiluminescence. A chemiluminescent reaction cell and photomultiplier tube (PMT) detector was constructed to detect the photons from the reaction. The chemiluminescent reaction was attempted without successfully seeing the light emitted with the bare eye.

Matthew Jungwirth

NON-LINEAR DYNAMICS: THE THEORETICAL MODEL

Faculty Collaborator: Dr. Marty Johnston

The field of non-linear dynamics involves the study of chaotic motion. A simple pendulum can move in a chaotic fashion when torques from non-linear magnetic fields are applied to it. This chaotic motion can be modeled through a computer program, utilizing numerical integration, and analyzing Poincare sections. The second-order differential equation of motion that describes our system is numerically integrated by an internal MatLab solver equipped with a Runge-Kutta method. By tweaking the three input parameters of driving frequency, driving torque and magnetic damping, chaotic behavior can be achieved by the MatLab program. The subsequent position and velocity data produced is sampled by a different program written in Java to create Poincare sections, a useful method to observe chaotic behavior. The ultimate goal of modeling is to accurately reproduce an experimental Poincare section. To do this, the three variable input parameters for the model must be equal the experimental parameters including a fourth unchanging parameter, frictional torque. Recent data taken has shown that the frictional torque is velocity dependent, not a constant as was previously assumed, making the ultimate goal as yet unachieved.

Maggie Kendall

EXAMINING ECOLOGICAL CHANGES IN AND AROUND STURGEON LAKE USING DEEP LAKE SEDIMENT CORES

Faculty Collaborator: Kevin Theissen

Climate change is on everyone's mind. Is it really happening? How will it impact my life and my region? The best way to understand how an area may be affected by modern climate change is to look at how it has responded to past climate fluctuations.

Lakes are often considered "natural beakers," and with 10,000 of them in Minnesota we have easy access to the wealth of information they can offer. My "beaker" was a large kettle lake in northern Minnesota's St. Louis County called Big Sturgeon Lake. Kettle lakes, remnants of the glaciers that once covered the area, have deep basins where sediment can accumulate and remain untouched by modern boat traffic, wave mixing, and aquatic life. This sediment settled in the bottom of deep lakes can be a great recorder of the ecological changes the region has experienced over

long periods of time. Lakes are very responsive to local and regional changes in climate and nearly all these changes will show up in the sediment record somehow – chemically or biologically. By collecting short sediment cores from basins within the lake, I have been able to look at a chronological picture extending roughly 400 years into the lake's past. I made smear slides that represented 1 cm increments through the core and charted their content, then compared those charts and graphs with various cores from different sections of the lake. My results indicated that fluctuations in the type of sediment as well as biological and mineral indicators paint a picture of both natural weather patterns and the possibility of human induced changes in the most recent past.

A.J. Langseth

MODULATION OF PHOTIC RESPONSIVENESS OF A CIRCADIAN PACEMAKER FOLLOWING LIGHT-DARK ENTRAINMENT

*Faculty Collaborator: D.E. Nelson**

In mammals, daily cycles of behavior and physiology are driven by an endogenous circadian pacemaker located within the hypothalamus. This pacemaker is entrained by environmental light information which is processed through the photic entrainment pathway. We have quantified the responsiveness of the mouse photic entrainment pathway over cycles 1-14 in constant darkness following LD entrainment. The circadian rhythm of running wheel running was monitored by a data acquisition system. Saturating light pulses (15min, 500lux) were delivered to each mouse at circadian time 16 on cycles 0-14 of DD (9-12/group). Phase delays measured during cycle 0 of DD (31±19min) were significantly smaller than delays of approximately 100min induced during subsequent circadian cycles ($N=71$; $P<0.05$; ANOVA, Tukey). We also measured photic responsiveness after 25.5hLD (12.75h:12.75h). Following this "delaying" LD cycle, shifts measured on circadian cycles 0, 1, and 2 of DD (16±11; 88±14; 87±10min) were significantly smaller than shifts of approximately 150min measured during cycles 10-14 ($N=55$; $P<0.05$; ANOVA, Tukey). These data demonstrate that there is an increase in the circadian pacemaker's response to light over the first several cycles in DD which reaches a steady-state maximum after 3-5 cycles. Phase response curves (PRC's) on cycles 0, 1, and 7 following 24h LD entrainment were measured to assess whether changes in PRC shape or amplitude could cause the observed growth in phase shifts with time in DD. The PRC shape appears to be conserved and phase delays are significantly smaller on cycles 0 and 1 than on cycle 7 ($N=71$, $P<0.05$; ANOVA, Tukey). These findings provide a link between experiments that measure light induced clock resetting after long durations in constant conditions and the daily synchronization of circadian clocks experienced by most mammals, including humans.

JoAnn Lawther, Jennifer Anderson, Ashley Keller, Lindsay Seim

DESIGN AND VALIDATION OF MEASUREMENT TOOLS TO EVALUATE MECHANICAL ENGINEERING COURSE INNOVATIONS

Faculty Collaborator: Elise L. Amel, Ph.D.

