NC STATE UNIVERSITY

ABSTRACTS

5th ANNUAL GRADUATE STUDENT RESEARCH SYMPOSIUM

WEDNESDAY • MARCH 10, 2010 • McKIMMON CENTER

5th Annual
Graduate Student Research Symposium
NC State University

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

Bridget Foy, Administrative Assistant

University Graduate Student Association (2009–2010)

Anne Riddle, Natural Resources (Chair)

Arpit Bhatt, Electrical and Computer Engineering

Tonya Elliott, Psychology

Elke Feese, Chemistry

Jessica Smeltz, Chemistry

Priyanka Tyagi, Crop Science

AGENDA

12:00 pm - 1:00 pm	Poster Set Up	Area 1
1:15 pm - 1:30 pm	Welcoming Remarks and Symposium Overview Ali Kefeli, University Graduate Student Association President Dr. Duane K. Larick, Dean of the Graduate School Dr. David Shafer, Assistant Dean of the Graduate School	Room 6
1:30 pm - 4:00 pm	Poster Session and Competition	Area 1
4:15 pm - 5:30 pm	Announcements of Awards and Reception Dr. Terri L. Lomax, Vice Chancellor for Research and Graduate Studies	Room 6

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College of Education

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ABSTRACTS

Sneha Athalye[1], Ratna Sharma-Shivappa[1], and Steve Peretti[2]
Graduate Programs: Biological and Agricultural Engineering[1]; Chemical and Biomolecular Engineering[2]
Advisor: Ratna Sharma-Shivappa

Enzymatic production of biodiesel with whole cell biocatalysts from cottonseed oil

Fossil fuels play a vital role in transportation, agriculture, industry, global trade, and many day to day needs but are rapidly diminishing resulting in inflated prices. Biodiesel, a fatty acid alkyl ester produced by transesterification between a triglyceride and an acyl acceptor in the presence of a catalyst, is a promising environment friendly renewable alternative to fossil fuel. Most commercial production of biodiesel involves soybean oil transesterification with methanol in the presence of sodium hydroxide. Miscibility of the catalyst with glycerol by-product is a major disadvantage as it necessitates an undesirable recovery step to reuse the catalyst besides generation of a large amount of alkaline waste water. Glycerol also needs additional purification prior to sale. An alternative to alkaline catalysis is enzymatic catalysis. Lipases are enzymes which act as catalysts in many lipid based reactions, and can be used for biodiesel production. Reuse of lipases can significantly reduce cost of biodiesel production though maintenance of lipolytic activity still remains a challenge that could be overcome by use of whole microbial cells. Three microbial species, *Candida rugosa, Aspergillus oryzae* and *Rhizopus oryzae* were tested for growth and lipase production on rigid biomass supports. *C.rugosa* did not attach well on the BSP's while *A.oryzae* had low biomass generation. Based on preliminary results, *R.oryzae* was selected to study the impact of culture time and media conditions on its morphology and lipase levels. A combination of three growth times: 48, 72, and 84 hrs and media compositions: Basal media + 1% Glucose, Basal media + 1% Oil, and Basal media + 1% Glucose + 1% Oil is being studied to identify optimal growth and media composition conditions leading to highest yield of crude cottonseed oil biodiesel. A combination of volumetric glycerol measurement and HPLC methods is being studied to analyze the biodiesel reaction products.

Lissete Betancur[1], Bir Singh[2], Ryan A. Rapp[3], Jonathan F. Wendel[3], M. David Marks[4], Alison W. Roberts[5], and Candace H. Haigler[1,2]
Graduate Programs: Plant Biology[1], Crop Science[2], North Carolina State University; EEOB Department, Iowa State University[3]; Department of Plant Biology, University of Minnesota[4]; Department of Biological Sciences, CBLS, University of Rhode Island[5]
Advisor: Candace H. Haigler

Phylogenetically distinct cellulose synthases are required for secondary wall thickening in arabidopsis shoot trichomes and cotton fibers

Thick secondary walls are deposited in some plant cells after expansion through primary wall synthesis is complete. The industrial uses of secondary walls range from textile and wood pulp fibers to forage and biofuel feedstocks. In order to improve these plant products in the future, we need to understand how they are synthesized. Secondary walls typically contain ordered cellulose, and it was assumed (based mainly on studies of xylem) that they were all synthesized by cellulose synthases (*CesAs*) encoded by genes in phylogenetic "secondary-wall clades". Previous phylogenetic analysis showed that the 10 member *CesA* gene family of arabidopsis was grouped into three "primary-wall clades" and three "secondary wall clades". Our objective was to test whether secondary wall-type *CesA* genes were transcribed during synthesis of diverse secondary walls, those of arabidopsis leaf trichomes and cotton fibers. Both of these cells are "trichomes", defined as elongated epidermal cells, but they have different cell wall chemistry (Marks et al. 2008, *Plant Journal* 56:483-492). Although the initiation of trichomes and cotton fibers share some similarities, prior comparison of their cell wall thickening processes was minimal. In this research, we: (a) analyzed the expression of *CesA* genes in arabidopsis shoot trichomes; (b) observed birefringent secondary walls in arabidopsis shoot trichomes with mutations in secondary wall-type *CesAs*; (c) assayed up-regulated genes during different stages of cotton fiber development; and (d) used bioinformatics to compare genes that were co-expressed with primary or secondary wall *CesAs* with genes up-regulated in arabidopsis trichomes, arabidopsis secondary xylem, or cotton fiber during primary or secondary wall deposition. Our results show that *CesAs* in either the "primary-wall clades" or the "secondary-wall clades" are employed to build the secondary cell wall of arabidopsis trichomes and cotton fibers, respectively. Therefore, the classification of *CesAs* as primary wall-related and secondary wall-related needs to be revised.

Sarah Cash
Graduate Program: Genetics
Advisor: Fred Gould

Analyzing the evolution of coupled traits: The case of sexual communication in two Heliothine moth species

Moth sexual communication offers an example of a "coupled" trait: for a male and female of the same species to find each other, both the sexual signal and its reception must match and be specific to avoid interspecific attraction. Any mutation resulting in a change in the signal or the response is expected to be selected against, constraining sexual communication systems and species diversification. Yet, we find a bounty of species in nature, including the related moths, *Heliothis virescens* (Hv) and *Heliothis subflexa*

(Hs), which utilize distinct sexual signals. In the Hs pheromone blend, the amount of (Z)-9-hexadecanal (Z9-16:Ald), a necessary Hs male attractant, is greater than in Hv, likely the result of specific desaturase enzyme activity. To test the role of a Δ11 desaturase gene in *Heliothis* pheromone biosynthesis and to investigate the enzyme's role in pheromone evolution, I created a fine-scale recombination-based map of the previously identified QTL affecting Z9-16:Ald amount. This region contained the Δ11 desaturase gene. To determine whether apparent variation in Z9-16:Ald between the species resulted from desaturase expression differences, qRT-PCR of the Δ11 desaturase was performed in homozygous Hv and Hs individuals. Combining the mapping results with genotype/phenotype data revealed a significant link between the presence of the Hs Δ11 desaturase allele and a higher amount of Z9-16:Ald. Initial quantitative real-time PCR results revealed a 2.5 fold increase in expression of the desaturase gene in Hs relative to Hv. Further elucidating the genetics underlying changes in signals and responses should provide us with a better understanding of how coupled traits evolve.

Alexandra C. Chaytor[1], M. Todd See[1], Jeff Hansen[2], Ana L. P. de Souza[2], Teena Middleton[3], and Sung Woo Kim[1]
Graduate Programs: Animal Science, North Carolina State University[1]; Murphy-Brown LLC.[2]; Ag ProVision LLC.[3]
Advisor: Sung Woo Kim

Effect of chronic exposure of low levels of aflatoxin and deoxynivalenol on growth and immune status of pigs

This study investigated the growth and immune responses of pigs fed diets with low levels of aflatoxin (**AF**) and deoxynivalenol (**DON**) from naturally contaminated corn. Sixty gilts (13.9 ± 0.2 kg BW) were randomly assigned to 4 treatments (5 replicates per treatment, 3 pigs per pen): **A** (pigs fed a control diet without detectable AF and DON); **B** (pigs fed a diet with 60 AF and 300 μg/kg DON); **C** (pigs fed a diet with 120 AF and 600 μg/kg DON); and **D** (pigs fed a diet with 180 AF and 900 μg/kg DON). Pigs were fed diets ad libitum for 33 d. Feed intake and BW were measured weekly, and pigs were bled (8 mL) through the jugular vein on d 33 to measure hematological, biochemical and immunological parameters such as IgG, IgM, TNFα, IFNγ, Il-4, and IL-6. One pig representing the average BW of each pen was euthanized to obtain the liver, kidney, and spleen for tissue color measurement and histological evaluation of tissue damage. Pigs in C and D tended to have smaller ADG (P = 0.058) and ADFI (P = 0.061) when compared with the control. White blood cell numbers of pigs in D was greater (P < 0.05) than those in A, B and C. Serum TNFα concentration of pigs in D was greater (P < 0.05) than those in A and C. Pigs in B and D had greater (P < 0.05) fibrosis in liver tissue than those in A. Collectively this study shows that diets containing AF ≥ 60 μg/kg and DON ≥ 300 μg/kg may reduce growth due to decreased feed intake, whereas diets containing AF ≥120 μg/kg and DON ≥ 600 μg/kg) may result in altered immune health, systemic inflammation, and partial liver damages causing further reduction in growth of pigs.

