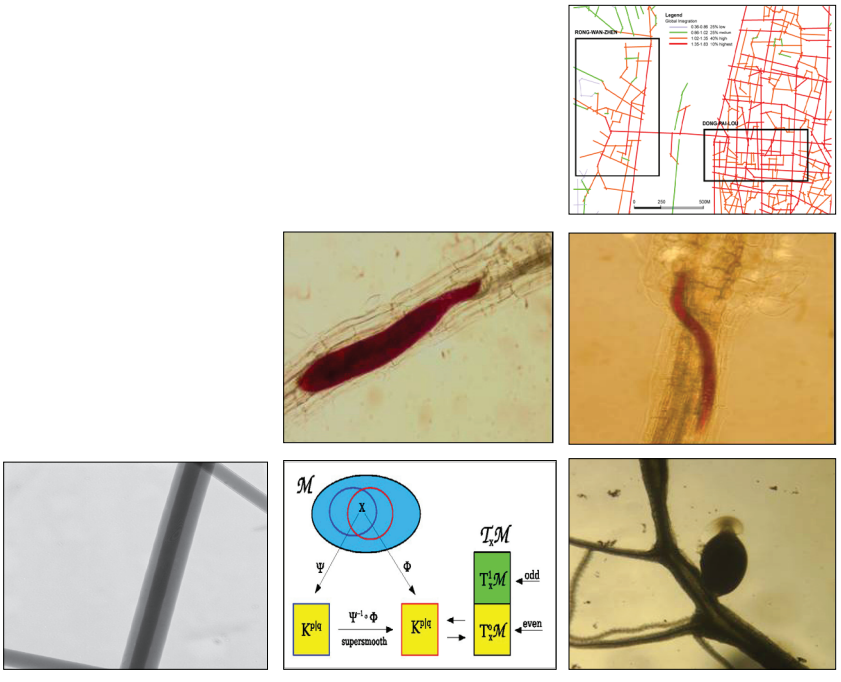
ABSTRACTS

THIRD ANNUAL GRADUATE STUDENT RESEARCH SYMPOSIUM

Wednesday
March 19, 2008

McKimmon Center



NC STATE UNIVERSITY

Third Annual
NC State University
Graduate Student Research Symposium

SYMPOSIUM ORGANIZERS

Graduate School

Dr. David Shafer, Assistant Dean for Outreach and Diversity
Todd Marcks, Fellowships and Grants Administrator
Darren White, Webmaster
Patricia Sullivan, Cover Design and Abstract Book

University Graduate Student Association (2007-2008)

Claudia Echeverria, Textiles (Chair, Academic Policy Committee)
Catherine Beck, Genetics
David Kiechle, Counselor Education/Agency Counseling
Justin Moody, International Studies
Jessica Roberts, Biological and Agricultural Engineering
Jian Wu, Plant Biology

Cover Photos: 2007 Symposium Winners – James Cook, Yixiang Long, Satyajeet Ojha, Nrupali Patel

AGENDA

12:00 pm - 1:00 pm	Poster Set Up (All)
1:15 pm - 1:30 pm	Welcoming Remarks and Symposium Overview Ling Xiang, UGSA President Dr. Terri L. Lomax, Dean of the Graduate School and Associate Vice Chancellor for Research and Graduate Studies Dr. David Shafer, Assistant Dean for Outreach and Diversity
1:30 pm - 4:00 pm	Poster Session and Competition
4:15 pm - 5:00 pm	Announcements of Awards Dr. John Gilligan, Vice Chancellor for Research and Graduate Studies

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ABSTRACTS

Pamela P. Abit and William A. Hoffmann
Graduate Program: Plant Biology
Advisor: William A. Hoffmann

Ecological and physiological basis for the distribution of woody plants along water availability gradients in the eastern US mixed forest

Higher temperatures under climate change are likely to result in greater evaporation and increased soil moisture deficits. Increased drought will likely cause a shift in the vegetation distribution. This study focused on woody plants of the Southeastern US mixed forest. Although water is not limiting in this forest, species distributions suggests that water availability exerts a strong control on the success of woody plants. We used a comparative approach to understand environmental factors and corresponding species traits that determine species composition across a gradient of water availability. We compared hydraulic architecture and the ability of xeric and mesic species to germinate, grow and survive under varying levels of drought stress. Congeners from either xeric or mesic sites were used. Seeds were subjected to polyethylene glycol solutions of different water potentials to test the constraints of water availability on germination. We performed a dry-down experiment to compare the ability of the xeric and mesic species to survive extreme drought by evaluating survival after re-watering subsequent to drought exposure. Growth was evaluated by measuring electron transport rate, shoot and root biomass of seedlings that were exposed to different levels of water availability. Results indicate that hydraulic architecture and the ability to germinate under water stress are not the primary determinants for the observed distribution of these species across a gradient of water availability. However, the ability of the seedlings to avoid cavitation and to survive extreme water stress appears to play an important role in determining such distribution.

Steven M. Bernacki and Niki Robertson
Graduate Program: Plant Biology
Advisor: Niki Robertson

Using VIGS to probe links between the cell cycle and development

The retinoblastoma-related protein (RBR) is an integral regulator of the cell cycle in plants and, like its animal counterpart, may function in cell differentiation. RBR functions as a checkpoint for S phase by binding members of the E2F family of transcription factors causing arrest the cell cycle in G1. Release of E2F occurs after RBR is phosphorylated by activated cyclin-dependent kinase (CDK). We used the Geminivirus, Cabbage Leaf Curl Virus (CaLCuV), as a viral-induced gene silencing vector to knockdown RBR in *Arabidopsis thaliana*. Plants showed premature cell death in mature leaves when tested by trypan blue staining, severely stunted growth, and lack of apical dominance. Longitudinal sections showed a proliferation of meristem-like structures compared to empty vector controls. SEM photos showed uneven pavement cells with development arrested at early stages, either overproliferation of pavement cells or underproliferation of mesophyll, and aberrant stomatal clustering and spacing. In contrast to empty vector plants, the majority of trichomes had one or two branches, rather than three, in the RBR knockdown plants. Our results suggest that reducing *RBR* expression promotes cell division and inhibits cell differentiation and endoreuplication.

Monica Blanco and J. B. Ristaino
Graduate Program: Plant Pathology
Advisor: J. B. Ristaino

Genetic structure of populations of the tobacco blue mold pathogen, *Peronospora tabacina* in North America, Central America and the Caribbean

Tobacco blue mold, caused by the oomycete pathogen *Peronospora tabacina* is a highly destructive pathogen of tobacco seed beds and production fields in tobacco producing areas globally. The disease has been responsible for multi-million dollars losses to growers.

In the US, epidemics can start in three different ways. First the epidemic may originate in Caribbean countries and move northward and infect tobacco plants in fields. Second, the *P. tabacina* pathogen can survive in more temperate states as Texas, where it can live on wild *Nicotiana* spp. as *Nicotiana repanda.* Final, it is possible that the pathogen survives in greenhouses in volunteer tobacco plants and moves with the transplants to other states. Tobacco blue mold is also a problem in southwestern and southeastern Europe, the Middle East and North Africa. Inoculum may overwinter in North Africa and it can be dispersed long distances to southern Europe.

A change on the genetic structure of the pathogen populations has been observed mainly on populations of the pathogen that are resistant to the commonly used fungicides such as metalaxyl and mefenoxam. Also a change

in temperature tolerance has been observed on the sporangiospores and the presence of more aggressive strains that lately remains as a frequent systemic infection on the tobacco plants.

The genetic structure of *P. tabacina* populations was examined through gene sequencing of specific mitochondrial and nuclear genes. The *cox*2, P3 (*rp1*14, *rp1*5, tRNA's), *Igs*2, *Ypt*1 and B-tubulin genes showed variation (heterozygous sites). The P3 region and *cox2* gene from mitochondrial and *Ypt*1 gene and *Igs*2 region from nuclear genome were selected for further phylogenetic analysis. Fifty six isolates from populations in Europe, North America, Central America and the Caribbean were cloned (10-12 total) and sequenced (8 total). Sequence data from the Intergenic spacer (*Igs*2) region are presented here. One hundred and twenty four different haplotypes were found. Eight haplotypes were found most frequently and 116 were considered less frequent haplotypes across the populations. Thus far, results from the single gene analysis suggest migration between populations and possibly the presence of sexual reproduction, which may have resulted in the highly polymorphic rare alleles found among populations. We plan to sequence additional gene regions from the mitochondrial and nuclear regions, test for neutrality, population subdivision, migration and infer gene genealogies using nonparametric and coalescent methods.

D.V. Bohorquez[1], A.A. Santos[2], Jr., R.L. Nanney[1], and P.R. Ferket[1]
Graduate Programs: Poultry Science, North Carolina State University[1]; Florida Hospital College of Health Sciences[2]
Advisor: Peter R. Ferket

Dietary supplementation of yeast extract nucleotides NUPRO® enhances small intestinal development and growth performance of turkey poults

Dietary inclusion of nucleotide-rich yeast extract may benefit early enteric development of young poultry, which may help resist enteric disease challenges. Nucleotides are precursors of DNA and RNA, energy metabolites, secondary messengers that mediate hormones responsible for growth, and the biosynthesis of protein inhibitors that have antibiotic-like properties. A study was designed to evaluate the effect of dietary supplementation of yeast extract on ileum histomorphometry of 7d turkeys and their growth performance through 21 d. Experimental diets were formulated to contain 0, 5, 10, and 15% NUPRO® (Alltech, Inc.) (4853 GE/kg, 72% C.P., 0.95% E.E., and 8% ash) at the expense of a typical corn-soy starter diet and fed *ad libitum*. The 4 treatments were each replicated by 4 pens of 15 poults. Dietary inclusion of NUPRO® up to 15% enhanced morphological development (higher crypt depth, villus height, and villus surface area) of 7 d poults. This enhanced enteric villi development was associated with increased 21 d body weights (498 g *vs* 603 g, P<.001) and reduced mortality rate (10 *vs* 3.7%, P<.06). Dietary inclusion of NUPRO® up to 15% had no adverse effects on feed intake. These experimental results demonstrate that dietary supplementation of nucleotide-rich yeast extract can enhance enteric development of turkey poults, which facilitates nutrient absorption and increases a poult's resistance to enteric disease challenges.

Goran Bozinovic[1], Margie Oleksiak[2], and Damian Shea[1]
Graduate Programs: Environmental and Molecular Toxicology, North Carolina State University[1]; Marine and Atmospheric Sciences, University of Miami[2]
Advisor: Damian Shea

Gene Expression, Physiology, Morphology and Pollution Exposures in Sensitive and Resistant Embryos

Populations of the teleost fish *Fundulus heteroclitus* inhabit heavily contaminated sites and have adapted to the pollutants in their environment. We are analyzing patterns of gene expression among and within multiple populations of developing *Fundulus* embryos adapted to these sites to better understand the effect of pollution during embryogenesis. Changes in gene expression can be used as a sensitive and measurable endpoint of toxicity and are thought to be an important factor in adaptation to environmental changes that may underlie phenotypes necessary for developing resistance. This resistance was confirmed by exposing embryos of parents collected at multiple clean and Superfund sites to polluted sediment extracts and comparing their physiological, morphological, and chemical responses: developmental delays and significant differences in survival and heart rates were observed among embryos of parents from clean sites, while embryos of parents from polluted sites developed normally with neither significant delays nor abnormalities. Chemical analyses of embryos detected byphenyl, naphtalene, phenanthrene, and anthracene pollutants during sensitive developmental stages among exposed "clean" and resistant embryo populations. Preliminary analysis of metabolic gene expression during late organogenesis revealed significant differences among reference, polluted, and hybrid embryo populations. Analyses of gene expression in these *Fundulus* embryos, along with developmental, morphological, histological, and chemical results, could clarify the roles of polygenic responses and gene-gene interactions important for adaptation to polluted environments during critical life stages of a developing organism.

Chad E. Cecil[1], Jeanine M. Davis[2], and Scott M. Laster[1]
Graduate Programs: Microbiology[1]; Horticulture Sciences[2]
Advisor: Scott M. Laster

Anti-inflammatory effects of isoquinoline alkaloids from Goldenseal

Goldenseal (Hydrastis canadensis) is a perennial herb in the buttercup family that has a long history of use in folk medicine. Extracts of the plant have been reported to have anti-bacterial, anti-diarrheal, and anti-inflammatory properties, although little is known about the molecular mechanisms underlying these effects. The goal of our studies is to develop a clear picture of the anti-inflammatory activity of two bioactive alkaloids from Goldenseal (berberine and hydrastine) and to define the underlying molecular mechanisms. Commercially available berberine chloride and hydrastine were tested using the macrophage cell line (RAW 264.7) by ELISA for their ability to inhibit production of the inflammatory lipid mediator PGE_2 upon stimulation with LPS. Our results demonstrate strong inhibition of PGE_2 with berberine, but no inhibition with hydrastine. The effect of berberine was also seen with normal mouse macrophages supporting the biological significance of this observation. We also evaluated the ability of berberine to block the expression of key cytokines and chemokines associated with inflammation using a protein array. We observed modest inhibition of several cytokines and chemokines in response to LPS stimulation of the RAW 264.7 cells; although the primary effects seem to center on the prostaglandin pathway. To identify the mechanism behind the inhibition of PGE_2, we are examining the PGE_2 biosynthetic pathway. To date, we have determined that berberine does not affect the $cPLA_2$ mediated release of arachidonic acid, nor does it affect the expression of the COX-2 enzyme. Current studies are aimed at evaluating the activity of berberine on the COX-2 enzyme as well as the impact on the prostaglandin synthases. These studies suggest that berberine may be useful to selectively inhibit PGE_2 dependent inflammatory disorders (e.g. rheumatoid arthritis) without completely incapacitating the immune response.

Susan Colucci and Gerald Holmes
Graduate Program: Plant Pathology
Advisor: Gerald Holmes

Fungicide resistance and host specialization of *Pseudoperonospora cubensis*, causal agent of cucurbit downy mildew

Since 2004, increased virulence of the cucurbit downy mildew pathogen, *Pseudoperonospora cubensis*, on cucumber requires fungicide applications for control and may suggest a host specificity shift. To test fungicide resistance, cucumber plants were grown in the NC State Phytotron growth chambers to the two-true-leaves stage and sprayed with mefenoxam (0, 0.01, 0.1, 1.0, 10, 100 ppm) and azoxystrobin (0, 0.001, 0.01, 0.1, 1.0, 10, 100 ppm). After 24 hours, plants were misted with *P. cubensis* (10^4 zoosporaniga/mL), incubated for 7 days at 18°dark/22°C light (12 hr photoperiod) and assessed for disease incidence and severity. Twenty-eight isolates were tested [NC (12), SC (2), IN (2), MI (3), FL (2), DE (2), OH (1), MD (1), NY (1), NJ (1) and KS (1)] and there was no reduction in disease at any fungicide concentration used. Field experiments were established in 2005, 2006 and 2007 to evaluate fungicide performance and test local field populations for resistance to these fungicides. Poor field performance in these trials indicates that resistance to mefenoxam and azoxystrobin is common and widespread. In addition, resistance to strobilurin fungicides was tested by PCR to determine the presence of a mutation in the cytochrome b gene (G143A).

To determine the host specificity of populations of *P. cubensis* in the U.S., 12 cucurbit differentials were grown in the NC State Phytotron. Leaf disks (13mm diam.) were cut from 6- 8-week–old leaves and inoculated with 4 droplets of a 10^4-zoosporangia/mL suspension. These disks were placed in moist boxes and kept in an incubator at 18°dark/22°C light (12 hr photoperiod) and inspected for infection and sporulation daily from day 4 through 14. Based on the compatibility of 23 isolates to the host differentials, it appears that contemporary populations of *P. cubensis* are similar to the pathotypes described in the U.S.

Heather R. Cutchin and K. Mike Mann
Graduate Program: Poultry Science
Advisor: Michael J. Wineland

Shaking eggs during incubation: the effects on hatchability and mortality

The process of turning eggs during incubation causes reduced air flow across eggs potentially leading to hot spots in the machine (Buhr, 1989). However, not turning eggs correlates strongly with decreased hatchability. This project was designed to study the effects of shaking eggs during various periods of incubation. Two customized Chickmaster setters were used, one that turns eggs (turns) and one that oscillates (osc) (shakes) through 4.5cm. Three trials are reported. In trial 1, the shaker ran at 1osc/sec for 20sec every 30min. In trial 2, the duration and frequency increased to 1osc/sec for 30sec every 10min. In trial 3, the speed was increased to 1.25osc/sec for 20sec every 20min. Each of the trials contained 6 treatments: turn control (TC), 3 (T3), and 7 (T7) as well as shake control (SC), 3 (S3) and 7 (S7). The controls remained in the setter for 18 days. The T3 and S3 groups started in their respective setter then were switched to the other setter at d3 of incubation and the T7 and S7 groups at d7.

This was performed to determine if there is a critical time period during which eggs should be turned vs. shaken. In all 3 trials, the hatch of fertile was significantly lower in the SC group than the TC group due to significantly high early (d1-3) and late (d17-20) embryonic mortality. Egg temp was monitored in trial 3 demonstrating a 0.1°F difference in the shake machine and a 0.5°F difference in the turn, a significant difference. In conclusion, shaking 1osc/sec for 30sec every 10min can produce an adequate hatch of fertile, though still significantly lower than turning. Shaking faster is very detrimental and shaking less frequently is not as beneficial to hatch of fertile.

William H. Duvernay
Graduate Program: Biological and Agricultural Engineering
Advisor: Mari S. Chinn

Saccharification of Industrial Sweetpotatoes for the Production of Ethanol

Starch is a renewable resource which is currently being used to produce ethanol from corn. Although corn starch to ethanol is a mature conversion process, corn production is not feasible for every region of the United States. Sweet potatoes (*Ipomoea* sp.) are a major starch crop grown primarily in the southeast region of the U.S. and offer a viable, alternative starchy raw material that can be converted to useful sugar feedstocks needed for production of ethanol and other value added products. The overall goal of this project is to effectively generate the information necessary to define an environmentally friendly process for conversion of industrial sweetpotato varieties into simple sugars and ethanol. Specific objectives are to: 1) Examine the effects of different enzyme treatments (e.g. α-amylase, pectinase, pullulanase, and glucoamylase) on sugar production during the conversion of gelatinized starch; 2) Investigate the effects of solid loading and different enzyme treatments on sugar production during the conversion of raw starch; 3) Determine ethanol production potential from separate hydrolysis and fermentation (SHF); 4) Examine the parameters necessary for simultaneous saccharification and fermentation (SSF) of sweetpotato starch and make comparisons to SHF. The significance of enzyme loading rate incubation time and temperature on changes in starch content, soluble sugar concentrations and ethanol yield (when appropriate) during each conversion step will be measured. The most promising process parameters will be identified and the results will enable further improvements to be made in enzyme function and cost, processing, scale up, and breeding.

W.T. Farmer[1], P.W. Farin[2], S.R. Bischoff[3], J.E. Alexander[1], L.M. Kuchenbrod[1], J.A. Piedrahita[3], and C.E. Farin[1]
Graduate Programs: Animal Science[1], Population Health and Pathobiology[2], Molecular Biomedical Sciences[3]
Advisor: C.E. Farin

Detection of Antisense to Igf2r (*AIR)* RNA in Cattle

The insulin-like growth factor type 2 receptor (Igf2r) regulates fetal growth by removing Igf2 from circulation, thus preventing overgrowth. In mice, expression of the *Igf2r* gene is imprinted only after implantation and is associated with expression of the antisense non-coding (nc)RNA, *Air.* In contrast, the human *IGF2R* gene is not imprinted and *AIR* ncRNA does not exist. Because it is known that *Igf2r* is imprinted in cattle, the objectives of this study were to

determine if *Air* ncRNA exists in cattle and, if so, whether bovine *Air (b*Air)* expression changes at developmentally important stages of gestation For objective 1, primer sets were designed for b*Air* based on bovine genomic sequence. The primer set, bAir3, was used to amplify a region of b*Air* corresponding to an antisense segment within intron 1 of *Igf2r*. Primer set bAir4 amplified a segment of b*Air* ncRNA corresponding to an antisense region upstream of the 5'-untranslated region of *Igf2r.* Whole cell RNA was extracted from liver samples of bovine fetuses at day 70 of gestation resulting from the transfer of either in vivo-produced (n=7, IVO) or in vitro-produced (n=6, IVP) embryos. Extracted RNA was subjected to DNase treatment, reverse transcription (RT) and PCR. Control RT reactions included RT without Superscript III (Invitrogen) and RT without Superscript III or DNase. Controls confirmed that amplification products resulted from RNA present in the sample and not from genomic DNA contamination. Amplicons were obtained for both the bAir3 and bAir4 primer sets and were sequence verified. These results demonstrated that b*Air* ncRNA does exist in cattle. For objective 2, conceptuses (n=9, IVO, mean ± sem length: 2.2 ± 0.6mm) were recovered from cows at day 15 of gestation and snap-frozen for RNA extraction. Blastocysts (n=2 pools of 20 IVO embryos and n=4 pools of 25 to 27 IVP embryos) were recovered from cows on day 7 of development and snap frozen for RNA extraction. Semi-quantitative RT-PCR assays were performed to assess levels of Igf2r mRNA, H2a mRNA and b*Air* ncRNA. Relative RNA expression was calculated as the ratio of band intensities of the RNA of interest to that of H2a. Data on levels of expression in fetal liver between IVO and IVP treatment groups were analyzed by Student's T-test. H2a mRNA was expressed in all day 70 fetal liver samples, day 15 conceptuses, and day 7 blastocyst pools. Igf2r mRNA was expressed in all fetal liver samples, in 8 of 9 day 15 conceptuses, and in all day 7 blastocyst pools. b*Air* ncRNA was expressed in 7 of 7 samples of day 70 fetal liver. In contrast, only 1 of 9 conceptuses expressed a b*Air* ncRNA signal based on the bAir3 primer set whereas 8 of 9 conceptuses expressed b*Air* ncRNA based on the bAir4 primer set. No b*Air* ncRNA was expressed in any blastocyst pools based on either the bAir3 or bAir4 primer sets. Relative levels of b*Air* ncRNA were greater ($P<0.05$) in fetal liver generated from the transfer of in vivo-produced embryos compared to that from in vitro-produced embryos (IVO: 0.426 ± 0.090 vs. IVP: 0.112 ± 0.098). In summary, the antisense ncRNA *Air* exists in cattle and is expressed following implantation. Furthermore, the relative level of b*Air* ncRNA can be altered by method of embryo production. These observations are consistent with data from the mouse and suggest that b*Air* may be involved in regulating imprinted expression of *Igf2r* in cattle. *[Supported by the NC Agricultural Experiment Station and the NCSU College of Veterinary Medicine.]*

Chunmiao Feng[1] Steven R. Manchester[2] Qiu-Yun (Jenny) Xiang[1]
Graduate Programs: Plant Biology, North Carolina State University[1]; Florida Museum of Natural History and Department of Botany, University of Florida at Gainesville[2]
Advisor: Qiu-Yun (Jenny) Xiang

Phylogeny and biogeography of Alangiaceae (Cornales) inferred from DNA sequences, morphology, and fossils

Alangiaceae consists of only one genus *Alangium* in the basal Asterids clade, Cornales. The family has approximately 24 species mainly in tropical and subtropical regions of the Old World, but well represented in the Tertiary fossil record of the northern temperate regions. We conducted phylogenetic and biogeographic analyses for *Alangium* by integrating data from DNA sequences, morphology, and fossil to evaluate the systematic and biogeographic hypotheses. The results largely agree with the traditional classification of four sections within the genus, and suggest Sect. *Conostigma* and Sect. *Rhytidandra* are successively sister taxa to the clade Sect. *Marlea* and Sect. *Alangium*. The biogeographic analysis using DIVA and divergence time dating with the Bayesian method (MULTIDIVTIME) resolved the ancestor of *Alangium* as being in southeastern Asia in the Late Cretaceous. Several intercontinental migrations involving the North Atlantic land bridge (NALB), island chains of the Tethys seaway (TESW), and long distance dispersals were suggested. The results support the role of NALB and TESW for plant migration of thermophilic (including evergreen) taxa in the early Tertiary. Our results also suggest that the widespread species *A. chinense* consists of at least two distinct lineages meriting recognition as two species.

Sharon R. Freeman, Matthew H. Poore, Peter R. Ferket, Gerald B. Huntington, and Teena F. Middleton
Graduate Program: Nutrition
Advisors: Matthew H. Poore and Peter R. Ferket

Novel Disposal Techniques for Spent Laying Hens: Technology Application and Evaluation of the Feeding Value of a Meal Produced from Spent Hen Hard Tissue in Diets for Meat Goats

With 144 million laying hens being removed from production annually, finding appropriate means of disposal is critical. Recycling the nutrients they contain into feedstuffs for livestock offers a potential solution. Our objective was to apply existing processing technologies to create new feedstuffs from spent hens. Hen carcasses were subject to grinding or mechanical deboning with or without prior mechanical picking. Deboning produced a hard tissue fraction (35% of carcass weight) and a soft tissue fraction (65% of carcass weight). With the exception of the feathers, hen products were 41 to 42% dry matter (DM), 35 to 58% protein, and 24 to 58% fat. Based on our initial processing results, mechanically deboning hens with feathers was selected to be the first step in generating

a novel feedstuff. After deboning, traditional steam hydrolysis was applied to the hard tissues and followed by the addition of keratinase to evaluate its efficacy for improving protein digestibility. Keratinase did not improve pepsin or true amino acid digestibility ($P > 0.10$) so it was not included in the final processing regime. Hydrolyzed hard tissue (30kg) was blended with soybean hulls (58kg) and dry extruded to produce feather-bone meal (FBM). The meal was substituted for soybean meal (SBM) in diets for meat goats to provide 20, 40, or 60% of added protein. Goats which received no supplemental protein had lower DM intakes than supplemented goats. Goats receiving all levels of FBM had similar DM intakes to goats receiving SBM. Diet DM digestibility was not impacted by treatment. Increasing FBM in the feed resulted in a quadratic increase in nitrogen retention (2.2, 1.4, 2.1, and 2.5 g/day for SBM, 20, 40, and 60% FBM, respectively). Our research demonstrated that the nutrients in spent hens can successfully be recycled into a feedstuff that supported animal growth.

Courtney A. Gallup, K.L. Ivors, and H. D. Shew
Graduate Program: Plant Pathology
Advisor: H. D. Shew

The biology of *Phytophthora nicotianae* in NC tobacco: Identification of pathogenic races and sources of genetic variability

The black shank pathogen, *Phytophthora nicotianae*, occurs in all tobacco-producing areas in North Carolina. This soilborne oomycete is heterothallic, requiring two mating types (A1 and A2) for the production of sexual spores. Races of the pathogen are based on deployment of two resistance genes, *Phl* from *Nicotiana longiflora* and *Php* from *N. plumbaginifolia*. Once deployed, growers experienced shifts from race 0 to race 1 in as little as one field season, compromising single-gene resistance from both genes. A new race, race 3, also was recovered in NC in recent years. Race 3 isolates cause disease on tobacco varieties with the *Phl* gene, but not the *Php* gene. This high rate of phenotypic adaptation suggests that NC populations of *P. nicotianae* are able to generate variability very rapidly. To identify the distribution of races and identify sources of variability within the pathogen, 575 isolates were collected from 65 fields in 23 counties in NC. All isolates were screened for race and mating type. Races 0, 1, and 3 were recovered across the state, with race 1 predominant. A1 and A2 mating types also were recovered throughout the state and occurred in all races. Both mating types also were present in 28% of fields surveyed. A1 and A2 isolates from the same field were paired, and results from two fields confirmed sexual sporulation may be occurring in pathogen populations.

A subset of these isolates was sequenced in two nuclear and two mitochondrial regions. Seven genotypes were identified, including 1 genotype that occurred only in the burley tobacco region in the mountains, 1 rare genotype in the southeast, and 1 clonal genotype that occurred throughout the state. AFLP investigations are underway to identify the contribution of asexual sporulation to pathogen variability.

Todd C. Guerdat, Thomas M. Losordo, Dennis P. DeLong, and John J. Classen
Graduate Program: Biological and Agricultural Engineering
Advisor: Thomas M. Losordo

A Large Scale Scientific Evaluation of Commercially Available Biological Filters for Recirculating Aquaculture Systems

As aquaculture production systems increase in intensity to meet the demands of the marketplace, the need for environmentally friendly technology and management practices becomes increasingly important. Recirculating Aquaculture Systems (RAS) rely heavily on biological filtration as a mechanism to reduce the volume of effluent and make the recirculated water suitable for the cultured organisms. The majority of previous studies have evaluated biological filter performance at the small, laboratory scale with artificial waste nutrients. Evaluating biological filters at the larger scale with production-based nutrients is important in determining performance characteristics for real world use. These performance characteristics will provide a more realistic model for proper sizing and selection of biofilters, thus aiding in the facility design process. For this study, the performance of three different types of biofilters was evaluated in terms of total ammonia nitrogen (TAN) removal rate from a $60m^3$ volume *Tilapia* production system at the North Carolina State University Fish Barn. The filters were evaluated in triplicate under normal freshwater operating conditions at various ammonia concentrations. Filters tested were the Aquatic Ecosystems Clearwater™ Low-Space Bioreactor 25, the Aquaculture Systems Technologies PolyGeyser DF15, and the Marine Biotech CycloBio® 24" fluidized sand filter. Flow rates were monitored and samples were taken comparing the influent and effluent TAN concentrations. The data collected was used to calculate a volumetric TAN removal rate (VTR; g TAN/ m^3 media /day) for each set of filters. The relationship between VTR was found to be linear for all three filter types, though at TAN concentrations > 0.8 mg/L the CycloBio filters showed increased variance. Statistical analysis showed possible influence due to organic carbon. The relationship between VTR and the ratio of chemical oxygen demand and ammonia nitrogen (COD/N) shows an exponential decrease in VTR as the COD/N increases. These results are similar to previous studies focused on organic carbon inhibition of VTR. This study provides TAN removal rates for three different biological filters at a commercial scale using actual aquaculture water.

Osman Gulseven
Graduate Program: Economics
Advisor: Michael Wohlgenant

Soymilk or Organic? A Hedonic Approach to Dairy Markets

The focus of this research is to analyze the value of attributes that determine the prices in the dairy market. A special emphasize would be on the differences in consumer's willingness to pay for soy derived products. Also, the factors that affect the price premiums for organic products would be highlighted. The initial idea here is to see whether these markets are separate markets or not. We can answer this question by looking at the factors that determine the scanner level consumer prices that reflect the actual transactions. A hedonic analysis helps us to discover whether soy derived, milk derived or organic products are differentiated versions of the same good. A regression that estimates the relationship between product prices and product characteristics (such as protein content, functional enhancements, flavor, form, formula, salt content, brand, organic and soymilk dummies, and container size) gives us the hedonic/shadow prices for these attributes. We can define an appropriate function that explains the scanner level price of the product in terms of the quantities of perceived attributes. Also, if we include the demographic variables for consumers in the second stage regressions, it would be possible to derive the consumers' utility function in terms of product characteristics. Once the consumer's utility function is derived in terms of product ingredients, it possible to calculate the changes in consumer surplus due to changes in product attributes. For example, the effect of attribute changing biotech innovations on consumer welfare can be derived from the attribute dependent utility functions. Finally, the degree of competition in the dairy market can also be computed by analyzing the price differentials for product attributes between different brands.