In pursuit of an Engineering degree, women face a number of barriers which do not necessarily challenge men. These barriers include the competitive environment fostered by such a field, a feeling of isolation, the detrimental effects of low self-confidence, childbearing and childrearing issues, not having female role models, insufficient financial assistance, the lack of hands-on experience, and the tendency of SMET faculty members to employ less student-centered learning techniques than other types of faculty members.

Besides facing gender-specific barriers during their undergrad education, women are widely underrepresented in Engineering careers. One possible explanation is that women have different reasons for choosing occupations than men. Women are more interested in the altruistic qualities of a career and less interested in higher earnings than men. Traditional female gender stereotypes are incongruent with the stereotypical view of Engineering. People who describe themselves as more masculine than feminine are better at spatial and mathematical tasks. In non-traditional female occupations women are more achievement than socially oriented, they have higher preferences for self-growth

opportunities, higher income and lower preferences for relationships at work, and they are less conservative regarding marital relationships and obligations. Women who are interested in conforming to sex-role stereotypes are more likely to end up in traditional occupations.

We predict that if a class is designed to break down these barriers, then more women will be interested in the Engineering field. If the course is designed such that women feel less isolated, less competitive, more confident, and more backed up by hands-on experience, then perhaps they will see the altruistic and feminine qualities in Engineering.

Our initial project goals were to design and validate measurement tools to determine if class design impacts the attitudes, learning, and behavior of women toward the field of mechanical engineering. The validated measurement tools will be presented.

Ryan A. Lloyd

IMPROVEMENTS IN THE CATEGORIZATION OF SIGNATURE CURVES USING LATENT SEMANTIC ANALYSIS

Faculty Collaborator: Dr. Cheri Shakiban

This project proposes advancements in the current algorithm of utilizing Latent Semantic Analysis to describe the features of signature curves. A revised order of transformations is suggested. Additionally, data reduction techniques and drastic noise-reduction methods are presented here. The report introduces a system for determining the correct category of a new object given a pre-existing database of information on objects. An algorithm for reversing LSA, or allowing the computer to sort objects into categories independently, is also included. The project also offers tests to determine which of two transformation combinations is optimal. Numerous theories for the algorithms are given. Examples with the various upgrades are also provided.

Ryan Lovik

COMPUTATIONAL ANALYSIS OF ELECTROMAGNETIC FIELDS AND WAVES

Faculty Collaborator: Dr. Greg Mowry

A Teaching Enhancement Grant was awarded for developing a new teaching pedagogy for ENGR 342, "Engineering Electromagnetic Fields and Waves". My project this summer was to develop several numerical modeling labs using the computer program ANSYS. ANSYS is a finite element analysis program capable of solving a wide variety of structural, thermal, fluid flow, and electromagnetic problems. My research had several goals. My first goal was to develop a basic understanding of electromagnetic principles. Based on this work, my next goal was to create a manual for students to use to learn how to solve basic electromagnetic problems using ANSYS. Building on this foundation, my next goal was to actually develop the laboratory projects for students to complete as a basis for learning the ANSYS program. My final goal was to explore how capable and useful the ANSYS program is for solving general electromagnetic problems.

I began my research, by learning basic electromagnetism and how electromagnetic problems are modeled using ANSYS, through guided independent research. After completing the independent study, I developed a basic student guide to using ANSYS to solve electromagnetic problems. Finally, I experimented with using ANSYS to model a wide variety of electromagnetic devices, for use in the ENGR-342 computer laboratory. The first laboratory project consists of modeling a permanent bar magnet, by following step by step instructions. The next laboratory project shows how to model a Yagi antenna and its far-field propagation pattern. The last laboratory project demonstrates how to model a transmission line, through modeling a microstrip transmission line. Finally, I investigated and determined that ANSYS is a very capable electromagnetic solver, capable of modeling a great variety of electromagnetic devices.

Rachel A. Lundeen

RAPID ANALYSIS OF AROMATICS IN WATER USING FAST EXTRACTION/FID RESULTS AGAINST MORE SELECTIVE ARSLID

Faculty Collaborator: Dr. Anthony J. Borgerding

A study was conducted to compare the universal flame ionization detector (FID) versus a redesigned aromatic selective laser ionization detector (ArSLID) while applying a fast extractor. Using the FID and a chromatograph oven, the fast extractor was applied to test aromatic compounds in aqueous samples of concentrations around 1.328 g/L. The results obtained from the prepared samples run in the FID were compared to results using a more selective detector, the ArSLID. The redesigned ArSLID setup allowed the detector to reach, previously impossible, higher temperatures (about 200 degrees Celsius) in order for the sample to remain in the gas phase after leaving the chromatograph oven (about 250 degrees Celsius). Aqueous samples of concentrations less than 674.2 mg/L were injected into the fast extractor with the ArSLID giving extremely selective results for whether a sample contained aromatic compounds or not. These results implicate the improved selectivity of the ArSLID for PAH compounds in aqueous samples. More results and work are necessary to completely understand the limitations of the fast extractor and ArSLID.