Lei Cheng[1], Fitzgerald L. Booker[2, 3], Kent O. Burkey[2, 3], Cong Tu[1], H. David Shew[1], Thomas W. Rufty[3], Edwin L. Fiscus[2, 3], and Shuijin Hu[1]
Graduate Programs: Plant Pathology, North Carolina State University[1]; USDA-ARS Plant Science Research Unit[2]; Crop Science, North Carolina State University[3]
Advisor: Shuijin Hu

Nitrogen dependence of soil microbial responses to elevated CO_2 and O_3 in wheat-soybean agroecosystems

Despite decades of study, the underlying mechanisms through which soil microbes respond to rising atmospheric CO_2 and O_3 remain poorly understood. A prevailing hypothesis, which states that changes in C availability induced by elevated CO_2 and O_3 drive alterations in soil microbes and the processes they regulate, successfully predicts outcomes in some cases, but it fails in others. Using a long term CO_2 and O_3 experiment conducted in a no-till wheat-soybean system, we show that N availability critically influences the magnitude and direction of soil microbial responses to elevated CO_2 and O_3. Elevated CO_2 significantly increased plant productivity, increasing residue inputs to soil by 28%. While it only had marginal effects on microbial respiration in the first two years, elevated CO_2 significantly stimulated microbial biomass and decomposition in the third and fourth years when N availability increased due to CO_2-enhancement of symbiotic N_2 fixation. In contrast to the CO_2 enrichment, elevated O_3 had no significant overall effects on any microbial parameters. These results suggest that high N availability in many agricultural soils may accelerate organic C turnover and limit the potential of C sequestration in agroecosystems under future CO_2 scenarios.

Justin M. Conley[1], David H. Funk[2], Dean L. Hesterberg[3], David B. Buchwalter[1]
Graduate Programs: Environmental and Molecular Toxicology, North Carolina State University[1]; Stroud Water Research Center, Avondale, PA[2]; Soil Science, North Carolina State University[3]
Advisor: David B. Buchwalter

Assessing selenium dynamics at the base of aquatic food webs: Application of a novel periphyton-mayfly test system

Selenium contamination in aquatic ecosystems provides management challenges because bioaccumulation in animals is largely a function of dietary exposure, whereas regulatory entities have traditionally focused on direct water to organism interactions. Selenium is known to be readily absorbed by primary producers and can potentially biomagnify in food webs and elicit adverse effects in fish and birds. However, Se bioaccumulation in the invertebrate prey of many fish and birds is poorly understood. Here, we used ^{75}Se (as selenite) as a radiotracer to characterize Se bioaccumulation into natural periphyton biofilms and subsequent

dietary and maternal transfer in the mayfly, *Centroptilum triangulifer*, in a life-cycle assay. On average periphyton biofilms bioconcentrated Se 1113 (± 430) - fold following 7-9 days of exposure to a range of environmentally relevant dissolved concentrations (2.4 – 13.9 μg L^{-1}). Mayflies grown to adulthood on these diets further biomagnified Se with trophic transfer factors averaging 2.2 (± 0.4) – fold in postpartum maternal tissues. Adults then transferred 46.5 (± 8.8) % of their body burdens to eggs with an observed reduction in fecundity for mayflies fed on diets greater than ~11 μg g^{-1}. Second generation mayflies exposed to dietary Se exhibited teratogenic defects in tibial and tarsal development. Additionally, we used XANES analysis at the Se K-edge to compare Se speciation in periphyton differentially treated with dissolved selenate or selenite, and in *C. triangulifer* larvae fed on these diets. Periphyton spectra were nearly identical following exposure to each anionic Se form, and displayed enrichment of organo-Se species. Larval speciation was different than periphyton, but was also characterized by a high proportion of organo-Se species. This result suggests that potential differences in the uptake kinetics of selenate and selenite at the base of aquatic food webs may determine the extent to which organic Se is incorporated into higher trophic levels.

Kevin Curry
Graduate Program: Agricultural and Extension Education
Advisor: Elizabeth Wilson

Scientific Basis vs. Contextualized Application of Knowledge: The Effect of Teaching Methodology on the Achievement of Post-secondary Students in an Integrated Agricultural Biotechnology Course

Amid an educational focus to integrate curriculum, contextual teaching and learning is an appropriate method to engage students so they acquire and exercise knowledge in ways that make the subject matter meaningful in the real world. Yet, there is little evidence in the literature to empirically support the benefits of contextual teaching and learning methods in postsecondary settings. The purpose of the study was to compare two teaching methodologies for an integrated agricultural biotechnology course at the postsecondary level. The two teaching methods tested were the explanation of the scientific basis for content (comparison treatment) versus the application of content to a real world agricultural context (experimental treatment). The study was implemented with two different classes over two semesters. The comparison treatment was administered to 22 students during the spring semester of 2009, and the experimental treatment was administered to 16 students during the fall semester of 2009. The research design used was a quasi-experimental non-equivalent control-group design with an identical pre/posttest given to each group as a means of assessing content achievement. Although the experimental treatment, based out of the principles of contextual teaching and learning, did have a greater mean gain on the pre/posttest it was not statistically significant ($p > .05$), so the study's null hypothesis was not rejected. Based on these results, compared with traditional methods, a curriculum of contextualized teaching and learning can be implemented while maintaining a comparable level of student achievement.

Lauren M. Dembeck
Graduate Program: Genetics
Advisor: W. Owen McMillan

Characterization of a hotspot for mimicry in *Heliconius erato*

The striking adaptive variation in the vivid wing patterns of *Heliconius* butterflies is controlled by few genomic loci that act in a Mendelian fashion. Each of these loci may contain multiple genes that affect color pattern. In *H. erato*, variation at the D-locus controls the distribution of red pigmentation in the fore- and hindwings. We are using the MAKER pipeline program to integrate automated gene predictions, transcriptome data, and small RNA sequences generated from three sequencing technologies (Sanger, Roche 454 and Illumina) at the DNA sequence of the D-locus. This analysis will allow us to identify intron-exon boundaries, candidate genes, non-coding RNA, repetitive DNA, and transcripts with alternative splice variants at the D-locus. This annotation will help guide future experiments to elucidate the functional sites within this evolutionary important genomic region.

Andrea L. Dolezal[1], Rebecca S. Boston[2], and Gary A. Payne[1]
Graduate Programs: Plant Pathology[1]; Plant Biology[2]
Advisors: Gary A. Payne and Rebecca S. Boston

Investigation into Internal Colonization of Developing Maize Kernels by the Plant Pathogen *Aspergillus flavus*

Aspergillus flavus is a pathogen of maize kernels. Fungal colonization reduces grain quality and results in accumulation of aflatoxin, a toxic and carcinogenic compound. Maize infection by *A. flavus* is of particular economic concern to North Carolina and the other southern states of the US. *A. flavus* is thought to enter the kernel through the connective tissue of the pedicel or breaks in the outer protective covering of the pericarp; however, the infection process has not been thoroughly elucidated. These studies were designed to trace internal colonization of maize seeds by *A. flavus* and to monitor gene expression in the fungus and maize seeds during infection. Transcriptional profiling was done using a custom-designed Affymetrix GeneChip DNA microarray containing probes representing all known *A. flavus* genes and over 8,000 maize genes. This permitted concurrent measurement of both plant and fungal gene expression during infection. Infection led to changes in gene expression for many genes, including ones encoding

defense-related proteins. Expression patterns also predicted a shift in carbohydrate metabolism from starch synthesis to sugar catabolism. The transcription profile of *A. flavus* during infection showed increased transcription of genes for hydrolytic enzymes, which was supported by LC/MS/MS identification of *A. flavus* hydrolytic enzymes in the apoplastic fluids of infected tissue. Transcript levels were also elevated in *A. flavus* for a member of the necrosis-inducing *Phytophthora* protein (NPP1) family. NPP1 proteins are known to cause foliar necrosis and trigger plant defense responses. The extent of fungal colonization was visualized by imaging samples from infected kernels stained with two fungal-specific dyes, GMS and PMS. Visual examination showed that the site of inoculation supported minor colonization but other regions in the kernel were more prone to fungal colonization. These regions offer exciting targets for future investigations into the maize - *A. flavus* interaction.