Tina Herfel, Sheila Jacobi, Xi Lin, and Jack Odle
Graduate Program: Animal Science
Advisor: Jack Odle

Stabilized rice bran improves weaning pig growth performance when feed in an antibiotic-free diet

Stabilized rice bran (SRB) is classified as a "functional food" because of its prebiotic characteristics. With increasing corn prices and the possible removal of antibiotics from swine diets due to concern over antibiotic resistance, SRB was investigated as a replacement for corn with and without the addition of antibiotics (ANT). Two hundred pigs were weaned at ~21 days of age, blocked by weight, and allotted to diets containing 0 or 10% SRB and (-) or (+) ANT according to a 2 x 2 factorial design. Five animals were housed per pen throughout a 28 day growth period. At the end of the trial, one pig from each pen was euthanized for measurement of intestinal parameters. Antibiotic supplementation improved average daily gain by 6.3% from day 14 to 28 ($P < 0.05$), but other production parameters were affected by ANT. Gain:feed improved by 22% in pigs fed the ANT-free + 10% SRB diet compared to pigs fed the ANT-free + 0% SRB diet ($P < 0.05$), but was similar to pigs fed diets containing antibiotics. Cumulatively, pigs fed the ANT-free + 10% SRB diet improved gain:feed by an average of 14% compared to all other treatments ($P < 0.05$). Ileal histology revealed a 28% decrease in crypt depth for pigs fed the ANT-free + 10% SRB and ANT + 0% SRB diets compared to the ANT + 10% SRB diet ($P < 0.05$). Villi length:crypt depth (V:C) decreased due to SRB (23%) and ANT (22%) supplementation ($P < 0.05$). Differences in ileal and cecal digesta short chain fatty acid concentrations were not detected. In conclusion, SRB appears to improve the efficiency of nutrient utilization with only modest alterations in ileal mucosal morphology. Further research is warranted to elucidate the underlying mechanism by which SRB effects are mediated.

Julie Hicks, Parbhakar Tambhurne, and Hsiao-Ching Liu
Graduate Program: Animal Science
Advisor: Hsiao-Ching Liu

MicroRNA Expression In Primary And Secondary Immune Organ Development In The Chick Embryo

MicroRNAs (miRNAs) are small, non-coding RNAs that participate in regulating gene expression. We derived and pyrosequenced four small RNA libraries from the spleen and the bursa of Fabricius of embryonic chicks at developmental time points E15 and E20. A total of 90,322 sequence reads were obtained from all four libraries, representing 44,387 known chicken miRNAs. Another 3,503 sequences were not found in the G. gallus database but were homologues of miRBase miRNAs from other species. Finally 2,023 reads represented potentially novel chicken miRNAs that have not previously been identified. Other small RNAs, such as tRNA, represented 24,672 of the reads, and 12,383 reads represented other types of sequences, such as degraded mRNA. Many RNAs exhibited differential expression patterns. For example, the microRNAs miRNAs miR-221 and miR-222 displayed differential expression between the two developmental time points for the spleen and bursa, being sequenced more frequently from the E15 libraries than from the E20 libraries. These miRNAs are known to target the Kit ligand, which is important in lymphocyte differentiation and maintenance. This differential expression pattern may reflect differential migration of lymphocytes or differential lymphocyte proliferation in these two developmental time points. Other miRNAs displayed a tissue specific pattern of expression. For example, miR-200b was sequenced

much more frequently from the bursa libraries than from either of the spleen libraries, which could reflect a role for this miRNA in the later stages of B-cell development. Overall, more than one hundred different known miRNAs and many novel miRNAs were identified in this study.

Matthew Jones
Graduate Program: Biological and Agricultural Engineering
Advisor: Bill Hunt

Effect of Urban Stormwater Best Management Practices on Runoff Temperature in Trout Sensitive Waters

Anthropogenic thermal discharges have been shown to have negative impacts on the aquatic environment, reducing the abundance and diversity of aquatic organisms. Although mechanisms are available to reduce the temperature of industrial discharges, little consideration has been given to non-point sources of thermal pollution, such as urban stormwater runoff. Due to their role in capturing stormwater runoff, urban stormwater best management practices (BMPs) may be able to mitigate thermal pollution; however, little is known about their effect on runoff temperature. A study was conducted in western North Carolina, near the southeastern extent of United States trout populations, to determine the effect of urban stormwater BMPs on runoff temperature and identify any design parameters that could be modified to reduce thermal pollution. To investigate these effects, temperatures were logged on a 5 minute interval at all major inlet, outlets, water depths, and soil depths at a stormwater wetland, wet pond, and 4 bioretention areas. Median direct runoff temperatures were significantly warmer than 21°, which is the upper avoidance temperature for trout, during the peak summer months. At the stormwater wetland and wet pond, water temperatures consistently increased between the BMP inlet and outlet, implicating these systems as sources of thermal pollution. Temperature measurements within the water column suggest that a modified outlet structure that draws from the bottom waters would result in significantly cooler effluent temperatures than existing outlet structures. Bioretention areas that were smaller than 7% of their contributing watershed significantly reduced maximum and median water temperatures, while bioretention areas larger than 11% of their watershed only reduced maximum temperatures significantly. Indications of substantial reductions in runoff volumes were observed at all bioretention areas, which should play a valuable role in reducing the thermal load to nearby creeks.

Deepak R. Keshwani
Graduate Program: Biological and Agricultural Engineering
Advisor: Jay J. Cheng

Microwave-based Pretreatment to Improve Bioethanol Production from Switchgrass

The current dependence on increasing limited crude oil supplies to meet growing energy needs and environmental concerns such as global climate change has resulted in considerable research on renewable alternatives. Bioethanol is one such alternative that is currently produced primarily from corn. With limitations on corn availability and the implications on food and feed markets, alternative feedstock for bioethanol are necessary. Switchgrass is a promising lignocellulosic feedstock that grows well on marginal land across a wide geographic range. However, the structure and composition of lignocellulosic materials require a pretreatment step to increase the amount of fermentable sugars available for ethanol production. This study evaluates the feasibility of microwave-based pretreatments to enhance enzymatic hydrolysis of switchgrass. Microwave radiation supplies internal to the biomass by disruption of polar bonds that can accelerate chemical, biological and physical process. Switchgrass samples immersed in water, dilute sulfuric acid and dilute sodium hydroxide solutions were exposed to microwave radiation. A factorial experimental design was used to study the effect of concentration and pretreatment time. Pretreated solids were enzymatically hydrolyzed using cellulase enzymes and reducing sugars in the hydrolysate were analyzed. Results indicate that microwave radiation of switchgrass immersed in dilute sodium hydroxide resulted in significantly higher reducing sugars in comparison to controls and dilute sulfuric acid. This could be explained by significant differences in dielectric properties that were experimentally determined. A pretreatment time of 10 minutes with 250 watts of microwave radiation and 3% sodium hydroxide resulted gave the highest sugar yields. These findings suggest that microwave-based pretreatment with sodium hydroxide can has the potential to significantly improve bioethanol production from switchgrass.

Jae-Young Kim[1], Rie Kajino-Sakamoto[1], Emily Omori[1], Gabriel Núñez[2], and Jun Ninomiya-Tsuji[1]
Graduate Programs: Environmental and Molecular Toxicology, North Carolina State University[1]; Department of Pathology and Comprehensive Cancer Center, University of Michigan[2].
Advisor: Jun Ninomiya-Tsuji

TAK1 is a central mediator of NOD2 signaling and required for preventing intestinal inflammation

NOD2 is an intracellular receptor that senses muramyl dipeptide (MDP), the minimal peptidoglycan motif. MDP binding to NOD2 activates NF-κB and MAPK pathways, and elicits innate immune response. It has been reported that mutations in NOD2 are highly associated with Crohn's disease. However, the molecular mechanisms by which NOD2 activates its downstream events and abnormality of NOD2 signaling causes Crohn's disease have yet to be elucidated.

Here, we show that TAK1 MAP3K is an essential intermediate of NOD2 signaling using TAK1 knockout (KO) skin epithelial cells as a model system. We found that TAK1 deletion completely abolished MDP-NOD2 signaling events, namely activation of NF-κB and MAPKs and subsequent induction of proinflammatory cytokines/chemokines. NOD2 and its downstream effector RICK associated with and activated TAK1. TAK1 deficiency also abolished MDP-induced NOD2 expression. To address the relevance of this TAK1 functions to the intestinal inflammation, we generated and analyzed intestinal epithelial specific TAK1 deletion mice. We found that intestinal epithelial specific TAK1 deletion caused epithelial damage and induced spontaneous intestinal inflammation.

These findings demonstrate that TAK1 MAP3K is an essential effector in NOD2-induced innate immunity and is important for the intestinal epithelial integrity. We propose that ablated NOD2-TAK1 signaling in the intestinal epithelium causes tissue damages involving chronic inflammation.

Alice M. Lee[1], Chung-Jung Chou[2], Robert M. Kelly[2], and Amy M. Grunden[1]
Graduate Programs: Microbiology[1]; Chemical and Biomolecular Engineering[2]
Advisor: Amy M. Grunden

Tungsten influences the metabolic potential of *Pyrococcus furiosus*

The hyperthermophilic archaeon, *Pyrococcus furiosus*, is a strictly anaerobic heterotroph that grows optimally at 100°C. Due to its relative ease of cultivation, it is one of the most studied organisms among the archaea and an important source of thermostable enzymes in biotechnology. It can be cultured in artificial seawater-based medium either with maltose or peptides as a carbon source. The cell yield of *P. furiosus* is significantly stimulated by the addition of tungstate to the growth medium. This tungsten-dependent growth stimulation is likely due in part to the replacement of the classical glycolytic enzyme glyceraldehyde-3-phosphate dehydrogenase (GAPDH) with the tungsten containing enzyme glyceraldehyde-3-phosphate ferredoxin oxidoreductase (GAPOR). Two tungstoenzymes important in peptidolytic metabolism include aldehyde ferredoxin oxidoreductase (AOR) that functions in the oxidation of reactive aldehydes generated during 2-keto acid conversion, and formaldehyde ferredoxin oxidoreductase (FOR), which is involved in the catabolism of basic amino acids. Recently another tungstoenzyme has been characterized, WOR4. It appears to play a role in sulfur metabolism. Since the metabolism of *P. furiosus* is so intricately linked to tungstoenzymes, this study focuses on the transcriptional response of *P. furiosus* to limited and high concentrations of tungsten in the growth media. To this end, *P. furiosus* was grown in continuous culture and the transcriptional profile was investigated by using a whole genome cDNA microarray**.** Variation of gene expression under different tungsten conditions was analyzed using a statistical mixed model. Preliminary analysis indicates a significant number of genes for phosphate transport, ABC-type transporters, amino acid biosynthesis, hydrogenases, and ribosomes were highly up regulated when tungsten concentration was increased relative to control. This suggests that tungsten concentration may play a critical role in shifting the metabolism of *P. furiosus*. Further microarray data analysis will give us insight into the role of tungsten in the metabolism of *P. furiosus*.

Jae Yun Lee
Graduate Program: Microbiology
Advisor: Eric S. Miller

qRT-PCR of KVP40 mRNAs during infection of *Vibrio parahaemolyticus*: expression analysis of a phage encoded NAD^+ salvage pathway

Vibrio parahaemolyticus (*Vp*) is a prevalent Gram-negative marine bacterium that can cause disease in fish and shellfish, and gastroenteritis in humans when consumed in raw or under-cooked foods (i.e., oysters). KVP40 is a T4-like bacteriophage whose dsDNA has been sequenced (244,835 bp) and infects *Vp*. The KVP40 genome carries bacterial-like genes that have the potential to encode a pyridine nucleotide scavenging system for synthesis of NAD^+. Nicotinamide adenine dinucleotide (NAD^+) is an essential cofactor involved in fundamental processes in cell metabolism and pathways for its synthesis are potential anti-microbial, therapeutic targets. The phage enzymes provide model targets for these studies. NadV catalyzes the first reaction in a two-step scavenging

pathway that converts nicotinamide to nicotinamide mononucleotide (NMN). In the second reaction, NMN adenyltransferase activity yields NAD^+, which can be catalyzed by the KVP40 encoded NatV enzyme. Here we focus on studies to characterize expression of the *nadV* / *natV* mRNAs during KVP40 infection by using qRT-PCR. *Vp* was infected with KVP40 and RNA samples were collected throughout the 40 minute infection cycle. qRT-PCR products were quantified using SYBR Green assays with phage and host gene-specific oligonucleotide primers. Progress and results to date will be presented.

Barry Lineberger and Mike Boyette
Graduate Program: Biological and Agricultural Engineering
Advisor: Mike Boyette

A Mobile Unit for Torrefaction of Woody Biomass Residues

Concern over the implications of global climate change resulting from the increase in the atmospheric concentrations of greenhouse gases due to human economic activity has spurred interest in the development of renewable energy technologies. Utilization of logging residues as a feedstock can help to reduce the net carbon emissions from coal fired power plants. But pretreatment of this material is necessary in order to make industrial co-firing with woody biomass economically feasible. Torrefaction is an endothermic process encompassing the pre-pyrolytic thermochemical decomposition of the hemicellulose fraction of woody biomass accompanied by some degree of depolymerization within the cellulose fraction. This results in a solid product retaining 90% of the energy content but only 70% of the initial mass on a dry basis. For wood chips with 50% moisture content, this translates into a nearly 3 fold increase in the energy density. Other material properties are improved as well. Work published by Prins, et al indicates that a satisfactory torrefied product results from elevating the feedstock material to a temperature of approximately 300C in the absence of oxygen for a period of 10 minutes. The objective of the present research is to develop a robust biomass torrefaction process which can be deployed on site to transform logging residues into a valuable energy product. A pilot scale torrefier has been designed and fabricated and is currently being assembled. Since freshly harvested material may exceed 50% moisture content, this unit will integrate biomass drying with the torrefaction process. The device will be tested using wood chips at various moisture levels. It is anticipated that wet biomass will require higher processing temperatures which may push the torrefaction into more extensive pyrolysis thereby reducing the solid product yield. A control algorithm will be developed to optimize the quantity and quality of the biochar product.

Mallorye Lovett
Graduate Program: Food, Bioprocessing, and Nutrition Sciences
Advisor: Jonathan C. Allen

Calcium Chloride and Vitamin D Fortified Beverages: Bioavailability in Wistar Rats

Calcium and vitamin D play a critical role in the prevention of metabolic diseases including osteoporosis, osteomalacia, and rickets. Epidemiological research indicates that average intake of these nutrients is well below the RDA, and greater intake has been correlated to a reduction in fractures, prevention of osteoporosis, and increased bone mass. The objective of this study was to test effects of a water-soluble form of vitamin D and calcium chloride as fortifiers for an aqueous sports drink solution with a rat bioavailability assay. A water-soluble vitamin D fortifying ingredient was prepared as a spray-dried complex with bovine beta-lactoglobulin. Vitamin D content of the complex was assessed by HPLC. Flavored beverages were formulated with various ratios of calcium and vitamin D in a 4x4 factorial design. Female Wistar rats were housed under incandescent lighting and randomly divided into the treatment and control groups. After a 4-week depletion phase, rats were given specialized drink formulations and low calcium, vitamin D-deficient diet for an additional six weeks. Blood and femur bones were removed for further analysis. Serum vitamin D was measured by ELISA. Results demonstrate that fortified drink solutions could be accurately formulated to contain calcium chloride at 0, 1, 2 and 2.5 g Ca/L with palatability to rats. The vitamin D content of the drinks was formulated to be 0, 10, 20, and 40 µg/L. Serum vitamin D was significantly greater ($p < .0001$) in rats receiving the vitamin D-fortified drinks. Water-soluble vitamin-D can be used to fortify aqueous products with this fat-soluble vitamin to help facilitate the uptake of calcium. Regular consumption of flavored sports drink fortified with calcium and vitamin D may significantly increase dietary calcium and vitamin D intake.

Avanika Mahajan and Chad H. Stahl
Graduate Program: Animal Science
Advisor: Chad H. Stahl

Treatment with 1,25 dihydroxyvitamin D_3 stimulates adipocytic differentiation of porcine mesenchymal stem cells

Depending on the species and culture conditions, 1,25-dihydroxyvitamin D_3 ($1,25(OH)_2D_3$) is known to have pleiotropic effects on the differentiation of mesenchymal stem cells (MSC). In this study, we characterized the

effects of $1,25(OH)_2D_3$ on the differentiation of porcine MSC under culture conditions designed to promote proliferation. The MSC were isolated from bone marrow of young pigs and grown in DMEM containing 10% fetal bovine serum and antibiotics (BM). Cells received either BM, BM + 10^{-8} M $1,25(OH)_2D_3$ or BM + 10^{-7} M $1,25(OH)_2D_3$ with complete media changes every 3d for a total of 12d of culture. On days 3, 6, 9, and 12 cell proliferation was measured using a non-radioactive MTS-based assay, and samples were collected for gene expression analysis. Regardless of treatment, there was a linear increase in cell numbers over time up to 6d ($P < 0.05$), after which the rate of increase gradually slowed down. Proliferation was also reduced by treatment with $1,25(OH)_2D_3$ in a dose dependent manner ($P < 0.05$). The concentrations of mRNAs encoding peroxisome proliferator-activated receptor gamma (PPARG), lipoprotein lipase (LPL) and adipocyte-binding protein 2 (AP2) were increased ($P < 0.05$) by treatment with $1,25(OH)_2D_3$ in a dose-dependent manner. An increased percentage of lipid filling, based on Oil Red O staining was also seen with $1,25(OH)_2D_3$ treatment. These data suggest that $1,25\text{-}(OH)_2D_3$ stimulates the differentiation of porcine MSC towards an adipocytic phenotype. *[This work was supported in part by the Biotechnology Research and Development Corporation (Peoria, IL) and the North Carolina Agriculture Research Service.]*

Elina L. Niño[1] and David Overman[2]
Graduate Programs: Entomology[1]; Biological Sciences[2]
Advisor: Christina M. Grozinger

Two Commonly Used Insecticides Reduce Honey Bee Queen (*Apis mellifera* L.) Survival and Quality

Commercially raised honey bees used for crop pollination are of tremendous value to our agriculture. The increase in crop value directly attributable to honey bee pollination has been estimated to $14.6 billion in the U.S. alone (Morse and Calderone, 2000). However, the populations of honey bees and native pollinators have declined dramatically over the last twenty years (Oldroyd, 1999). The recent scare by Colony Collapse Disorder (CCD) has brought much needed attention to the current state of our pollinators. Although they are very important for colony survival, honey bee queen health and quality are often overlooked. Since the queen is the only reproductive female in the colony, even minor reduction in her quality and fitness could have profound effects on colony productivity and health. We have observed the effects of sublethal doses of two commonly used pesticides, oxalic acid and imidacloprid, on queen rearing and reproductive quality. Oxalic acid is used for control of honey bee pest Varroa mite, while imidacloprid can be accidentally picked up by foragers and brought back to the hive. Queens were reared in the presence of three different concentrations of these pesticides and the % adults emerging as well as their total body weights and lipid stores were observed. Our preliminary data shows a significant negative effect of both pesticides on honey bee queen rearing and quality. Future research will investigate the effect of pesticides on queen mating behavior (e.g., mating flights, egg-laying pattern), physiological changes (e.g., ovary development, pheromone production), gene expression patterns, and determine the effects these pesticides may have on immune function and disease resistance in queens. These studies will provide insight into the sublethal effects of pesticides on beneficial pollinators and insects, which could lead to modifications of the in-hive pest management practices as well as the crop pest control programs.

Suzanne O'Connell
Graduate Program: Horticultural Science
Advisor: Mary M. Peet

Nutrient Uptake Efficiency and Plant Growth Indicators of Grafted Tomatoes

Grafted herbaceous plants maybe more efficient at absorbing certain macro- and micro-nutrients (Ruiz, 1996: Leonardi, 2006) but these effects are not well-documented. A greenhouse study evaluating the tomato cultivars, Trust (*Solanum lycopersicum*) and German Johnson (*Solanum lycopersicum*), grafted onto the Maxifort rootstock (*Solanum lycopersicum x Solanum habrochaites*) was conducted in 2007 at the North Carolina State University Phytotron. Total nutrient uptake efficiency was calculated for both macro- and micro- nutrient content in the leaf tissue (leaf biomass x leaf nutrient concentration) and plant growth indicators measured.

The experiment was a completely randomized block design with 5 replications, consisting of 6 treatments: Maxifort-Trust grafts, self-grafted Trust, non-grafted Trust, Maxifort-German Johnson grafts, self-grafted German Johnson, and non-grafted German Johnson. Five successive weekly destructive harvests were conducted representing the period 4-8 weeks post-grafting. Shoot biomass, root biomass, and height of Maxifort-Trust and Maxifort-German Johnson grafts were significantly higher compared to the non-grafted treatments (*P<0.05*). The shoot biomass and height of the self-grafted treatments were also significantly higher for than the non-grafted treatments. The total macro- and micro-nutrient content of the leaf tissue of the Maxifort-Trust and Maxifort-German Johnson grafts were significantly higher for: N, P, K, Ca, Mg, Fe, Mn, Zn, Cu, B than the non-grafted treatments (*P<0.05*). The total macro- and micro-nutrient content of the leaf tissue of the self-grafted treatments were significantly higher for: N, P, K, Mg, Zn, Cu, and B than the non-grafted treatments *(P<0.05).* Further understanding the nutrient requirements and growth habits of grafted tomatoes will aid in the development of best management practices for U.S. growers, including potentially more efficient use of fertilizers.

T. Peacock, J. M. Bruno-Barcena, and H. M. Hassan
Graduate Program: Microbiology
Advisor: Hosni M. Hassan

Cloning of MnKat from Lactobacillus plantarum and Expression in Probiotic Lactobacilli Lacking Such Activity

Oxidative stress mechanisms within species of *Lactobacillus* vary widely, encompassing manganese accumulation, peroxidases, and both heme and non-heme (Manganese containing) catalases. While most all species of *Lactobacillus* accumulate manganese, to mM levels, and contain peroxidases, heme and manganese catalases are limited to a select few lactobacilli. Furthermore, manganese catalases are documented in only two *Lactobacillus* species. Current research involves the cloning of the 1.449-kb manganese catalase gene from *L. plantarum* CECT 221 (ATCC 14431), containing its native promoter, into the shuttle vector pTRK563. The resulting pMnKat has been transformed into the probiotic lactobacilli; *L. reuteri* NCK 932 and *L. gasseri* NCK 334. Catalase activity has been assayed and detected in both species. Furthermore, through PCR, sequencing, and BLAST analysis the plasmid based manganese catalase gene has been confirmed.

Angela R. Post[1], Alexander Krings[2], Joseph C. Neal[1], Bryon Sosinski[1], and Qui-Yun (Jenny) Xiang[2]
Graduate Programs: Horticultural Science[1]; Plant Biology[2]
Advisor: Joseph C. Neal

Taxonomy and Phylogeny of Weedy *Cardamine* Species in United States Nurseries

Cardamine is one of the most common and troublesome weeds in container nurseries in the United States. The majority of specimens collected are identified as *Cardamine hirsuta* but it is suspected that several closely related species occur in United States nurseries. Taxonomic and phylogenetic relationships of *Cardamine* species found in the United States nurseries were examined using morphological and molecular methods. Samples were collected from 21 nurseries in California, Mississippi, Missouri, New York, North Carolina, and Oregon. The species were characterized morphologically through the examination of voucher specimens. Type specimens and additional sheets of each species were also examined from material on loan from 12 herbaria to produce updated taxonomic keys to delineate these species. Molecular data were collected from each accession as well as from known herbarium samples. Total genomic DNA was extracted. Sequences of the ITS1 and ITS2 regions of nrDNA and two single copy nuclear regions: Cip7 and Chs were amplified and examined. Analysis of these gene regions failed to fully resolve the phylogenetic relationships between these species. Other single copy nuclear regions are now being explored to further resolve these relationships.

Brantlee Spakes Richter, Kelly L. Ivors, and D. Michael Benson
Graduate Program: Plant Pathology
Advisors: D. Michael Benson and Kelly L. Ivors

Microbiological profiling of cultural systems for control of Phytophthora root rot in Fraser fir

Phytophthora root rot of Fraser fir caused by several *Phytophthora* spp. is a severe problem in Christmas tree production. Since fungicides and host resistance are ineffective in disease control, mulches and compost were tested on field planted trees at five sites. Treatments included wood chips (WC), wood chips plus compost (WCC), or pine bark (PB) as raised beds, and compost or sulfur (S) tilled into soil. Microbial populations were characterized by dilution plating and calculation of a log series diversity index, and by enzyme analyses. Bacterial counts were highest in mulch at all locations at five and twelve months after planting, while diversity was lowest in mulch. Fungal counts showed a less consistent pattern, but where differences were significant (α=0.05), numbers were higher in mulch than soil, while diversity was lower. Five months after planting, total microbial activity (by fluorescein diacetate hydrolysis) was two to six times higher in mulches than in soils, with no significant difference between upper and lower mulch layers. One year after planting, activity was higher in the upper half of mulch than in the lower half, and at two sites was also higher in soil under mulch than in bare soil treatments. Cellulase enzyme activity showed a similar pattern, with higher activity in mulches than soils at both time points; while activity was also higher in composted than control soils, activity in mulches was three to four times those in composted soil. Two of five sites showed the hypothesized effects of treatments on disease severity, with higher disease ratings in control and compost treatments than in mulch beds. Survival in WC and WCC plots, however, consistently ranked higher than in compost or control treatments. Correlation analysis is underway to identify factors which may be contributing to the differences in treatment efficacy among sites.

Christopher Sistrunk, Everardo Macias, and Marcelo L. Rodriguez-Puebla
Graduate Program: Environmental and Molecular Toxicology
Advisor: Marcelo Rodriguez-Puebla

Skp2 deficiency induces hair follicular apoptosis through p53 stabilization mediated by CBP/p300

The highly ordered progression of the cell cycle is achieved by a series of elaborated mechanisms that control the periodic expression of many regulatory proteins. The intracellular concentrations of these proteins are regulated predominantly by the ubiquitin-mediated proteolityc pathway. The ubiquitin ligase Skip1-Cul1-F-box (SCF) complex and the anaphase-promoting complex/cyclosome (APC/C), are responsible for the specific ubiquitylation of many of the key regulators of the G1-S phase progression. Skp2 belongs to the F-box protein family and has been implicated in regulation of several cyclin-dependent kinases inhibitors (CKI) such as $p27^{Kip1}$, cyclin E, etc. An oncogenic role of Skp2 in human and experimental tumorigenesis has been described by several groups. We have previously shown that deletion of Skp2 in mouse epidermis results in reduced skin tumorigenesis under a two-stage carcinogenesis protocol. To determine whether the reduce tumorigenesis in $Skp2^{-/-}$ mice is dependent of $p27^{Kip1}$ accumulation we have developed the $Skp2^{-/-}/p27^{-/-}$ compound mice which have been used in a two stage carcinogenesis protocol. Our preliminary results predict that inhibition of tumorigenesis on $Skp2^{-/-}$ epidermis partially dependent on $p27^{Kip1}$ accumulation, suggesting that ablation of Skp2 affects other pathways. To evaluate the role of Skp2 ablation in mouse skin tumor development, we have analyzed the interfollicular epidermis and hair follicle of $Skp2^{-/-}$ mice. Increased interfollicular and follicular apoptosis was observed in $Skp2^{-/-}$ mice compared to wild type siblings. Molecular analysis of Skp2 substrates showed that in addition to $p27^{Kip1}$, CBP/p300 also accumulated in $Sp2^{-/-}$ epidermis. It is well known that CBP/p300 plays an important role in regulating p53 stability and activity. In fact, p300 binds to p53 activation domain and functions as an acetyltransferase. Consistent with these data, we demonstrated elevated p53 acetylation in $Skp2^{-/-}$ epidermis. Altogether, our results suggest that Skp2 is an oncogenic protein that plays an important role in deregulation of cell proliferation, through $p27^{Kip1}$ degradation, and apoptosis via CBP/p300-p53 interaction, highlighting the potential use of Skp2 as a therapeutic target. *[Supported by NIH grant CA 90864.]*

Amanda M. Stephens[1] and Timothy H. Sanders[2]
Graduate Program: Food, Bioprocessing, and Nutrition Sciences[1]; USDA-ARS, Raleigh, NC[2]
Advisor: Timothy H. Sanders

Cardiovascular Disease Risk Factors of Male Syrian Golden Hamsters as Influenced by Peanuts, Peanut Oil and Fat Free Peanut Flour

Peanuts and peanut oil have been demonstrated to be cardio-protective by lowering total serum cholesterol (TC), low density lipoproteins (LDL-C) and triglycerides without decreasing high density lipoprotein (HDL-C). Even though fat free peanut flour contains arginine, folate, flavonoids and other compound that have been implicated in cardiovascular health, it has never been evaluated for cardio-protective properties. The objective of this study was to evaluate the effects of fat free peanut flour (<0.5% oil), and other peanut components on blood lipids important as risk factors for cardiovascular disease (CVD) in male Syrian golden hamsters. Seventy-six hamsters were randomly divided into four groups and each group was fed a different semi-purified, isocaloric diet for 24 weeks. Each experimental diet was a modification of the AIN-76A/Clinton-Cybulsky Cholesterol Series high fat and high cholesterol control diet. Modifications to the control diet were made by substituting fat free peanut flour, peanut oil or peanuts for similar caloric components in the control diet. Hamster weights were recorded weekly for the first seven weeks and then biweekly till the end of the study. Randomly selected hamsters from each diet group were euthanized at 0, 12, 18 and 24 weeks. Blood was collected on each sample date and TC and lipoprotein distribution were determined by high-performance gel chromatography. Body weight at the end of the study was not significantly different among all diet groups. Peanut oil, peanuts and fat free peanut flour diet groups had significantly ($p<0.05$) lower TC, VLDL-C and LDL-C than the control group. There were no significant differences in HDL-C among any of the peanut component diet groups. The results indicated that peanuts, peanut oil and fat free peanut flour lower blood chemistry risk factors for CVD in hamsters. The results suggest that peanut components, even added to a high cholesterol diet, have cardio-protective properties.