Maged Makled, Christopher Emerson, Kevin Krautbauer, Michelle Dotson, Brian Falk, Teldon Turner, Edward Heuer and Michael Aschenbeck

CLIENT SERVER CRYPTOGRAPHY

Faculty Collaborators: Raymond, Robert L., Ph.D and Jarvis, Patrick L., J.D., Ph.D

The desire to safely transmit information between parties has existed for centuries, from the time of Caesar, for whom the *Caesar Cipher* method is named, to today's society. The science of cryptology, creating and reading encoded messages, provides a means by which one can achieve the goal of secure communications.

This ancient subject is very active today, due in large part to the use of computers as communication devices. Data must be encrypted, altered using a secret code, and then decrypted (decoded) by the receiving party. With intelligent devices at either end of the communication line, messages can be encrypted and decrypted in an expedient manner. Internet commerce has irrefutably become a core member of the ever-growing global economy and depends upon the ability to send information such as credit card numbers without fear of interception; cryptology makes this possible.

Our project combines cryptographic algorithms from a QMCS Topics course with computer communication in the *client/server* mode. We wrote programs that allowed one computer to act as a server that could be contacted over a network by other computers (clients) so the server would perform cryptographic services for them. The services we implemented included encryption and decryption using these algorithms: El Gamal, Rabin, and RSA. Another service is Diffie – Hellman key negotiation; this is a step preceding encryption in which the specific encryption is chosen without allowing eavesdroppers to understand what key was chosen. Additionally, Caesar and Vigenere ciphers and frequency counting, a tool in code breaking, were implemented to run on client machines. These programs are written in the Java™ language, which provides tools for efficient client/server communication as well as the ability to do arithmetic with integers so large that code breaking is difficult.

William Miley

OSTRACOD ANALYSIS OF LAKE CHRISTINA AS PALEOECOLOGICAL INDICATORS

Faculty Collaborator: Dr. Kevin Theissen

I examined fossil ostracod distributions of two sediment cores to learn about the past ecology of Lake Christina (Douglas county, MN), clues to the past climate of the region. Ostracods are tiny bivalved crustaceans whose calcite shells are left behind as fossils after they die. Ostracods are sensitive to a range of ecological factors including habitat type, nutrient status, and the salinity, temperature and chemical composition of their host water (Holmes, 2001). The

ostracods sensitivity to their environment makes them useful indicators of past water conditions and climate reconstruction.

Ostracod distributions were counted for two sediment cores taken from Lake Christina. The data show that the total number of ostracods fluctuates in each of the cores, but there is an apparent decline in the most modern portion of each core. The decline in total number of ostracods may indicate a water level rise, less saline and/or more acidic waters. Accompanying this decline in core 1 the most dominant species, *Limnocythere herricki,* and second most dominant species, *Potamocypris granulose,* change positions. These features of the data may indicate a change in various environmental factors of Lake Christina. In order to provide further environmental information, approximately 10 individual ostracod valves were extracted from each interval for future geochemical analysis.

My research is part of a larger multi-proxy project involving three other lakes in the same region. The project is investigating alternative stable states in shallow lakes. Alternative stable state is a phenomenon in which a lake alternates back and forth from clean and turbid states. Ultimately, we would like to understand what causes lakes to alternate states.

Paul Morales

SEASONAL ACCLIMATION OF CONIFERS

Faculty Collaborator: Dr. Amy Verhoeven

Plants that keep their leaves during winter are not able to do photosynthesis, but still absorb large amounts of light. They must therefore acclimate to winter by increasing mechanisms for dissipating the absorbed light in a safe manner. This process is thought to involve large changes in the quantity and organization of the various proteins involved in harvesting light. The goal of this project was to quantify changes in the concentration of the photosynthetic proteins of white pine *(Pinus strobus)* and balsam fir *(Abies balsamea)* through out a year. Needles were collected in the summer, fall, winter, and spring and thylakoids were isolated from them. Proteins were separated using gel electrophoresis and antibodies specific to the light harvesting complex proteins (Lhca1-4, Lhcb1-6) and the reaction centers (Psba and Psaa) were tested using western blotting. The antibodies for the light harvesting proteins Lhca1-4, Lhcb1 and Lhcb2 were found to work in the conifer samples. Visible changes can be noticed in the band density, indicating decreases in most of the proteins during winter. Other systems such as the reaction center proteins, Psba and Psaa, and further light harvesting proteins such as B3, B5, B6 need to be optimized for the conifer system. Images of the antibodies were taken using the Versa Doc imaging system and will be further analyzed to obtain numeric density data.