P.E. Eusebio-Balcazar[1], E.O. Oviedo-Rondón[1], J.T. Brake[1], M.J. Wineland[1], N.A. Barbosa[2], Carlos E. Aker[3], Nain A. Ardón[3] and H.R. Cutchin Evans[1]
Graduate Programs: Poultry Science, North Carolina State University[1]; Animal Science, Universidade Estadual Paulista, Jaboticabal, Brasil[2]; Animal Science, Escuela Agrícola Panamericana Zamorano, Tegucigalpa, Honduras[3]
Advisor: Edgar O. Oviedo-Rondón

Effect of broiler breeder diet type, feeding to peak of production, and feeder space change in production on leg health of progeny

This study examined the effects of broiler breeder nutrition and feeding practices on leg health of broiler progeny. Cobb 500 breeders were housed in 16 pens of 81 females each, and fed either corn (C) or wheat (W) based diets during rearing and production. Two feeding programs, sigmoid late fast (LF) and sigmoid late slow (LS) were used until peak of production. At 23 wk, 69 females that represented the BW distribution from each pen were placed in a two-thirds slat layer house where feeder space either remained the same (S) or was increased (M). Forty eggs were collected to obtain yolk, albumen and shell percentages, yolk/albumen (Y:A) ratio, haugh units, egg shape index (SI), egg surface area (ESA), and additional eggs were incubated to obtain egg moisture loss and eggshell conductance (G). Eggs produced at 32 wks of age were incubated and 16 male and 16 female chicks were assigned to 48 pens using 6 replicates per broiler interaction cell and 2 breeder pens per interaction cell in the 2x2x2 factorial design with diet type, feeding program, and feeder space as main factors. Broiler gait scores (GS) and leg problem incidence were evaluated at 42 d. Eggs coming from breeders fed C based diets had lower ($P<0.05$) haugh units and ($P<0.001$) Y:A ratio compared with W group; however, only LS chickens showed higher severe valgus incidence when were fed C. M breeders eggs weighed less ($P<0.01$), had higher ($P<0.05$) SI and their progeny had higher ($P<0.05$) GS 2 at 42 d. Breeders raised with LS feeding program laid smaller ($P<0.05$) eggs with lower ($P<0.05$) percentage shell and their progeny had higher ($P<0.05$) incidence of mild valgus. It was concluded that breeder feeding programs and feeder space affect egg traits that could be important during embryo development and influence leg problems and ability to walk in the broiler progeny.

Sarah E. Friedl[1], Jeffrey A. Buckel[1], Joseph E. Hightower[2], Frederick S. Scharf[3], and Kenneth H. Pollock[4]
Graduate Programs: Biology, North Carolina State University Center for Marine Sciences and Technology[1]; United States Geological Survey, Biology, North Carolina State University NC Cooperative Fish and Wildlife Research Unit[2]; Biology, University of North Carolina at Wilmington[3]; Biology, Statistics, and Biomathematics, North Carolina State University[4]
Advisors: Jeffrey A. Buckel and Joseph E. Hightower

Telemetry-based mortality estimates of juvenile spot in two North Carolina estuarine creeks

We directly estimated natural mortality rates (*M*) of juvenile spot (*Leiostomus xanthurus*) using a sonic telemetry approach. In spring of 2009, we surgically implanted 48 age-1 spot (mean weight 69.0g; mean FL 161.9mm) with sonic transmitters in two North Carolina creeks. Spot were tracked for 80 days using a stationary VR2 receiver array and manual tracking. No spot stopped moving during the study period and swimming speeds (≤0.5 m/s) did not indicate predation events. Many of the telemetered spot exhibited a similar diel change in location and swimming speed at dawn and dusk with more activity during diurnal compared to nocturnal periods. Potential spot predators were collected using gill and trammel nets and stomach content analysis confirmed that predation events were unlikely. Our estimated *M* of 0 was based on a mean period at risk of 22 d. Lorenzen's (1996) model predicts that *M* over a 22 d period would be 0.053 for this size fish. Low observed natural mortality in estuarine creeks has implications for the stock assessment and management of this species.

Julianne E. Harris[1] and Joseph E. Hightower[2]
Graduate Programs: Biology[1]; Fisheries and Wildlife Sciences[2]
Advisor: Joseph E. Hightower

A demographic population model for American shad: will access to additional spawning habitat upstream of dams increase population sizes?

American shad is an ecologically, commercially, and recreationally valuable anadromous fish that spawns in coastal rivers on the east coast of North America from Canada to Florida. American shad are in decline in their native range and modeling possible management scenarios could help guide restoration efforts. One cause of population decline is the presence of dams, which block

access to historic spawning habitat. We developed a density-dependent, deterministic, stage-based matrix model to predict whether transporting American shad to historic spawning habitat above dams on the Roanoke River would aid restoration. We used field data on sonic-tagged adults and oxytetracycline-marked young released above and below dams in the Roanoke River to estimate the initial American shad population size and vital rates. We used the model to predict stock size over 30 years under different scenarios of transport, egg production, and outmigration survival. We also evaluated possible effects of increased survival for young or adults. The model predicted a slow population increase over the next 30 years. Transport was predicted to benefit the population only if high rates of egg production and young survival were achieved. Predicted effects of increased survival for young and adults were dependent on the assumed value of carrying capacity. Presently, the estimated adult population size (5,224 females) is much smaller than either of two assumed values of carrying capacity for the lower Roanoke River (136,526 and 54,610 females). Access to additional spawning habitat would be most beneficial for American shad populations nearing carrying capacity. Better information about natural mortality and carrying capacity in regulated rivers would improve the model's evaluation of the benefits of access to additional spawning habitat upstream of dams.

Tina Herfel[1], Sheila Jacobi[1], Xi Lin[1], D.C. Walker[2], Z.E. Jouni[2], and Jack Odle[1]
Graduate Programs: Animal Science[1]; Mead Johnson Nutritionals, Evansville, IN[2]
Advisor: Jack Odle

Polydextrose enrichment of infant formula acts as a prebiotic by increasing ileal lactobacilli and lactic acid concentration and decreasing pH

Oligosaccharides, the 3rd largest component in human milk, are virtually absent from cow's milk and most infant formula. Polydextrose (PDX) is a proposed substitute for human milk oligosaccharides. One-day old pigs were fed a cow-milk-based formula supplemented with PDX (0, 1.7, 4.3, 8.5 or 17 g/L) for 18 days (n=13). Additional reference groups included 12 pigs sampled at day 0 and 12 sow-reared pigs sampled at day 18. Ileal lactobacillus CFU, but not bifidobacteria, increased linearly with increasing PDX ($P = 0.02$). Short chain fatty acids did not differ among treatments, but lactic acid increased linearly with PDX ($P = 0.001$). Lactic acid increased ten-fold over control pigs in those supplemented with 8.5 and 17 g/L PDX. Accordingly, digesta pH decreased linearly ($P < 0.05$) as PDX increased, with a maximal reduction approaching 0.5 pH units in those fed 17 g/L. Ileal villus height, crypt depth, maltase, myeloperoxidase and the number of intraepithelial lymphocytes were not affected by dietary PDX ($P > 0.1$). Polydextrose enrichment of infant formula acted as a prebiotic by increasing lactic acid production and decreasing pH. Research supported by Mead Johnson Nutrition.

Julie Hicks, Nares Trakooljul, and Sunny Liu
Graduate Program: Animal Science
Advisor: Sunny Liu

Cracking the code of avian microRNAs

The microRNA (miRNA) family of small RNAs is a diverse class of regulatory RNA that primarily functions to post-transciptionally suppress gene expression. MiRNAs are particularly important during eukaryotic development. Considerable effort has focused on the identification of miRNAs, however, currents efforts are beginning to shift toward the functional characterization of these small RNAs. Many miRNAs are expressed in a specific spatio-temporal pattern while others are more ubiquitously expressed. Therefore, in order to fully characterize a particular miRNA's function its expression profile as well as its target genes need to be determined. To establish the involvement of miRNAs during avian development we have recently developed multiple approaches. First, pyrosequencing and miRNA Real-Time PCR (RT-PCR) are utilized to determine expression profiles of avian miRNAs across tissues in both embryonic and post-hatch chicks. In addition, potential miRNA binding sites are predicted using the miRNA target prediction algorithm miRanda (www.microrna.org). A group of potential miRNA target genes is then selected based on gene function and/or miRNA target site conservation in other species. These miRNA putative binding sites are then validated using a retroviral-based RNA interference (RNAi) strategy, employing an RCAS-miRNA expression system. Our work suggests that a wide range of miRNAs are dynamically expressed in developing chicks and that avian miRNAs have many diverse functions including the regulation of cell proliferation and differentiation.

Aya Isumi
Graduate Program: Human Development and Family Studies
Advisor: Karen DeBord

What Works for Child Maltreatment Prevention?

Child maltreatment is one of the most significant and pervasive social problems in the United States. Research consistently examines what factors cause and prevent child maltreatment and how child maltreatment prevention efforts have been undertaken to reduce risk factors and increase protective factors. Programs for child maltreatment prevention, however, target different sets of risk and protective factors with using various approaches, including home visitation, parent education, and parent support groups. The

objectives of this project is 1) to review the literature and interview professionals in an effort to study and compare the effects of practices used to prevent child maltreatment by parents and extended family, focusing on their content and 2) to suggest the best way for parent educators to inform and teach parents about managing their stress and seeking social support to prevent child abuse. Research indicates parental stress, lack of social support, and economic hardship are among the most critical diverse risk factors leading to child maltreatment. Based on what the literature and professionals say, coping skills, access to social support, and use of community resources will be discussed as strategies to reduce child maltreatment potential.