Roselyn Whitney
Graduate Program: Plant Biology
Advisor: William Thompson

The Effects of Matrix Attachment Regions on Transgene Expression

Gene transfer technology has become an important tool in studying plant molecular biology and in the production of crops with added favorable characteristics. However, we are hindered by the fact that plants possess epigenetic mechanisms that can “silence” transgenes, suppressing their expression. Matrix Attachment Regions (MARs) are sequences of DNA that facilitate the binding of DNA to the nuclear matrix, a protein scaffold that is present in the nucleus. Previous studies suggest that including MARs with transgenes can increase and stabilize transgene

expression in plants. However, the mechanisms by which MARs increase transgene expression are largely unknown. In this study we are testing two hypotheses. The first hypothesis is that MARs may act as transcriptional enhancers when they are placed in front of transgenes. We are testing this hypothesis by comparing the activity of "reporter" genes in which a minimal promoter (lacking any enhancers) is used with or without an adjacent MAR element, using the model plant *Arabidopsis thaliana.* The second hypothesis we are testing is that MARs act as transcriptional terminators, effectively blocking read-through transcription that can lead to RNA-mediated gene silencing. We are testing this hypothesis by making a construct containing inverted copies of a reporter gene transcribed convergently, but separated by an intervening MAR. In this study we use the *FLP*-FRT site-specific recombination system to excise the MAR *in vivo* in some of the progeny of the original transgenic plant. This strategy allows us to produce isogenic plant lines in which we can compare the same transgene at the same genomic locus, but with and without the MAR. Initial results from the first set of experiments suggest that MARs do not work as simple transcriptional enhancers. Experiments to test the terminator hypothesis are still in progress.

John C. Zwonitzer[1], David M. Bubeck[2], Dinakar Bhattramakki[2], James B. Holland[3], Major M. Goodman[3], and Peter Balint-Kurti[1]
Graduate Programs: Plant Pathology[1]; Pioneer Hi-Bred International, Inc.[2]; Crop Science[3]
Advisors: Peter Balint-Kurti and James B. Holland

Genetic Dissection of Quantitative Disease Resistance to Southern Leaf Blight in Maize Using Near-Isogenic Lines

Southern leaf blight (SLB) is an important foliar pathogen of maize, especially in topical and sub-tropical regions. Stiff stalk line B73 is susceptible to SLB, while the sister lines NC250 and NC250A, derived from crosses between temperate and tropical germplasm, show extremely high resistance. Two highly SLB-resistant B73 near-isogenic sister lines, NC292 and NC330, were derived from a B73 x NC250 cross followed by several backcrosses to B73 under recurrent selection for SLB resistance. The research objectives were: 1) identify NC250 introgressions in NC292 and NC330 genomes; 2) map SLB disease quantitative trait loci (dQTL) in B73 x NC250A $F_{2:3}$ mapping population; 3) generate near-isogenic lines (NILs) with different single or multiple NC250 introgressions; 4) Evaluate the NILs for SLB resistance to determine effects of specific NC250 introgressions. Sixteen NC250 introgressions were identified during a genome scan—13 NC250 introgressions in the NC292 genome and 11 in the NC330 genome. Eight SLB dQTL were identified, five of which colocalized with the previously identified NC250 introgressions. NILs with single or multiple NC250 introgressions were generated using marker-assisted selection during additional backcrossing to B73. Evaluation of the effects of specific NC250 introgressions on juvenile and adult plants in field and growth chamber experiments showed that many had an effect on SLB resistance. Some of the most SLB resistant lines were BC_1F_3 lines containing a NC250 introgression within a region flanked by SSR markers phi099 and umc1025 on chromosome 3. A SLB QTL was identified in this region in this and other QTL studies. NILs with multiple NC250 introgressions generally had higher levels of SLB resistance than NILs with single or double NC250 introgressions. SLB resistance in NC292 and NC330 is likely conditioned by many genomic regions.

McArthur Freeman II
Graduate Program: Art and Design
Advisor: Patrick Fitzgerald

***Gimme' Some Sugah*: A Creative Dialogue Between 3-D Modeling and Animation, and Traditional Drawing and Painting**

New Media not only creates new ways of working with images in expressive ways, but also offers new ways of thinking about the creative process. For my thesis project, I am modeling, texturing, and lighting an environment based on one of my paintings entitled *Gimme' Some Sugah*. The project will allow me to extend my current work into another medium and consider relationships between painting, film, photography, sculpture, and animation. The final constructed characters and digital set will be used in the production of a short animated project and series of 2-D prints.

My creative research is informed not only by collecting information, planning, and discrete tests, but also by intuitive engagement in the act of making through creative production. Even when pursuing similar creative goals, using new media emphasize a new set of considerations. That awareness of visual relationships, process, and conceptual aims creates a dialogue between how one works with traditional media and new media. I have found that within that dialogue there is an opportunity for an increased awareness of form, sensitivity to media, and transformation of the artist's creative process. Likewise, a hybrid craft that is neither confined to the conventions of digital or traditional media can be born within that exchange.

Technology, meaning any tools that are used in addition to the body of knowledge about how they can be employed, has always heavily influenced the creative production of artists and designers and their aesthetic/conceptual direction.

This project will allow me to interact with an audience in a different way, understand more about the potential of several media, and most importantly learn more about my creative process and myself.

Zaki Islam
Graduate Program: Design
Advisor: Robin C. Moore

I don't go out anymore: Relationships Between the Built Environment and Children's Outdoor Activities in Dhaka, Bangladesh

Childhood obesity is a major problem in developed nations like the USA. Obesity is also fast approaching the urban areas of developing nations as a result of similar sedentary lifestyles (Popkin 2006; Shafique, Akhter et al. 2007).

Studies have shown that obesity has a direct relationship with lack of physical activity. Because more than half of the world population is currently living in urban areas where built environment plays a major role in child development, it is crucial that relationships between characteristics of the built environment and well-being of children are better understood.

The aim of this study is to analyze relationships between built environments and children's outdoor activities. One hundred and eighteen children 10 to 12 years of age were selected from seven randomly selected schools in Dhaka, Bangladesh. Interviews were collected at each respondent's home. During the interview, an aerial view of the respective respondent's neighborhood was used via laptop and internet phone connection along with the survey questionnaire. Information regarding favorite places, independent mobility, identified neighborhood areas, etc. was recorded on the spot with the child and the investigator using available tools in Google Earth.

Preliminary analysis indicates that characteristics of the built environment are associated with children's outdoor activities. Children living in "government housing", which has unique physical characteristics (less density of building footprint coverage) ensure more outdoor activities than other types of housing. Girls living in government housing have even more independent mobility than boys living in new apartment type housings. Road characteristics (dead-end and thoroughfares streets) also have association with children's outdoor activities.

The preliminary results of this study suggest key areas of urban planning and design such as housing and street engineering that could potentially create pro-healthy environments.

Gretchen Caldwell Rinnert
Graduate Program: Graphic Design
Advisor: Scott Townsend

Interactive Video Tools That Amplify Classroom Participation

Many educational institutions frame the student–teacher relationship around specific behavioral interactions and expectations. How students experience this relationship is often key to their success in school activities. Some middle school students, girls, tend to disengage and isolate themselves from participating in class activities. Although these students begin to disengage in the classroom environment, they are active members of participatory cultures. According to Henry Jenkins, author of Convergence Culture: Where Old and New Media Collide, a Participatory Culture includes relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing, mentorship, all members are convinced that what they contribute will be valued, and they feel a degree of social connection with the other members (Jenkins, "Confronting the Challenges of Participatory Culture..." 7). The design of interfaces and interactions within web-based applications can inspire learning and participation through the inclusion of specific values and capabilities. As part of a final project, this research reflects on Jenkins observations of participatory culture and compares them to Kolb and McCarthy's learning theories which offer explanations for their success. This research reveals a framework for a successful (community based) web application. Through the execution of three design studies I will demonstrate the agency designers hold, and how they can inspire meaningful participation. These studies are specifically developed for middle school girls and explore the possibilities of interactive video tools and how they can encourage collaboration and creation in a language arts classroom.

Zeynep Cigdem Uysal
Graduate Program: Design
Advisor: Kristen Schaffer

Cognitive Use of Cultural Schemas in Architectural Design: An Examination Through the Projects of Aga Khan Award for Architecture

The literature on the cognitive role of culture in design brings up two distinct aspects, which are respectively: 'culture's cognitive role in the interpretation of design products', and 'its role in their creative production'. Revolving around the reception and generation of designed artifacts this way, it forms a framework where the 'interpretation',

'production', and the 'designed cultural artifact' are connected over the cognitive use of culture (in the form of cultural attributes, such as cognitive schemas or precedents).

Within this framework, the cognitive function of cultural knowledge in the 'interpretation of new information' accumulated a considerable research interest. However its role in the 'production of designed artifacts' still seems to be an area that needs further attention.

In this project, within this two partite cognitive role of culture, the emphasis will essentially be on the production. Accordingly, the project will question 'how we could conceive creativity differently if we consider culture through the use of cultural attributes such as cognitive schemas and precedents'.

Having such a goal, the project will firstly examine the notions of culture and creativity from within a cognitive perspective; secondly study creativity and culture in relation to each other; thirdly discuss their implications for architectural design; and lastly develop a conceptual framework and methodology, which will be utilized in the examination of a case study formed by a sample of projects gathered from the Aga Khan Award for Architecture.

Altogether the project will develop as an interpretive-historical inquiry with data collection methods such as archive search, field survey, project analysis, and interviews. Consequently, the project will try to articulate a cultural and cognitive theory of architecture that examines the cognitive utilization of cultural schemas in architectural design.

Michele Wong Kung Fong
Graduate Program: Graphic Design
Advisor: Meredith Davis

Online Mentoring of Concrete Learners in Science

How can the design of an interactive system support the remote yet synchronous mentoring of a middle school concrete learner by a college student through concrete representation of abstract concepts?

Acknowledging and investigating the potential for design and technology in the development of educational applications and tutorial is crucial in keeping up with current research trends that demonstrate active discourse about educational applications, learners, design and technology.

This question investigates ways in which the design interactive tools could support the learning behaviors of a concrete middle school learner, who "records information received from their five senses of sight, smell, touch, taste, and hearing…and views things in a tangible, factual and literal way" as well as the mentoring behaviors of the college student in a remote setting. (McCarthy)

When designing interactive tools that will support the remote yet synchronous mentoring of a middle school concrete learner by a college student through concrete representation of abstract concepts (in science), framing the main question into sub question was necessary.

The first sub question explores the ways in which the design of the visual, textual, aural and temporal aspects of information could support the student in his exposure to and engagement with information (inquiry driven process). The second sub question looks at ways in which the design of interactive tools could support the learner in his comparison and construction stage, while the third sub question considers the discourse-driven interactions between mentor and learner.

In the process of designing this remote mentoring application—informed by the learning and mentoring behaviors—conditions for remote yet concrete experiences had to be designed; conditions that would allow the learners in his inquiry and discourse- driven interactions to not only have access to the necessary content but to conceptualize—navigate, collect and understand—as well as construct and converse about the complex information in ways that are meaningful to him, in ways that meet his learning style.

There is the hope and potential for the design strategy that comes out of this design problem to be transferable to other design and non-design problems in fields ranging business, politics and socioeconomic settings.

Frim Ampaw, Toni Cerbo, and Karen Haley
Graduate Program: Adult and Higher Education
Advisor: Leila Gonzalez-Sullivan

Community College faculty, academic freedom, student focus and their overall satisfaction

Community Colleges are known for their commitment to access and their focus on students. While this is an advantage for students, the structure and organization of community colleges limits faculty involvement in institutional decision making and faculty autonomy compared with four-year college faculty. This study looks at the interrelationship of faculty perceptions about their role in decision making, their autonomy, the institutional student focus, and overall satisfaction. The data are from a national data base, which includes climate survey results from community colleges across North America.

Kim Bowen
Graduate Program: Curriculum and Instruction
Advisor: Ruie Pritchard

What the Data Says about Making Data-Based Decisions: The Personal Epistemology of North Carolina High School English Language Arts Teachers

Data, data, everywhere and not a change to see. Despite the emphasis on using research-based practices (supported by data) and analyzing student demographic and performance data, little change is evident in our high school classrooms. Teachers attend workshops, participate in professional learning committees, and then all too often teach as they have always taught when they are faced with the pressures and restrictions of the classroom. Perhaps the problem is not in what data we have, but in how teachers view data and other forms of knowledge.

The field of personal epistemology is concerned with the nature of knowledge including such concepts as what it is, how it is created, how it is justified, and how it might change. While much attention has been paid to assessing student epistemology, few researchers have explored the epistemology of practicing teachers. One of the most comprehensive models of epistemic development is the Reflective Judgment Model which provides a theoretical framework for understanding how personal epistemology influences the ways in which individuals approach ill-structured problems from late adolescence through adulthood.

This quantitative study investigates the personal epistemology of North Carolina high school English language arts teachers, including how that epistemology relates to demographic characteristics, education and experience, including National Board Certification and participation in National Writing Projects. 143 teachers from 54 school districts across the state completed the Reasoning about Current Issues Questionnaire (RCI), an instrument designed to assess assumptions about the nature, source, and certainty of knowledge claims. Preliminary findings suggest that education is the dominant factor influencing reflective judgment, with North Carolina teachers viewing knowledge from a relativistic standpoint in general.

Matthew Campbell, **Cyndi Edgington**, and **Marrielle Myers**
Graduate Program: Mathematics Education
Advisors: Patricia Marshall, Jessica DeCuir-Gunby, and Allison McCulloch

Nurturing Mathematics Dreamkeepers Project

The Nurturing Mathematics Dreamkeepers Project is a 5-year study of professional development with a focus on how K-2 teachers adopt and incorporate standards-based mathematics teaching practices and techniques that are grounded in the tenets of cultural relevance and focused on promoting children's conceptual understanding. We are currently in our third and final year of data collection of this project. This mixed methods, triangulation designed study seeks to answer the following questions:

- How do K-2 teachers re-organize their teaching toward a knowing-in-practice that is grounded in conception-based pedagogy?
- How do teachers re-organize their mathematics instructional practice to reflect intercultural sensitivity and to incorporate cultural relevance?
- To what extent do teachers' evolving understandings and practices lessen the achievement gap in mathematics between African American and White American K-2 students?

These questions will be answered using a triangulation of videotaped classroom lessons, videotaped reflective sessions between teachers and their buddies, field notes, student pre- and post- academic year mathematics assessments, and teacher disposition questionnaires.

Our primary role in this project as research assistants is to go to each of the participating schools, video each teacher a total of eight times per year, take field notes, perform lesson mapping on each videotaped lesson, score and enter scores for student mathematics assessments and score and enter scores for teacher disposition questionnaires and mathematics instruments. We are currently working with the project PIs on a data lesson coding rubric which will be used to quantify instances of culturally relevant pedagogy and conception-based teaching in each videotaped lesson. Next year (2008-2009), the final year of the project is reserved for analysis and dissemination of results. At this point, there are no findings yet to report.

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Kristen Corbell
Graduate Program: Curriculum and Instruction
Advisors: Alan Reiman and Jason Osborne

Evaluation of the Perceptions of Success Inventory for Beginning Teachers and its Connection to Teacher Retention Intentions

This study evaluated the psychometric properties of the Perceptions of Success Inventory for Beginning Teachers (PSI-BT). The PSI-BT assessed the areas known to contribute to beginning teachers' perceptions of success as well as beginning teacher retention. The PSI-BT was designed to assess eight factors associated with beginning teachers' perceptions of success: Mentor Support, Colleague Support, Administration Support, Classroom Management, Student Success, Instructional Resources, Assignment and Workload, Parental Contacts, Satisfaction, and Commitment. Each of the factors was assessed based on two categories: the beginning teacher's *current experience* and what the beginning teacher perceived to be *essential for effective teaching*. In addition to these 8 factors, the PSI-BT also assessed a beginning teacher's retention intentions, Satisfaction, and Commitment. This research included responses from 437 beginning teachers from 12 counties in North Carolina.

The first question addressed the psychometric properties of the *current experience* category of the PSI-BT including construct validity. An extensive literature review, expert opinions, and confirmatory factor analysis established the construct validity of the PSI-BT. Adequate fit indices provided evidence that the PSI-BT assessed Mentor Support, Colleague Support, Administration Support, Classroom Management, Student Success, Instructional Resources, Assignment and Workload, and Parental Contacts.

The second research question used multiple regression analyses to determine the factors that predicted beginning teacher retention intentions, Satisfaction, and Commitment. Satisfaction and Commitment predicted beginning teacher retention intentions. Administration Support, Classroom Management, Student Success, Instructional Resources, Assignment and Workload, and Parental Contacts predicted Satisfaction and Commitment. Mentor Support and Colleague Support predicted these factors.

The culmination of this research has provided a psychometrically sound instrument that school systems can use to reliably assess beginning teachers' perceptions of success. The gathered data can then be used to make informed decisions for improving induction programs and ultimately to retain beginning teachers.

Brad H. DeWeese
Graduate Program: Adult Education
Advisor: James E. Bartlett II

Coach Preferences and Satisfaction Levels of Elite Marathoners Participating in the 2008 Olympic Trials

Introduction. A limited number of athletes participate at the Olympic level and fewer athletes participate in individual sports at this level. It is widely accepted that the coach-athlete relationship influences performance. The limited number of athletes at this level creates a unique challenge for researchers to examine the coach and athlete relationship. Marathoners, a small sub-group of the elite athletes, participate at the Olympic level and their satisfaction with coach's and preference for coach characteristics are an important dynamic to understand.

Purpose. The purpose of this study was twofold; (1) to investigate elite male marathoner's preferences for coach characteristics and the marathoner's level of satisfaction with current coach characteristics; (2) examine if a relationship exists between the level of elitism and the preference for coach characteristics and level of satisfaction with the current coach characteristics.

Literature. A review of existing literature on coaching theory suggests that a void is present as it relates to the specific characteristics and preferences that are desired by independent sport athletes. Even more specifically, the literature has gaps when trying to understand marathoning at the elite level of competition in regards to coaches.

Methods. In order to understand the needs and levels of satisfaction of athletes at this level all men (N=134) athletes were selected to participate. Of the 134 athletes, 61 (46%) participating in the 2008 Men's Olympic Trials Marathon completed an online questionnaire. The instrument based on a review of literature was designed to measure preferred coaching characteristics, levels of satisfaction with their current coach, if coaching services were utilized, as well as gain descriptive information such as: weekly training mileage, level of experience, and variables that would suggest if an athlete is considered elite at the International, National, or Regional levels. Descriptive data was analyzed using means, standard deviations, frequencies, and percents. Reliability was examined using Cronbach's Alpha. Correlations were used to examine if a relationship existed between coach's characteristics and the level of competitor.

Findings and Conclusions. Of those that took part in the study, 28 were "A" standard, which can be considered to be the National Class Level of competition in U.S Marathoning. Only 22 (36%) of the 61 athletes completing the survey used the services of a coach, while a majority (n= 49, 80%) were competing in their first Olympic Trials.

Based on the initial findings, it seems that elite marathoners desire similar coaching attributes when compared to their independent-sport counterparts. When asked to describe their ideal coach, most athletes agree that a strong background in exercise science, experience as a runner, and previous success with another athlete are important

characteristics. In relation to previous studies done on independent-sport athletes, the males did not emphasize the need for a coach to be nurturing or be able to provide direction as important factors when listing ideal attributes.

Shelton Jerome Ford
Graduate Program: Mathematics Education
Advisor: L.V. Stiff

The Use of Technology in the Mathematics Classroom: A look at self-efficacy, motivation, and student achievement

Research has found that students who are motivated to study mathematics are more likely to pursue careers related to mathematics and that self-efficacy is an important determinant in academic motivation. Based on this information, it is reasonable to explore how the use of technology in the mathematics classroom can influence self-efficacy and motivation to improve mathematics achievement. This quantitative study sought to answer the research questions, how does active participation in technological tasks by students in mathematics classes affect student achievement? and how do hands-on technological tasks affect students' attitudes toward mathematics class, toward mathematics, toward mathematics teacher, toward the use of computer-assisted activities, and student achievement? Two mathematics class sections of the same course participated from a regional college. Algebra 2 topics with contextual problem solving were emphasized. One class was the control group and the other class was the experimental group. The instruction for both classes was facilitated by the researcher. The main differentiation between the facilitation of both classes revolved around student's active hands on participation in the technology used in the mathematics classroom. The intervention took place throughout Test 2 instruction. Participants in both groups completed the same assessments. The Statistical Package for the Social Sciences (SPSS) was used to analyze the data. Students in the experimental group had a more positive perception about the mathematics classroom and about the use of technology in the mathematics classroom after the intervention. There was also a significant difference in the Test 2 Performance after the intervention. Also, the results seem to indicate that with or without the intervention, the students had an average attitude about mathematics and its importance in society.

Jennifer Forrester, Gail Jones, Amy Taylor, Bethany Broadwell, and Tom Oppewall
Graduate Program: Science Education
Advisor: Gail Jones

Experiences, Relationships, and Identity Formation: Factors Influencing a Scientists' Career Choice

There is a shortage of students choosing STEM (science, technology, engineering, and mathematics) majors in college as well as a decline in people pursuing a career in a science and engineering field. This study was conducted to determine if common experiences exist across scientists in different science disciplines that are influential in an individual's decision to select science as a career through the investigation of the following research questions. (1) What in-school experiences influenced participants' scientist identity formation, (2) what out-of-school experiences influenced participants' scientist identity formation, and (3) what role did relationships with peers, teachers, and family members play in participants' scientist identity formation? Thirty-seven scientists participated in the study. Semi-structured interviews were utilized to explore scientists' childhood experiences in-and-out of school as well as relationships with peers, teachers, and family members. All interviews were audio-recorded, transcribed, and analyzed for themes and patterns using Atlas Ti qualitative software. The relationships with peers and adults reported by scientists had a powerful influence in shaping their sense of self. These relationships took place in the context of doing science. Time and time again these individuals told us about the rich experiences of learning and doing science with a caring adult. Clearly significant others shaped these participating scientists' identity and promoted their feelings of belonging to scientific communities of practice. The results of this study illustrate the value of in and out-of-school experiences and significant relationships as factors influencing an individual's decision to choose science as a career. Further research is needed to determine whether or not formal and informal educational experiences can be structured to replicate the positive effects on an individual's identity as a science learner. Participants indicated that relationships with peers, teachers, and family members, experiences with science, and out-of-school learning environments influenced their decisions to become scientists. These experiences and relationships illustrate the intersection between participants' personal histories and of their cultural histories; components that comprise their communities of practice allowing their evolution from student to scientist.

Grant E. Gardner
Graduate Program: Science Education
Advisor: M. Gail Jones

An Assessment of the Impacts of Education on Undergraduate Students' Risk Perception of Emergent Science and Technology

One unifying goal in science education at all grade levels is the development of scientifically literate citizens who are capable of understanding the nature of science and are able to access the relevant content for decision-making within their daily lives. A critical component of functional scientific literacy that has seen limited discourse in education research is students' understanding and negotiation of risks associated with modern society. Risk literacy is particularly important for a new generation of students who are faced with the rapid development of new sciences such as biotechnology and nanotechnology for which the risks are little understood by the general public. Risk is itself a difficult construct to define as it contains components of technological probability and subjective individual perception. This presentation reports data from a pilot study collected on undergraduate students' risk perceptions of nanotechnology applications before and after educational interventions. The results show significant differences in risk perception based on student demographics and educational characteristics. Various levels of educational intervention also indicate that the type of instruction provided (explicit versus implicit content) affects how students perceive the risks of nanotechnology. A research design is then proposed to more formally assess the impacts of educational interventions on students' risk perception using interviews and pre- and post-surveys. The psychometric paradigm borrowed from risk communication literature will be used to analyze data on students' risk perceptions. Data will be examined to uncover demographic differences, explore the impact of educational intervention, and examine psychometric attributes sensitive to change following instruction.

Erin T. Horne
Graduate Program: Curriculum and Instruction
Advisor: Alan Reiman

The Relation of School System Beginning Teacher Retention Efforts and National Trends

Across the United States, teacher attrition is an expensive problem in our education system. Recent research reports 50% of new teachers leave within the first five years (Ingersoll & Smith, 2003). Current estimates are that it costs about 50% of the average teaching salary to replace one new teacher in North Carolina (Villar & Strong, 2007). That means for the 2003-2004 school year, the average teaching salary in North Carolina was $43,343, costing $21,671.50 to replace a teacher (AFT, 2007). The purpose of this study was to identify the extent to which induction supports are being implemented across North Carolina. A survey design was used to measure the types of implemented teacher induction supports such as mentoring, face-to-face time with administration, orientations, beginning teacher seminars, collaborative opportunities with colleagues, extra resources, and reduced teacher workload will decrease the amount of teacher attrition among beginning teachers. The survey was designed to assess the prevalence of induction supports used by North Carolina Local Education Agencies (NCLEA) (n=50). Few school systems are currently implementing a full induction package as outlined by Ingersoll & Smith (2003). A statistically significant difference was found when the data was disaggregated between school systems with an Institute of Higher Education (IHE) within their district and those without in regards to providing beginning teacher seminars ($p<0.05$) and teacher assistants in K-12 classrooms ($p<0.01$). As well, statistically significant differences were found in school systems with an IHE within their district and those without in regards to formal partnerships with IHEs ($p<0.05$), the perceptions of those partnerships as positive ($p<0.05$) and needing help forming partnerships with IHEs ($p<0.01$).

Pooneh Lari
Graduate Program: Adult and Higher Education
Advisor: Colleen Aalsburg Wiessner

Understanding Teaching Experiences: Faculty Transitions from Traditional to Online Classroom

The purpose of my study was to describe the transition of faculty members from traditional to online environments and to examine their assumptions about their teaching and learning in face-to-face and online environments. By describing the transition experiences of faculty members from traditional to online environments, their teaching and learning assumptions and possible changes and transformations, my study may assist those faculty members who have been frustrated and resistant to transitioning from traditional to online classrooms. The questions guiding this research were 1) How do faculty members describe their transition from teaching face-to-face to teaching in an online environment?, 2) What personal, professional, pedagogical or other assumptions do faculty members hold about teaching and learning in traditional and online environments before starting their transition and how do those assumptions change after their transition?, and 3) How are the changes the faculty members experience as they transition from traditional to online environments defined along a continuum in relation to change theories? This research was a qualitative study and was conducted as multiple case studies, meaning participants at various locations were interviewed. The reason for reviewing several cases was that it was very difficult to generalize from

only one single case or to identify major patterns. Each case was comprised of one faculty member, one of their colleagues, and one of their students for a total of 15 participants, for a total of five cases. The results of this study contribute to creating a body of knowledge useful to institutions, faculty members, and others transitioning from traditional to online classrooms. It expands the online teaching literature regarding what teaching and learning means to the faculty members and allows them to bridge technology with pedagogy.

Gemma Foust Mojica
Graduate Program: Mathematics Education
Advisor: Jere Confrey

Middle School Mathematics Teachers' Implementation of Experiments and Simulations

As a result of recent curricular reforms in the United States and other countries, probability and statistics have become an important part of the K-12 mathematics curriculum. With an increased focus on probability and statistics, as well as greater access to technologies, teachers are encouraged to use an empirical introduction to probability. This study examines the practice of nine middle school mathematics teachers' implementation of probability experiments and simulations. At the time of the study, all participants were enrolled in a National Science Foundation funded graduate-level course, focusing on data analysis and probability for middle grade teachers. Although these teachers engaged students in learning experiences using experiments, teachers often missed opportunities for deepening students' probabilistic reasoning, especially relating to the following concepts: variability, role of sample size in experiments, and the relationship between empirical and theoretical probability.

Maura J. Murphy
Graduate Program: Adult and Higher Education
Advisor: Alyssa N. Bryant

How Sisters Do it for Themselves: The Impact of Professional Development Programs for Women

Numerous recent studies have examined the issue of gender parity in higher education (Hora, 2001; Perna, 2001; Wilson, 2005). Despite the progress of the women's movement in the 1970's and legal victories in the 1980's and 1990's, women still have not achieved parity in the number of faculty and administrative positions held, nor in compensation earned (Wilson, 2005). Furthermore, women are perceived as having less power than men, because they participate less often in the decision-making processes on campus (Denton & Zeytinoglu, 1991). The higher education industry addressed this problem by creating various professional development programs for women. While higher education has made progress in the last twenty years toward gender equity, there remains unintentional discrimination that creates a glass ceiling and prevents parity.

This case study sought to examine how having both a professional development program designed to encourage and promote women's leadership, as well as a progressive and accepting culture that encourages women to advance may or may not create the critical mass needed to overcome the barriers to change. This research investigates how a professional development program for women shapes the culture for women at a four year college.

Benefits of professional development programs for women include an increase in self-esteem and self-confidence, increased understanding of the complexity of higher education institutions, and the increased opportunity for career mapping. Women need to gain skills in reflective assessment to help them evaluate the culture of their institution. Institutions need to create mentoring programs to help encourage networking on campus, as well as actively engage in assessment to ensure gender parity. Finally, professional development programs need help participants engage in reflective assessment to better understand and diagnose elements of institutional culture that create a glass ceiling and limit gender equity.

Kenny Nguyen, Jere Confrey, Alan Maloney, Peter Holt Wilson, and Gemma Mojica
Graduate Program: Mathematics Education
Advisor: Jere Confrey

Diagnostic E-Learning Trajectories Approach (DELTA) Applied to Rational Number Reasoning for Grades 3-8

This project synthesizes the literature on rational number reasoning (including partitioning, multiplication, division, fractions, ratio and proportion, rates, decimals and percents, and similarity and scaling) and identifies the learning trajectories which are most consensually supported in the literature. Articles are summarized and assessment items are amassed in an online database. From these syntheses, we are collaborating with the Berkeley Evaluation & Assessment Center and Wireless Generation to produce a diagnostic system for teachers to use in assessing their students' understanding and knowledge in grades 3-8. The diagnostic system will identify students' difficulties in understanding concepts and skills in rational number reasoning. We will also be investigating the diagnostic system's effects on student and teacher learning in relation to state standards, assessments, and

curricular programs. This cluster of topics is critical to successful pursuit of advanced mathematics and is poorly learned by many urban children. To date we have collected more than 500 articles, reviewed 250 of them, synthesized the literature in partitioning, constructed progress variables for partitioning, and have begun to collect empirical data to support findings from the literature and our partitioning progress variables.

Jo-Ann Robinson
Graduate Program: Educational Leadership and Policy Studies
Advisor: Robert Serow and Paul Bitting

A Qualitative Study. Governance in Higher Education: How Life Experience Informs Practice, an Interpretive Biography of Mr. Benjamin Ruffin, UNC Board of Governors

The qualitative study will examine the life experience of Mr. Benjamin S. Ruffin through an interpretative biography. The interpretive biography is a life story. The significance of telling the life story is to contribute to understanding and the advancement of knowledge. The study of Mr. Benjamin Ruffin will bring insight to how life experiences inform practice. Examining the life experiences of Mr. Ruffin as a social activist and education leader in North Carolina will enhance our understanding of governance in higher education. How early experiences influence the development of belief systems and how these belief systems influence decision-making and problem solving are key questions for educators and policy makers. Understanding these inner dynamics are vital to understanding governance and how decisions are made.