Jennifer Mosier & Jill Spude

EPOXIDE FORMATION FROM ALKYLATED KETONES

Faculty Collaborator: Dr. J.T. Ippoliti

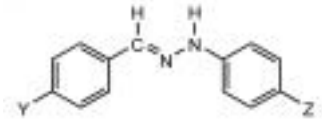
Through careful research and experimentation on the synthesis of ketones, epoxides have been constructed by various methods of alkylation. The compounds 2-allylcyclohexanone and 1-(oxiran-2-yl)pentan-3-one were synthesized from cyclohexanone and hept-6-en-1-one resulting in sufficient yields. The 2-allylcyclohexanone has yet to form the epoxide, however, many attempts have been made. The chemical properties from these new epoxides will add to further organic research.

Yeng Moua

CRYSTAL STRUCTURES OF BR/CN BRIDGE-FLIPPED ISOMERS COMPARED TO I/CN

Faculty Collaborator: Dr. William H. Ojala

I have been working on a project that consisted of synthesizing selected pairs of substituted phenylhydrazones designated as "bridge-flipped" isomers. The goal was to determine whether the isomeric pairs of the bridge-flipped isomers assume identical or different molecular packing arrangements in the solid state that might encourage or discourage co-crystallization. For the bridge-flipped isomers, another aspect of the research was to identify any chemical factors, such as hydrogen bonding, Lewis acid-base interactions, or steric interactions, that might result in close intermolecular interactions that would influence these isomers to possess the same packing arrangements. To prepare each phenylhydrazone, a benzaldehyde derivative was reacted with a phenylhydrazine derivative. The isomeric products differ only in the orientation of the carbon-nitrogen bridge joining two substituted phenyl groups. Although this particular flipping of the bridge creates different molecules chemically, it creates no significant difference between the bridge-flipped isomers in molecular shape and size that would have an influence on co-crystallization. The I/CN substituted compound I was found to be isostructural with its Br/CN substituted analog II. Neither I nor II is isostructural with the CN/Br isomer III, probably due to different intermolecular interactions involving the attraction of the nitrile unshared electron pair for the N-H hydrogen atom of the bridge.



I Y = I, Z = CN
II Y = Br, Z = CN
III Y = CN, Z = Br

Duc M. Nguyen

THE SYNTHESIS OF AN ISOTOPICALLY LABELED LAMIVUDINE

Faculty Collaborator: Dr. J. Thomas Ippoliti

The synthesis of an internal standard for the analysis of Lamivudine in blood follows a six-step reaction scheme. Five of the six steps were completed and confirmed by 1H NMR spectroscopy. Un-labeled cytosine synthesis was successful but the labeled cytosine is yet to be completed.

Callie M. Peotter

In Situ DECORATION OF G-DNA NETWORKS WITH GOLD NANOPARTICLES

Faculty Collaborator: Dr. Thomas C. Marsh

Small guanine-rich oligonucleotides can self-assemble into large organized arrays that have the potential to function as a molecular scaffold. An oligonucleotide with the sequence GGGGTTGGGG (Tet1.5) containing an amine modification on one thymine base enables the covalent attachment of other molecules or nanoparticles to the self-assembled array. Gold nanoparticles are one of the structures with the ability to attach to the G-wire. These gold nanoparticles are specifically made to attach to the G-wires and form a nano-scale wiring complex. Two different schemes have been used to create these nano-wires. The conductivity of these newly synthesized G-wires decorated with Au is yet to be determined.

Brian V. Petschel

COAXIAL ILLUMINATION SYSTEM

Faculty Collaborator: Dr. Greg Mowry

Under a grant from Innovative Laser Technology we were tasked to design an improved coaxial illumination system that attached to a common laser focusing head. The LLBK 60 is a laser head that accepts an infrared laser beam (1 micron) from a fiber optic cable and focuses it onto a target. The best way to view the target for precision welding and cutting applications is on the same axis as the beam that will perform the welding and cutting.

Implementing a vision system that can look down the beam at the target is fairly straight forward since the wavelength of the working beam is far enough removed-from the visible band that "hot mirrors" can be used to steer the laser beam, while it transmits in the visible.

However, the best way to illuminate such a system is to orient a light source on the same axis as the other two components, the camera and laser head. Implementing this successfully is fairly challenging since shinning an intense illumination beam down the LLBK-60 cavity introduces imaging affects that are difficult to eliminate.

Our project was to implement a coaxial illumination system that eliminated optical problems in the existing illumination system without making changes to the LLBK-60 laser head.