Aswini K. S. Jasrotia and K.P. Sandeep
Graduate Program: Food Science
Advisor: K.P. Sandeep

Investigation of water phases in wheat dough during frozen storage studied using Time Domain Nuclear Magnetic Resonance (TD-NMR)

The physical state and mobility of water in wheat dough is very important factor affecting the shelf-life of dough and the quality of final baked product. Freezing the dough increases its shelf-life. However, frozen storage of wheat dough longer than 6 - 8 week significantly decreases quality of the baked product (such as loaf volume and texture) when compared to that made using fresh dough. Depending on the ingredients (different emulsifiers used to improve quality of baked product) and cooling rates, frozen dough has different proportions of water phases which effects the quality of the baked product when compared to that of fresh dough. The objective of this study was to compare the proportions of different water phases present in frozen wheat dough during 16 week frozen storage, to that in fresh dough. Fresh and frozen dough were prepared using different emulsifiers along with water, oil, salt, and yeast. Frozen dough was prepared using two cooling rates – CR0 (still air) and CR1 (forced air) and stored at -20 °C for 0, 8, and 16 weeks. TD-NMR studies using minispec mq-20 indicated that there are more water molecules with less mobility (T_2 values: 0 – 50 ms) at CR1 when compared to that at CR0. Dough prepared at CR1 had wider range (T_2 values: 0 – 900 ms) of water phases present when compared to dough prepared at CR0 (T_2 values: 0 – 300 ms). In addition, at a frozen storage time of 16 weeks, the amount of highly mobile water phase decreased for both cooling rates, which indicates a decrease in overall water mobility. These changes in water phases of frozen dough due to different cooling rates and frozen storage times can help understand the dough characteristics which affect the quality of baked products.

Suzanne D. Johanningsmeier and Roger F. McFeeters
Graduate Program: Food Science; USDA Agricultural Research Service, Raleigh, NC
Advisor: Roger F. McFeeters

Effects of sodium chloride and pH on anaerobic lactic acid utilization during spoilage of fermented cucumbers

Cucumbers are preserved commercially by fermentation in brine with approximately 6% sodium chloride (NaCl). Efforts to reduce the NaCl in the fermentation process have resulted in an increased incidence of post fermentation spoilage. This spoilage has been characterized by a decrease in lactic acid concentration and subsequent rise in pH. The objectives of this study were to determine the effects of NaCl and pH on anaerobic lactic acid utilization by spoilage microorganisms and to identify the chemical changes caused by spoilage organisms in fermented cucumbers. Cucumbers fermented at four NaCl concentrations (0, 2, 4, and 6 %) were blended into slurries and adjusted to pH 3.2, 3.8, 4.3, and 5.0 prior to centrifugation, sterile-filtration, and inoculation with spoilage brines. Organic acids and pH were measured after 3 weeks, 2, 6, 12, and 18 months anaerobic incubation at 25°C. Non-targeted, comprehensive two-dimensional gas chromatography-time-of-flight mass spectrometry (GCxGC-TOFMS) was used to determine changes in metabolites that occurred in sterile-filtered fermented cucumber slurry (SFCS) with 6% NaCl at pH 3.8 after inoculation with mixed spoilage cultures or a *Lactobacillus buchneri* spoilage isolate. Anaerobic lactic acid degradation occurred in SFCS at pH 3.8, 4.3 and 5.0 regardless of NaCl concentration. Over 18 months incubation, only 6% NaCl and pH 3.2 completely prevented anaerobic lactic acid degradation. A clear association between lactic acid utilization and increases in acetic acid, propionic acid and propanol was evident across treatments. *L. buchneri* was able to partially metabolize lactic acid in SFCS with concurrent increases in acetic acid and 1,2-propanediol. Spoilage metabolite profiles obtained with GCxGC-TOFMS showed that although *L. buchneri* metabolized lactic acid, it did not produce several changes in metabolites that occurred during spoilage with mixed cultures. Therefore, *L. buchneri* may be one of multiple organisms that play a role in fermented cucumber spoilage.

Jyoti Kajla, Chris Brown, and Heike Winter-Sederoff
Graduate Program: Plant Biology
Advisor: Heike Winter-Sederoff

Functional characterization of gravity-regulated sterol-binding protein ROSY1 in *Arabidopsis thaliana* roots

Plants use light and gravity to orient their direction of growth. Roots grow towards the vector of gravity to anchor the plant in the soil and find water and nutrients. Changes in environmental conditions cause changes in gene expression that affect the plants' response. We identified gravity-induced fast and transiently up-regulated transcripts in Arabidopsis root apices (Kimbrough et al.

2004). One of these transcripts, Regulator of Synaptotagmin (rosy1), is a root specific MD2 lipid binding domain containing protein. Further characterization of rosy1 showed that it is also up-regulated in response to directional light in a fast and transient manner (Salinas-Mondragon et al. 2005). Computational analysis showed the protein ROSY1, has a high structural similarity to protein NPC2, malfunctioning of which causes the lethal Niemann Pick disease in human infants. The recombinant protein binds to stigmasterol and sitosterol, and with a lower affinity to cholesterol. Immunolocalization shows that ROSY1 is localized in vesicular membranes at the root tip, and in tips of root hairs. Preliminary data show that knockout mutant *rosy1-1* roots bend faster in response to gravity stimulation. Enhancer trap mutant plants for the gene show a distinct growth phenotype. In agar medium, *rosy1-1* plants are significantly larger than wild type plants, but in soil, *rosy1-1* plants are much smaller and often delayed in their life cycle. The *rosy1-1* seedlings are more salt and cold tolerant. ROSY1 protein interacts with Synaptotagmin1, a plasma membrane localized membrane trafficking protein. Currently, experiments to understand the role of this protein in plants, and how it helps the plant integrate light and gravity information are underway. [*Supported by NASA.*]

Leonardo C. Magalhaes, Jaap B. van Kretschmar, Kevin V Donohue, and R. Michael Roe
Graduate Program: Entomology
Advisor: R. Michael Roe

The first tarnished plant bug transcriptome: searching for new insecticidal targets

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is the most common and abundant mirid species in North America. This insect is a generalist herbivore and often becomes a pest, threatening more than 100 crops of economic importance. Although it impacts many crops, its importance is most frequently noticed in cotton production. After the introduction of transgenic Bt cotton, lepidopteran pests were essentially eliminated and pierce-sucking insects, such as the tarnished plant bug, emerged as new pests. Due to widespread resistance and other factors, cotton control costs and yield losses have been increasing considerably. As a result finding and utilizing new insecticide targets are necessary to prevent yield losses caused by this destructive pest. The first 454 transcriptome from gut and whole body of the tarnished plant bug was constructed as an attempt to find such targets. It was obtained 229,919 reads (3,549 contigs) from the gut library and 292,714 (5,529 contigs) reads from the whole body library. In total we obtained 116,635,527 bases of data. The data was organized according to the Gene Ontology (GO) and contigs in different categories were selected as potential targets to control this pest. The feasibility of these targets will be further evaluated later. A transgenic approach may be developed to control this pest in the future, which may change pest management completely as Bt changed lepidopteran pest management.

L. Michelle McElhannon, John M. Dole, and Brian E. Whipker
Graduate Program: Horticultural Science
Advisors: John M. Dole and Brian E. Whipker

Evaluation of propagation environments for unrooted vegetative cuttings

Plant producers in the United States use vegetative cuttings from around the world for production of finished plants. Approximately $64 million worth of unrooted cuttings were imported to the United States in 2008. Two of the most valuable floriculture crops, geranium (*Pelargonium* L'Hér. Ex. Ait.) and New Guinea impatiens (*Impatiens hawkeri* W. Bull), had a combined wholesale value of $115 million from the top 15 producing states. The condition of cuttings and propagation methods can be a limiting factor in production and are important areas of research. In this study, the rooting of shipped and non-shipped geraniums and New Guinea impatiens was evaluated to determine if propagation environment is a key factor in successful rooting. The rooting of four zonal geranium and four New Guinea impatiens cultivars was evaluated in four propagation environments (contact-spun woven polyester cloth laid directly on cuttings, humidity tent, mist, and fog) after receiving three simulated shipping durations (0, 2, and 4 days) at 20°C. Rooting, cutting quality, color, chlorophyll content, and cutting survival were determined. We established that the four propagation environments work equally well for non-shipped geranium cuttings and both shipped and non-shipped New Guinea impatiens cuttings. However, the mist environment provided the highest shoot dry weight and root number for shipped geranium cuttings. We conclude that New Guinea impatiens are tolerable to a wide range of propagation environments; however, geraniums require adequate rehydration after shipping for rapid rooting and shoot growth. Future work involves the study of geranium water relations during shipping and the effects of stock plant nutrition on storage and rooting of cuttings.