The overarching question of this study is how does life experience inform practice in university governance? The postmodernist perspective that I will draw from promotes an examination of how race, class, and gender contributed to Mr. Ruffin's social activism and how this social activism influenced his leadership.

Ryan C. Smith[1] and Kathleen Iwancio[2]
Graduate Programs: Mathematics Education[1]; Mathematics[2]
Advisors: Karen Hollebrands and Irina Kogan

The Affects of a Dynamic Program for Geometry on College Students' Understandings of Properties of Quadrilaterals in the Poincaré Disk Model

Prior research on students' uses of technology in the context of Euclidean geometry has suggested technology can be used to support students' understandings of properties of geometrical objects. Such programs show promise for working with models of hyperbolic geometry, where interpretations of planes, lines, and angles are unconventional. Various technological tools have been developed to assist students in reasoning within different non-Euclidean systems (e.g., NonEuclid, Castellanos, 2007), but little research has examined how students' uses of such tools affects their understandings of properties of geometrical figures. This study examined the ways in which students used a dynamic geometry tool, NonEuclid, as they examined properties of quadrilaterals in the Poincaré Disk model. Five students enrolled in a college geometry course participated in a series of three task-based interviews, one of which focused on quadrilaterals. The van Hiele levels were used to characterize students' understandings of properties of quadrilaterals and the ways in which students used the technology when reasoning at each of these levels was identified. In the process of analyzing students' van Hiele levels and uses of technology, themes related to students' uses of technology and their relationships to the way in which they were reasoning about properties of different quadrilaterals were identified. One theme that became evident is that at level two (Analysis) students mainly made use of the diagram, appearances, and measures. A second theme was students' uses of the drag feature while reasoning at level three and four (Informal Deduction and Deduction). A third theme was their use of technology as a visual referent at levels four and five (Deduction and Rigor).

Amy R. Taylor
Graduate Program: Science Education
Advisor: Gail Jones

Students' and Teachers' Conceptions of Surface Area to Volume in Science Contexts: What Factors Influence the Understanding of the Concept of Scale?

National Science Education Standards emphasize teaching unifying concepts and processes such as basic functions of living organisms, the living environment, and scale (NRC, 1996). Since the relationship of surface area to volume is a pervasive concept that can be found throughout different sciences, it is important for students to not only understand the association of the two, but to also be able to apply it to various situations.

The purpose this study is to investigate the factors that influence the understanding of the concept of scale involving surface area to volume relationships. The pilot study with middle school participants explored whether or not there is a correlation between proportional reasoning ability and a student's ability to understand surface area to volume relationships. A statistically significant correlation was found for the proportional reasoning scores and the surface area to volume posttest scores. For further investigation, middle school students', high school

students', and science teachers' abilities in proportional reasoning, visual-spatial skills, and understanding surface area to volume relationships were assessed using four specific instruments. Correlation and multiple linear regression analyses determined that there is a relationship between one's ability to understand surface area to volume relationships and proportional reasoning and visual spatial ability. Regression results indicated that all participants' proportional reasoning and visual-spatial scores could be a possible predictor for one's ability to understand surface area to volume relationships. Discussion of the results is followed by implications for teaching scale concepts such as surface area to volume in the science classroom.

Michael Yoder
Graduate Program: Educational Research and Policy Analysis
Advisors: Robert C. Serow and Louis D. Hunt

Rural Student's Access to and Success in Higher Education: A Case Study

Rural communities are challenged by geographic isolation, high unemployment and poverty, and low educational attainment, including limited participation in higher education. Familial and community attitudes towards higher education and other factors may contribute to the limited enrollment of rural students in selective universities. This research investigates the extent to which students from rural communities were admitted to North Carolina State University (NCSU) in the fall semester, first-time, first-year freshman cohorts of 1999 and 2000 and, once admitted, whether they successfully complete degrees at rates similar to non-rural students. The theory of distributive justice served as the framework for this study. Data, which included indicators of high school academic success, demographic information, and university admission status was compiled by the NCSU Office of Planning and Analysis with Rural-Urban Continuum Codes used to classify students as rural or non-rural. Quantitative research methods, including logistic regression analysis, were used to determine the impact of independent variables on previously identified dependent variables (admission to the university, graduation in four years and graduation in five years), in this post-hoc, longitudinal case study. Non-rural students outperformed rural students on both portions of the SAT, completed more Advanced Placement and Honors courses, their parents completed higher levels of education and were more likely to be alumni/ae of North Carolina State University. In relation to the percent of North Carolina residents classified as rural, rural students did not apply for admission to the University at rates equal to those for non-rural students, nor were they admitted to the University at comparable rates. The results further indicate there was no difference between rural and non-rural students when comparing four-year graduation rates and that the odds of graduating in five years were greater for rural students.

Fadhel Azeez
Graduate Program: Chemical and Biomolecular Engineering
Advisor: Peter Fedkiw

Lithium Bis(Oxalato)Borate (LiBOB)-Based Electrolyte for Lithium-Ion Batteries

The need for compact, light-weight rechargeable batteries offering high-energy densities has become necessary in the 21st century especially for portable electronic devices, hybrid electric vehicles, and load leveling in electric power generation /distribution. Among rechargeable batteries, lithium-based systems are capable to fulfill these needs. The current state-of-art electrolyte for lithium-ion batteries, which consists of $LiPF_6$ dissolved in organic-carbonate solvents, has disadvantages in low- and high temperature environments

In order to improve the performance and enhance the safety of current lithium-ion batteries, a candidate electrolyte for these batteries is under investigation. The electrolyte consists of lithium bis(oxalato)borate (LiBOB) salt dissolved in a mixture of organic solvents consisting of γ-butyrolactone (GBL), ethyl acetate (EA), and ethylene carbonate (EC). In addition, we have added fumed silica to this mixture to improve mechanical properties of the electrolyte. Ionic conductivity, battery cycling, and rheology are used to evaluate the performance of our electrolyte.

In preliminary results, we find that LiBOB in a mixture of GBL + EA + EC yields a technologically acceptable conductivity, and upon adding fumed silica (FS) to LiBOB-based electrolyte, a 3-D network structure (solid-like structure) is formed that improves the rheological properties of the electrolyte and safety of Li-ion batteries without greatly affecting conductivity. In addition, preliminary results show that cathode half cells using LiBOB-based electrolyte give a satisfactory performance.

Christopher Basciano
Graduate Program: Mechanical and Aerospace Engineering
Advisor: Clement Kleinstreuer

A New Patient-Specific Paradigm for Endovascular Aneurysm Repair

Aneurysms are a balloon-like expansion of a blood vessel that results in a weakened structure with an increased chance of biomechanical failure, often without any warnings. Ruptured abdominal aortic aneurysms (AAAs) are

among the leading causes of mortality in developed nations. A modern surgical technique of AAA treatment is the implantation of a bifurcating stent-graft, forming a new (synthetic) blood vessel which shields the weakened aneurysm wall from the physiological blood pressure.

Based on experimentally validated computational multiphysics simulation results, increased knowledge of patient-specific aneurysm biomechanics will yield effective AAA-rupture risk prediction as well as guidelines for optimal endovascular aneurysm repair (EVAR). Hence, the new computational paradigm for surgical intervention will improve overall healthcare in terms of lives saved, reduced post-operative complications, and lower cost.

A novel model of the abdominal aortic aneurysm wall, that achieves a greater degree of biological realism, has been previously constructed and verified with experimental data. In continuation of our previous blood flow and AAA-dynamics simulations, the new model is being implemented in numerical analyses of representative and patient-specific geometries. Specifically, the different transport phenomena between fluid-particle flow and solid walls will be captured using two-way fluid-structure interaction analysis. Contact between intra-luminal thrombus within the aneurysm and the aneurysm wall will also be included in the study. As alluded to, the knowledge gained from these simulations will be used on a patient-by-patient basis for realistic laboratory testing as well as the assessment of biomarkers for possible aneurysm rupture and recommendations for improved stent-graft design.

Michelle K. Bowman[1], Jon Samseth[2], Steve D. Smith[3], Kim Ø. Rasmussen[4], Russell B. Thompson[5], Michael R. Bockstaller[6], and Richard J. Spontak[1,7]
Graduate Programs: Materials Science and Engineering[1] and Chemical and Biomolecular Engineering[7], North Carolina State University; Department of Process Technology, SINTEF, Trondheim, Norway[2]; Miami Valley Innovation Center, Procter & Gamble Company, Cincinnati, OH[3]; Los Alamos National Laboratory, Los Alamos, NM[4]; Department of Physics, University of Waterloo, Ontario, Canada[5]; Department of Materials Science & Engineering, Carnegie Mellon University, Pittsburgh, PA[6]
Advisor: Richard J. Spontak

Nanoscale Structure Development in Microphase-Ordered Block Copolymers and Their Hybrid Nanocomposites

Block copolymers exhibit a wealth of morphologies that continue to find use in a diverse and growing variety of emergent (nano) technologies, such as photonic crystals, fuel cells, batteries and data storage devices. While numerous studies have explored the effects of molecular confinement on such copolymers, relatively few have examined the use of nanoscale objects to controllably modify the morphological characteristics and phase stability of microphase-ordered block copolymers via modification of internal interfaces. In this work, a poly(styrene-*b*-methyl methacrylate) (SM) diblock copolymer and a poly(styrene-*b*-isoprene) (SI) diblock copolymer have been selectively modified with surface-functionalized fumed and colloidal silica nanoparticles, as well as native fullerene (C-60) nanoparticles. The neat copolymers are predicted to exhibit bulk order-disorder transition temperatures (T_{ODT}s) in the vicinity of 186 and 113°C, respectively. Dynamic rheological measurements have been conducted to measure T_{ODT} as a function of nanoparticle aggregation and concentration, surface chemistry and particle type. In all but one case, addition of the nanoparticles reduces the stability of the copolymers, as evidenced by a general, sometimes subtle, reduction in T_{ODT}. These trends have been verified by birefringence, and the morphologies of these hybrid materials have been examined by transmission electron microscopy (TEM). To complement our experimental work, self-consistent field theory (SCFT) calculations have been performed and serve as a means by which to predict nanocomposite phase behavior as a function of nanoparticle/polymer selectivity and size ratio. The surface functionalities selected here are anticipated to probe the importance of chemical interactions with the constituent blocks of the copolymer, which governs both copolymer morphology/stability and dispersion of the nanoparticles within the copolymer.

Travis Breaux and Annie Antón
Graduate Program: Computer Science
Advisor: Annie Antón

The Effect of Ambiguity on Legal Conformance in Information Systems

Government laws and regulations place strict requirements on new and emerging information practices, such as corporate accounting, electronic voting, patient medical recordkeeping and universal access. However, these laws contain intended and unintended ambiguities and lack specific guidance that software developers need to provide assurances that information technology complies with the law. As a result, products or services that affect our rights in the United States, such as the right for individuals with disabilities to access government information, may be limited due to incorrect implementations of the law. This includes 36.4 million adults who experience some hearing difficulty without a hearing aid, 20.2 million adults who report trouble seeing even with glasses or contact lenses, and 32.4 million adults who have limited reach or mobility. Methods that improve a company's ability to comply with accessibility regulations will have a direct and positive effect on these individuals.

To support requirements and software engineers in their effort to develop compliant products and achieve societal goals, this research summarizes a series of multi-disciplinary, multi-case studies that employ formal and empirical

methods to discover theory and practitioner guidance. The research findings were empirically observed during the analysis of two important regulations: the Privacy Rule that governs electronic patient medical records under Part 164 of the Health Insurance Portability and Accountability Act (HIPAA); and the Accessibility Standards that govern access to information by individuals with disabilities under Section 508 of the Workforce Investment Act of 1998. The findings include important requirements engineering patterns that can be used to resolve ambiguity and increase compliance assurance through regulatory clarification, simplification and innovation.

Brad J Busche[1], Alan E Tonelli[2], and C. Maurice Balik[1]
Graduate Programs: Materials Science and Engineering[1], Fiber and Polymer Chemistry[2]
Advisor: C. Maurice Balik

Solution properties of polystyrene/polydimethylsiloxane blends compatibilized by star molecules with a γ-cyclodextrin core and polystyrene arms

Blending of various homopolymers is a method used for harnessing unique properties from individual polymers resulting in combined material properties that meet specific needs for a given application. Homogeneously mixing two or more homopolymers (or intimate blending) is challenging and difficult due to solubility factors which arise from enthalpy and free-energy of mixing effects. Therefore most mixed homopolymer systems contain at least two different phases that are phase separated or, in other words, remain immiscible. To aid in compatibilizing two immiscible phases, star molecules containing a γ-cyclodextrin (γ-CD) core and twelve polystyrene (PS) arms, with degrees of polymerization of 11, 19, and 29 per arm as determined from quantitative ^{1}H-NMR analyses, were synthesized by atom transfer radical polymerization (ATRP). The γ-CD core serves to anchor and may partially blend a second polymer that is typically immiscible with the PS arms via threading through the γ-CD cores. These stars were blended with PS homopolymer to give a 1 wt% γ-CD incorporation and which resulted in clear miscible solutions. Further blending experiments were conducted using polydimethylsiloxane (PDMS), a polymer normally immiscible with PS. Characterization of this blend shows evidence that points to threading of PDMS though the γ-CD cores. These and other results will be presented and discussed.

Amit K. Chopra
Graduate Program: Computer Science
Advisor: Munindar P. Singh

Agents and Commitments: Abstractions for Business Processes

A primary challenge for Computer Science is devising suitable abstractions for a given application domain so that solutions may be assembled and analyzed at the level of the domain. For example, in personal finance, 'transfer', may be considered an abstraction; 'add' and 'subtract' are too low level. Our interest lies in the domain of business processes. We claim that agents and commitments are among the fundamental abstractions for modeling business processes. An agent represents a real business entity, and a commitment is a promise from one agent to another. In the poster, we explain why agents and commitments are eminently suitable for modeling business processes, and their advantages over current approaches involving data and control flow abstractions.

H.S. Craft, E.A. Paisley, and M.D. Losego
Graduate Program: Materials Science and Engineering
Advisor: Jon-Paul Maria

Investigation of Oxide – GaN Growth and Interface Properties Using X-ray Photoelectron Spectroscopy

Integration of wide-bandgap and functional oxides on GaN is of interest for a variety of device applications. Using x-ray photoelectron spectroscopy (XPS), the interface between GaN and the oxides MgO and CaO, and the ferroelectric oxides $Pb_xZr_{1-x}TiO_3$ (PZT) and $Ba_xSr_{1-x}TiO_3$ (BST) have been investigated. Using sequential growth experiments with *in-situ* XPS, the growth of MgO on GaN is found to be 3-dimensional with slow film coalescence. Attenuation data indicates that coalescence of MgO over GaN does not occur until thicknesses greater than 10 nm. In the case of CaO growth on GaN, the behavior is indicative of Stranski-Krastanov growth, in which coalescence is much more rapid. For MgO on GaN, we determine a valence band offset (ΔE_V) of 1.2 eV, and a conduction band offset (ΔE_C) of 3.2 eV, suggesting large tunneling barriers. For CaO/GaN, values for ΔE_V and ΔE_C are found to be 1.0 and 2.5 eV, respectively. To investigate degradation of rocksalt oxides via hydroxylation under controlled experiments, polycrystalline films of MgO and CaO were characterized using the O 1s photoelectron line. As-deposited oxides were phase-pure, with increasing coverages of hydroxide forming as *in-vacuo* exposures progress. The MgO hydroxylation saturates at ~1 monolayer. For CaO, a higher degree of reactivity was expected. After undergoing identical treatments as MgO films, hydroxylation was found to be ~3 monolayers of $Ca(OH)_2$. Clean surfaces are recoverable after vacuum anneals. PZT has been deposited via sputtering on GaN and rocksalt/GaN stacks. Using air anneals, the growth of good quality epitaxial PZT films on oxide/GaN structures was verified by x-ray diffraction. Achieving similar results in growing PZT directly on GaN has met with

difficulty. Additionally, BST films have been deposited on GaN templates by RF sputtering. In contrast to PZT, epitaxial BST films can be deposited directly on GaN with atomically sharp interfaces.

Mina Dawood
Graduate Program: Civil, Construction and Environmental Engineering
Advisor: Sami Rizkalla

Strengthening Steel Bridges with Carbon Fiber Reinforced Polymer (CFRP) Materials

Increasing traffic demands and deterioration of older structures due to corrosion have resulted in a significant need to develop an effective, durable system to repair steel bridges and structures. This need was highlighted by the recent collapse of the I35-W Bridge in Minneapolis. Researchers have demonstrated that conventional carbon fiber reinforced polymer (CFRP) materials can be used to strengthen steel bridges and structures. However, due to the relatively low modulus of elasticity of conventional FRP materials compared to steel, large amounts of the strengthening materials are typically needed to increase the allowable service load level of the structure.

This poster presents the details of a comprehensive experimental and analytical research program that was conducted to develop a high modulus CFRP system for strengthening steel bridges and structures. The research program was conducted in five phases. The first phase of the research focused mainly on selecting a suitable adhesive for bonding the CFRP materials to steel structures. In the second phase, three large-scale steel-concrete composite girders were strengthened with different configurations of CFRP materials and tested to determine the effectiveness of the different systems. In the third phase the behavior of the strengthened beams under was examined under overloading and fatigue loading conditions. The bond and splice behavior of the strengthening system was studied in detail in the fourth phase of the research program. The fifth phase of the research was designed to evaluate the environmental durability of the strengthening system. Based on the findings of the research program, a series of guidelines were developed to facilitate the design and installation of the strengthening system by engineers and practitioners. This research demonstrates that the proposed CFRP system represents an effective, durable method to strengthen and repair steel bridges and structures.

Dan Edwards
Graduate Program: Mechanical and Aerospace Engineering
Advisor: Larry Silverberg

Implementation Details and Flight Test Results of an Autonomous Soaring Controller

Existing high-endurance unmanned aerial vehicles (UAVs) carry a high mass-fraction of fuel. However, the vehicle's endurance could be improved an order of magnitude by adding intelligence to find and use favorable atmospheric motion to supplement or replace the onboard fuel stores. The Autonomous Locator of Thermals (ALOFT) mission objective is to fly 141.7 miles point-to-point without human intervention, beating the world record for model aircraft cross-country distance.

The ALOFT software monitors the vehicle's motion and geo-locates convective updrafts near the aircraft. It then actively commands the commercial-off-the-shelf autopilot to orbit inside the strongest part of the updraft. A 10 mile cross-country flight was performed with a research glider. The soaring algorithm was turned on just after launch and proceeded to keep the aircraft aloft for over 2 hours and cover over 60 miles air-distance. This equates to starting with 4 W-hr from the launch and gaining approximately 200 W-hr over the flight for a performance gain of 5000%. This energy gain represents 20% of the aircraft weight in batteries that did not need to be carried.

As has been demonstrated, autonomous soaring can substantially improve the endurance and efficiency of aircraft. Particularly for high-endurance missions, these flight path optimization algorithms can provide an essential performance improvement at no weight gain.

Sumit Gangwal[1], Olivier J. Cayre[1], Martin Z. Bazant[2] and Orlin D. Velev[1]
Graduate Programs: Chemical and Biomolecular Engineering, North Carolina State University[1]; Department of Mathematics and Institute for Soldier Nanotechnologies, Massachusetts Institute of Technology[2]
Advisor: Orlin D. Velev

Dielectrophoretic Assembly and Electrohydrodynamic Mobility of "Janus" Metallodielectric Particles in Electrical Fields

The synthesis of "Janus" particles (whose hemispheres are physically or chemically different) is of growing importance for the development of novel materials, but the behavior of such particles in external fields has not been studied in depth. We investigated the effect of external alternating current (ac) electric fields on Janus particles consisting of one dielectric hemisphere and one conductive hemisphere. The application of low frequency (< 10 kHz) ac electric fields to aqueous suspensions of these anisotropic metallodielectric particles leads to unbalanced liquid flows and nonlinear, induced-charge electrophoretic (ICEP) motion. We report experimental observations of the motion of Janus microparticles induced by uniform fields of frequency 100 Hz – 10 kHz in NaCl

solutions. The motion is perpendicular to the field axis and persists after particles are attracted to a glass wall. This ICEP effect is suppressed in ac electric fields of higher frequency (> 15 kHz). In this case, the particles self-assemble by dielectrophoresis into new types of two-dimensional (2D) metallodielectric colloidal crystals, where the metallized halves of neighboring particles align into conductive lanes through the crystals. The propelling metallodielectric particles could be used as microscopic mixers, "shuttles" and self-propelling on-chip sensors. Their self-assembly at high frequency could be used in the fabrication of photonic crystals of new symmetries, massively parallel waveguides, and materials with directional electrical and heat transfer.

Alfred G. Hathaway III[1], Jeremy Moxom[1], Ayman I. Hawari[1], and Jun Xu[2]
Graduate Program: Nuclear Engineering[1]; Oak Ridge National Laboratory, Chemical and Analytical Sciences Division[2]
Advisor: Ayman I. Hawari

Design of a Slow Pulsed Positron Beam for Positron Annihilation Lifetime Spectrometry

The annihilation of positrons within a material provides a useful tool for the non-destructive study of subsurface microscopic defects. The lifetime of positrons within matter is inversely proportional to the electron configuration at the site of annihilation; therefore the measurement of this lifetime can be related to the size and concentration of defects within materials. One technique to measure this lifetime is a slow positron buncher. In this scheme, the lifetime of the positron is determined using a start signal obtained from the electronics of the system and a stop signal corresponding to the detection of an annihilation photon. Positrons are time focused into small bunches (on the order of 100ps) which are magnetically guided onto the sample to be studied. The enhancement of the timing resolution brought about by this focusing allows for the measurement in variations of very short positron lifetimes, which occur within defects in metals. The source for the spectrometer is the intense slow positron beam being implemented at the North Carolina State University 1-MW PULSTAR Reactor. The positrons produced by the source will be focused onto a tungsten transmission moderator to begin the bunching process. Slow positrons emitted from the moderator will be accelerated into bunches due to electric fields brought about by a time-varying potential placed on the moderator. A potential waveform has been developed which is capable of bunching the positron beam into pulses. Following this initial chopping stage, the positron bunches are further time focused with stages of rf bunching using double gap coaxial resonators. Bunching stages are designed such that positrons entering and exiting the stage are in phase with an applied potential in the form of a sine wave. The final goal is to obtain a variable energy pulsed beam with bunches on the order of 100ps.

Timothy J. Horn and **Jessica Springer**
Graduate Program: Industrial and Systems Engineering
Advisors: Ola Harrysson and Denis Marcellin-Little

Direct Freeform Fabrication of Custom, Load Bearing, Transcutaneous, Osseointegrated Implants for the Attachment of Prosthetic Limbs

Osseointegration is a term which is commonly used to describe the process of incorporating a synthetic implant with living bone tissue in such a way that a permanent bond is formed. The concept of osseointegration has been well demonstrated in the literature and is widely accepted in the medical community. For applications that involve load bearing prosthetic lower limbs, osseointegration has addressed many of the problems associated with traditional (socket type) prosthetics. By transferring loads directly through the skeleton rather than through the soft tissue (which often leads to nerve damage, sores, discomfort, and bone deterioration) these implants have the potential to increase the mobility and functionality of prosthetic limbs, and to improve the and quality of life of amputees. However, loosening of implants over time, poor bone fixation, and the constant presence of bacterial infection have been barriers to the practical implementation of this technology. This research, in cooperation with the North Carolina State University College of Veterinary Medicine, has utilized advances in; radiography, 3-D computer modeling software, and direct freeform fabrication of biocompatible metals to provide a total manufacturing solution for creating custom implants designed to overcome these barriers. Accurate 3-D computer models of skeletal and soft tissue features are typically derived from computed-tomography imaging systems. From these models a custom implant can be designed which incorporates features optimized for a given individual. The implant is then fabricated using a direct freeform fabrication process known as electron beam melting (EBM). The same process facilitates the generation of engineered mesh surfaces which can be optimized for either bone fixation or skin ingrowth. Both feline and canine cases with congenital limb deformities have been included in preliminary research efforts with promising results. Additional cases are currently being selected for inclusion in this research in the near future.

Young K. Jhon[1], Ramanan Krishnamoorti[2], and Jan Genzer[1]
Graduate Programs: Chemical and Biomolecular Engineering, North Carolina State University[1]; Chemical and Biomolecular Engineering, University of Houston[2]
Advisor: Jan Genzer

The effects of monomer sequence distribution and isotopic substitution on solution phase behavior of random copolymers

Over the past few decades, multiple experimental and theoretical studies have reported on the physico-chemical characteristics of copolymers with ordered sequences, including, alternating (…ABAB…), diblock (…AABB…), triblock (…AABB…BBAA…), etc. Because of challenges associated with synthesizing random copolymers (RCPs) with tunable co-monomer sequences and analyzing their monomer sequence distribution, only few computer simulations and sophisticated theoretical approaches have been employed that provided insight in the thermodynamical behavior of such RCPs. Recently, we developed a methodology facilitating the formation of RCPs with tunable co-monomer sequence distributions. Here we report on the effect of chemical composition, co-monomer distribution and $^{1}H/^{2}D$ isotopic substitution on the phase behavior in copolymers of poly(styrene-co-4-bromostyrene) (PBr_xS), where x denotes the mole fraction of 4-bromostyrene (4-BrS), in cyclohexane. By adjusting the solvent quality during bromination of parent polystyrene, either random or random blocky PBr_xS, (r-PBr_xS or b-PBr_xS, respectively), were synthesized. We studied the temperature dependence of phase behavior of PBr_xS with various x in cyclohexane as a function of the polymer concentration using light scattering. Our results reveal that for a given 4-BrS content, the cloud points of b-PBr_xS solutions are consistently higher and broader than those observed in r-PBr_xS solutions. The transition temperature has also been found to depend on the isotope substitution of ^{1}H or ^{2}D in either the polymer or the solvent. Small angle neutron scattering measurements indicate significant differences in the temperature dependence of the thermodynamic behavior for the random and blocky samples and the nature of the fluctuations upon approaching the phase boundaries.

Ali Kefeli, Reha Uzsoy, Yahya Fathi, and Michael Kay
Graduate Program: Industrial and Systems Engineering
Advisor: Reha Uzsoy

Using A Mathematical Programming Model To Examine The Marginal Price Of Capacitated Resources

The marginal cost or shadow price of a production resource with limited capacity is of interest in a number of different situations. One example is in short-term scheduling and dispatching, where a number of authors have proposed dispatching rules based on cost-benefit ratios, where the value of processing a job at a given time is contrasted to the marginal price of the resource consumed by scheduling it at that time (e.g., Morton et al. (1988)). Other authors have examined the marginal price of capacity using queueing concepts (Morton and Singh (1988); Banker et al. (1986)), and others have used them as a basis for overhead cost allocations in cost accounting schemes (e.g., Kaplan and Thompson (1971)). However, the linear programming models commonly used in a wide variety of resource allocation models have the difficulty that only resources whose capacity is fully utilized will have a nonzero dual price. In this paper we present a mathematical programming model that uses nonlinear clearing functions (Asmundsson et al. (2006b)) to represent the congestion phenomena observed in capacitated production and service systems, which provides nonzero dual prices across a wide range of operating conditions. We use this model to study the structure of dual prices for congested resources and present structural results.

Jitendra Kumar
Graduate Program: Civil, Construction, and Environmental Engineering
Advisors: Ranji Ranjithan and G. Mahinthakumar

Contamination Threat Management in Water Distribution Systems

Contamination threat management in water distribution systems continues to receive immense research focus in the wake of recent terrorist attacks on critical civil infrastructures. Water distribution systems are vulnerable to accidental and intentional contamination. A contaminant introduced in the system can spread rapidly and may adversely impact public health. Fast and accurate identification of the contaminant source characteristics is needed for the design of any control and mitigation measure. Contamination source identification problem is solved as an inverse problem using water quality observations from a sensor network. The sensed information is then typically filtered and accordingly each sensor triggers a detection/no-detection binary signal based on some detection threshold. As the information available to reconstruct the source characteristics is not complete and error-free, the solution to the inverse problem is not necessarily unique, i.e., several different sets of source characteristics may match the observations equally well. One approach to address non-uniqueness is through identification of sets of different source characteristics leading to similar observations at the sensors. An evolution strategies (ES)-based simulation-optimization is used in the present study for identification of the contaminant source characteristics. This method is structured to generate simultaneously a set of alternatives with maximally different source characteristics while fitting the observations within an acceptable degree of difference. This study tests this methodology for realistic instances of contamination events in an example water distribution network. Effects of sensor sensitivity on the accuracy and degree of non-uniqueness were studied. Decrease in the

accuracy and increase in non-uniqueness was observed as the sensitivity of the sensors decreases. Also, the effect of the quantity of available data (i.e. number of installed sensors and frequency of observations) on accuracy and non-uniqueness was analyzed. Accuracy of source identification and resolving non-uniqueness decreased with decrease in available sensor data. The proposed ES-based methodology was established to work robustly after testing over a wide range of contamination scenarios. This method was extended to assess its applicability under a range of measurement error conditions. Again, the method was shown to function robustly even under high degree of noise in the measurements.

Po-Yao Kuo,[1] Charles Villa[2] and H. Christopher Frey[1]
Graduate Program: Civil, Construction, and Environmental Engineering[1]; Advanced Engineering Group, Volvo Trucks North America, Inc., Greensboro[2]
Advisor: H. Christopher Frey

Measurement and Modeling of Fuel Use and Exhaust Emissions from Idling Long-Haul Truck Engines and Auxiliary Power Units

Drivers of long-haul trucks typically idle the base engine to provide “hotel” services such as electricity, heat or air conditioning for rest stops. An auxiliary power unit (APU), which is a small diesel engine-generator set, is an alternative for supplying these services. Twenty new in-service field trucks, with 10 trucks of Fleet A and 10 trucks of Fleet B, have been equipped with a data acquisition system and one of two types of APU systems. Fleet A trucks are operated by single drivers. Fleet B trucks are operated by a pair of team drivers who alternate driving and rest. The data acquisition system reports data every several hours for characterizing idle and stopping patterns. Fuel use rates for field trucks vary depending on ambient temperature. APU fuel use was measured as a function of electrical load. Exhaust emissions concentrations of CO_2, CO, HC, and NO were measured using a Portable Emission Measurement System (PEMS) and converted to fuel-based emission factors. These data are incorporated with activity data from the 20 field trucks to estimate total fuel use and emissions with or without APUs usage based on real-world data. The actual fuel savings and emissions reductions are highly variable. The average reduction in idle fuel use and CO_2 emissions for Fleet A trucks is 24%, and the reduction for Fleet-B trucks is 6%. The average reduction in NO emissions is 46 percent for Fleet A and 14 percent for fleet B. APU systems are clearly more useful for trucks operated by single versus team drivers. Drivers who use the APU system frequently were found to do so not only for long duration rest stops but also for shorter duration loading and unloading stops, which provides new insight into the activity pattern and potential fuel and emissions savings for such systems.