Hieu Pham

SENSITIVITY ANALYSIS OF GENETIC ALGORITHM (GA) FOR USE IN DIGITAL FILTER DESIGN

Faculty Collaborator: Dr. Jeff Jalkio

As more consumer and industrial products become digital, the use of efficient techniques to design digital filters becomes more important. A radio or television must filter unwanted channels from the signal it receives through the antenna. Current digital filter design methodologies do exist but each have their own pros and cons. Genetic Algorithms (GA) have been proposed as a new and effective design technique for digital filter design. This technique simulates evolution to generate acceptable filters from an initially random population. The results produced by a GA depend on a number of parameters such as crossover, mutation, and population size. The objective of this research is to analyze how changing the values of the different parameters affects the digital filter response that the GA produces. The results will provide a better understanding of how effective is the use of GA for digital filter design and how sensitive the generated filter is to variations in parameter values.

Kevin M. Piper

DETERMINING THE EFFECTIVENESS OF A NEW ANTIMICROBIAL DRUG

Faculty Collaborators: J. Thomas Ippoliti, and Jayna L. Ditty*

The increase of bacterial resistance to many antibiotics has created a tremendous need for new antimicrobial drugs. The continued rise of antibiotic resistance in pathogenic microorganisms has lead to the resurgence of the development of new antibiotic treatments for patients infected with resistant pathogens. One of the latest drugs synthesized to treat such pathogens is Zyvox, an oxazolidinone antibiotic that inhibits the initiation of protein synthesis in Gram-positive bacteria. Experiments were conducted to test the antibacterial effectiveness of a novel Zyvox derivative (OxA) and an intermediate compound in the synthesis of an isoxazolidinone compound (AUXX) against the Gram-positive bacterium Staphylococcus aureus and the Gram-negative Escherichia coli. The two antimicrobials were synthesized in the laboratory of Dr. Thomas Ippoliti at the University of St Thomas. Bacteria were grown in the presence of increasing antimicrobial concentrations to determine the Minimum Inhibitory Concentration (MIC). The S. aureus MICs for Zyvox and OxA and were 3°g/ml and 2°g/ml, respectively. For E. coli, an MIC could not be determined for OxA or Zyvox. In addition, an MIC was indeterminable for the AUXX

compound for either S. aureus or E. coli. Thus, the novel oxazolidinone antibacterial OxA, although ineffective against the Gram-negative bacterium E. coli, is an effective antibacterial drug in vitro with slightly better results than Zyvox, for use against the Gram-positive bacterium S. aureus.

Laura Prasek

SHALLOW LAKE RESEARCH PROJECT: PRELIMINARY GEOCHEMICAL RESULTS FROM LAKE CHRISTINA

Faculty Collaborators: Dr. Kevin Theissen, Melissa Konsti, Dr. Kyle Zimmer

Shallow Lakes have long been theorized to have two alternative stable states. The first state is characterized by clear water, submerged vegetation, and strong communities of fish and invertebrates. The second state, equally stable, is less species rich and less diverse, with an absence of submerged vegetation, fish communities, and invertebrates. This state is recognized by the turbidity of the water and strong algal blooms. We set out to study past transitions of four shallow lakes in northwestern Minnesota, namely Lake Christina, Lake Hagstrom, Lake Morrison, and Lake Rolland, that have been studied over the past decade by Dr. Kyle Zimmer. We collected sediment cores from each of the four lakes in March, 2004 and then prepared samples to be sent to Stanford University for isotopic and elemental analysis. The data indicated periodic changes in the amount of productivity and the sources of organic matter reaching the basin. These trends and patterns in the data could represent transitions from one stable state to the other. We cannot make more definite conclusions of what the data means until we have some age dates of the samples.

Susan Pribyl, Kayla Kent

AN EFFICIENT SYNTHESIS OF KETO-DIOLS FROM ACID CHLORIDES

Faculty Collaborator: Dr. J Thomas Ippoliti

Synthesis of keto-diols from keto-alkenes was investigated using different experimental routes. Various keto-alkenes were synthesized from Grignards reacted with acid chlorides in the presence of a catalyst. The most efficient route was found by converting the keto-alkenes into epoxides using a compound called Oxone. The epoxides created were then hydrolyzed into diols using a route that employs the use of Jacobsen's catalyst.

Brandon Rowekamp

CONSTRUCTION OF SPECIAL MATRIX POLYNOMIALS

Faculty Collaborator: Radka Turcajova

In signal processing applications certain types of matrix polynomials can be useful. For this project we considered the case of 2x2 matrix polynomials that are limited to entries of ones, zeros and negative ones, and also are paraunitary up to a constant factor. Finding matrices of this type has been limited to a process of trial and error, which is a major problem because of the exponential way in which the possibilities increase when the degree of the polynomial increases. The goal of this research was to examine these matrix polynomials, find ways to eliminate certain potential polynomials quickly by finding necessary or sufficient conditions for a valid polynomial and ideally to find either a recursive or non-recursive method for generating matrix polynomials of this type.

A great deal of conditions must be met, some sufficient, some only necessary, for a matrix polynomial (of ones zeros and negative ones) to be considered paraunitary. This includes observations about the block circulant, and shifted orthogonality conditions. There is also a relation between the number of non-zero entries in the polynomial and the constant the polynomial is paraunitary up to. Since restrictions exist for this constant, many of matrices can be eliminated, saving time even in trial and error methods.