Stephen Meyers, Katie Jennings, and David Monks
Graduate Program: Horticultural Science
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Palmer Amaranth Interference in Sweetpotato

North Carolina produces 40% of sweetpotato hectarage in the U.S., worth $141 million. Sweetpotato yield and quality are greatly threatened by Palmer amaranth (*Amaranthus palmeri* S. Wats.), the most troublesome weed in N.C. crops. Control of this weed is very difficult. Yet parameters governing competitive interactions between Palmer amaranth and sweetpotato have never been

reported. Modeling these interactions, particularly as they pertain to sweetpotato yield loss, is critical in guiding decision making processes of N.C. growers in implementing a control strategy for this weed. Field studies were conducted in 2007 and 2008 at Clinton and Faison, N.C. to evaluate the influence of Palmer amaranth on 'Beauregard' and 'Covington' sweetpotato yield and quality, and to quantify the influence of Palmer amaranth on light interception. Palmer amaranth was established at 0, 0.5, 1.1, 1.6, 3.3, and 6.5 plants m^{-1} within the sweetpotato row and remained season-long. Marketable sweetpotato yield loss was fit to a rectangular hyperbola model, and predicted yield loss ranged from 36 to 81% for Palmer amaranth at 0.5 to 6.5 plants m^{-1}. Marketable sweetpotato yield loss displayed a positive linear relationship with Palmer amaranth light interception as early as 6 to 7 weeks after planting (R^2 = 0.93). Predicted Palmer amaranth light interception 6 to 7, 10, and 13 to 14 weeks after planting ranged from 47 to 68%, 46 to 82%, and 42 to 71%, respectively for Palmer amaranth densities of 0.5 to 6.5 plants m^{-1}. Palmer amaranth height increased from 177 to 197 cm at densities of 0.5 to 4.1 plants m^{-1} and decreased from 197 to 188 cm at densities of 4.1 to 6.5 plants m^{-1}. Palmer amaranth canopy width (69 to 145 cm) and shoot dry biomass $plant^{-1}$ (0.2 to 1.1 kg) decreased linearly as density increased.

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Advisor: Ignazio Carbone

Distribution of mating-type genes correlates with genetic recombination and aflatoxin-chemotype diversity in worldwide populations of *Aspergillus flavus* and *A. parasiticus*

Aflatoxins are toxic polyketides produced by several *Aspergillus* species that contaminate food crops worldwide. *Aspergillus flavus* and *A. parasiticus* are the most common agents of aflatoxin contamination. The genes involved in aflatoxin biosynthesis are clustered and convert acetate and malonate to aflatoxins B_1, B_2, G_1, and G_2. We determined the frequency of the *MAT1-1* and *MAT1-2* mating-type idiomorphs in *A. parasiticus* and *A. flavus* sampled from single peanut fields in the United States (Georgia), Africa (Benin), Argentina, Australia, and India. Population samples for each species were clone corrected using multilocus sequence typing, which included two aflatoxin cluster regions (*hypE* and *aflW/aflX*), three non-cluster genes (*trpC*, *amdS* and a hypothetical protein encoding gene), and the *MAT* gene. Analysis of molecular sequence variation across 21 intergenic regions in the aflatoxin gene clusters of *A. flavus* and *A. parasiticus* revealed significant linkage disequilibrium (LD) organized into distinct blocks. To determine whether sexual reproduction gives rise to recombination blocks, we tested the null hypothesis of an equal number of *MAT1-1* and *MAT1-2* in populations sampled from each locality/species using a two-sided binomial test. For both *A. flavus* and *A. parasiticus*, when the number of *MAT1-1* and *MAT1-2* was significantly different in both uncorrected and haplotype corrected samples, there was more extensive LD in the cluster and isolates grouped into specific chemotypes, either the nonaflatoxigenic class in *A. flavus* or the B_1-dominant and G_1-dominant classes in *A. parasiticus*. In *A. flavus*, a 1:1 distribution of *MAT* genes in a population with high numbers of nonaflatoxigenic strains increases the cluster recombination rate and increases the resolution of LD blocks. In *A. parasiticus*, sexual reproduction and recombination reduces the frequency of B_1-dominant and G_1-dominant chemotypes, and isolate G_1/B_1 ratios show a continuous distribution in the population.

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Advisors: Philip Awadalla and Eric Stone

Direct Estimates of *De novo* Mutation Rates and Constraints in Autism and Schizophrenia

The role of *de novo* and rare mutations in neurological diseases remains unknown. Nonetheless, the rate of deleterious mutations and the strength of selection against novel mutations are critical to the genetic etiology of human disease. Discovery of such high impact point mutations requires substantial high-resolution sequencing of partial or complete genomes of families. We hypothesized that deleterious *de novo* mutations, as well as rare segregating mutations, may play a role in cases of Autism Spectrum Disorder (ASD) and Schizophrenia (SCZ), both etiologically heterogeneous disorders with significantly reduced reproductive fitness. We present the first deep re-sequencing effort of ~ 0.5 Gigabase (Gb) of DNA from two large cohorts of ASD and SCZ trio families (n=285), and a large cohort of randomly selected families (n=285), to directly observe *de novo* mutations, to estimate the human mutation rates (μ), and map candidate causal genes. A survey of 401 synapse-expressed genes found 28 candidate *de novo* mutations, 13 of which were cell-line artifacts, but 15 of which were validated in blood DNA. The neutral mutation rate is similar to previous indirect estimates but a significant excess of *de novo* mutations that are protein-disruptive and highly deleterious occurs in individuals with ASD and SCZ. Deleterious *de novo* mutations were discovered in genes encoding synapse structure proteins and

kinesins. We also find that the overall distribution of variation indicates a significant excess of rare deleterious alleles relative to control cohorts or previous population genetic studies. Three genes; *MAP1A, CACNA1,* and *GRIN2B*, exhibit an excess of rare missense mutations. This study emphasizes the need for careful validation of rare mutations. Using DNA from archived cell lines can overestimate mutation rate by at least two-fold.

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Advisor: Ralph A. Dean

Differential accumulation of small RNAs during *Magnaporthe oryzae* growth and development

Due to its genetic tractability and pathogenic association with many important economic crops, *Magnaporthe oryzae* is a leading model fungus to study plant-pathogen interactions. Although new insights into the mechanisms by which *M. oryzae* causes disease has been elucidated through genomics and transcriptome studies, a detailed investigation of the small RNAs (sRNAs) of ~ 20 – 40 nucleotides (nt) has not been undertaken to-date. In plants and animals, sRNAs regulate gene expression at transcriptional and posttranscriptional level at several developmental stages. Thus, we hypothesized that sRNAs also play a role throughout *M. oryzae* life cycle. In this study, we used the next generation of sequencing technology, 454 Pyrosequencing platform (Roche), for deep sequencing coverage of sRNAs from *M. oryzae* mycelia and appressoria tissues and generated 124,024 and 25,832 sequences ≥ 16 nt, respectively. SRNAs perfectly matching the genome were characterized based on genome features (genes, repetitive DNA, rRNA, tRNA). Surprisingly, about 14.0% of sRNAs from mycelia mapped to repeats such as MAGGY in contrast to only 2.3% in appressoria. Notably, sRNAs mapped to both sense and antisense strands in equal frequency and had a peak length of 22 – 23 nucleotides; characteristics of siRNA. Our results suggest that expression of repetitive elements such as transposons were silenced in mycelia. In addition, we found ~ 19.5% of appressoria sRNAs mapped to tRNA in contrast to ~ 9.4% from mycelia. *M. oryzae* small RNAs exhibited a bias for U enrichment and C suppression at position 1 especially on the antisense strand. Our data, demonstrates that tRNA cleavage occurred at the tRNA anticodon and was tissue dependent suggesting that tRNA processing may regulate protein synthesis. In conclusion, evidence suggests different classes of sRNAs exist in *M. oryzae* and their frequency profiles in different tissues suggest they may play an active role in growth and development.

Heather A. Olson
Graduate Program: Plant Pathology
Advisor: D. Michael Benson

Characterization of *Phytophthora* from North Carolina greenhouse ornamentals

Root rot, crown rot, and foliar blight, caused by species of *Phytophthora*, are common diseases on ornamentals and are ongoing problems in greenhouse production. In-depth characterization of *Phytophthora* will further our understanding of the impact on the NC floriculture industry and aid in developing disease management strategies. Greenhouses in NC were surveyed for *Phytophthora* to expand the information from a 2001-2002 survey. Isolates of *Phytophthora* were collected from symptomatic plants and identified primarily as *P. nicotianae*, *P. cryptogea*, *P. drechsleri*, and *P. tropicalis* using morphology and DNA sequencing. Growth at 35°C has been used to distinguish the morphologically similar *P. cryptogea* (no growth) and *P. drechsleri* (growth). Utility of this assay was evaluated. Results were in conflict with the sequencing identification. Isolates of *P. cryptogea* did not grow; however, not all *P. drechsleri* isolates grew. Mating type was determined for heterothallic species by observing cultures for the formation of sexual structures. Both mating types of *P. nicotianae*, *P. cryptogea*, and *P. tropicalis* were found. Only the A1 mating type of *P. drechsleri* was found. Mefenoxam is a fungicide used in the management of *Phytophthora*. Resistance has been reported in multiple species. Mefenoxam sensitivity was tested using growth on mefenoxam-amended medium. All isolates of *P. cryptogea* were sensitive. In contrast, all isolates of *P. drechsleri* were resistant. Sensitive and resistant isolates of *P. nicotianae* were found. Resistant isolates were evaluated further for the EC_{50} using regression analysis. *Phytophthora drechsleri* exhibited the greatest resistance with EC_{50} estimates of over 700 ppm mefenoxam. EC_{50} estimates for *P. nicotianae* ranged from 246 to 435 ppm. Isolates identified as *P. cryptogea* by ITS RFLP during the 2001-2002 survey were characterized further by sequencing of the ITS and *coxII* regions. Inconsistencies between the ITS RFLP and sequence identifications were found and are being explored.