Kyoung O. Lee
Graduate Program: Nuclear Engineering
Advisor: Mohamed A. Bourham

Atmospheric pressure plasma surface treatment of cotton yarns in a concentric cylinder dielectric-barrier discharge device

Atmospheric pressure plasma surface treatment of yarns is performed by discharge instability appearing in the form of streamer and filamentary discharge in a helium and oxygenated helium plasma generated by a Dielectric Barrier Discharges (DBD). Coaxial capacitive geometry in such low-frequency discharge allows for the gas flow only in one direction, which is the same direction of yarn feed through, and the electric field has a cylindrical symmetry. The theoretical model is based on the electrical equivalent circuit of the discharge through which the electron-neutral collision frequency and electron number density can be obtained, and the power balance equation to solve fro the plasma electron temperature. The electron temperature of the model is compared to that of Optical Emission Spectroscopy (OES). Scanning Electron Microscopy (SEM) with Energy-Dispersive Spectroscopy (EDS) was used to investigate the surface morphology of the treated cotton yarns. The SEM micrographs of the exposed yarns show surface smoothness, which are attributed to surface etching and possible oxidation. Power balance and discharge thermal behavior revealed that the power input to the discharge is mostly dissipated in heating electrons and ions and that the losses are minimal, thus indicating good discharge efficiency.

Xianglin Li, Ramón Collazo, and Zlatko Sitar
Graduate Program: Materials Science and Engineering
Advisor: Zlatko Sitar

Highly Oriented Diamond Film Grown at High Growth Rate

Diamond embraces a rich collection of distinctive properties, which makes it a valuable and strategic material for many practical applications. However, even though its extraordinary properties make diamond suitable for a broad range of scientific and industrial applications, diamond films have been limited to low volume “niche” applications. This is partially because of the polycrystalline nature of the diamond grown on non-native substrates and the slow

growth rate of diamond films. This research investigates the high-rate growth of highly oriented diamond (HOD) (100) films since it possesses many properties close to those of single crystal diamond.

HOD is commonly grown at a growth rate of 0.3 μm/hr by microwave plasma chemical vapor deposition (MPCVD) with a 1.2 kW microwave source on (100) silicon substrates. By exploring different growth parameters, HOD films with similar crystalline properties and phase purities can be grown at 4.5 μm/hr within the same growth system. The growth rate and crystalline quality were investigated as a function of total pressure employed (25-100 Torr), methane concentration in hydrogen (1.6-7%), and air concentration (30-3000 ppm). It was observed that the required air concentration for obtaining HOD is higher for higher growth rates. For a growth rate 0.3 μm/hr, the air concentration required was 30 ppm, while for a growth rate 4.5 μm/hr, an air concentration of 1000 ppm was needed to get a similar HOD morphology and crystalline quality. A detailed study of the crystalline quality as determined by X-ray diffraction texture analysis and phase purity as determined by Raman spectroscopy as a function of methane and air will be presented.

Mark D. Losego[1], Alina Efremenko[1], Crissy Rhodes[2], Marta Cerruti[2], Stefan Franzen[2] and Jon-Paul Maria[1]
Graduate Program: Materials Science and Engineering[1]; Chemistry[2]
Advisor: Jon-Paul Maria

Investigating Surface Plasmon Resonance (SPR) in Indium Tin Oxide (ITO) Thin Films for Molecular Sensing Applications

Devices utilizing surface plasmon resonance (SPR) to sense chemical / biological species or probe molecular interactions at surfaces are well established. Most devices employ the interface between a thin metal film, such as gold or silver, and a dielectric substrate to generate the necessary surface plasmon wave. However, metal films are limited to specific surface chemistries and their opacity restricts multiplexing with complimentary spectroscopic techniques. To expand the capabilities of SPR systems, transparent conducting oxides are investigated as a possible alternative materials set. In this work the SPR characteristics of indium tin oxide (ITO) thin films on glass substrates are investigated. ITO films are prepared by RF magnetron sputtering and crystallized in a controlled atmosphere tube furnace. Film microstructure can be controlled through sputter parameters, particularly sputter pressure. This allows control of electron mobility (35 to 7 $cm^2/V*s$), which strongly impacts the width of the SPR absorption band. Charge carrier density can be modified by controlling the partial pressure of oxygen during post deposition annealing. Controlling the number of charge carriers allows for manipulation of the SPR frequency, which can be shifted by more than 40%. Such control over SPR response is unprecedented in conventional devices using metallic films. We apply the Drude free electron model and the Fresnel equations to explain the observed SPR response. We also demonstrate that molecules functionalized with thiol and carboxylate groups attach to ITO surfaces and that these adsorbates can be detected with SPR spectroscopy. Near-edge x-ray absorption fine structure (NEXAFS) experiments are undertaken to investigate optimization of ITO surface morphology / crystallographic orientation for deposition of well-ordered self-assembled monolayers. An understanding of molecular assembly on ITO surfaces is critical for the eventual development of chemical / biological sensors.

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Advisor: Denis Cormier

Experimenting with Personal Fabrication: Quest for the Santa Claus machine!

A single machine that can make anything has for ever existed in the realm of science fiction. Disruptive technologies in automation, computing and other support hardware are bridging the gap between fiction & bringing methods that could *make "almost" anything* a step closer to realization.

Systems that could go beyond the confines of traditional manufacturing require the development of new processes & materials/metamaterials as well as CAD environments that are suited to define the organization of material. In the next section, I shall describe some of my experiments over the past 10 years that address these areas.

Process Development:

- A new process employing electrophotographic printing to print 3D parts was proposed in 2000. An existing laser printer was modified to permit it to print in 3D Experiments were carried out to print over a variety of materials over different surfaces.
- More recently, I worked on the development of 3D digital materials called GIKs that resemble Legos™. Fabrication using these materials is scalable, multi-material and reversible. Concepts from the realm of information theory are adapted in manufacturing to produce near error free parts.

New Material Development

- The FDM™ system by Stratasys Inc. uses layered manufacturing to produce freeform parts in thermoplastics. Experiments were carried out to demonstrate in situ building of customized reinforcements (e.g. metal plates) into the parts. A continuation of these experiments led to demonstration of in situ embedding of circuit boards into plastic parts.
- My current research involves development of parameters for processing fully dense parts on the newly acquired Electron Beam Melting System by Arcam, AB. Process parameters have been developed for specialty alloys of Titanium, Copper and Aluminum as well as for non-stochastic foams in the same materials The physical properties of the manufactured parts was measured. Future work in this field would lead to the development of model to evaluate the feasibility of a set of process parameters on the melting of a specific material.

CAD for metamaterials

- The complexity of the structure of non-stochastic foams makes it extremely difficult to develop and manipulate CAD models of these foams. Tools are currently being developed to model both surface conforming (via parameterization) as well as space filling (via voxelization) metamaterials.

Joshua L. Manasco[1], Carl D. Saquing[1], Juan P. Hinestroza[2], and Saad A. Khan[1]
Graduate Programs: Chemical and Biomolecular Engineering, North Carolina State University[1]; Department of Fiber Science and Apparel Design, Cornell University, Ithaca, NY[2]
Advisors: Saad A. Khan and Juan P. Hinestroza

High Throughput Electrospun Nanofibers of Polycaprolactone Melts and Concentrated Solutions

The production of polycaprolactone nanofibers via melt and heated solution electrospining will be presented. Typical electrospun nanofibers involve the use of low concentration polymer solutions making it a low yield, solvent intensive process with limited commercially viability. Spinning at higher concentrations is not an attractive alternative owing to the linear relationship between fiber diameter and concentration which results in micron-sized fibers that can be produced using traditional methods and at lower costs. In order to overcome these issues, we took a two-prong approach. In the first method, we show the use of an extrusion-based route to produce nanofibers directly from polymer *melts*, in particular poly(caprolactone) (PCL). In the second approach, we use a high temperature electrospinning process to fabricate nanofibers at high concentrations. The use of the high temperature not only allows for significantly higher polymer content in the solution, but also reduces fiber diameters from the micron to the nanometer range. Details of these approaches, which provide for new avenues of producing high throughput nanofibers in either a solvent-less or solvent-limited process will be discussed. A simple mathematical model will also be presented to provide insights into this temperature-modulated electrospinning method, and to correlate process parameters with fiber properties.

Douglas McClusky
Graduate Program: Computer Science
Advisor: Robert Fornaro

Teaching Programming Concepts with Robowulf

The decreasing interest in math and science has led to decreased enrollment in computer programming courses and computer science as a discipline. At the same time, many students continue to struggle with fundamental programming concepts even as they enter more advanced studies. These are two symptoms of one core issue in teaching computer programming. There is a tradeoff between the functionality of a computer language and how simply it can be taught as a clear progression of concepts. Functionality maintains student interest by demonstrating the language's relevance to their continued studies and deepens student understanding by exposing them to a wider range of problem solving examples. On the other hand, too much unstructured information initially can lead students to despair over their ability to learn programming at all. There have been several good solutions to the problem of creating a clear conceptual framework for teaching programming, but such solutions have been constrained by attempting to be self-contained programming languages. This project will draw from the principles of previous solutions, such as Karel the Robot and Lego Mindstorms, but with a focus on creating an extensible framework, which will allow students to grow towards more sophisticated program control mechanisms and more complicated system designs. This semester's phase of the Robowulf project includes designing the robotic platform, creating the basic language, designing the interface for interacting with the robots, creating mechanisms for maintenance and distribution of the interface and developing an introductory curriculum. These design and development processes are taking advantage of feedback from an experimental course being taught this semester on the Robowulf platform to Computer Science and Computer Engineering freshmen.

Kaushal K. Mishra
Graduate Program: Nuclear Engineering
Advisor: Ayman I. Hawari

Investigation of Phase Contrast Neutron Imaging of Mixed Phase-Amplitude Objects

A Neutron Imaging Facility has been set up at the North Carolina State University (NCSU) PULSTAR reactor. Currently, work has started on tailoring the design of the facility to allow the performance of phase contrast neutron radiography. This is an imaging modality that has been extensively applied in X-ray imaging and was demonstrated using neutrons over the past few years. In this case, contrast formation in the image, especially at edges, is enhanced due to phase shifts that take place as the neutron wave passes through regions in the sample that differ in the coherent scattering length density. Usually, the pure phase object approximation is used to formulate the problem, whereas realistic samples represent mixed phase-amplitude objects. In this work, a formulation for mixed phase-amplitude objects with moderate neutron attenuation coefficients and its effect on the neutron image is being presented. Using computational simulations, it is observed that the pure phase object approximation results in over enhancement of edges for a phase-amplitude object, with significant change in the case of neutron imaging depending upon the edge forming material characteristics. The total contrast for the mixed phase-amplitude object is less than the sum of the individual attenuation and phase contrast components. The difference depends on the scalar product of the gradient of the coherent scattering length density and the attenuation coefficient. The presented formulation can aid in predicting the performance characteristics of neutron phase imaging experiments.

Walid M. Mohamed
Graduate Program: Nuclear Engineering
Advisor: K. L. Murty

Influence of Fast Neutron Irradiation on Nanocrystalline Metals

With the growing interest in developing a new generation of nuclear reactors and future fusion reactors, the need for materials that are highly resistant to intense radiation fluxes has become an essential challenge. The proposed study involves the effects of processing and radiation doses on various structural metals that are of importance to current and next generation nuclear power reactors. Nanocrystalline materials are polycrystals with an ultra-fine grain size (diameter < 100 nm) and a high volume fraction of interfaces. While in conventional metals, radiation produces various defects (point, line, surface and volume), it is not clear how these defects especially dislocations (line defects) and stacking faults (surface defects) can be accommodated in the relatively minute grains of nm-scale. The effect of processing will be investigated through the study of the effects of radiation on nanograin structured metals processed via different routes such as high energy ball milling and electrodeposition (ED). A miniature tensile tester has been built for the purpose of determining the mechanical properties of nanocrystalline samples. Small size specimens (3mmx10mm) and typical Transmission Electron Microscopy (TEM) type samples (3mm dia.) have been irradiated at the PULSTAR, A 1 MW_{th} research reactor at NCSU, and they are currently undergoing cooling and testing. Primary studies have been conducted on the unnirradiated samples which include the effects of annealing on the grain size distribution and hardness of nanograin structure metals. Mechanical testing of unnirradiated samples is currently in progress and a comparison between conventional and nanocrystalline materials would be established. While the experimental data are being gathered, attempts will be made to simulate the effect of radiation on the materials under consideration via molecular dynamics (MD) simulation techniques. A major objective here is to correlate the simulations with the experimental findings at the nm-scale.

Babak Parkhideh
Graduate Program: Electrical and Computer Engineering
Advisor: Subhashish Bhattacharya

Improved Wind Farm's Power Availability by Battery Energy Storage Systems

Wind energy is one of the major available renewable energies that can be transformed to electric power. Although the system representation of a wind farm may be straightforward, there exist several issues concerning the wind farm integration to either the national or local electric grid. The main problems with integrating the large-scale wind farms to the power transmission girds are the voltage and power variations at the bus of interconnection. While the voltage variations at the bus degrade the power transfer capability of the grid, the intermittent power at the bus makes the output power of the wind farms un-distributable or "un-dispatchable". Therefore, an interface between the wind farms and the main grids which can be in form of power electronic systems is inevitable.

For the voltage issues, it is known that the bus voltage can be regulated with the help of fixed capacitor banks, or SVC (Static Var Compensator), or STATCOM (Static Synchronous Compensator). In this project, an STATCOM integrated with Battery Energy Storage System (BESS) is considered not only to modify the first issue but also to smooth out the changing output power. This work proposes a model and control strategy for an integrated Battery Energy Storage Systems interfaced with Voltage Source Converter (VSC) to the grid. The proposed model of the

BESS/VSC is validated by detailed simulation results based on real power charge and discharge cycles provided for a real 50 MW wind farm application. The VSC control strategy is developed to enable this charge / discharge of the BESS, in addition to regulation of bus voltage at the point of coupling with the supply grid. The motivation for this project is to provide improved real power (MW) “dispatchability” of wind farms sponsored by Bonneville Power Administration (BPA), EPRI, DOE, and Sandia National Labs.

Qing Peng[1] Xiao-Yu Sun[1] Joseph C. Spagnola,[2] G. Kevin Hyde[3] Richard J. Spontak,[1,2] Carl Saquing,[1] Saad A. Khan,[1] and Gregory N. Parsons[1]
Graduate Programs: Chemical and Biomolecular Engineering[1]; Materials Science and Engineering[2]; Textile Engineering, Chemistry, and Science[3]
Advisor: Gregory N. Parsons

Applications of Atomic Layer Deposition on Three Dimensional Electrospun Fiber Templates to Designer Nanomaterials

Three dimensional (3D) macro structures consisting of nanostructures with well-defined dimensions and properties attracted significant interest for various fields including electronics, photonics, nanofluidics, medicine, sensing, catalysis, and controlled release etc. To date, fabrication of those 3D macrostructures in large scale proposed an outstanding challenge. Atomic layer deposition (ALD) is stepwise, surface self-limited vacuum-based thin film deposition technique. ALD process is able to produce thin films and overlayers of different materials (inorganic, organic, hybrid) into highly complex structures with perfect thickness (~angstrom), uniformity and conformality control. In our work, Al_2O_3 and ZnO ALD were successfully applied onto the 3D poly vinyl alcohol electrospun fibers matrix templates to fabricate 3D matrix of Al_2O_3, ZnO and coaxial Al_2O_3/ZnO nanotubes with precisely controlled tube wall thickness. Moreover, the effect of thermal annealing and the kirkendall effect on the formation of unique nanocomposite materials from the coaxial Al_2O_3/ZnO nanotubes were studied. Furthermore, surface properties of the Al_2O_3 nanotubes matrix were modified by 3-aminopropyltriethoxy silane to enable further functionalization. This method represents a robust and inexpensive way to synthesize designer 3D nanomaterials in large scale. The as-formed materials have promising applications in sensors, solar cells, catalysts, micro/nanofluidics, bio-separation and other related fields.

Anand Ramamurthy
Graduate Program: Electrical and Computer Engineering
Advisor: Subhashish Bhattacharya

Flexible Digital Power Management System (DPMS) for Satellites

The power requirements for satellites are on the rise with increase in size and inclusion of innovative payloads. The power system has to be reliable and efficient to optimize the limited energy resources available in space. The power supply requirements are mission specific and the system has to be redesigned or built from scratch. A modular and scalable power distribution architecture concept to achieve flexible, reliable and cost-effective power management for satellites is needed. The goal of the project is to build a modular DC power distribution architecture with “plug and play” loads and sources. The system enables Maximum peak power tracking for multiple PV array interface and it provides battery charge management for expandable battery resources. It ensures fault tolerant operation and redundancy for supplying critical loads. The power conversion is digitally controlled which offers precise regulated voltages for the subsystems. The health of the system is monitored and managed by a central processor which also performs sophisticated diagnosis to ensure system stability. The use of digital signal controllers for power supplies gives us a feature of re-configurability and results in high performance. Monitoring of power resources and load shedding is seamlessly accomplished without any room for errors. Digital control of power supply is not only novel but also cost effective and saves space by avoiding analog components. The number of PV arrays connected to the satellites can be expanded and the controller recognizes the connection and configures its parameters for its optimum operation. The battery charging algorithm also changes accordingly when the systems detects additional batteries connected to it. The voltage rails for the satellite subsystems are reconfigurable along with its compensation parameters.

On the whole the DPMS offers an autonomous, flexible, reliable and scalable power supply solution which maximizes the life of the satellite power management system and power sources.

Matthew Schmidt
Graduate Program: Computer Science
Advisor: Nagiza F. Samatova

Scalable, Parallel, and Distributed Memory Framework for Combinatorial Search and Enumeration in Modeling Large-Scale Biological Systems

Predictive models of complex biological systems such as genome-scale biological networks can be derived from high-throughput biological data by using combinatorial search algorithms. However, the size and the complexity of biological data often insure that the runtime of the combinatorial search algorithms becomes intractable when the algorithms are run on single processor machines. The NP-hard nature of such algorithms necessitates the development of high-performance parallel algorithms that could scale to real-size biological systems on the next generation supercomputer architectures such as Cray XT4. The data-intensive nature of the underlying combinatorial enumeration process and highly irregular search structure of the search space, however, make efficient scaling up of such algorithms quite challenging.

I propose a parallelization framework for combinatorial search algorithms that are quite ubiquitous in modeling and comparative analysis of biological networks. The framework (a) enables parallelization via the proposed decomposition of the algorithm into subtasks that are independent from one another; (b) ensures load balancing between the processors and minimization of the processors' idle time via an efficient initial work distribution, on-demand work stealing, and a task stack splitting scheme; and (c) minimizes both the per-processor memory requirements and the data transfer between the processors via an efficient data structure. Using real biological data, I demonstrate the scalability of such a framework to both to the genome-scale networks and to the thousands of processors on Cray XT systems. The applications of this framework to real biological problems related to efficient bioethanol production are presented.

Thomas Sebastian
Graduate Program: Mechanical and Aerospace Engineering
Advisor: Robert Tolson

Determination of CEV Aerodynamic Coefficients and Flight Parameters from Ballistic Range Measurements

Determination of aerodynamic coefficients and stability derivatives is necessary to define a model of the Orion Crew Exploration Vehicle (CEV) flight dynamics. This involves reducing experimental data, which can include acceleration, angular rate, or orientation data. This sort of extraction of dynamics from experimental data is often performed on data gathered from experiments conducted on un-instrumented models at indoor ballistics ranges. The US Army Research Laboratory (ARL) has developed a high-g survivable stand-alone instrumentation package that can transmit in-flight measurements of acceleration, angular rate, and local magnetic field. This telemetry module (TM) was installed in a scale model of the Orion CEV, which was fired from a 120mm gun at the ARL range. This paper presents the methodology used to extract the aerodynamic coefficients from this data and solve the orientation ambiguity problem. This information is then used to verify vehicle stability. Validation of this method of data generation and analysis supports a low-cost method of vehicle testing. Further testing will incorporate a crucifix-patterned array of nine piezoresistive pressure transducers with the instrument package to improve the determination of flight parameters. Wind tunnel and CFD data was used to determinate of the optimum pressure tap locations and develop an aerodynamic database from which the CEV flight parameters will be obtained.

Arun Suresh and Patrick Wellenius
Graduate Program: Electrical and Computer Engineering
Advisor: John F. Muth

A New Semiconductor Material for Transparent Electronics – Indium Gallium Zinc Oxide

Thin film transistors (TFTs) are basic building blocks for niche applications such as flat-panel displays and electronic systems-on-glass. There has been a strong interest in developing these technologies on flexible substrates. Amorphous silicon (a-Si:H) and organic semiconductors have been extensively investigated for this purpose. However, low mobilities of these channel materials (~1-2 $cm^2V^{-1}s^{-1}$) lead to limitations in device performance. Recently a new material system based on amorphous oxide semiconductors (AOS) has been proposed for TFT applications. AOS based on post-transition-metal cations show surprisingly higher mobilities, ~10–50 $cm^2V^{-1}s^{-1}$, even in the amorphous state. This is believed to be the result of the overlap of spherical *s*-orbitals of the heavy-metal cations with $(n-1)d^{10}ns^0$ ($n \geq 4$) electronic configuration. Moreover the wide band gap of AOS leads to their transparency at visible wavelengths which is expected to lead to transparent display elements with transparent driving circuits opening up numerous new designs and applications.

The goal of this work is to develop AOS based active and passive elements for flexible and transparent electronic applications. Here we have used pulsed laser deposition (PLD) to deposit amorphous indium gallium zinc oxide (a-IGZO) at room temperature to fabricate high performance transparent TFTs on both glass and flexible PET

substrates. Carrier concentration control is achieved by varying the deposition conditions. N-channel enhancement mode devices were fabricated with an extracted field effect mobility of ~ 11-15 $cm^2V^{-1}s^{-1}$, on/off current ratios > 10^7, subthreshold gate voltage swing of 0.20-0.25 V/decade, low off-state currents and good saturation. Low and tunable threshold voltages of 1-2 V were achieved. The effect of bias stress on a-IGZO based TFTs have been studied and a charge trapping model has been used to explain the threshold voltage shift seen as a bias stress effect (BSE).

Mehmet B. C. Ulker and M. S. Rahman
Graduate Program: Civil, Construction, and Environmental Engineering
Advisor: M. Shamim Rahman

Response of Saturated Porous Media: Different Formulations and Their Applicability

Problems in many fields ranging from geomechanics to biomechanics require response of saturated porous media subjected to quasi-static or dynamic loading. In geomechanics, transient phenomena during impact loading, earthquakes, water wave loading and consolidation are of significant importance. In biomechanics, problems involving the response of porous tissues are of practical significance. An engineering problem requiring the true behavior of the saturated porous medium should consider the effect of coupling of both fluid and solid phases. That is, the simultaneous analysis of flow of pore fluid and the deformation of solid skeleton by including the contribution of one process to another. Depending on the nature of loading vis-à-vis the characteristics of the media, different formulations; full-dynamic (FD), partially-dynamic (PD), quasi-static (QS) are possible. In this study, analytical solutions are developed for the response of general plane strain saturated porous media under harmonic loading. The solutions are developed in terms of non-dimensional parameters and the results are presented in terms of pore pressure and shear stress distributions within the depth of the medium. The response is then studied for various conditions and the regions of validity for all formulations are identified in parametric space. An assessment of the needed formulation for few important problems is illustrated. The results showed that the regions of validity of formulations depend significantly on the non-dimensional parameters. For low period wave induced seabed response, QS is adequate except for large permeability; for larger periods, PD is needed. For earthquake response, except for high frequency and/or large permeability, PD is adequate and for fine grained soils an undrained formulation is needed. In blast induced response, FD is needed more because of higher frequencies. In porous tissue response under pulsating blood flow, problem is well within the range of applicability of consolidation formulation due to relatively slow phenomenon.

Arun S. Veeramani[1], John H. Crews[1], Gregory D. Buckner[1], Stephen B. Owen[1], Richard C. Cook[2] and Gil Bolotin[3]
Graduate Programs: Mechanical and Aerospace Engineering, North Carolina State University[1]; Cardiovascular Surgery, University of British Columbia[2]; Cardiac Surgery, Rambam Medical Center, Israel[3]
Advisor: Gregory D. Buckner

Development of a Shape Memory Alloy Actuated Catheter for Cardiovascular Procedures

Although catheters have proven effective in numerous cardiovascular procedures, their functionality and versatility could be greatly improved by enabling active tip steering. Such capabilities could allow, for example, a cardiologist to select points on the cardiac surface during an ablation procedure and have the catheter automatically trace the ablation path via computer motion control. We have developed such a steerable catheter using Shape Memory Alloy (SMA) actuation and demonstrated its ability to precisely track trajectories in its reachable workspace. SMA materials are ideally suited to this application, as they offer superior power density, energy density and biocompatibility. Our research efforts focus on the design, fabrication and modeling of the catheter dynamics, enabling us to develop real-time control algorithms. The current active catheter prototype consists of four SMA tendons distributed at 90° intervals about a central tubular substructure. The tendons are enclosed in a Teflon sleeve to electrically insulate them from each other and the surgical environment. Joule heating is used to generate tip deflections in 3 dimensions, which are measured in real-time using a dual-camera imaging system. The catheter's bending mechanics are described using an experimentally validated circular arc model. SMA actuation is described using the Seelecke-Muller-Achenbach model whose parameters are experimentally derived from stress-strain characteristics of the SMA tendon at different temperatures. Kinematic relationships are derived, specifically relationships between tendon strain recovery and resulting tip deflections. Dynamic simulations of the catheter reveal excellent correlation to experimental data for low frequency actuation. Preliminary closed-loop control experiments exhibit reasonable tracking performance; more sophisticated controllers that account for system nonlinearities are under development.

Patrick Wellenius and Arun Suresh
Graduate Program: Electrical and Computer Engineering
Advisor: John Muth

Bright, low voltage europium doped gallium oxide thin film electroluminescent devices

Efficient red light emitting phosphors have historically been difficult to achieve but are an important requirement for full color displays. This difficulty is illustrated by the frequent use of ZnS:Mn high efficiency phosphors that typically produce a broad yellow emission, but use long-pass optical filters to make red phosphors. Rare earth elements represent an interesting solution if they can be efficiently incorporated into a host material as a dopant because of their interesting optical properties. Due to screening of the local electric field, intra-atomic transitions are largely unaffected by changes in the host material. Their spectrally narrow emission is also attractive as it results in high color purity which can be used to render a larger color gamut and more saturated colors in displays.

Europium doped gallium oxide thin film electroluminescent devices with bright, red emission and relatively low threshold voltages of 60 V were fabricated by pulsed laser deposition. The use of transparent conducting electrodes of amorphous InGaZnO on transparent aluminum titanium oxide/indium tin oxide/7059 Corning glass substrates resulted in a device that is transparent throughout the visible spectrum. At 100 V, with 1 kHz excitation, the luminance was 221 cd/m^2. Electronic properties of the device were characterized by Sawyer-Tower circuit analysis which, when coupled with time dependent optical emission measurements, suggest that charge trapping at the aluminum titanium oxide/Ga_2O_3:Eu interface plays an important role in producing efficient emission at lower voltages. The time dependent electronic and optical observations formed the basis for a theory of operation for these devices.

Alexander York
Graduate Program: Mechanical and Aerospace Engineering
Advisor: Stefan Seelecke

Towards Advanced Control Algorithms for Active Material Actuators Used in Nano-Scale Positioning: Experiments and Modeling

Nano-Positioning devices such as translation stages have found applications in ultra-high precision manufacturing, biomedical research, scanning tunneling microscopes, atomic force microscopes, and many other research and development areas. Piezoelectric materials, which produce a strain under the influence of an external electric field, have become elementary components for these nano-positioning devices due to their high-frequency response and almost infinite resolution. Piezoceramics, however, exhibit a complex and strongly non-linear behavior, including hysteresis, rate-dependence, temperature dependence, and creep. The non-linear behavior is amplified with higher electric fields or higher stresses, thus limiting the device operation under conventional linear control to the short stroke and low frequency regime. In order to make efficient use of the actuator, one has to incorporate the non-linear, hysteretic behavior of the actuator into the control algorithm via a model. The rate-dependent hysteretic behavior is known to be due to domain switching processes in the material. This research presents a model-based controller capable of compensating for the hysteretic behavior along with the frequency-dependence present in these materials. The controller uses a free energy model based on the theory of thermal activation for single crystal piezoceramics that couples mechanical stress and electric field. A systematic experimental study of piezoelectric actuators was conducted to identify model parameters and for simulation validation. The model is coupled with a SDOF model of a commercial nano-positioning stage (Nano-OP30, Mad City Labs) and is implemented into an optimal control package. The efficiency of this type of stage controller will allow it to track arbitrary set point functions at high frequencies and will not be limited to harmonic set points, enabling technologies like, e.g., 3-D force microscopy.

Xueliang Zhao and T.M. Evans
Graduate Program: Civil, Construction, and Environmental Engineering
Advisor: T.M. Evans

Granular Material Response for Different Loading Conditions: Discrete Numerical Study

It is well-known that all three principal stresses play a role in the stress-strain-strength response of solids and granular materials, yet axisymmetric compression tests and direct shear tests are typically used for the determination of design parameters, even when field conditions may be plane strain (e.g., behind a long retaining wall). The effects of loading conditions on the macroscale response of granular materials have been studied extensively using experimental methods and it is relatively straightforward to quantify the variations in material macroresponse using continuum constitutive equations. However, these methods provide relatively little insight into the driving micromechanics that govern macroscale behavior, particularly in soils that fail in a non-constitutive manner (e.g., via regions of high localized strain). Thus, it is desirable to develop a set of models that reproduce the expected macroscopic behavior and allow insight into the governing microscale mechanics. To this end, a series of numerical experiments has been performed to assess the effects of loading (i.e., boundary) conditions on

particulate material response. Three-dimensional discrete numerical specimens were assembled to similar void ratios and confining stresses and then subjected to plane strain compression, axisymmetric compression, and direct shear loading conditions. Simulated material response is generally in good agreement with previously published results from laboratory investigations. In the future, it may be possible to exploit the discrete nature of the simulations to observe changes in material microstructure under different boundary conditions and to infer how micromechanics influence the macroresponse of the assemblies.