There are also a few recursive methods that build new valid matrix polynomials from known ones. For example there are a number of basic matrices that can be multiplied by the polynomial and produce a new (and in many cases useful) polynomial. Another method disassembles the polynomial into various bits, and then uses each bit twice to make a new, larger, polynomial.

Though neither the necessary conditions nor the recursive methods can generate all possible matrices of this type, in combination they can quickly generate a large number of matrix polynomials useful from an applications standpoint.

Benjamin L. Sanders

CRYSTAL STRUCTURES OF BRIDGE-FLIPPED ISOMERS

Faculty Collaborator: Dr. William H. Ojala

Bridge-flipped isomers of phenylhydrazones and benzylideneanilines are compounds that have the same chemical formula, but the bridge of atoms connecting the phenyl rings is flipped over. Bridge-flipped isomers are important because they have the potential ability to co-crystallize, and that can lead to the development of new materials. Another important aspect of benzylideneanilines and phenylhydrazones is how different compounds compare to each other structurally; for example, it is of interest to determine what effect a fluorine atom has on a compound's crystal structure compared to what effect replacing the fluorine with a hydroxyl group has on the crystal structure. The research done thus far has yielded the crystal structure of the fluorinated benzylideneaniline I, a structure that gives a good comparison to a previous structure done by the Ojala research group, that of the hydroxy-substituted benzylideneaniline II. Another structure, that of the phenylhydrazone III, has proved difficult to solve and refine successfully due to pseudosymmetry in the crystal structure. The co-crystallization portion of the research project is still in progress.

The support of the Young Scholars Program for this project during Summer 2004 is gratefully acknowledged.

John Schwekoske

SYNTHESIS OF AN OLIGOPHENYLENE FOR USE AS A HOLE-TRANSPORTING AGENT IN ORGANIC LIGHT EMITTING DIODES

Faculty Collaborator: J. Thomas Ippoliti

Two components of a new hole-transporting molecule have been synthesized and are in the process of being coupled to form two distinct hole-transporting molecules. This hole-transporting molecule that strays from the traditional triaryl 3° amine structure will incorporate the double Michael addition to form an eight membered dialkyl mono-aryl structure. a unique ability to easily transport electrons along with the characteristic high resistance to oxidative decay that is needed to make them good hole-transporting candidates for future integration into organic light emitting diodes (OLED).

Ryan Sharma

DIATOMS AS ENVIRONMENTAL PROXIES IN LAKE CHRISTINA

Faculty Collaborator: Dr. Kevin Theissen

Diatoms from sediment cores taken from Lake Christina (Douglas County, MN) were analyzed for information regarding past environmental conditions as this may aid in understanding alternating stable states in shallow lakes. Preliminary analysis of the most dominant species indicates that Lake Christina is mildly saline to saline (species optimum range from .5 to 5 g/l), alkaline (pH » 8), and eutrophic. Most species are found in the littoral zone with a mix of planktonic and epiphytic/benthic forms. Cocconeis was a dominant genus throughout core 1, with *Fragilaria*

construens being very common from 40-138 cm. Core 2 was dominated by two planktonic forms: *Melosira ambigua,* and *Aulacoseira granatula.* Other dominant species in both cores include *Lanceolata navicula, L. oblonga, Cymbella inaequalis,* and *Fragilaria vaucherie.*

The ratio of centric to pennate diatoms can be used to determine the trophic status of a lake (Nygaard 1949, Foged 1954). We suspect that examination of this ratio, as well as salinity, pH, color, and phosphorus optima, will allow us to create a record of Lake Christina's trophic changes. The upper 15 cm of both cores are characterized by high percentages of centric species which may suggest a shift to a more eutrophic turbid state in recent times. Salinity appears to have decreased over the same interval since the centric species found in Lake Christina have low salinity requirements and those that dominate in 15 through 138 cm (30 cm in core 2) have high salinity requirements. Further examination of the relationship between diatoms and environmental conditions is required before we are able to fully reconstruct the history of Lake Christina.

Zach Simmons

SONOLUMINESCENCE

Faculty Collaborator: Dr. Marty Johnston

Sonoluminescence, a phenomenon where light is emitted from bubbles trapped in a sound field in a liquid, was first observed early in the last century. There was little interest until single bubble sonoluminescence (SBSL) was discovered in the early 1990's. An investigation into SBSL began this summer, and although the first apparatus didn't work, progress will continue this fall and hopefully we will be able to get the experiment to work based on the knowledge and experience gained this summer.