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Advisor: Fred P. Hain

Scanning Electron Microscopy as a Tool in Understanding Hemlock Woolly Adelgid Biology, Feeding Behavior, and Host Plant Resistance

The hemlock woolly adelgid (HWA) is an invasive aphid-like insect responsible for massive mortality of hemlock populations in the Appalachians, ranging from Georgia to Maine. An attacked tree can die in as little as four years. In a unique ecological niche, loss of

the hemlock has implications for native trout decline and substantial loss of bird habitat, both which depend on its distinct canopy. In its natural range hemlocks are protected by resistance and natural enemies. To date, HWA control methods include chemical treatments, which are expensive and impractical for forest settings, and biological control, which is also expensive and has shown limited success. Resistance to HWA would provide the ability to withstand attack without continual maintenance. Reports of putatively resistant eastern and Carolina hemlock have indicated the likelihood of inter- and intraspecific variation in susceptibility. Mechanisms of this resistance are relatively uninvestigated, especially HWA feeding mechanisms. Feeding is unique in that once its mouthparts (stylet bundle) are inserted, the insect remains stationary. A gel-like sheath material with unknown function surrounds them. Our objectives are to examine HWA feeding mechanisms, concentrating on sheath material, and to determine susceptibility of the nine species of hemlocks. Scanning electron microscopy has shown to be an effective tool in stylet bundle insertion observation. We are able to study insertion sites and the sheath material surrounding the stylet bundle. Our hypotheses for sheath function include: assistance in sucking mechanisms, maneuvering advantage, reinsertion ease following molts, and protection against plant defenses. Susceptibility of six hemlock species was measured using a cut-branch infestation technique. Variation in susceptibility was shown in eastern and Carolina hemlock, both stated in literature to be highly susceptible. Continued studies will lead to a better understanding of the host-plant interactions and further the development of a resistant hemlock.

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Graduate Program: Poultry Science
Advisor: Charles Stark

Evaluation of expeller-produced and solvent-extracted soybean meal at two particle sizes on broiler performance

Expeller soybean meal is what remains after the oil is mechanically removed from whole soybeans. Expeller soybean meal (ESBM) typically has a higher fat and energy content but lower protein than solvent-extracted soybean meal (SSBM). Local production of ESBM can benefit both the soybean grower and livestock producer by reducing the cost associated with the movement of soybeans and soybean meal (SBM). The objective of this study was to evaluate the nutritional value of ESBM, as compared to SSBM and the effect of SBM particle size on broiler performance. The experiment was a 2 x 2 factorial of SBM type (ESBM and SSBM) and particle size (coarse and fine). The fine SBM was produced by grinding the material through a 1.6 mm hammermill screen (390 microns), the coarse treatments were fed as received from the supplier (1,040 microns). A total of 1,024 male 1-d old broiler chicks were randomly assigned to one of four treatments with 8 replicate pens per treatment and 32 birds per pen. The starter diets were fed in crumbled form and the grower and finisher diets in pelleted form. Commercially available SSBM and ESBM were used in the experiments. The SBM was analyzed for moisture, crude protein, and crude fat, which were then used to estimate the ME of the SBM. The estimated ME content of ESBM and SSBM was 2,800 and 2,588 kcal/kg, respectively. Feed consumption and BW were determined at 1, 14, 35, 42, and 49 d of age and adjusted feed conversion (AdjFCR) calculated by including the weights of all dead birds. There was an interaction between particle size and SBM type for 49 d BW. The coarse SSBM and ESBM and fine SSBM resulted in heavier 49 d BW (3,794, 3,803 and 3,762 g respectively) as compared to the fine ground ESBM (3,605 g). The AdjFCR of birds fed the SSBM (1.90) was poorer than birds fed the ESBM (1.77). Birds fed the fine SBM had poorer AdjFCR (1.86 vs 1.80). The results of this experiment indicated that birds performed better when fed the coarse the SBM. The difference in AdjFCR results also indicated that energy value of 2,800 kcal/kg for ESBM was underestimated in the diet formulation.

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Advisor: Joshua L. Heitman

Soil Moisture Characterization with North Carolina Environment and Climate Observing Network

Soil moisture content has important implications for agriculture, hydrology, weather prediction and climatology. Research has examined a large number of factors including soil texture, vegetation and precipitation, among others that influence soil moisture. Based on these factors, scientists have tried to build physically realistic models to fit soil moisture observations made in the field. This ongoing process has now become even more challenging as field data are collected at a large spatial scale, encompassing a wide range of soil types and landscapes. In this research, multi-year soil moisture observations, gathered from North Carolina Environment and Climate Observing Network (NCECONet), are examined both spatially and temporally. Near real time data are recorded at 35 NCECONet stations across the state at 20cm depth. This study aims to investigate the connection between soil moisture data at these monitoring sites and site-specific soil and land properties. With an ultimate goal of prediction at non-monitored locations, multivariate linear regression is being used to analyze the controlling soil and landscape factors within the NCECONet coverage area. In the preliminary model presented here, soil moisture was correlated to precipitation, clay content and Topographic Wetness Index. ANOVA tests reveal that soil clay content has a positive effect on soil moisture content at significance level of 0.1; analysis of other parameters will continue. The intended outcome of our study is to provide continuous spatial soil moisture data layers covering the entire state, which will benefit end-users including farmers, engineers, hydrologists and policy makers.

Virginia H. Rodillas
Graduate Program: Human Development and Family Studies
Advisor: Karen Debord

Power of Observation in Early Childhood and Adult Learning Settings increased through Contemporary Methods

Observation is a powerful tool for insight into the functioning of groups and individuals. The Incredible Years (IY) parenting education groups, an inner-city Head Start classroom, a rural More at Four classroom, and a preschool-aged daycare center were observation sites for this Masters Degree capstone experience. Sample observations to perform fidelity checks were completed at IY classes through the use of checklists. The Head Start classroom was observed using the ECERS rating scale to rate classroom quality and teacher-child interactions. Two Event Recordings were also used to record how many times certain behaviors occurred in two children. One classroom for 4-year olds in the Bright Horizons Child Care Program was observed using Anecdotal Records to develop a report about an individual child's behavior. Running Records along with the ECERS were completed in the More at Four classroom to rate classroom quality and child-teacher interactions and to record the observed interactions between three children. These observational methods are powerful tools in drawing conclusions about program fidelity, effectiveness of the programs, and in making program recommendations, but can they be improved?

A more contemporary method of observation might include software and cell phone applications capable of collecting checklist data, anecdotal records, running records, duration recordings, rating scale scores, and event recording along with video recording and photo taking. I propose the application, EyeConnect. *EyeConnect* for multimedia devices could significantly decrease the time it would usually take to process observational data. This application would integrate several methods into one easy to use program while keeping data compartmentalized and organized. Data could also be shared with other professionals within seconds. The EyeConnect application might become the new and improved method of observation for professionals in the field of Family Studies and Parenting Education and increase the power of observation in various learning environments.

Juan B. Rosario
Graduate Program: Genetics
Advisor: James W Mahaffey

Establishment of leg development: generation of distal organizers using the gene *disconnected*

The fruit fly, *Drosophila melanogaster*, is an excellent model organism for the study of limb development. Our goal is to understand the role of the gene *disconnected (disco)* in leg development. In *Drosophila*, adult appendages arise from the imaginal discs, which are cells set aside during embryogenesis to give rise to specific adult body structures. Specific signals (morphogens) induce the proximal to distal pattern in the appendage and create an "organizer" in the leg imaginal disc. Organizers are groups of cells capable of inducing differentiation and controlling growth and development of specific organs. The *disco* gene is required for proper leg development, and ectopic expression of *disco* in the wing imaginal disc induces a wing-to-leg transformation. This wing-to-leg transformation provides an opportunity to study the intrinsic gene network responsible for the differentiation of adult structures. Here we show how the ectopic expression of *disco* in the wing imaginal disc can interact with endogenously expressed genes to induce medial-to-distal leg development. These interactions allow us to elucidate the events leading to the formation and function of the leg organizer at the molecular level.