Gina Agostini and **Emily Gomez**
Graduate Program: Anthropology
Advisors: Ann Ross and Troy Case

Testing the Repeatability of New Carpal Measurement Techniques

Standards of measure exist for nearly every aspect of the human skeleton, including many elements of the hands and feet. These standards allow for consistent, replicable measurements to be taken of bones with varying morphologies by individuals with varying levels of expertise. However, to date there have been no standardized measurement techniques devised for the eight carpals which comprise the most proximal aspect of the hand. For this project, a minimum of two measurement techniques were devised for each carpal (excepting the pisiform). These techniques where then subject to repeated interobserver trials so that their percent repeatability could be assessed. Then, these techniques were subject to repeated trials by an inexperienced individual so that their percent repeatability could be assessed as well as the descriptive success of each measure evaluated.

Glenda Burch
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Carolyn Miller

Cartesianism as a design problem in graphical user interface (GUI) development

The Cartesian ideology that instantiates a mind/body split is a design problem for technical communicators because of the effect this dichotomy has on the design of the tools that technical communicators must use and because research suggests that engaging the body as both a medium of communication and as a contributor to personal knowledge-building enhances learning. As most technical communicators are practitioners active in transferring knowledge to audiences, using traditional graphical user interface (GUI) designs can rob the user of effective learning and limit the scope of how information can be presented and interpreted. Part 1 reviews research that shows how the body itself can enhance teaching and learning both through nonverbal communication and through bodily experience. Part 2 points out the limitations in holding a Cartesian view of the mind and body in light of the research presented in Part 1 and, of particular interest to technical communicators, shows how the traditional GUI is a symbol and tool of Cartesianism, which privileges the mind over the body, focuses on ocularcentrism, robs the technical communicator of useful ways to teach and limits the ways users can learn. Part 3 points out some steps that have been taken that can help remove these limitations and proposes action that technical communicators can take to initiate change in the way the traditional GUI design is viewed, which could include, for example, using the Socratic method of interruption or gaining an understanding of metakinesis. Part 3 also includes a consideration of future designs yet to be implemented that could ideologically rejoin the mind and body to engage the user more holistically.

Jonathan Burr
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Victoria Gallagher

The Snowsuit Effort: A Digital Representation of an Urban Space

Although difficult to define, urban space might be thought of as an extensive collection of the material (e.g., transportation and communication infrastructures) and imaginary (ideologies manifested within the space). There is, however, a tendency to reduce cities to one dominant text, the cityscape. For those unable to look beyond the towering view from without, the cityscape may become a symbolic visualization for the space as a whole. Reduced to a glance, the urban space is left largely untouched, unexplored, and, ultimately, misunderstood. This paper addresses this “legibility problem” by exploring how digital contexts provide new ways of thinking about urban space. The artifact for this analysis is a photoblog, *The Snowsuit Effort*, a representation of a specific urban space, Detroit, Michigan. In order to capture the unique intersection between *The Snowsuit Effort* and the city it represents, this study utilizes an interdisciplinary approach to intertwine historical, visual, and theoretical contexts to discuss specific images and trends appearing on the photoblog. The unshakeable impact of history on the city's “racial divide” is incorporated through several key events—the Ossian Sweet Incident, the 1943 Race Riot, and the 12th Street Riot—which provide a way of thinking about the unseen on *The Snowsuit Effort.* The truth is, however, that Detroit's tumultuous history makes ideological, racial, and social issues difficult to address. Thus,

resoundingly, the time for digital representations of urban space, photoblogs like *The Snowsuit Effort*, is now. We can trace its significance to its presentation of the digital street as a national, regional, and local meeting space, a site that transcends race, social status, and the individual as other to realize the human being.

Christian F. Casper
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Carolyn R. Miller

Reconsidering the Genre Ecosystem of Science: Post-Publication Review in an Online Journal

The scientific research article in the primary literature has been characterized by information scientist John Mackenzie Owen as having been stabilized by a process of "encapsulation" in which the basic form of the genre is preserved even as the mode of delivery changes. However, forums for discussion and annotation in some online journals allow commentary and criticism to be directly appended to research articles, creating new genres for a kind of post-publication review that can interact with research articles on their own turf. Because research articles published in journals play a central role in the construction of scientific knowledge, discussion forums associated with articles published in online journals have the potential to help determine what is considered knowledge and what isn't. Even though, as Mackenzie Owen noted, this development is resisted by significant disciplinary inertia, these new interactions serve to remind us of the constant tensions between stability and change that exist in rhetorical genres. In this work I combine a quantitative empirical study of post-publication review discussions in an online journal, focusing on the types of claims made, the rhetorical tactics employed, and the objects of discussion, with theoretical work on genre assemblages in order to investigate how new genre assemblages in the scientific community can affect how knowledge is constructed and how new media are raising new potentialities for the interactions of texts within generic ecosystems. My preliminary work indicates a significant difference in the treatment of experimental methods and data interpretation compared to questions of significance and impact of the research articles in question and sheds light on possible new roles for even the "encapsulated" research article within the genre ecosystem of science.

Amy L. Housley Gaffney
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Deanna P. Dannels

Sounding like a designer: What critique feedback tells students about competent communication

Students in Design majors give numerous presentations, often referred to as "critiques," throughout their education. The feedback given to students during these communication events provides both explicit and implicit information on what it means to be a competent communicator in Design. Although Design literature acknowledges the importance of communication within the discipline, Design research seldom addresses the communication competencies required of students. This current research project sought to provide preliminary understandings of Design communication competencies using the Communication in Disciplines theoretical framework. This approach allowed for a close examination of competencies within Design, based on observations of critiques. The data examined came from the feedback given in one design studio over the course of a semester. Feedback was broken into t-units, which were subsequently coded according to categories inductively derived from reading the data. Feedback given to students indicated that students' presentations should support their design objects, explain their process, and explain their concept, while being precise, clear, and complete. The results also indicated trends over the course of the semester (e.g., less focus on supporting the design object initially, with an increased focus on this competency in later critiques) and differences based on critique types (e.g., more focus on preciseness while students were still working on a project). The results from this study provide a foundation for understanding communication competencies in Design, and with further validation, can be used to develop educational tools to teach students communication competencies.

Erika J. Galluppi
Graduate Program: English
Advisor: Leila May

"Liminal Taint": Literal, Metaphoric, and Allegorical Vampires During the Victorian Fin de Siècle and Y2K, or "To Bram Stoker Thanks For Everything, M. T. Anderson"

If folkloric vampires are literally (re)animated corpses that feed upon living blood, cultural vampirism is more metaphorically representative of social infections on energy, prosperity, and purity. In either stringent sense, a vampire is defined by extreme thirst. Author M. T. Anderson explores complicated vampiric thirst by humanizing the "living dead" in *Thirsty*. Part coming-of-age tale, fantasy, and social commentary, *Thirsty* reflects paradigm shifts in vampire studies that expand vampires from isolated, heteronormative constructions to communal expressions that reinterpret social liminality. Anderson promotes an empathetic, culturally metaphoric approach to vampirism by exploring social "otherness." His half-human, half-vampire protagonist, a vampire due to

circumstance rather than choice, prompts readers to re-conceive vampiric "otherness" by comprehending the incomprehensible bloodthirst as an all-too-human bodily function. Because Anderson is inspired by the 'godfather' of the vampire novel, Bram Stoker, critiquing *Thirsty* is a twofold process: *Thirsty* is first viewed through a Draculean lens; then, the "thirsty" gaze is applied to the hysteria that is a notable turn-of-the-century phenomenon. Exploring the purification obsession during the Victorian fin de siècle posits a better understanding of social consciousness during the Y2K turn of the century. When provoked, women, gay/lesbian individuals, and young adults prove significantly liminal. Victorian liminality reveals the following: feminism as threat to the domestic "Angel in the House"; same-sex relations as synonymous with homosexual "taint" and disease; and adolescence as more than the impressionable post-childhood maturation stage. Recent developments in gender, sexuality, and age identity illustrate similar issues: women, gay/lesbian individuals, and young adults remain liminal creatures and Y2K literature remains "infected" by culturally-reflective vampires. Exploring literal and metaphoric vampirism thus highlights parallels between cultural fears and fascinations with "creatures that go bump in the night" and fin-de-siècle resurgences of vampire literature, with particular "spikes" in romance novels, GLBTQ fiction, and YA stories.

Alyssa A. Gamaldo[1], Jason C. Allaire[1], and Keith E. Whitfield[2]
Graduate Programs: Psychology, North Carolina State University[1]; Department of Psychology and Neuroscience, Duke University[2]
Advisor: Jason C. Allaire

Assessing Mild Cognitive Impairment among Older African Americans

Many mild cognitive impairment (MCI) studies have used divergent criteria to classify their participants, which has made the current understanding of MCI vague. In addition, few studies have examined MCI in older African Americans who as a group have been shown to have a higher prevalence of dementia compared to other racial groups. Thus, the purpose of this study was to examine how the prevalence of MCI among African Americans would adjust based on Petersen's criteria (1999) and a modified version of the age-associated cognitive decline criteria (m-AACD; Ritchie, Artero, & Touchon, 2001). In addition, this study examined whether there are differences on demographics, health, and cognitive performance among individuals identified as MCI and cognitively normal individuals. Analyses were conducted on a sample of 306 African American adults ranging in age from 48 to 95 years (M = 69.74, SD = 9.22). None of the participants met Petersen's criteria for MCI. However, the m-AACD criteria classified 5 to 41% of the participants as MCI depending on the impairment cutoff score employed within the diagnostic criteria. Individuals classified as MCI were not significantly different than cognitively normal individuals on demographic characteristics and health factors. Yet, depending on the impairment cutoff score, individuals classified as MCI performed significantly worse on cognitive measures than cognitively normal individuals. Discussion will focus on the diagnostic implications of modifying MCI criteria, particularly for minority populations.

Sheena M. Harris
Graduate Program: Anthropology
Advisosr: Troy Case and Ann H. Ross

A Possible Undiagnosed Case of a Craniofacial Syndrome

The John Hopkins University Center for Craniofacial Development and Disorders estimates that 1 in 3,000 children born in the United States is diagnosed with a rare form of craniosynostosis. Although the medical literature has documented numerous descriptions of craniofacial disorders from an anthropometric or genetic perspective, considerably fewer reports of these anomalies have been documented in the context of forensic anthropology. Similar genetic origins of many craniofacial anomalies generate ranges of phenotypic variation between and even within documented cases, producing difficulties in acquiring correct diagnoses. Identical physical characteristics, manifested in different disorders, create further complications in identifying a craniofacial syndrome in skeletal remains. Reported here is an unusual case of a possibly undiagnosed craniofacial abnormality in a set of identified skeletal remains from a North Carolina homicide case. The individual, a white female of 31 years of age, exhibited an underdeveloped maxillary region, a high, narrowly arched palate and shallow eye orbits. Several upper and lower teeth were absent, possibly congenitally, and prior orthodontic treatment was obvious, possibly performed to correct dental abnormalities associated with the small palate. The literature documents several craniofacial disorders, usually distinguished in the living by a combination of genetic testing and examination of physical features, which exhibit these characteristics of the skull. A mild form of spina bifida of the sacrum was also present. Traditional metric and geometric morphometric approaches were utilized to further investigate morphological shape differences between the case study and a reference sample. Results show significant differences suggesting a non-syndromic form of craniosynostosis. Although the individual was positively identified, the abnormalities of the skull and sacrum were not documented, suggesting that the identification and differentiation of similar craniofacial abnormalities in skeletal remains warrants further research.

Chia-Lin Ho[1], Jennifer L. Welbourne[2], and Pierce J. Howard[3]
Graduate Programs/Institutions: Psychology, North Carolina State University[1]; Department of Psychology and Anthropology, University of Texas-Pan American [2]; CentACS, Charlotte, NC [3]
Advisors: Jennifer L. Welbourne, Pierce J. Howard, and Joan Michael

Personality Assessment in the Taiwanese Workplace: Evidence for the Interpersonal Relatedness Construct

Personality assessments have been widely applied to personnel selection, team development, leadership, and career planning in the workplace. In the framework of personality taxonomy, the Five-Factor Model (FFM) of personality has been supported by numerous cross-cultural studies. However, recent studies have shown evidence for a unique, indigenous Interpersonal Relatedness (IR) construct in the Chinese culture (Cheung et al., 2001). Focusing on workplace personality assessment, the current research examined the FFM and the indigenous IR construct among workers in Taiwan, an Asian country with strong Chinese cultural influences. A Taiwanese workplace personality inventory assessing both the FFM and the IR construct was developed using a combined etic-emic approach. The etic approach assumed cross-cultural generalization of personality constructs; the emic approach emphasized the development of culture-specific personality constructs. The inventory consisted of an imported workplace personality measure based on the FFM (translated into Traditional Chinese) and a newly developed measure assessing the indigenous IR construct specific to the workplace. A sample of 676 Taiwanese workers, recruited from throughout Taiwan, completed the on-line assessment. The reliability and factor structure of the assessment were examined. The results indicate that a six-factor model was superior in explaining workplace personality traits in the Taiwanese sample. The IR construct, except the Flexibility subtrait, was independent of the work-specific constructs from the universal Big Five.

Guangya Liu
Graduate Program: Sociology
Advisor: Feinian Chen

Predictors of Health among Staff in Assisted Living

The number of people who need long-term care (LTC) continues to increase as large numbers of people survive into old age. Assisted living plays an important role if providing care to a growing aging population. To date, much of the care worker research has been conducted in nursing homes, and little has addressed well-being among the staff in ALFs. Using findings from a statewide study of satisfaction and retention of direct-care staff in assisted-living facilities in Georgia, this study examines the effect of sociodemographic, job, and attitudinal characteristics on self-rated health. The results of this study emphasize the need for new strategies to improve health among workers in ALFs.

Andrea N. E. Lloyd
Graduate Program: Psychology
Advisor: Denis O. Gray

An Investigation of Research Partnerships between Historically Black Colleges and Universities and Predominantly White Institutions

The creation of collaborative partnerships between historically black colleges and universities (HBCUs) and predominantly white institutions (PWIs) is regarded as a very promising mechanism for strengthening the educational pipeline for student populations that are underrepresented in research fields of study and for strengthening the research infrastructure of HBCUs. In spite of the growing popularity of HBCU-PWI research partnerships, there is virtually no data on the characteristics of these partnerships and the factors that affect partnership outcomes.

The current research sampled a population of HBCU-PWI partnership principle investigators (HBCU PIs, n=8; PWI PIs, n=8). For the purposes of comparative analyses, a sample of PWI-PWI partnership PIs (n=10) also was obtained. Partnership PIs responded to forced-choice and open-ended items during a structured interview. Based on their responses, the major characteristics of these partnerships are described, and comparisons are made between the PI groups. Regression analyses were performed to determine which factors predict partnership outcomes, including satisfaction with the partnership process and project outcomes, perceptions of partnership success, and PI willingness to participate in similar partnerships in the future. Qualitative analyses of responses to open-ended interview items were also conducted. Study results indicate that PIs of HBCU-PWI partnerships regard their partnerships as successful and are satisfied with project outcomes and partnership processes. Furthermore, the data show that HBCU-PWI partnerships have goals that are more focused on the research training underrepresented groups than do PWI-PWI partnerships. The extent to which university resources were allotted for PIs' participation in their partnerships, PI perceptions of partner capability, the location of face-to-face meetings, and the number of partners involved were found to predict some partnership outcomes. Implications for partnership strategy and public policy are also discussed.

Kelly N. Martin
Graduate Program: Communication, Rhetoric and Digital Media
Advisor: Vicki Gallagher

Design for Facebook: Target's visual argument in the world of social networking

The United States of the 21st century is often characterized as an image-saturated society. The increasing flow of images has led to what some scholars and image makers refer to as the design economy. The consumers in this economy appreciate style and have made style a mandatory consideration for businesses who wish to succeed, whether they make MP3 players or scrub brushes. The Target Corporation is often credited as a key player in bringing the design revolution to the masses. In 2002, Target made "Design for all" its official company philosophy and the success of its design ventures have prompted some designers to argue that, "if there were an organization devoted to the advancement and support of design, it could hardly do the job better [than Target]" (Shapiro, 2005, p.50). Further extending its influence, Target launched one of the only successful sponsored group pages on Facebook lifting its back-to-school sales 6.1 percent in 2007. Given Target's influence in design and social networking sites, questions about Target and its visual rhetoric are investigated: What do Target's web-based representations and design features argue about individuality, creativity and beauty? What do they argue or imply about design and control? In order to explore these questions, this paper examines the visual argument, as defined by Birdsell &Groake, of the Target Facebook group page as part of a broader analysis of the website as a whole using Lister & Well's (2001) method for analyzing visual culture. The analysis specifically explores the context of the visual and the context of the verbal as related to visual culture—defined as the values, conditions of production, habits of interpretation – and the concept of the gaze. Findings reveal that the Facebook page introduces and provides a particular perspective on issues of democracy and power. Target incorporates a modernist stance in its argument, namely, that users have the power to improve and reshape their personal environment simply by shopping at Target. By making visible an aesthetically perfect world, the typical Target images bate the Facebook user into accepting the message: great design is for everyone—or, at least, for everyone to purchase.

Fred Mayhew
Graduate Program: Public Administration
Advisor: Elizabethann O'Sullivan

Mandated Evaluation: The Influence of the Funder-Fundee Relationship on Factors Associated with Utilization

Two forces drive the presence of evaluation within the nonprofit sector. First, a confluence of events has led to concerns over nonprofit accountability (Fredericks, Carman, & Birkland, 2002). Expansion of the size and influence of the nonprofit sector has prompted calls for oversight and accountability from a wide range of stakeholders including government, foundations, individual donors, clients, and the media (Kearns, 1994). Second, there is a prevailing belief that funding organizations can serve as the impetus for increased efficiency and effectiveness within the sector (Porter & Kramer, 1999). The rhetoric of evaluation is that it can serve as tool that accomplishes these goals. The role played by the funder-fundee relationship in determining whether this connection takes place is a focus of this study.

While considerable research has been conducted in the areas of evaluation utilization and collaboration, the two streams of research have yet to be integrated in an effort to assist in our understanding of how the funder-fundee relationship will influence the evaluation process and the use of evaluation findings. By viewing the funder-fundee relationship as a strategic alliance and examining how the form of the relationship influences factors associated with evaluation utilization, this study seeks to broaden our understanding of why mandated evaluations are or are not used. This paper is based on data currently being collected on the North Carolina Smart Start initiative. Data is analyzed using structural equation modeling. Preliminary analysis indicates that a more integrated and formalized funder-fundee relationship leads to a more participatory evaluation process and a greater likelihood that evaluation findings will be used in organizational decision-making.

Laura McKinney, Gregory M. Fulkerson, and Edward L. Kick
Graduate Program: Sociology
Advisor: Edward L. Kick

Investigating the Correlates of Biodiversity Loss: A Cross-National Quantitative Analysis of Threatened Bird Species

Sociological literature has increasingly become concerned with environmental issues. One less developed area of inquiry in this vein has been the study of anthropogenic impacts on biodiversity. Expanding the scope of the intersection between political economy and environmental sociology, this study investigates the causes of biodiversity loss by focusing on bird species. We approach this topic through the study of threatened bird species by drawing on the small number of existing studies and by contributing our own original cross-sectional analysis of

country-level data. We test our main hypothesis that world system position produces differential processes that lead to different levels of species loss in the core, semiperiphery, and periphery. Findings from a cross-national analysis of 139 countries support this hypothesis. Utilizing OLS regression techniques, results reveal several interaction effects that provide support for the basic theoretical propositions of world-systems theory. Additionally, we find that world system position is especially important in predicting the effectiveness of state environmentalism. Other findings are related to modernization and treadmill of production theory. We find partial support for Treadmill of Production theory and the various ecological perspectives in the Malthusian tradition. Our results fail to support ecological modernization theory. More broadly, this research emphasizes the importance for sociologists investigating environmental impacts to consider the role of differential world system effects. Future research goals are also addressed.

Andrea V. McPherson, Kristen L. Lewis, Amy E. Lynn, Mary E. Haskett, and Tara S. Behrend
Graduate Program: Psychology
Advisor: Mary E. Haskett

Predictors of Parenting Stress for Abusive and Nonabusive Mothers

Stress that arises from the demands of parenthood is linked to several aspects of parenting, including parental warmth and discipline practices. Because stress has a negative impact on parenting quality, there has been an effort to achieve an understanding of determinants of parenting stress. There is some suggestion in the literature that determinants of parenting stress might vary across groups of parents. However, few investigations have been designed to examine models of stress for samples that include both high risk parents and those without elevated levels of stress. It seems likely that determinants of stress might be different for low-risk samples of generally warm, sensitive parents and those at the extreme end of harsh discipline, such as abusive parents. This study was designed to explore a model of parenting stress for abusive (n=80) and nonabusive (n=86) mothers through a series of hierarchical linear regression analyses. In the model, the degree to which mothers were bothered by child misbehavior and severity of mothers' psychological distress were hypothesized to mediate the relationship between observed child behavior and parenting stress. Results indicated that, for both sets of mothers, tolerance for their children's misbehavior and severity of psychological distress served as significant predictors of parenting stress. However, observed child behavior was significantly related to parenting stress only for abusive mothers. For abusive mothers, tolerance for disruptive child behavior and level of psychological distress mediated the relationship between observed child behavior and parenting stress. In conclusion, abusive and nonabusive mothers might benefit from similar intervention practices aimed at reducing overall parenting stress. However, abusive mothers might also benefit from interventions that aim to reduce the influence of their child's behavior on their level of stress in the parenting role.

Michael Noschka
Graduate Program: English
Advisor: Carmine Prioli

Oration of a Condemned Soul: Confession and Performance in the Execution Sermon of Rebekah Chamblit

In his 1718 ordination sermon, "A Practical Discourse Relating to the Gospel Ministry," Thomas Foxcroft acknowledged his use of shocking language and rhetoric as a means by which to "breathe heavenly fire to melt and enliven…dead affections." On the 23rd of September 1733, there can be no doubt that dead affections were enlivened in the hearts of all those present to witness the execution of Rebekah Chamblit and hear her final words.

For contemporary scholars, Rebekah Chamblit's "Declaration, Dying Warnings and Advice" stands as one of the fundamental narratives of guilt and confession in eighteenth-century New England, serving as a model of the theater of conversion which unfolded regularly on the executioners' stage: the pillory. Chamblit was so morally blackened by her crime of infanticide that private confession and death were supposedly not enough to slake her guilt. After weeks in jail, and purportedly of her own volition, Rebekah expressed her desire to publicly acknowledge her shame that it might seek to dissuade other young people, most adamantly those of her own impressionable sex, not to follow in her tarnished footsteps, which, though she may be pardoned by Christ, she was not by the law, and thusly climbed not Jacob's ladder, but ascended the gallows.

Chamblit's confession, accompanied here for the first time in over two hundred years by both excerpts from Foxcroft's sermon, and her dialog with Mather Byles, a local minister, just minutes prior to her ascension to the pillory, paints a vivid picture of the dynamic drama of the Puritan conversion narrative which was so crucial to the retention and maintenance of social order in colonial New England.

Sharon R. Paynter and Richard C. Kearney
Graduate Program: Public Administration
Advisor: Richard C. Kearney

Who Watches the Watchmen? Evaluating Judicial Performance in the American States

Judicial Performance Evaluation (JPE) is an objective process for assessing the performance of judges. It has two overriding institutional objectives: judicial self improvement and constituent education. JPE programs are presently mandated in 20 states and under consideration in several others.

Scholars and practitioners in human resource management are in general agreement that effective performance appraisal systems must meet the following criteria: clear objectives; reliability and validity of the appraisal methods; separation of personal judgments and bias from job-based performance assessments; employee acceptance of the evaluation system; and leadership's commitment to the appraisal process.

Based on data gathered from state reports, surveys, case histories, and the very few empirical analyses of judicial performance appraisal extant, this paper juxtaposes JPE and the criteria for effective appraisal systems. We find that JPE is a performance appraisal tool that meets the criteria for effective performance appraisal. We conclude that public administration can contribute significantly to the study of the courts.

Zoraya Place
Graduate Program: Foreign Languages and Literatures
Advisor: James Michnowicz

Second person singular pronouns in San Salvador: vos, tú, and usted

The Spanish of El Salvador has been singled out as a variety that presents the beginnings of a three pronoun system, with *tú* being employed by some as an intermediate form between *vos* and *usted* (Lipski 1986). Previous attempts to explore this development have concentrated on Salvadoran speakers within the United States (Lipski 1986, Schreffler1994, Hernández 2002), where they are in close contact with dominant Mexican varieties of Spanish employing consistent *tuteo*. The present study, however, examines pronoun choice among speakers within El Salvador, designed as an initial step in understanding pronoun use within a noncontact environment, the capital city of San Salvador. For the present study, 84 linguistic surveys (adapted from BaumelSchreffler 1994) were administered in San Salvador by a native speaker from that city. The participants were asked to identify which pronoun they would use with various interlocutors, as well as open ended questions about the perception speakers have of each pronoun. Surveys were accompanied by a questionnaire, used to locate the subjects within the social groups of age, gender, education, place of birth, place raised, and if they have lived outside of El Salvador. Results show that, as expected for a region defined by *voseo*, *vos appears* in the present corpus almost twice as often as *tú* (29% vs. 15%). The rest of the cases are made up of the formal *usted*, used almost categorically according to standard Spanish norms (with persons of authority, older people, etc.). A more in depth analysis of contexts open to pronoun variation, however, discovers some interesting trends. First, for interlocutors identified as friends, middle aged speakers report the highest rates of *tú* (21%). This result supports Lipski (1986), which showed an incipient three part system on the part of speakers from this generation. The present data demonstrate, however, that pronoun preference has changed among young speakers. Across the data, young speakers consistently report higher rates of *vos* and lower rates of *tú* regardless of interlocutor. Gender and education were also found to be significant factors, with men and higher educated speakers preferring *vos.*

These data, and others to be discussed, suggest that the previously identified trend towards *tuteo* has reversed among young speakers, possibly reflecting a widespread trend toward the adoption of regional forms among younger. Further data and conclusions based on interlocutor, gender, education and residence are discussed.

Sarah G. Ross, John C. Begeny, Brian Robinson, and C. Fleming Harris
Graduate Program: Psychology
Advisor: John C. Begeny

Effects of Varied Duration and Participant Groupings on Reading Fluency

A large number of students in the US do not acquire basic literary skills. A critical element in learning to read well is reading fluency. Although there are several evidence-based fluency interventions, research is still needed to better understand how to implement these interventions in the most efficient way. This presentation will describe the differential effects of a reading intervention package implemented with varying durations (12-15 minutes vs. 17-20 minutes) and student groupings (small group vs. one-on-one). Using an alternating-treatments design, the general findings of the study suggest that using a longer intervention is more effective, but there is little difference between small-group vs. one-on-one implementation. Attendees of this presentation will learn about previous research, plus the effects of varying intervention duration and student grouping on reading fluency.

Jennifer Schneider
Graduate Program: Psychology
Advisor: Denis O. Gray

A Multivariate Analysis of Factors that Predict Graduate Student Satisfaction and Performance in Cooperative Research Centers

Graduate students who participate in NSF Industry-University Cooperative Research Centers (CRCs) are perceived as having educational advantages such as interactions with industry members, career opportunities, increased scholarly production, and development of soft skills (teamwork, communication). However, these educational advantages are mostly speculative assumptions. Evaluation occurs regularly on several components of the CRC program; yet, there is a lack of analysis concerning students involved with the centers. Consequently, center programs are missing opportunities to enhance their educational outcomes. The purpose of this study was to identify center characteristics and training mechanisms that explain positive graduate student outcomes and to develop and test a multivariate model that explains the impact of center, and individual factors on subjective and objective outcomes of graduate students involved in cooperative research centers. A web-based survey was used to collect data from almost 200 graduate students trained at 34 CRCs from around the country. A cross-sectional predictive analysis was conducted to identify which individual center mechanisms (e.g., training activities; center experiences; technical involvement, interactions) and individual characteristics positively or negatively influence graduate student subjective (e.g., satisfaction, skills), and objective (e.g., career goals, scholarly productivity) outcomes. The results of this study suggest that centers that provide rich informal multidisciplinary and experiential center training experiences and who involve their students more in their center's technical process (design, data collection, results) have a positive impact on student benefits (e.g., satisfaction, perceived skills). Preliminary multivariate analyses suggest CRCs vary to a considerable extent on the training mechanisms (e.g., seminars, internships) they deploy and the informal training experiences students receive and that these differences explain a significant amount of the variance in student benefits. Since this is the first multivariate study on center training mechanisms, findings from this study will help CRCs improve the center-based training experiences they offer their students.

Todd M. Skorich
Graduate Program: English
Advisor: Carolyn R. Miller

Tragic Culture and *Chronos* in *A Course in Miracles*: *Nietzsche's Concept of Time Embraced in Religious Thought*

As stated in *Beyond Good and Evil*, Nietzsche became engrossed in "the fight against Plato … the fight against the Christian-ecclesiastical pressure of the millennia." Nietzsche argued that Christianity is ensconced with Plato's philosophical, linear idea of time, and, in *Genealogy of Morals*, that "there could be no happiness, no cheerfulness, no hope, no pride, no *present*, without forgetfulness." This "forgetfulness" is an impossibility in philosophical, linear time (and thus in Christianity), but Nietzsche offers an alternative in tragic culture. Tragic culture lacks memory and provides no relationships other than momentary ones that are forgotten when the moment passes; moreover, tragic time *has depth* as it is a singular moment running eternally.

In *A Course in Miracles*, Columbia psychology professor Helen Schuman offered an alternative to many Christian ideas in the 1970's. *ACIM* is the closest thing alternative spiritualities have to a revered, widely accepted sacred text—with over 1.5 million English versions in circulation (as well as translations in nearly 20 other languages), thousands of discussion groups have formed, blossoming into support organizations around the world.

Much as Christianity draws upon Plato's idea of philosophical, linear time, *ACIM* draws upon Nietzsche's idea of tragic time. Some scholarship has connected Nietzsche's writings with *ACIM* and its concept of time, but none has specifically linked Nietzsche's tragic culture with the writings in *ACIM.* My project redeems Nietzsche's grandiose opinions of those he called 'the ancients' by comparing them to a contemporary subculture that attempts to apply the same notions of tragic time to everyday life. My research elucidates *ACIM*'s foundations in tragic time and delineates the intellectual (and spiritual) effects of living in a contemporary subculture that subscribes to some radical notions of a metaphysical text that invites the embrace of tragic culture.