Although the apparatus is fairly straightforward, it became apparent that it is very important to have precise geometry, or at least that is the conclusion that was reached. The apparatus consists of a spherical glass flask with piezoelectric transducers attached to the flask that introduce ultrasonic sound via vibrating the flask. The transducers are driven with an amplified sine wave run through a matching inductor to maximize power to the transducers. Bubbles were observed to levitate with this arrangement although light emission was not observed. It was thought that perhaps more power was needed by the transducers to get luminescence, so audio transformers were added to step up the output, but increasing the power did not lead to light emission. An investigation into the quality factor of the chamber revealed that it was not very good, so a new chamber is being constructed.

Zach Simmons

NON-LINEAR DYNAMICS: LYAPUNOV EXPONENTS

Faculty Collaborator: Dr. Marty Johnston

Both the instrumentation and theoretical modeling aspects of the chaotic pendulum project have been greatly improved this summer. Now that we have more confidence in our system and a more thorough understanding of it, it would be nice to be able to quantify *how* chaotic it is. One of the ways that this can be done is using Lyapunov Exponents.

Lyapunov exponents give a measure of the average rate of divergence among neighboring trajectories on an attractor. To say this another way, Lyapunov exponents provide a measure of the extreme sensitivity to initial conditions which is a hallmark of chaos.

Software is available to extract the Lyapunov exponents from experimental time series data. However, software for this purpose doesn't analyze divergence in phase space, but on an attractor reconstructed using time-delay reconstruction. Time-delay attractor reconstruction became one of the main topics of exploration during this investigation into Lyapunov exponents. Two principle parameters, time delay and embedding dimension, are integral to correct attractor reconstruction. Topics including the Autocorrelation function, Mutual Information and False Nearest Neighbors were explored to assure correct time delay and embedding parameter selections.

Even so, Lyapunov Exponent calculation was not as parameter independent as was hoped; there are other parameters in the software that proved to affect the calculation.
A poster on Lyapunov Exponents will be the third of a three poster presentation on the Chaotic Pendulum project.

Joseph Skaja

DEVELOPMENT AND CHARACTERIZATION OF AU NANOPARTICLE ARRAY EMPLOYING A G-DNA MOLECULAR SCAFFOLD

Faculty Collaborator: Dr. Thomas Marsh

Nanoparticles have become very important materials in the development of nanoscale devices. The ability to control the assembly of ordered Au nanoparticles is a huge step in the development of devices such as nanoscale circuitry. Nucleic acids, in particular B-DNA, have been used as molecular scaffolds for the positioning of nanoparticles. An alternative to B-DNA is the use of a simpler molecule, G-DNA. The ten base pair oligonucleotide GGGGTTGGGG (Tet1.5) is able to self assemble into higher order G-DNA tetramers known as G-wires. The Tet1.5 molecule has been synthesized with a primary amine functional group on an internal thymine residue. The amine serves as an attachment point for a Au-nanoparticle. G-wires deposited on a surface are incubated with N-hydroxysuccidamidyl-modified Au nanoparticle to form a DNA-nanoparticle array. The modified Au nanoparticles are formed in situ. The G-DNA Au nanoparticle structures were characterized by Transmission Electron Microscopy (TEM) and Atomic Force Microscopy (AFM). These images showed G-wire network formation with the TM1-6 amine modified oligonucleotide. EM images also showed ordered linear arrays of nanoparticles when placed into solution with NHS-acivated Au nanoparticles.

Jonathon Stierman

HATE SPEECH AND THE SERVERS THAT HOST IT

Faculty Collaborators: Dr. Kristie Bunton, Dr. Mari Heltne

The internet has allowed for millions of people to speak their minds. And some minds think up hate speech. This project investigated the Acceptable Use Policies (AUPs) of 118 Internet Service Providers (ISPs). Twenty of those ISPs were located in Canada, 19 in the United Kingdom, 36 were nation-wide US ISPs, and 33 were located in Minnesota.

The Acceptable Use Policy (what users are allowed to say, or do online) of each ISP was analyzed for its use of words or phrases regarding hateful language. Specifically, I looked for words such as “hateful,” “harmful,” “threatening,” “obscene,” “indecent,” and others. The resulting data were analyzed for statistically significant differences between the types of ISPs.

The analysis showed there was no significant difference in policy between UK and Canadian ISPs. Both countries seemed to agree on what is forbidden to internet users. Statistically significant differences did exist between US and UK or Canadian ISPs, however. The combined US ISPs (local and national) held significantly different policies when compared to foreign providers. Those in the UK were more likely to restrict “abusive,” “obscene,” “offensive,” and “indecent” material when compared to US ISPs. Canadian ISPs were more likely to forbid “abusive” and “defamatory” material when viewed next to US ISPs. Between US local and US national providers, there was no significant difference.

Overall, the study concluded that the First Amendment to the U.S. Constitution, which protects free expression of most ideas, despite how hateful, makes ISPs in the United States significantly more likely to protect hateful expression than ISPs in the United Kingdom and Canada.

Future research for this project will involve contacting the ISPs to obtain their definitions of words “obscene,” “abusive,” “indecent,” and “offensive” and possibly combining some of the like groups. Expanding the study to other European countries, such as France and Germany, will also be included.