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Graduate Program: Animal Sciences, North Carolina State University[1]; Hanor Company[2]
Advisor: Eric van Heugten

Sow and litter response to supplemental dietary fat in lactation diets during high ambient temperatures

Piglet performance is reduced during the summer season when sow feed intake is low because of heat stress. The objective of this study was to determine the impact of supplemental dietary fat on total caloric intake and sow and litter performance during high ambient temperatures. Data were collected from 337 sows (PIC Camborough line) from July to September in a 2,600-sow commercial unit in Oklahoma. Lactation diets were supplemented with fat (animal-vegetable blend) at either 0, 2, 4, or 6%. Sows were balanced by parity, with 113, 109, and 115 sows representing parity 1, 2, and 3 to 7 (P3+), respectively. Feed disappearance (4.09, 4.18, 4.41, and 4.35 kg/d; $P = 0.05$) and caloric intake (13.3, 14.0, 15.2, and 15.4 Mcal/d; $P < 0.001$) increased linearly with increasing dietary fat. Back fat loss was lower ($P < 0.02$) and loin depth gain was greater ($P < 0.001$) in P3+ sows compared to P1 and P2 sows. Litter weight gain was greater ($P < 0.02$) in P2 sows compared to P1 and P3+ sows (2.30 vs. 2.09 and 2.15 kg/d). Dietary fat improved litter weight gain in P3+ sows (1.99, 2.14, 2.15, and 2.32 kg/d for 0, 2, 4, and 6% fat, respectively). Rectal and skin temperature and respiration rate of sows were greater ($P < 0.002$) when measured at week 3 compared to week 1 of lactation. In conclusion, caloric intake increased with the addition of fat because of the effects on dietary energy density and feed intake. Increased caloric intake did not have beneficial effects on any measured criteria, except for improved litter gain in P3+ sows. Future studies with different sources of fat will be performed to analyze the effect of fat quality (free fatty acids content).

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Graduate Programs: Biology[1]; Environmental and Molecular Toxicology[2]
Advisors: D. Derek Aday and James A. Rice

Evaluating mercury dynamics and trophic transfer in aquatic ecosystems

Since the industrial revolution, mercury (Hg) concentration in the atmosphere has increased substantially, largely from anthropogenic inputs such as coal-fired power plants. Owing to its ease of atmospheric transportation and long residence time, Hg contamination in freshwater and marine ecosystems has become a global problem. After atmospheric Hg enters aquatic systems it is chemically transformed by bacteria into methylmercury (MeHg), the organic, highly neurotoxic form of Hg that enters the aquatic food web and becomes a health threat to wildlife and humans. The mechanisms associated with MeHg uptake and accumulation in fish tissue are still poorly understood, and for that reason human health officials are often forced to recommend fairly nonspecific fish consumption advisories. Our goal was to gain a better understanding of mechanisms associated with Hg contamination of, and movement in, aquatic systems to help policy makers better manage human health risk and exposure to this neurotoxic contaminant. To that end we have completed an extensive, statewide survey of North Carolina waterbodies and fish that identified a suite of environmental factors that drive methylmercury formation and movement through aquatic food webs. From those data, we have developed a predictive statistical model. We are also evaluating how Hg dynamics are affected by proximity to an atmospheric point-source of Hg (coal-fired power plants) and plan to examine the link between fish size and tissue Hg concentration in relation to fishery regulations. Finally, we plan to examine the relationship between hurricanes and potential Hg pulses through aquatic food webs. In sum, our work provides a mechanistic understanding of Hg contamination and bioaccumulation in aquatic systems and will provide policy makers with additional tools for assessing and managing human health risks.

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Advisor: Ralph A. Dean

Functional Characterization of Protein Kinases between Fungi and Animalia

Eukaryotic organisms depend on several essential regulatory networks to control gene expression. Proteins in these networks are activated through a cascade of protein-protein interactions where protein kinases activate target proteins through phosphorylation. The well studied MAP kinase (MAPK), cAMP (PKA), and Ca/calmodulin (CAMK) signal pathways are known to participate in responding to environmental signals, growth factors, apoptosis, memory retention, metabolism, etc. While these evolutionary conserved pathways exist throughout Eukarya, determining common network characteristics across distantly related organisms remains a challenge.

Using Proteome chip technology, protein substrates can be phosphorylated *in vitro* by activated protein kinases. Chips were prepared for the model organisms *H. sapiens, S. cerevisiae,* and *M. oryzae*. Select Protein Kinases from each organism were formed, purified, and activated for the MAPK (11), CAMK (7), PKA (9) pathways. Protein kinase phosphorylation was then scored for each kinase across each chip resulting in 81 datasets and over 870,000 data points. 30,245 phosphorylation events were observed with an average of 1120 interactions per kinase ranging between 598 - 1791.

Utilizing data from each chip, common functional patterns of phosphorylation between Protein Kinases within (homolog) and between (ortholog) species are determined. Functional patterns are identified by creating organism and network specific interaction data sets. The robustness of these data sets is confirmed by permutation test and comparison to previously published protein interactions. Functionally orthologous Protein Kinases are then determined based on shared targets with most orthologous pairs belonging to the same network family. Protein targets from orthologous pairs are then analyzed to determine shared phosphorylation motifs. The global insight into MAPK, CAMK, PKA cellular networks revealed by these analyses is described.

Amanda Saville, Alexander Krings, Rose Grinnan, and Wade Wall
Graduate Program: Plant Biology
Advisors: Alexander Krings and Jenny Xiang

Delimiting species boundaries in the *Dichanthelium dichotomum* complex (Poaceae)

Dichanthelium dichotomum (L.) Gould (Poaceae) is a complex of diploid grasses, all found within the eastern United States. This widely encountered species complex is an important component of the eastern North American flora, but our current understanding of it is chaotic at best. The objectives of this study are: (1) to analyze taxonomic limits in the *D. dichotomum* complex, using data from multivariate analyses of morphology, and (2) to test the fit of taxonomic circumscriptions of four major taxonomic treatments of the complex. In a continuation of previous work, morphological data comprised of 12 quantitative and 24 qualititative characters have been captured from 576 herbarium specimens, including 44 of 47 types, spanning the complex's range. Results from multiple analyses, including cluster and principal coordinate analyses (PCoA), show three mostly distinct groups referable to *Dichanthelium annulum* (Ashe) LeBlond, *D. yadkinense* (Ashe) Mohlenbrock, and a third including all other OTUs sampled. These groups were best

circumscribed in treatments by Hitchcock and Chase (1910) and LeBlond (2001). Structure was evident in the clustering of remaining OTUs, although these exhibited varied overlap. Preliminary analyses of quantitative characters against geographic location show little evidence of a morphological cline within the group. Additional analyses, including ecological niche modeling and further examinations of character patterns within groups are planned.

Mingzhu Shi
Graduate Program: Plant Biology
Advisor: Deyu Xie

Red Callus Culture of pap1-D: A Tool for the Study of Global Impact on Metabolisms by the overexpression of MYB75 Transcription Factor in Arabidopsis thaliana

PAP1 is the MYB75, which is considered the key regulator of anthocyanin biosynthesis in Arabidopsis. The overexpression of PAP1 gene leads to enhanced accumulation of anthocyanins, which are the most prevalent pink/red/purple natural pigments in plants. We established anthocyanin-producing red callus cell lines from pap1-D (production of anthocyanin pigment-dominant) plants, which were obtained by T-DNA activation tagging, for the purpose of studying the impacts of the overexpression of PAP1 on global metabolisms. As a control, WT callus culture was also established. Genome-wide analysis using microarrays determined 31 significantly differentially up-regulated and 103 down-regulated genes in PAP1 vs. WT callus. The transcript level of several genes involved in anthocyanin pathway was dramatically increased, especially late pathway genes (eg. DFR and ANS), which were confirmed by regular RT-PCR and qRT-PCR analysis. The expression level of many genes essential for photosynthesis was significantly reduced in PAP1 callus. Several target genes are determined for further functional analysis. LC-MS based metabolomics analysis confirmed the dramatic increase in anthocyanin level in PAP1 vs. WT callus and identified seven anthocyanins including two new ones from the profiling of PAP1 callus. Other impacts of the overexpression of PAP1 on metabolisms will be discussed in this presentation.