Avril A. Smart, Niambi Hall-Campbell, and Pamela Martin
Graduate Program: Psychology
Advisor: Pamela Martin

Parental Religious Beliefs and their Racial Socialization Practices: Relationship to their Adolescents Racial Identity Attitudes

Research on race related socialization messages and racial identity has received a great amount attention in understanding adult and adolescent behavior (Stevenson 1994; Hughes & Johnson 2001; Thomas and Speight 1999; Baldwin 1948). Recently, researchers have begun to explore theological orientations with African American

churches as a racial socialization agent (Martin & McAdoo, 2007). Empirical research reports that African American parents socialize their children about race and racism differently (Marshall 1995; Peters 1985; Parham and Williams 1993; Thornton, Chatters, Taylor and Allen 1990; Sanders- Thompson 1994; Thomas and Speight 1999), and that the African American church has a responsibility to help parents in socializing their children about race (Lincoln and Mamiya 1990; Mitchell and Thomas 1994; Paris 1985). To date, a dearth of research exists regarding how both parental religious beliefs and racial socialization practices influence their adolescents' racial identity. Thus, the purpose of this poster is to investigate the aforementioned relationship between parents' religious beliefs, methods of racial socialization and the impact they have on adolescent racial identity attitudes. The participants were part of a larger study examining religiosity, theology, and racial socialization. The 206 parent-adolescent dyads were recruited from twenty-five predominantly faith communities in the Mid and Southeastern Michigan. Several hierarchical regressions assess the studied relationships in this research.

Sarah R. Weatherbee, Alyssa A. Gamaldo, and Jason C. Allaire
Graduate Program: Psychology
Advisor: Jason C. Allaire

Examining the Within-person Coupling of Physiological Functioning and Cognition

The current study examined the extent to which day-to-day fluctuations in systolic blood pressure and reading vision are associated with performance on three measures of cognition. Data came from 36 community dwelling elders with a mean age of 73 years (range = 60 – 87; SD = 5.45), whose blood pressure, vision and cognitive functioning were tested on 120 occasions (twice a day for 60 consecutive days) for a total of 4320 observations. Hierarchical linear modeling was used to examine the within- and between-person effects of blood pressure and vision on reasoning, memory, and processing speed. Results indicated that there was significant variability on all three cognitive tests; the within-person variability ranged from 23 – 67%. Significant within-person variability was also found for reading vision (50%) and systolic blood pressure (29%). Coupling analysis indicated a significant and negative within-person relationship between systolic blood pressure and reasoning as well as an effect of daily reading vision on memory and speed performance. Specifically, on occasions of high blood pressure or low vision, cognitive performance suffered. Discussion will focus on the theoretical and practical implications of the within-person coupling of physiological and cognitive functioning.

Blake Wilder
Graduate Program: English
Advisor: Jon Thompson, Ann Baker and Milton Welch

MANHOOD MATTERS: The Racial Politics of Constructed Masculinities

My research project incorporates theoretical perspectives and literary analyses in order to illuminate the structural creation and functioning of racial identities. Grounded in a reexamination of the historical context following the Civil War and the collapse of Reconstruction and making use a of methodological approach informed by post-structuralist, critical race, and gender theory, I interpret the rise of lynching as a concerted effort to reinstitute the racial power structures of slavery through a coded gender hierarchy. Lynching and castration enacted a physical *and* symbolic emasculation of African American men. This violent and symbolic construction of masculinities created a stratified system that positioned white masculinity as hegemonic and black masculinity as subordinate.

Silence regarding the arbitrary construction of racial categories is a necessary structural requirement for those categories to appear stable. I aim to destabilize the apparently natural quality of racial categories, and thus the notion of white superiority, by tracing how key works of American literature have been shaped by and responded to these structural relations.

The racialized and gendered symbolic nature of lynching remains largely unacknowledged and makes this topic not only illuminating from a literary perspective but also relevant to ongoing social issues. This critical approach provides a useful way to interpret such varied subjects as the 1898 Wilmington race riots, the rhetoric of Martin Luther King Junior's "I have a dream speech," the braggadocio of hip hop culture, and the recent furor surrounding nooses and racial justice in Jena, Louisiana. This work will promote a more equitable society by furthering an understanding of the ways in which language structures social relationships. More specifically, it will advance an understanding of race relations in America and critique the erroneous view that racial injustice ended with the Emancipation Proclamation or the Civil Rights Movement.

Simone Carolina Bauch
Graduate Program: Forestry and Environmental Resources
Advisor: Erin Sills

To Log or Not to Log: Discount rates and the fate of the Amazon

Management of tropical forests has received considerable attention in the literature, but models providing guidance on production of multiple outputs are scarce. Harvest of timber damages non-commercial species, affecting fruit production from all species; therefore the production of timber and non-timber products should be modeled jointly. My study addresses this gap by simulating joint timber and fruit production under different logging scenarios and evaluating these scenarios by the net present value of profit. As fruit production and market conditions are highly variable, I included stochastic components in these parameters. I applied the model to the Tapajós National Forest in the Brazilian Amazon in which 1200 households live from subsistence agriculture and extraction of forest products. Data come from literature, ecological data, and community questionnaires. Results show great variability in profits both between products and between years for a same product, which illustrates the difficulties of relying on non-timber forest products as a main income generating activity. The optimal management scenario depends on the discount rate: higher discount rates are associated with intensive logging, while the lowest rates imply that optimal management should be for fruit only. One policy implication is that developing the market for native fruit (by increasing prices and decreasing their variability) could reduce incentives for unsustainable logging practices.

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Advisors: Erin Sills and Bob Apt

The cost of gypsy moth sex in the city

Increasing global trade and travel are resulting in the unintentional introduction of many non-indigenous species. Although only a minority become established upon their arrival, there are considerable costs associated with these alien species (estimated at $122 billion USD annually in the US). The gypsy moth, *Lymantria dispar* (L.), is responsible for a portion of these costs. Prior research on gypsy moth has shown that most of the economic impact occurs in residential areas, but this impact has not been well quantified. Therefore, we focus on the impacts of gypsy moth in urban and suburban forests. We quantify these impacts in Baltimore and Jersey City, two cities that have experience with gypsy moth outbreaks and detailed urban forest inventory data. We develop a three-stage conceptual framework to assess the consequences of gypsy moth outbreaks. The first and second stage are combined into low and high outbreak scenarios of three-year duration, with percent defoliation and mortality varying by species susceptibility. In the third stage, we quantify costs (out-of-pocket expenditures on suppression, tree removal and replacement, and treatment of rashes) and losses (decreases in monetary and non-monetary values associated with aesthetics, reduced energy consumption, air quality, nuisance, and recreation). This model will be applied to other cities that are not yet infested by the gypsy moth to determine potential future impacts. Our study provides not only a quantification of current and future gypsy moth impacts in cities, but also a framework that could be applied in future studies that seek to quantify impacts of other non-indigenous invasive pests.

Rachel L. Cook[1], James Landmeyer[2], Brad Atkinson[3], Jean-Pierre Messier[4], and Elizabeth Nichols[1]
Graduate Programs: Forestry and Environmental Resources, North Carolina State University[1]; US Geological Survery[2], North Carolina Department of Environmental and Natural Resources-Division of Waste Management[3]; US Coast Guard[4]
Advisor: Elizabeth Guthrie Nichols

Phytoremediation of a Petroleum-Hydrocarbon Contaminated Aquifer US Coast Guard Support Center, Elizabeth City, NC

This project is a demonstration site for North Carolina Department of Environmental and Natural Resources (NCDENR) as part of the US EPA 319 Program. The primary project goal is to prevent petroleum contamination from entering the Pasquotank River at the US Coast Guard Support Center, Elizabeth City, NC. We will also evaluate the impact of trees on polycyclic aromatic hydrocarbons (PAH) weathering of the residual fuel in soil. The river is approximately 500 feet from a former fuel distribution facility that contained both above-ground and below-ground storage tanks. Prior to planting a mixture of hybrid poplar and willow trees, additional monitoring wells were installed, and groundwater, soil, and soil-gas samples were collected and analyzed. Three phases of planting have occurred at the five-acre site. In April of 2006, 120 poplars were planted between the estimated contaminant plume and the river. In June of 2006, 380 poplars and willows were planted over the most concentrated residual petroleum contamination. Between June and November 2006, 7.5% of Phase I and 60% of Phase II trees died. In April 2007, 2,222 hybrid poplar and willow trees were planted to cover the remainder of the site along with 237 replacements for Phase I & II tree mortality. Three-foot cuttings were planted in auger holes

that were backfilled with clean topsoil. Site assessment includes: (1) monitoring groundwater for BTEX and MTBE; (2) analyzing soil samples for 42 alkylated and non-alkylated PAHs, and (3) analyzing soil-gas samples for total petroleum hydrocarbons, BTEX, MTBE, and specific PAH analytes by W.L. Gore and Associates, Inc.

Rafael Estevez, Dennis Hazel, Erin Sills, Robert Bardon, and Arnie Oltmans
Graduate Program: Forestry and Environmental Resources
Advisors: Dennis Hazel and Robert Bardon

Using Cost-Benefit Analyses of a Landowner Cost-Share Program for Southern Pine Beetles to Design Outreach Programs

Publicly-funded forestry cost-share programs usually have the following common objectives: (1) provide incentives for private landowners to implement better management practices on their forests, and (2) provide ecosystem service benefits for the public at large through improved management. In implementing these programs, state and federal government agencies have the challenge of documenting benefits to legislative bodies for long-term funding. The North Carolina Division of Forest Resources (DFR) Southern Pine Beetle Prevention Program (SPBPP) was authorized and funded by the USDA Forest service Forest Health Protection program in 2004. The objective of this program is to encourage eligible forest landowners in North Carolina to improve forest health and reduce the threat and severity of Southern Pine Beetle (SPB) attack through technical assistance and cost-sharing of precommercial thinning (PCT) of pine stands. This study documents the costs and benefits of this cost-share program from both the landowner and the State of North Carolina perspective. Factors considered included risk reduction for SPB for landowners, SPB suppression cost savings, changes in volumes and values of future harvested products due to PCT, PCT direct costs (both landowner and agency), and program administration costs. Although not evaluated metrically, interest in the program across the state with its diverse stand types and conditions and demographics was examined. This study aided NCDFR program administrators with periodic evaluations and recommendations regarding more effective program administration and an update of the preliminary results is provided.

Balazs Horvath
Graduate Program: Wood and Paper Science
Advisors: Ilona Peszlen and Perry Peralta

Preliminary Study to Compare Micromechanical and Dynamic Mechanical Properties of Young Trees

Researchers at the Department of Forestry and Environmental Resources, NC State have been successful in genetically modifying the lignin content and/or composition of various hardwood species. This advancement has a potential influence on the properties of wood derived from the transgenic trees. Advanced evaluation of these young (1-3 years old) engineered trees are crucial to understanding the nature of lignin on the mechanical and viscoelastic properties of wood. The objective of this study was to develop and compare two mechanical testing methods to determine mechanical properties of small diameter (8-15mm) poplar trees (hybrid cross of *Populus nigra* and *Populus maximowiczii*). One approach involves micromechanical testing, where ASTM standard methods were modified to provide reliable and accurate modulus of elasticity (MOE) measurements. Special sample preparation and new clamps were introduced to measure cylindrical-shaped specimens. The other approach uses dynamic mechanic analysis (DMA). Softening temperature and MOE were measured on the same specimens that were used during the micromechanical tests. Preliminary results were analyzed and will be presented.

Gang Hu, John A. Heitmann, and Orlando J. Rojas
Graduate Program: Wood and Paper Science
Advisors: John A. Heitmann and Orlando J. Rojas

A New Method to Measure Cellulase Activity Using a Quartz Crystal Microbalance

The development of more efficient utilization of biomass has received increased attention in recent years. Cellulases play an important role in processsing biomass through advanced biotechnological approaches. Both the development and the application of cellulases require an understanding of the activities of these enzymes. A new method to determine the activity of cellulase has been developed using a quartz crystal microbalance (QCM) technique. We compare the results from this technique with those from the IUPAC DNS standard method, and also from the biccinchoninic acid and ion chromatography methods. It is shown that the QCM technique provides results closer to the ones obtained from the actual reducing sugars. The elimination of the use of color development in the standard redox methods makes the QCM platform easier to implement; it also entails more flexibility in terms of the nature of the substrate. Finally, the relationship between cystallinity of substrate used and the cellulase activity was explored. Numerical values of cellulase activities measured with the QCM method confirms that cellulose with higher crystallinity is hydrolyzed less and at slower rates than those with lower crystallinity.

Stan J. Hutchens and Christopher S. DePerno
Graduate Program: Fisheries and Wildlife
Advisor: Christopher S. DePerno

Using Community Parameters to Determine Land-use Effects on Reptile and Amphibian Assemblages in a Pocosin Wetland

Populations of reptiles and amphibians are declining world wide. Arguably, the primary cause of declines is land-use change (e.g., silviculture or conversion to agriculture). We employed 11 sampling techniques to determine the species richness of the herpetofaunal community at Bull Neck Swamp, a pocosin wetland. Data were used to compare observed (S(obs)) and estimated species richness (S), relative abundance, and species composition among four habitat preserves and a "manageable" area within the wetland. Our objectives were to: (1) derive community parameters for each habitat, (2) determine which preserves had species more vulnerable to the effects of land-use practices, and (3) provide recommendations for monitoring and management regimes in the future. Species richness estimates and similarity indices were derived using EstimateS 8.0. A post hoc species distribution across habitats was derived by the Nestedness Temperature Calculator Program. After two field seasons, 1, 581 total captures were recorded for 33 observed species (S = 34). Observed richness ranged from 7 – 32 species across habitats (S = 13 – 44) and abundances ranged from 99 – 873 individuals. Similarity indices were comparable between all habitats, with 90% of comparisons over 0.75 in similarity. Nestedness temperature calculation resulted in an even distribution (T = 12.6 °C). The Manageable area had the highest values of observed and estimated species richness and relative abundance, including 13 species captured only in that area. However, comparable similarity indices between habitats, an even species distribution, and habitat continuity suggested land-use practices would have little impact on the herpetofaunal community. Future management practices should be carefully considered and planned to mitigate effects to potentially vulnerable species detected within the Manageable area. We recommend other studies employ observed and estimated species richness, relative abundances, and species composition when comparing assemblages.

Inés M. Palacios
Graduate Program: Parks, Recreation, and Tourism Management
Advisors: Gene Brothers and Larry Gustke

An Investigation of Potential Segmentation Variables for the North Carolina Zoological Society

Many states and non-profit managed tourist attractions are supported by a large cadre of "friends'" or membership groups. Zoological parks rely extensively on membership groups, which are traditionally referred to as "society" groups. The purpose of this study was to examine the relationships that demographic or travel behavior variables might have with type of membership or reason for joining the NC Zoo Society. Secondary data acquired from the NC Zoo Society were analyzed. The conceptual framework that guided the investigation was market segmentation. The data were collected by the NC Zoo Society using a web-based questionnaire sent to 10,000 of their members (18.7% response rate). Results of cross-tabulations, chi-square tests of association, ANOVA for selected variables supported 8 of the 12 proposed hypotheses. There was a positive association between education level and type of membership, income level and type of membership, age and type of membership, and distance traveled and type of membership. Similar associations were found between time traveled and type of membership. Additional associations were found between number of children and reason for joining. Regarding reason for joining, distance traveled and time traveled appeared positively associated with interest in conservation. Recommendations for market segmentation of the NC Zoo Society were offered based on the results. The results of this study did not confirm an association between gender, ethnicity, or number of children and type of membership or the relationship between gender, ethnicity, age, education, or income and reason for joining. These should be investigated further. Future investigation of the NC Zoo Society and other "friends' groups" should also include a mixed-mode approach (a combination of online, paper/pencil, and personal interviews), which will allow for the collection of richer data that can be used to develop marketing programs to attract new and retain current zoo society members.

Sameerkumar Patel[1], Richard A. Venditti[1*], Joel J. Pawlak[1], Ali Ayoub[2], Said Rizvi[2]
Graduate Programs: Wood and Paper Science, North Carolina State University[1]; Department of Food Science, Cornell University[2]
Advisors: Richard Venditti and Joel Pawlak

Development of cross-linked starch microcellular foam by solvent exchange and reactive supercritical fluid extrusion

There is an interest to produce hydrophobic biodegradable materials from renewable resources like starch that can be utilized as a filler or pigment in paper, coating, and packaging applications. Over the last two decades significant research has been conducted to utilize starch in its solid form as a biodegradable material. Starch microcellular foams (SMCF) are foams prepared by pore preserving drying or formation processes that contain significant concentrations of pores below 10 micrometers. Such materials will have high specific surface area and

thus be useful for applications such as opacifying pigments or as absorbent or adsorbent materials. For applications such as fillers or coating particles applied in an aqueous media, SMCF may lack the water resistance required to maintain its structure. To overcome this obstacle several alternative ways can be applied to SMCF to increase water resistance such as cross-linking, as studied herein. The objective of this research was to determine how the processing conditions and the use of a cross-linking material would affect the foam structure, physical and optical properties and moisture related properties.

Molded SMCF was produced by a slow solvent exchange (40, 70, 90, three 100% ethanol exchanges at 48 hr) and fast solvent exchange (three 100% ethanol exchanges at 48 hr) from corn starch cooked at three different cooking extents. Extruded starch samples were also processed with the slow and fast exchange. Three types of extruded samples were made: (1) extruded cornstarch, (2) extruded cornstarch with cross-linker, and (3) extruded starch with cross-linker and CO_2. Pore structure was characterized from SEM images. Density, brightness, water swelling and mass loss, moisture content and water contact angle were measured.

Extruded samples showed large pores whereas molded samples showed a much finer pore structure. The molded starch samples had significantly lower density and higher brightness than did extruded samples and cross-linking had a significant effect on water resistance.

Aimeé Rockhill and Chris DePerno
Graduate Program: Fisheries and Wildlife
Advisor: Christopher S. DePerno

Using bobcat as an indicator species in developing a management plan for Bull Neck Swamp Research Forest, N.C.

Currently, hunting and trapping regulations for bobcat in North Carolina are based on an incidental harvest survey of deer hunters conducted in the late 1980's. Although bobcats currently are not threatened or endangered, survey techniques that accurately estimate population sizes do not exist to aid in population management. We compared a number of survey techniques for population estimation of bobcat in coastal plain habitat of North Carolina. Survey techniques implemented include; spotlight, scent station, camera monitoring, predator calling, hair-snares, wildtrack, and opportunistic. An index of 26 bobcats was estimated with the scent-station survey technique, whereas an index of 51 bobcats was estimated with the camera monitoring technique. Also, the camera monitoring technique allowed us to identify 6 individual bobcats based on unique coat patterns. No bobcats were detected with the predator calling, hair-snare, or spotlight techniques. The wildtrack database is in the process of being constructed through the help of local zoo's and will aid in developing a more precise population estimation of bobcat once completed. This research will give wildlife managers a number of techniques to estimate bobcat populations and help set season dates and limits throughout North Carolina.

Amelia L. Savage[1], John A. Gerwin[2], and Christopher E. Moorman[1]
Graduate Program: Fisheries and Wildlife[1]; North Carolina Museum of Natural Sciences[2]
Advisor: Christopher Moorman

Foraging habits of *Limnothlypis swainsonii* in a managed forest landscape

A significant percentage of southeastern U.S. bottomland forests have been lost or altered as a result of flood control projects and conversion to agriculture, pine plantations, and urban areas. Swainson's Warbler (SWWA), a migratory songbird that breeds in bottomland hardwood, is thought to be one of the least abundant breeding songbirds in the Southeast, and has disappeared entirely from its historical ranges in Maryland, Delaware, Missouri, and Illinois. Little is known about their foraging habits except that they are insectivores with a large bill used to flip fallen leaves on the forest floor. To identify SWWA food habits, we captured and crop flushed 78 SWWA in a South Carolina bottomland. We also sampled leaf litter arthropods and vegetation at each SWWA capture location. We compared the frequency of arthropod orders detected in crop flush samples to the frequency of arthropods collected in leaf litter samples to determine which orders were eaten by SWWA more or less than their proportional availability. Finally, we determined if the arthropod orders most frequently recorded in SWWA crop flush samples were more abundant in specific types of microhabitats (e.g., low sedge cover, high leaf litter cover).

Corey S. Shake
Graduate Program: Fisheries and Wildlife
Advisor: Christopher E. Moorman

Effects of Patch Size, Shape, and Landscape Context on Bird Occupancy and Nesting Success in Scrub-Successional Riparian Buffer Habitat

Populations of many bird species associated with scrub-successional habitat are declining in the eastern United States. The Conservation Reserve Enhancement Program (CREP), which aims to reduce soil erosion and improve

water quality on agricultural land, has potential to create habitat for declining scrub-successional birds. However, the riparian buffer habitat patches created by CREP are highly variable in size, shape, and surrounding habitat matrix and it is unclear how these characteristics affect species composition and breeding productivity of birds that use the patches. Our objectives are to determine how patch size, shape, and landscape context affect (1) which scrub-successional bird species of concern will occupy a patch and (2) the nesting success of five scrub-successional focal species: blue grosbeak (*Guiraca caerulea*), field sparrow (*Spizella pusilla*), indigo bunting (*Passerina cyanea*), prairie warbler (*Dendroica discolor*) and yellow-breasted chat (*Icteria virens*). We surveyed 35 individual habitat patches for the presence of 11 scrub-successional species to model individual species occupancy relative to patch characteristics. We also selected a subset of 12 of these habitat patches and monitored focal species' nests within each patch to calculate nesting success. Analysis of our first year of data for this two-year study is ongoing and preliminary results are pending. Results of our research will help CREP administrators and field personnel design riparian buffers with characteristics that are most likely to improve avian diversity and reproductive success.

Hayley D. Stevenson[1], Daniel J. Robison[1], Fred W. Cubbage[1], J. Paul Mueller[2], Matthew H. Gocke[1], and Michael G. Burton[2]
Graduate Programs: Forestry and Environmental Resources[1]; Crop Science[2]
Advisor: Daniel J. Robison

Mulching with Farm Wastes as a Management Technique in Agroforestry

Agroforestry is the practice of managing crops and trees on the same land, and has long been practiced in tropical regions. The positive social and environmental benefits of these systems have been studied in the tropics, but are only recently being recognized in many temperate regions. Using mulch around newly planted trees can have a positive impact on tree success. Further, using on-farm waste materials as mulch can be helpful as excess organic material on farms is often problematic to the farmer. This study aimed to measure the efficacy of mulches around tree seedlings in an agroforestry plot. An agroforestry study was installed in Goldsboro, North Carolina, with five replications. Alley strips (running the length of the 5ha soybean field) were planted with tree seedlings: longleaf pine (*Pinus palustris*), loblolly pine (*Pinus taeda*), and cherrybark oak (*Quercus pagoda*). The wastes used as mulch were bermudagrass hay (*Cynodon dactylon*), corn stover that had been used as hog bedding, black plastic film (4mm), and a no-mulch control. Mulch material was placed around study trees in a replicated approach. Mulched trees and surrounding areas were measured and evaluated for first year weed suppression, soil moisture and temperature, nutrient concentration in wastes, plant tissue and soil, and seedlings growth. Data were subjected to ANOVA, and the Tukey-Kramer pair-wise comparison tests. In control plots, weed biomass and stems averaged twice as many than the mulched plots. Soil moisture was higher under mulched plots, and soil temperature followed moisture trends. Hay mulch had more nitrogen concentration than other waste materials and had a positive effect on the height of the longleaf pine as compared to the other mulches. These first-year findings support the position that mulching with on-farm wastes may be a valuable management tool in agroforestry systems. Continued monitoring of this study is planned.

Geoffrey Bell
Graduate Program: Marine, Earth and Atmospheric Sciences
Advisor: David Eggleston

Molecular keys unlock the mysteries of variable behavioral and survival responses to hypoxia

Low dissolved oxygen (DO) (i.e. hypoxia) is a major threat to coastal ecosystems, yet generalizing impacts of episodic hypoxic events on fish and shellfish populations across hypoxic events is difficult due to differences in event hydrodynamics as well as behavioral and physiological responses among individuals. Identifying the specific hydrodynamic cues that elicit animal responses as well as understanding how physiology modifies behavior and survival are key to predicting the impact of hypoxia on estuarine animals. My research integrates laboratory experiments, computer models, and molecular techniques to understand the physiological basis for avoidance behavior and survival of blue crabs (*Callinectes sapidus*) during hypoxic events. Blue crabs were tolerant of hypoxia but exhibited considerable inter-individual variability in survival due to the structure of their oxygen-binding protein, hemocyanin (Hcy). Hypoxia-tolerant individuals expressed an Hcy phenotype with high affinity for DO suggesting that blue crabs acclimate to hypoxia; potentially mitigating the impact of hypoxia on wild populations. Changes in DO initiated blue crab avoidance behaviors, regardless of whether the change resulted in hypoxia, but the magnitude of this behavior was positively correlated with rate of change in DO. Therefore, blue crabs may anticipate hypoxic events and modify their escape responses based on hypoxic event severity. Crabs expressing the high O_2 affinity Hcy phenotype were less active in hypoxia than less tolerant conspecifics, suggesting hypoxia-acclimated crabs may use a "wait-and-see" avoidance strategy in contrast to an alarm response by less tolerant individuals. This study is the first to document a physiological mechanism in invertebrates to explain behavioral and survival differences among individuals. How these physiologically-induced differences affect population-level responses to hypoxia is unknown but I am developing an individual-based computer model that simulates hypoxic events as well as crab behavior and survival to predict the impacts of hypoxia on blue crab population dynamics.

Miyuki Breen[1,2], Michael S. Breen[3], Natsuko Terasaki[4], Makoto Yamazaki[4], and Rory B. Conolly[1,2]
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Advisors: Alun L. Lloyd and Rory B. Conolly

Computational Steroidogenesis Model to Predict Biochemical Response to Endocrine Active Chemicals: Model Development and Cross Validation

Steroids, which have an important role in a wide range of physiological processes, are synthesized primarily in the gonads and adrenal glands through a series of enzyme-mediated reactions. The activity of steroidogenic enzymes can be altered by a variety of endocrine active chemicals (EAC), some of which are therapeutics and others that are environmental contaminants. We are developing a dynamic mathematical model of the metabolic network of adrenal steroidogenesis to predict the synthesis and secretion of adrenocortical steroids (e.g. mineralocorticoids, glucocorticoids, androgens and estrogens), and the biochemical responses to EAC. We previously developed a deterministic model which describes the biosynthetic pathways for the conversion of cholesterol to adrenocortical steroids, and the kinetics for enzyme inhibition by the EAC, metyrapone. In this study, we extended our model for a multiple enzyme inhibitor, aminoglutethimide. Experiments were performed using H295R human adrenocarcinoma cells, and concentrations of 12 steroids were simultaneously measured with a newly developed LC/MS/MS method. We performed cross validation of our model for the baseline data across multiple experimental studies. Results show that the model simulation closely corresponds to the time-course baseline data. Our study demonstrates the feasibility of using the *in silico* mechanistic steroidogenesis model to predict the *in vitro* adrenocortical steroid concentrations using H295R cells. This capability could be useful to help define mechanisms of action for poorly characterized chemicals and mixtures in support of the H295R steroidogenesis screening system, and to screen drug candidates based on steroidogenic effects in the early phase of drug development. *[This work was reviewed by the U.S. EPA and approved for publication but does not necessarily reflect Agency policy.]*

S. McKay Curtis and Sujit K. Ghosh
Graduate Program: Statistics
Advisors: Subhashis Ghosal and Sujit K. Ghosh

A Variable Selection Approach to Bayesian Monotonic Regression with Bernstein Polynomials

The simple regression problem in statistics consists of determining the relationship between a response variable and a single predictor variable through a mean function. Prior information is often available that suggests the function should have a certain shape (e.g. monotonically increasing or concave) but not necessarily a specific parametric form. Recently, Bernstein polynomials have been used to impose certain shape restrictions on regression functions. In this work, we demonstrate a connection between the monotonic regression problem and the variable selection problem in the linear model. We develop a Bayesian procedure for fitting the monotonic regression model by adapting the variable selection procedure of previous authors. We demonstrate the effectiveness of our method through simulations and the analysis of real data.

Wesleigh F. Edwards, Douglas D. Young, and Alexander Deiters
Graduate Program: Chemistry
Advisor: Alexander Deiters

Biochemical Light Switches: Photochemical Control of DNA Processing

Whole-genome sequences are now available for many organisms. Essential to annotating and elucidating gene function is first gaining precise external control over biological processes. The flow of genetic information can be affected at various stages, ultimately leading to the up- or down-regulation of gene expression. Many techniques currently employed to perturb gene function may interfere with normal downstream processes or irreparably harm the organism of study, and their applications often lack specificity. An alternative approach to these conventional molecular techniques lies in photochemical biology, whereby a light-removable protecting group (termed “caging group”) installed on a protein or regulatory small molecule inhibits its nascent function; non-damaging UV light-irradiation removes the caging group and restores activity. Since light-irradiation can be precisely regulated, decaging can be achieved with a high level of spatial and temporal control. We are developing novel tools to achieve spatio-temporal control of DNA processing. Our methods involve the direct installation of caging groups to enable the photoregulation of proteins and DNA, both *in vitro* and *in vivo*. With this approach, we have successfully modulated the enzymatic activity of Cre recombinase through the installation of a nitrobenzyl caging group. Photocaged Cre was thus inactive until the caging group was removed with light-irradiation, restoring its activity. Additionally, incorporation of photocaged thymidine nucleosides into standard oligonucleotide primers has allowed us to up- and down-regulate the polymerase chain reaction (PCR) via light-irradiation.

Elke Feese and Reza A. Ghiladi
Graduate Program: Chemistry
Advisor: Reza A. Ghiladi

Exploring New Treatment Options for Tuberculosis: Photodynamic Therapy of *Mycobacterium Smegmatis*

Tuberculosis (TB) is one of the leading causes of death due to a single disease with 8.8 million new infections and 1.6 million deaths reported for 2005 alone. Efforts to control TB infection have been hampered by the rise of multiple-drug resistant strains, thereby necessitating research into new treatment options. Herein, we explore the feasibility of photodynamic therapy (PDT) as an alternative approach to the current drug-based tuberculosis treatments. In photodynamic antimicrobial therapy, microorganisms are treated with a photosensitizer, which upon irradiation with visible light generates cytotoxic radicals and singlet oxygen, ultimately leading to cell death. In the present study, the non-pathogenic *Mycobacterium smegmatis* was employed as a model for *M. tuberculosis.* The reduction in colony forming units (CFU) was examined as a function of both the type of photosensitzer, as well as the light dose employed (varying irradiation time and light intensity).

Several photosensitizers were examined at micromolar to nanomolar concentrations. The most promising results were achieved using the cationic tetrakis(1-methyl-4-pyridinio)porphyrin (146 nM), with a 5 $\log_{10}$ unit reduction of CFU after irradiation (400-700 nm) for 5 minutes at 60 mW/cm^{2}s. Longer irradiation times resulted in no CFUs being detected. Alternatively, *meso*-tetra(4-N,N-trimethylanilinium)porphyrin (146 nM) as the photosensitizer resulted in a 2 $\log_{10}$ unit reduction of CFU after 15 minutes irradiation at 60 mW/cm^{2}s. Further data obtained using other photosensitizers, along with a comparison to analogous experiments with *E. coli*, will be presented. The data show that mycobacteria can be photodynamically inactivated, suggesting that PDT may be an attractive treatment option for drug resistant tuberculosis.