James A. Thielen

HIGH-SPEED, HIGH-PRECISION POLARIMETRY

Faculty Collaborator: Dr. Adam S. Green

Our goal is to create a fast, high-precision optical polarimeter that utilizes a photoelastic modulator. This device will determine the Stokes parameters that characterize the polarization of light after it has scattered from a target. Our polarimeter has worked well in preliminary tests. It qualitatively measures Stokes parameters correctly, but it encounters problems reaching our desired sensitivity of ten parts per million. Once the device is working to our specifications, we will carefully measure various polarization properties of simulated and real human tissues. We would also like to experiment with a type of randomly ordered medium called a "volume reflector" and determine if it can be used as part of a highly unpolarized light source.

Michelle Verant

SUCCESSION OF A FISH COMMUNITY FOLLOWING A CATASTROPHIC DIE-OFF IN A MINNESOTA LAKE

Faculty Collaborator: Kyle Zimmer

Lake rehabilitation measures via lake-wide removal of fish were implemented in Lake Christina, MN in the fall of 2003 in an effort to restore favorable waterfowl conditions. This management practice has been executed successfully in the past in this and other Minnesota lakes, but the response and pattern of succession of the fish community has never been assessed. I studied the response of Lake Christina's fish community from April to August of 2004 using trap nets and gill nets. The results show that the current fish community is comprised primarily of adult black bullheads, indicating this species is most resistant to rehabilitation efforts. Species including northern pike, bluegills, and bigmouth buffalo were not collected in large numbers until late summer, and consisted largely of young-of-the-year fish, likely reflecting low adult densities during the summer. However, a large number of carp approximately 160mm long were sampled in August, indicating moderate numbers of juvenile carp also survived the rehabilitation efforts. These results indicate that bullheads and carp are most resistant to lake rehabilitation efforts, and that these management efforts may result in a fish community initially dominated by "rough fish". Sampling in 2005 will determine whether the carp-bullhead dominated community currently present in the lake undergoes a transition into a fish community with higher species diversity.

Tyler E. White

JUST WAR THEORY AND THE BUSH DOCTRINE

Faculty Collaborator: Dr. John Kronen

On September 11, 2001, the United States was attacked by an unnamed and unrecognizable enemy. This attack was the first of its kind in American history, and it presented the United States government with a unique problem. With the events of 9/11 in mind, was there perhaps a better way for the United States to carry out its international policy? Up until 9/11, the United States had typically adhered to a policy of defensive war, whose sole end was the rectification of "wrongs received," and the achievement of justice. But in March of 2003, the United States went to war with Iraq to further ensure the safety of the American people. The invasion of Iraq was preemptive in nature, but ultimately necessary because of the inherent danger to the American people. If the danger to the American people was so imminent, however, then why was the invasion met with such opposition from the global community?

The fact is, the Bush Administration, in its actions, went against the centuries-old Just War Tradition; a tradition that sought to instill ethical considerations within the realm of international policy. The purpose of this research project is to evaluate the inherent differences between the "Bush Doctrine" and the Just War Theory, and what those differences mean for the direction of American international policy.

Kaija Wilson

INTERINDIVIDUAL REPEATABILITY OF RESTING METABOLIC RATES IN SNAPPING TURTLE HATCHLINGS, *CHELYDRA SERPENTINA*

Faculty Collaborator: Dr. Anthony Steyermark

All organisms are required to allocate a limited amount of energy to a variety of processes. Resting Metabolic Rate (RMR) is one of these processes, which incorporates the minimal energy costs needed to physiologically sustain an organism. Resting metabolic rate (RMR) is a trait that has been measured for hundreds of species, but biologists are just recently studying repeatability of RMR at the level of an individual. RMR is thought to be a trait of natural selection. For selection on a trait to be effective, a trait must be consistent (repeatable) across some part of an individual's life. To date, there have been no published studies investigating repeatability of RMR in ectotherms. Thus, we measured RMR in 56 snapping turtle *(Chelydra serpentina)* hatchlings in September-October and in May-June. Though RMR was not significantly repeatable between autumn and spring trials ($p=0.08$), the data suggests a general trend towards repeatability. This is the first report investigating RMR repeatability in ectotherms over a long period of time (8 months).

Tyler Winkelman

HYBRID POLYMERS PREPARED VIA SOL-GEL PROCESSES

Faculty Collaborator: Dr. J. Thomas Ippoliti

Hybrid polymers were synthesized via the sol-gel process, which allows inorganic nano particles to be incorporated into organic polymer chains. These hybrids maintain properties of both inorganic strength and organic flexibility. Organic isocyanates were reacted with hydroxyl terminated polymers to form hybrid precursors used in the sol-gel processes. Photochromes were included in several of the matrices to test how the acidic sol-gel environment would affect the ultra-violet sensitive particles.

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