Nicholas A. Foley[1], T. Brent Gunnoe[1], Thomas R. Cundari[2], Jeffrey L. Petersen[3], and Paul D. Boyle[1]
Graduate Program: Chemistry, North Carolina State University[1]; Center for Advanced Scientific Computing and Modeling (CASCaM), Department of Chemistry, University of North Texas[2]; C. Eugene Bennett Department of Chemistry, West Virginia University[3]
Advisor: T. Brent Gunnoe

The Impact of Sterics and Electronics on Transition Metal Mediated Hydroarylation of Olefins

Nearly 95% of the vast array of manufactured chemicals are produced from simple small molecules extracted from petroleum and natural gas reserves (i.e., ethylene, benzene, toluene, propene, methane, xylenes and butenes). These components are converted through many C-C bond forming steps to more complex molecules that make-up many consumer goods from plastics to pharmaceuticals to agrochemicals. Current methodologies for these early C-C forming steps suffer from poor selectivity, multiple step syntheses, high energy consumption and harmful waste generation. It is our goal to make use of homogenous transition metal catalysts to skirt some of these synthetic drawbacks. We have developed a series of Tp-supported {Tp = hydridotris(pyrazolyl)borate} ruthenium systems which catalyze olefin hydroarylation; that is, the direct atom-economical insertion of an olefin into a strong inert C-H bond of an arene. Disclosed herein is a comparative study of the reactivity of four unique systems TpRu(L)(NCMe)R {L = CO, PMe_3, $Ppyr_3$ (pyr = *N*-pyrrolyl) and $P(OCH_2)_3CEt$; R = Me or Ph}. The distinct electronic and steric effects of ligand "L" on catalysis help us to understand how we can tactically improve these systems for catalytic olefin hydroarylation.

Xiaohua Gong[1,2], Wenbin Lu[2], Melissa Ashwell[3], and Zhao-Bang Zeng[1,2]
Graduate Programs: Bioinformatics[1]; Statistics[2]; Animal Science[3]
Advisor: Zhao-Bang Zeng

Mapping Quantitative Trait Loci in Multiple Half-sib Families

The widely used multiple interval mapping method is appropriate for mapping multiple quantitative trait loci (QTL) within a half-sib family, but it remains a challenge to model and test QTL effects across a number of half-sib families. We propose a hierarchical model to jointly analyze multiple half-sib families by treating QTL effects as random effects at the level of founding sires and develop a variance component score test for QTL analysis. An important step in QTL mapping is to obtain appropriate significance thresholds for genome scans. We investigate a score-based resampling method and evaluate the statistical properties of test statistics and thresholds through simulation. We apply our method to a dairy cattle dataset and detect QTL influencing economic traits. Our goal is to incorporate this procedure into freely available public software.

Elinor Keith and Lian Xie
Graduate Program: Marine, Earth and Atmospheric Sciences
Advisor: Lian Xie

Seasonal Prediction of Atlantic Tropical Cyclone Activity

Tropical cyclones are some of the most destructive weather events on Earth. Many factors are believed to influence Atlantic seasonal hurricane activity, including vertical wind shear, sea surface temperatures (SSTs) and the strength of African Easterly Wave activity. One of the primary challenges in generating a seasonal hurricane forecasting model is the selection of the best possible of predictors at lead times of several months. This study uses a new methodology of cross-correlating potential predictors against Empirical Orthogonal Functions (EOFs) of the Hurricane Track Density Function (HTDF). Those predictors are then used in a Poisson regression model for forecasting seasonal counts of named storm, hurricane and major hurricane occurrence in the entire Atlantic, the Caribbean Sea, and the Gulf of Mexico. In addition, a scheme for predicting landfalling tropical systems along the U.S. Gulf of Mexico, Southeastern, and Northeastern coastlines is developed, but predicting landfalling storms adds an extra layer of uncertainty to an already complex problem, and on the whole these predictions do not perform well.

Testing of the final model shows that the model is quite promising for the Atlantic as a whole, but the subregions and landfalling predictions are not as strong, particularly for major (categories 3-5) hurricanes. Basinwide, the model's predictions of Caribbean hurricanes are found to be significant at a 95% confidence level. In the landfalling categories, only southeastern landfalling named storms and hurricanes and Gulf Coast named storms reach that significance level.

Casey D. Kennedy[1], David P. Genereux[1], D. Reide Corbett[2], Helena Mitasova[1], Scott T. Leahy[1], D. Brad Elkins[2]
Graduate Programs: Marine, Earth, and Atmospheric Sciences, North Carolina State University[1]; Department of Geology, Coastal Resource Management Program, East Carolina University[2]
Advisor: David P. Genereux

Spatial and temporal variability in groundwater-based nitrogen input to West Bear Creek, Atlantic coastal plain, North Carolina

Nitrogen (N) is a ubiquitous contaminant in agricultural areas worldwide. One of the most poorly-known aspects of its environmental transport and fate is the rate of N movement from groundwater to surface-water. We quantified this rate and investigated its controls in a 262.5-m section of West Bear Creek, an agricultural stream that contributes a significant amount of N to the Neuse River. We accomplished this with measurements directly in the streambed (bimonthly, 12/05-12/06) of hydraulic conductivity (*K*), hydraulic head gradient (*J*), and groundwater N concentrations (NO_3^-, NH_4^+, dissolved organic N or DON). Data were used to calculate groundwater-based N fluxes (*f*) to the stream (e.g., for NO_3^-, $f_{NO3}=KJC_{NO3}$, where *C* indicates concentration). NO_3^- accounted for 90% of the total groundwater-based N input, DON about 9% and NH_4^+ <1%. Mean f_{NO3} over the 7 measurement runs was 154 mmol•m^{-2}•day^{-1}, at least 8x larger than f_{NO3} for other agricultural streams. There was significant spatial variability in f_{NO3}: ~70% came through 1/3 of the streambed, ~24% through another third, and ~6% through the remaining third. Despite significant spatial variability, f_{NO3} was lower in the center of the channel and controlled by aspects of physical hydrology and the history of N fertilizer use; groundwater-seepage was higher in the center of the channel where *K* was higher (due to the nature of streamwater velocity and sediment transport in the channel), and C_{NO3} was lower in the center of the channel where groundwater was older. This systematic variability suggests the possibility of using targeted measurements to model/predict watershed-scale estimates f_{NO3}. Groundwater recharge-dates ranged from 1947-1994, a time over which increases in C_{NO3} were proportional to increases in N fertilizer use. Assuming steady-state physical hydrology, these data suggest that values of f_{NO3} may increase by ~3x over the next 20 years.

Arun Krishna, Howard D. Bondell, and Sujit K. Ghosh
Graduate Program: Statistics
Advisor: Howard D. Bondell

Bayesian Variable Selection Using Adaptive Powered Correlation Prior

The problem of selecting the correct subset of predictors within a linear model has received much attention in recent literature. Within the Bayesian framework, a popular choice of prior has been Zellner's g-prior which is based on the inverse of empirical covariance matrix of the predictors. However Zellner's prior implicitly puts larger prior variance in the principal component directions with smaller eigenvalues, thus putting less information in the directions that are underdetermined by the data, particularly when the predictors are highly correlated. An extension of the Zellner's prior is proposed in this article which allow for a power parameter on the empirical covariance of the predictors. The power parameter helps control the degree to which correlated predictors are smoothed towards or away from one another. In addition, the empirical covariance of the predictors is used to obtain suitable priors over model space. In this manner, the power parameter also helps to determine whether

models containing highly collinear predictors are preferred or avoided. The proposed power parameter can be chosen via an empirical Bayes method which leads to a data adaptive choice of prior. Simulation studies and a real data example are presented to show how the power parameter is well determined from the degree of cross-correlation within predictors. The proposed modification compares favorably to the standard use of Zellner's prior in these examples.

Youfang Liu
Graduate Program: Bioinformatics
Advisors: Jung-Ying Tzeng and Zhao-Bang Zeng

Association Studies of Case-Control Data with Genotyping Uncertainty

Current genotyping technology produces two dimensional fluorescent intensity (FI) data. Genotypes are inferred from FI data by a scoring algorithm and association analysis is conducted between genotypes and phenotypes. Genotyping scoring errors remain a challenge for automated scoring programs and it renders a negative impact on association analysis. Here, we propose a new score test that incorporates the genotyping uncertainty to assess the association between traits and SNPs. In this method, we directly use the original FI data and regard genotypes as unobserved variables. Therefore genotyping scoring error would be no longer a problem. Extensive simulation studies for both binary and continuous traits demonstrate that our method outperforms other approaches using inferred genotypes.

David A. Long and Dmitry V. Zenkov
Graduate Program: Mathematics
Advisor: Dmitry V. Zenkov

Relaxed Matching for Stabilization of Relative Equilibria of Mechanical Systems

Bloch, Leonard, and Marsden proved that under certain matching conditions a controlled mechanical system can be rewritten as an uncontrolled system for a suitable new Lagrangian. This new representation leads to an interesting feedback stabilization strategy. However for many systems these matching conditions do not hold. We present a modification to this method which relaxes the matching conditions. The theory is illustrated with the problem of stabilization of the steady-state motions of an inverted pendulum on a rotor arm.

Kristen M. Olsen
Graduate Program: Marine, Earth, and Atmospheric Science
Advisor: Yang Zhang

Fine-scale Modeling of Air Quality Using Two Air Quality Models Over the Southeastern United States

Fine particulate matter ($PM_{2.5}$) and tropospheric ozone (O_3) are major foci for air quality simulation and forecasting because of their impact on human health and the environment. In this study, two three-dimensional air quality models (3-D AQMs), the U.S. EPA Models-3 Community Multi-Scale Air Quality (CMAQ) Modeling system and the ENVIRON's Comprehensive Air Quality Model with Extensions (CAMx), are used to simulate air quality at a 4-km horizontal grid resolution for July 2002 over North Carolina, South Carolina, and portions of the surrounding states. A model evaluation is conducted by comparing observations from several networks, such as the Clean Air Status and Trends Network (CASTNET) and the Speciation Trends Network (STN), with the simulations from CMAQ and CAMx for O_3, $PM_{2.5}$ and its major components, wet deposition, and visibility. The evaluation includes statistical performance, spatial distributions, and temporal variations. Preliminary analysis shows an overall good skill but moderate underprediction for 1-hour and 8-hour maximum O_3 and $PM_{2.5}$ by both models. Further analysis is conducted to identify likely causes for discrepancies between model results and observations and to assess the specific strengths and weaknesses of each model.

Sarah Olson
Graduate Program: Biomathematics
Advisor: Mansoor Haider

Mathematical modeling of cartilage regeneration

Articular cartilage is a connective tissue that lines the surface of bones in diarthrodial joints (hips, shoulders, and knees). Cartilage has a limited capacity for growth and repair of large defects due to injury or aging; therefore biomaterials such as hydrogels are being explored to provide a 3-d scaffold for cartilage regeneration. A mathematical model and numerical solutions are presented for an interface problem that models an *in-vitro* experiment for regeneration of articular cartilage in a localized defect region. In this experiment, a cylindrical cartilage explant has a core region removed and replaced with a nutrient-rich hydrogel. The gel-tissue aggregate is

then immersed in media for a period of several weeks. An axisymmetric reaction-diffusion model of this experiment is developed to capture coupling between cell-mediated nutrient absorption and matrix biosynthesis, and diffusive transport of nutrients and matrix constituents. The reaction governing turnover of the hydrogel to newly synthesized tissue is modeled via a level set method that captures the moving gel-tissue interface. After non-dimensionalization of the governing partial differential equations, finite difference numerical solutions are employed to simulate cartilage regeneration as a function of cell mediated reaction rates in the model. Both the cases of external media maintained at a homeostatic nutrient concentration, and at a higher concentration associated with the nutrient-rich hydrogel are considered. The model is used to compute regeneration times required to completely degrade the hydrogel and parametric ranges and sensitivity are evaluated.

Hong Qian
Graduate Program: Chemistry
Advisor: Lin He

Synthesis of Colorimetric Copolymers for DNA Sensing Using ARGET ATRP

Atom transfer radical polymerization (ATRP) is an efficient technique for synthesis of precisely controlled (co)polymer and has been successfully applied in DNA biosensing. Its needs for an oxygen-free environment to minimize undesired reaction termination, however, have limited the mobility of this sensing platform. Here we report the development of a fine-tuned ATRP process, known as activators regenerated by electron transfer (ARGET), which uses reducing agents to continuously regenerate active Cu species as the reaction catalyst, allowing ATRP to proceed under limited air and at a significant lower $Cu^{+/2+}$ concentration (10 ppm). In particular, ascorbic acid is used as the reducing agent with 1,4,8,11-tetramethyl-1,4,8,11-tetraazacyclotetradecane (Me_4Cyclam) as the new catalyst ligand during ARGET ATRP. A rapid living controlled polymerization reaction (PDI < 1.3) is realized for both homopolyer and copolymer formation. Eliminating the need of deoxygenation, ARGET ATRP greatly simplifies the polymerization procedure and allows high throughput DNA biosensing in a 96-well platform.

To further improve the performance of polymerization-based DNA sensing, a blue-colored monomer, 1,4-bis(4-(2-methacryloxyethyl)phenylamino) anthraquinone, is synthesized and characterized. Copolymerization with 2-hydroxyethyl methacrylate (HEMA) in ARGET ATRP produces a blue-hued polymer with the incorporation ratio of both monomers quantitatively determined.

Teresa M. Selee[1], Tamara G. Kolda[2], W. Philip Kegelmeyer[2], and Josh Griffin[2]
Graduate Programs: Mathematics, North Carolina State University[1]; Mathematics, Informatics, & Decision Sciences, Sandia National Laboratories, Livermore, CA[2]
Advisor: Ilse Ipsen

Computing PARAFAC on large-scale tensors with special structure

Similarity measures are often used for clustering data objects, and most clustering methods operate on a single similarity matrix. However, there can be different ways to measure the similarity between objects and it would seem that using all the similarities of a dataset simultaneously should yield the most accurate clustering. For this work, we are using tensors so that we can include multiple object-object similarity matrices. Storing multiple dense similarity matrices can be expensive in terms of memory and time. As an alternative, we store each similarity matrix implicitly as the product of a sparse object-feature matrix and its transpose. All operations are done only on the sparse object-feature matrices. Instead of storing the full tensor, we store the sparse matrices used to form the slices. Based on this tensor representation, we present a new tensor decomposition called Implicit Slice Canonical Decomposition (IMSCAND), which is equivalent to the tensor CANDECOMP/PARAFAC decomposition, a higher-order analogue of the matrix singular value decomposition (SVD) or principal component analysis (PCA). In contrast to CANDECOMP/PARAFAC, IMSCAND performs all computations on the sparse object-feature matrices and not on the dense object-object similarity matrices, thereby reducing both memory requirements and computational complexity. IMSCAND produces compilation feature vectors, which are clustered by k-means. We illustrate the applicability of our decomposition and clustering scheme on a set of SIAM journal articles.

Althea M. Smith[1] and Sharon R. Lubkin[2]
Graduate Programs: Biomathematics[1]; Mathematics/Biomedical Engineering[2]
Advisor: Sharon R. Lubkin

Mathematical Models for an *Escherichia coli* Infection in the Intestinal Tract

The small intestine is prone to infections by bacteria that can adhere to the surface wall. We wish to better understand an infection of the small intestine caused by enteropathogenic *Escherichia coli* (EPEC) and to achieve this objective we present three models: a chemostat and two mechanistic spatial models in 1-D and 2-D. The chemostat model is a dynamic model where four biologically significant steady states of the infection were

observed: washout, persistence, threshold, and blowup. These results concur with previous work done in this field; however in this instance our model is far less complex. The 2-D mechanistic spatial model suggests that bacteria that adhere to the intestinal wall cause the infection to persist. The 2-D model also suggests that the radial gradients of EPEC are less important than the longitudinal gradients, allowing us to proceed with a 1-D analysis. The 1-D model permits an in-depth realization of the infection process, including bacterial growth and microvilli growth kinetics. This poster will discuss how our 3 models merge EPEC pathogenesis mechanisms with current-day Continuous Stirred Tank Reactor and Plug Flow Reactor colonization models.

William V. Sweet
Graduate Program: Marine, Earth and Atmospheric Sciences
Advisors: John Morrison and Dan Kamykowski

Tropical Instability Wave Interactions within the Galapagos Archipelago

Tropical instability waves (TIW) are intra-annual phenomena that appear in the equatorial Pacific as the SE trades strengthen in the boreal fall. Increasing shear between the westward South Equatorial Current (SEC) and the eastward Equatorial Undercurrent (EUC) spawn ~20-day TIW along the equator that cause large co-varying undulations of the thermocline (20°C) across it. Upwelling within the Galapagos Archipelago brings colder, saltier waters that are nutrient-rich to the surface feeding the plankton and biodiversity in this otherwise high-nutrient low-chlorophyll region of the equatorial Pacific. In late 2005, TIW are observed in the sea surface temperature (SST) along the equatorial front (EF) as westward propagations with wavelengths of ~900 - 1400 km, periods (P) of ~19 - 29 days and speeds of 48 km day^{-1}**.** The TIW meridional currents (V_y) at the equator had a P of ~17.1 (~19.4) days at 140°W (110°W) and penetrated below the core of the Equatorial Undercurrent (EUC). At 95°W and western Isabela Island, the thermocline and SST had a P of ~15.3 days and their oscillations were close in phase, unlike those to the west which lagged from the north/south advection of the EF. Moored temperature and water level resolve a 14 to 15-day TIW period centrally in the Galapagos. Upwelling speeds reached ~5.5 m day^{-1} at the height of a 1.5-month period of strong TIW in the Archipelago where chlorophyll coincident with coldest temperatures increased by >25 to 40% above its 2004 – 2006 mean. Much higher chlorophyll near the Archipelago compared to 95°, 110°, and 140°W implicates that the Archipelago iron-enriched the upwelling waters. The TIW appear to spatially modulate the intensity of topographic upwelling of the EUC against the Archipelago, and its vertical pumping may be fundamental to its ecology, washing the region with high chlorophyll possibly from a more spatially equalized primary production.

ClarLynda Williams-DeVane[1], Maritja Wolf[2], and Ann Richard[3]
Graduate Programs: Bioinformatics/U.S. EPA COOP[1]; Lockheed Martin (Contractor to U.S. EPA) [2]; U.S. EPA/Office of Research and Development (ORD)/National Center for Computational Toxicology (NCCT) [3]
Advisor: Ann Richard

Exploration of the Chemical Space of a Public Genomic Database, ArrayExpress, for Toxicogenomic Integration with Public Data

The current project aims to chemically index the content of public genomic databases to make these data accessible in relation to other publicly available, chemically-indexed toxicological information. There are currently more than 20 public genomic data repositories/databases, five of which contain data of chemogenomic interest: the Chemical Effects in Biological Systems (CEBS) knowledgebase; Public Expression Profiling Resources (PEPR) web database; ArrayExpress genomic repository; the Gene Expression Omnibus (GEO) repository; and the Environment, Drugs, and Gene Expression database (EDGE). ArrayExpress and GEO contain the most chemical exposure experiments but require the development of new methodologies consisting of Perl scripts and manual annotations to mine the author-submitted content. CEBS, EDGE, and PEPR do not require additional chemical indexing methodologies. After chemical exposure experiments are identified, the chemical space is defined through structural similarity and compared to the chemical space of public toxicological data from the EPA DSSTox project (www.epa.gov/ncct/dsstox). By evaluating the chemical space of public genomic data in relation to public toxicological data, it is possible to identify classes of chemicals on which to develop methodologies for the integration of chemogenomic data into predictive toxicology. These methodologies will involve comparisons of experimental data across labs, chemicals, platforms and species. The chemical space of a public genomic database, ArrayExpress, will be presented with the methodologies and tools developed to identify this chemical space as well as an analysis of the chemical space of public genomic data in relation to public toxicology data. *[This work does not necessarily reflect official U.S. EPA policy.]*

Stacey Frederick
Graduate Program: Textile Technology Management
Advisor: Nancy Cassill

Using the Value Chain Framework to Analyze, Visualize, and Connect the Textile Complex

In the last few decades, rapid developments in technology and changes in trade agreements have increased the global and fragmented nature of the textile industry. Whereas the media and declining employment statistics well document the *negative* impacts on the U.S. textile manufacturing industry, they do not articulate the *new*, *emerging* opportunities in research and development, design, performance markets, logistics, marketing, and customer service.

This research uses the global value chain framework to analyze the dynamics facing companies in today's global economy and more accurately portray the current situation in the restructured textile complex. Value chain analysis extends the focus from the traditional textile supply chain (fibers, yarns, fabrics, finished goods) to include value-adding activities (R&D, design, logistics, marketing, service), auxiliary industries (machinery, chemicals, packaging), and local to global institutions (trade associations, government, international trade organizations). Furthermore, global value chain theory emphasizes the importance of relationships and power between the actors in the value chain, and the impact this has on individual actors' ability to upgrade in the industry.

One of the first outcomes of this research is *Textile Connect*. *Textile Connect* is a new website resource (www.textileconnect.com) created by N.C. State University's College of Textiles. The goal of the *Textile Connect* is to provide vital information in a comprehensive, user-friendly format that will make it easy to understand how the textile complex is connected using the value chain framework. A unique feature of the website is the ability to traverse the information for each stage of the value chain through a visual depiction. The visualization gives users a better sense of how textile complex members are connected to other stages in the supply chain, tangential industries, and the supporting environment.

Leslie Spinney Hatch
Graduate Program: Textile Technology Management
Advisor: Traci Lamar

A revolutionary but marketable new patient garment: Assessing the requirements

The objective of this project is to develop a comprehensive description of the requirements for a revolutionary healthcare garment that could supersede the inadequate attire patients are currently expected to wear when receiving healthcare services. Literature and patent research revealed that attempts have been made to revise and improve the current hospital gown. To date, none of them has yielded a garment that has achieved widespread acceptance in the market. In fact, of the top 10 hospitals (based on the *US News* 2007 edition of "America's Best Hospitals") only two hospitals have adopted widespread use of nontraditional reusable gowns. We believe this is largely due to lack of consideration of all stakeholders in the supply chain in the development and introduction of a new garment. To be successful, a new patient garment must meet the needs of not only the patient but of caregivers and administrators as well. So, this project is documenting the needs of diverse stakeholders. Our approach is to interview and survey patients, health care providers, and hospital purchasing and administrative decision-makers to identify their specific needs in relation to the hospital gown. We have utilized charts to identify the similarities and differences among each group's needs in order to define the key requirements which can ultimately become the criteria to develop a new patient garment. We have realized that patients have certain comfort and privacy needs during treatment, that health care providers must have unrestricted access to the patient's body, and that the administrators have clear financial and operational responsibilities. Within these groups, more specific needs have been highlighted. Results of the needs assessment will be used to develop a prototype incorporating the weighted needs for all three groups in the next phase of the project.

Liwen Ji
Graduate Program: Fiber and Polymer Science
Advisor: Xiangwu Zhang

Preparation of Porous Carbon Nanofibers and their Application in Lithium-Ion Batteries

Porous carbon materials have fascinating applications in the fields of gas separation, water purification, catalyst supports, sensors, and lithium-ion batteries. We present here the preparation of porous carbon nanofibers that rely on the electrospinning process with subsequent carbonization and chemical treatment. The procedure involves using polyacrylintrile (PAN) solutions in N, N-dimethylformamide (DMF) containing different amount of silica nanoparticles to form PAN/silica composite nanofibers through electrospinning, followed by carbonizing these composite nanofibers at temperatures and removing silica nanoparticles with hydrofluoric acid. We selected PAN as the polymer precursor because of its high dielectric constant and good solubility which are desirable for electrospinning. In addition, this polymer provides well-known routes to prepare for excellent carbon nanofiber structure. The physically entangled conducting carbon nanofibers enable us to fabricate lithium-ion battery

electrodes without using additional other binding and/or conductive materials. We characterized their microstructure and morphology through various analytical techniques, and evaluated the electrochemical performance of the porous carbon nanofiber electrodes. Out results demonstrated that that thermally treated porous carbon nanofibers with micropores and large surface areas provide excellent capacitive behavior to the resultant lithium-ion batteries.

Rebecca R. Klossner[1], Hailey A. Queen[2], Andrew J. Coughlin[3], and Wendy E. Krause[1]
Graduate Programs: Fiber and Polymer Science[1], Textile Engineering[2], North Carolina State University; Bioengineering, Rice University[3].
Advisor: Wendy E. Krause

Rheological Properties of Chitosan and Their Influence on Electrospinning

Chitsoan-based nanofibers fabricated via electrospinning are desirable for use in many biomedical applications such as wound healing and drug delivery because they have the ability to mimic the size and porosity of the extracellular matrix. However, chitosan is difficult to electrospin, mainly because of its high viscosity at even moderate concentrations, which greatly affects the electrospinning process. In order to better understand this obstacle, detailed rheological studies were carried out to determine the entanglement concentration, a necessary parameter for electrospinning. The viscosity of chitosan exhibited a strong concentration dependence, $\eta \sim c^{6.0}$, which corresponds to an associating polymer. Additionally, the viscosity of the chitosan solutions exhibit a strong time dependence. Chitosan/poly(ethylene oxide) (PEO) blends were also investigated in varying concentrations to reduce the viscosity of the solutions and to ultimately obtain defect free electrospun fibers. SEM imaging demonstrated that generally as total polymer (chitosan and PEO) concentration increased, the number of beads decreased; and as chitosan concentration increased, fiber diameter decreased. The blended solutions also showed a drastic decrease in viscosity over time, which was attributed to phase separation. The challenges of electrospinning a charged biopolymer (chitosan is cationic) will be discussed in rheological terms and compared to results of a neutral polymer.

Shreya Paul[1,2] **,** Svetlana Verenich[2], and Behnam Pourdeyhimi[2,3]
Graduate Programs: Fiber and Polymer Science[1], Nonwovens Cooperative Research Center[2], Textile and Apparel, Technology and Management[3]
Advisors: Behnam Pourdeyhimi and Svetlana Verenich

Surface Modified Polypropylene/Elastomer Laminates for 'Breathable' Nonwovens

Comfort and protection are two of the most important attributes sought after in textile garments, especially in highly functional ones. Thermoplastic Polyurethane (TPU) has been widely used to achieve this aim because of its inherent property of breathability by a process called as 'activated diffusion'. But TPU cannot be used by itself as it lacks mechanical rigidity; it is tacky and also expensive. This is where we can use an olefin, especially the ubiquitously available Polypropylene (PP). But PP's low surface energy restricts its use for such purpose. Our aim was to modify (increase) the surface property of PP and make it more functional. Amongst the various methods and modifiers sought, blending with Glycidyl Methacrylate (GMA) was found to be very effective. Films of modified PP were analyzed to determine the blending efficiency and characterized by contact angle measurements, differential scanning calorimetry (DSC), X-Ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM). Molecular dynamics simulations were done to determine surface and bulk properties of PP blended with GMA. The computational results correlated very well with the experimental data and revealed that the changes in the surface energy can be linked to the position of the functional group within the sample. T-Peel tests indicated a 2.4 times increase in adhesion to the elastomer compared to unmodified PP. XPS data revealed a 10 times increase in the Oxygen to Carbon ratio which is an indicator of the increased surface energy of the modified PP.

Sridevi Seshabhattar
Graduate Program: Textile Engineering
Advisor: Russell. E. Gorga

Mechanistic Understanding and Optimization of Thermal Bonding for Bicomponent Polymer Fibers

Thermal bonding is prevalently used method for the manufacture of Nonwovens as a bonding technology. The extensive research done in this field reveals that there is an ample opportunity to improve the strength of the bond at the interface without compromising the intrinsic fiber properties. Polymer mobility or reptation is responsible for formation of entanglements at the interface thus leading to strong adhesion among the fibers. The same mechanism is responsible for disruption in the crystalline regions leading to the reduction in mechanical properties of the nonwoven. One of the highly researched polymers in the field of thermal bonding is polypropylene. Reptation increases with increase in temperature and with decrease in molecular weight of the polymer. The purpose of the study is to design bicomponent polymer fibers to optimize thermal bonding without negatively affecting the fiber

properties. Specifically the study aims at producing bicomponent fibers with higher molecular weight polypropylene as the core and the low molecular weight polypropylene as the sheath. This provides for the sheath to melt and form a strong bond at the interface by forming entanglements and the core keeps the crystalline structure in tact which provides for the mechanical properties of the fiber. In this work we have bonded the bicomponent fibers into webs at various temperatures and demonstrated that thermal bonding temperature and the nature of the blend influences the strength of the bonded fabric.

Vanessa Cook, Marsha McDowell, Jennifer Jones Shults, Nigel Campbell, Jennifer Davis, and Anthony Blikslager
Graduate Program: Physiology
Advisor: Anthony T. Blikslager

Attenuation of Ischemic Injury in Equine Jejunum by Administration of Systemic Lidocaine

The incidence of gastrointestinal ischemic injury is increasing as survival from predisposing diseases improves. Rapid repair of injured intestine is essential to restore the mucosal barrier. Previous studies have shown that a non-selective cyclooxygenase (COX) inhibitor, flunixin meglumine (FM), retards recovery of the mucosal barrier. Lidocaine has novel anti-inflammatory effects and reduces cardiac and cerebral ischemic injury. We hypothesized that treatment with systemic lidocaine would hasten recovery of mucosal barrier function in ischemic-injured equine jejunum. Horses were assigned to one of four groups (n=6/group): 1) 1mL/50Kg 0.9% NaCl IV 2) FM 1mg/kg IV q12 hours 3) Lidocaine 1.3mg/kg loading dose followed by 0.05mg/kg/min CRI 4) FM & lidocaine combined. Sections of jejunum were subjected to 2 hours of ischemia by temporary occlusion of the local blood supply. After 18 hours of recovery, mucosa was mounted on Ussing chambers for measurement of transepithelial resistance (TER), and fluorescent labeled-LPS flux. Mucosal damage was assessed by histomorphometry. COX-1 and COX-2 expression was examined by Western blotting. Blood samples obtained at 0 & 8 hours post ischemia were analyzed for prostanoids. Treatment with FM alone significantly reduced mucosal barrier function in ischemic-injured sections, as evidenced by reduced TER and increased permeability to LPS. There was no significant difference in TER and permeability in ischemic-injured sections between lidocaine and saline groups, even when treatment was combined with FM. COX-2 was up regulated in ischemic-injured tissue regardless of treatment group. Lidocaine did not affect the COX-1 associated production of thromboxane B_2, however, it did reduce the COX-2 associated production of prostaglandin E_2 metabolites, suggesting an anti-inflammatory effect. Systemic lidocaine may ameliorate some of the negative effects of FM on recovery of the mucosal barrier when the two treatments are combined.

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