Michael C. Shields[1], Eric van Heugten[1], Jack Odle[1], and Charles Stark[2]
Graduate Programs: Animal Science[1]; Poultry Science[2]
Advisor: Eric van Heugten

Evaluation of the nutritional value of glycerol, a byproduct of biodiesel production, for swine

With the increase in the production of alternative fuels, it is important to find uses for their byproducts. Three experiments were conducted to evaluate the effect of glycerol on feed production efficiency and two performance studies were conducted to determine the benefit of glycerol in growth performance of nursery pigs. In Experiment 1, nursery feed was used to examine feed mill performance at glycerol levels of 0, 2.4, and 5%. In Experiment 2 (100 lbs) and 3 (1000 lbs), finisher feed was mixed at glycerol levels of 0, 2.5, and 5%. In Experiment 1, increasing glycerol in nursery pig diets from 0, to 2.4 and 5% improved, feed flowability, feed pelleting efficiency, and pellet quality significantly increased, while horsepower, and hot pellet temperature significantly decreased. In Experiment 2, increasing glycerol in finisher pig diets from 0, to 2.5 and 5% improved feed flowability, while in Experiment 3, pellet mill efficiency and pellet durability significantly increased and hot pellet temperature significantly decreased. In Experiment 4, pigs weaned at 21 days of age were fed one of six treatments arranged in a 2x3 factorial with factors: 1) glycerol inclusion in phase 1 diets (0 or 5%) and 2) glycerol inclusion level in phase 2 diets (0, 5, or 10%). Results showed that supplementation of glycerol significantly improved growth performance. In Experiment 5, newly weaned pigs were assigned to one of six dietary treatments. Glycerol was supplemented at 0, 2.5, 5, 7.5, 10% to replace up to 10% lactose in a starter diet containing a total of 20% lactose and a negative control was included with 10% lactose and 0% glycerol. Results demonstrated that glycerol supplementation at 10% improved daily gain by 30% compared to the negative control. In conclusion, glycerol greatly improved feed production efficiency and improved growth performance in nursery pigs.

Shilpa Swarup[1,3], Trudy Mackay[1,3], and Robert Anholt[1,2,3]
Graduate Programs: Genetics[1]; Biology[2]; W. M. Keck Center for Behavioral Biology[3]
Advisors: Robert Anholt and Trudy Mackay

RNAi-mediated dissection of olfactory behavioral response profiles of odorant binding proteins in Drosophila melanogaster

Chemosensation in Drosophila is mediated by large multigene families of chemoreceptors, including olfactory receptors, gustatory receptors, and odorant binding proteins (OBPs). The latter are highly divergent soluble proteins, which in the antennae and maxillary palps are secreted into the aqueous perilymph where they are thought to facilitate transport of hydrophobic odorants to olfactory receptors on the chemosensory membranes of olfactory sensory neurons. Although some OBPs have been functionally implicated in pheromone responses and host plant selection, their functions in general odorant recognition are thus far poorly characterized. To assess molecular response properties of OBPs, we have systematically suppressed the expression of 16 OBPs by crossing a tubulin-GAL4 driver line to lines from the Vienna Drosophila RNAi Center collection that express RNAi corresponding to individual Obp transcripts under UAS promoters inserted in the neutral PhiC31 integration site. RNAi expression was enhanced with a UAS-GAL4

enhancer and real time qRT-PCR showed effective suppression of target RNAs in the GAL4-UAS hybrid offspring. We measured behavioral responses to a spectrum of odorants, and different odorants revealed altered behavioral responses in subsets of lines in which Obp gene expression was suppressed. Moreover, the response profiles showed sexual dimorphism. Our results demonstrate that our approach can delineate odorant response profiles of OBPs and confirm that interactions between general odorants and OBPs are combinatorial. Furthermore, our results show that males and females experience the chemosensory environment through different expression patterns of chemoreceptors. Supported by NIH grant GM059469.

Katy Vanninen
Graduate Program: Human Development and Family Studies
Advisor: Karen DeBord

Reconnecting Families and Nature: Play, Benefits, Barriers

While many generations of children and families thrived in outdoor environments, a modern cultural shift has brought many families indoors with an increased dependence on technology and a hypersensitivity to potential risk and danger. This new paradigm has left families unaware of the benefits of engaging with nature and of the potential negative consequences of associated development in indoor and artificial environments. Humans have evolved in and thrive in nature. Constructed and natural environments offer different benefits and drawbacks for family engagement and play. Play is an essential aspect of childhood development, and play in nature offers many unique and developmentally appropriate experiences for families. Parental involvement in children's development, learning, and play is particularly beneficial for parents and children when in nature. In recent years, families have opted to use technology as a substitute for play, communication, and activity. However, many parents do not understand the long term consequences associated with frequent screen exposure, media influence, overstimulation, and perpetual distraction. Families face many barriers to engaging with nature through influence by the media, peers, government policy, and a society focused on risk aversion and fear. Families are overworked, stressed, and feel they lack the time needed to play outside. Parents have expressed being either being uncomfortable in nature, and having many fears concerning outdoor spaces, or not enough time to spend playing out of doors. Communities however can influence the quality of a neighborhood by design and maintenance, which can determine how families interact with their environment. Families must be made aware of the impact of nature on their lives to make informed decisions and create a healthy environment.

Arielle Waldstein[1], Theodore R. Simons[1], Allan F. O'Connell Jr.[2], Kenneth H. Pollock[3], and Michael K. Stoskopf[4]
Graduate Programs: NC USGS Cooperative Research Unit, Department of Biology, North Carolina State University[1]; USGS Patuxent Wildlife Research Center, Beltsville, MD[2]; Centre for Fisheries and Fisheries Research, Murdoch University, Perth, Western Australia, Australia Pathology[3]; College of Veterinary Medicine, Department of Clinical Sciences, North Carolina State University[4]
Advisor: Theodore R. Simons

Assessing the Effect of Population Reduction on Raccoon Population Dynamics, Predation Rates and Prey Nesting Success

Removal of predators to protect prey species is a growing but contentious field of study in biology and the efficacy of this technique is often questioned. Even where removal efforts have been successful, predator populations require constant management to avoid rebounding back to their former levels or beyond. On Cape Lookout National Seashore (CLNS) in North Carolina, raccoons (*Procyon lotor*) have reached high population densities due to the absence of natural predators and an abundance of food resources. Raccoons depredate up to 87% of nests on CLNS and are considered a major threat to several species of concern. The objectives of this study were to document the ecology of raccoons at CLNS in 2007 and 2008 and then to evaluate the response of the raccoon population to an experimental reduction in late 2008. In addition, we explored the effect of raccoon population reduction on the rate of nest depredation and productivity of the threatened and endangered species monitored by CLNS. Projected raccoon population response was modeled using local parameters gathered from mark-recapture, radio-telemetry and data gathered from raccoon necropsies. Differences in movement, home range size and home range overlap were assessed using radio-telemetry. Data on nest depredation and productivity were gathered by the National Park Service and differences pre- and post-removal were evaluated using a BACI design. Our population models projected a higher resulting population size in 20 years following raccoon removal than if no removal had been implemented. We found no difference in home range size or overlap following removal but did find differences in movement. Analysis of nest predation rates and productivity did demonstrate a benefit following removal based on one year of post-removal data. Further monitoring of this population will be undertaken over the next two years.

Wade A. Wall[1], Norman Douglas[1], Qui-Yun (Jenny) Xiang[1], William A. Hoffmann[1], Thomas R. Wentworth[1], Janet Gray[2], and Matthew Hohmann[3]
Graduate Programs: Plant Biology, North Carolina State University[1]; Endangered Species Branch, Fort Bragg, NC[2]; US Army Corps of Engineers, Construction Engineering Research Laboratory[3].
Advisors: William A. Hoffmann and Thomas R. Wentworth

No evidence for southern refugium during the latter Pleistocene in *Pyxidanthera barbulata*

The Wisconsin glacial period of the Pleistocene had a major impact on the distribution of plant species in Eastern North America (ENA), with major range shifts into one or more southern refugia during the glacial period and subsequent colonization of northern areas after the last glacial maximum. Most studies have focused on widespread species that occur across multiple physiogeographic regions, while species restricted to the Atlantic Coastal Plain have been relatively understudied; this could lead to biased inferences regarding the response of species to changing climatic conditions. We investigated the phylogeography and taxonomic status of the two varieties of *Pyxidanthera barbulata* using a variety of summary statistical and coalescent approaches. *P. barbulata* is an Atlantic Coastal Plain endemic plant species that occurs in a variety of habitats from New York to South Carolina. There are two morphological types that occupy different ecological (var. *barbulata* in wet and var. *brevifolia* in dry) habitats and debate exists as to whether the two types are separate species or two varieties of the same species. We found no evidence for a southern refugium or range shift for *P. barbulata* during the last glacial period with no decrease in genetic diversity or rare alleles in northern populations. The northern populations included a number of private alleles not found in southern populations. In addition, there is overlap of morphological measurements between the two varieties and little genetic differentiation. The phylogeography of *P. barbulata* is different from typical patterns documented so far in ENA, and suggests that the Atlantic Coastal Plain may have a different vegetation history relative to other physiographic regions in ENA. It appears that var. *brevifolia*, represents an ecological variant differentiated from var. *barbulata* that only develops under extreme edaphic conditions in the Carolinas and we suggest varietal status for the two taxa.

Jordan Wallace
Graduate Program: Human Development and Family Studies
Advisor: Karen DeBord

The Influence of Parental Control on Identity Development in Emerging Adults

For today's adolescent, growing up includes an additional developmental period in between adolescence and adulthood, where individuals are not solely adolescents, but are not yet adults. *Emerging Adulthood,* described by researcher, Jeffrey Jensen Arnett (2004), is the period marked by five characteristics; identity exploration, instability, being self-focused, feeling in-between and endless possibilities. Since adolescents in industrialized countries like the US are experiencing the newly defined, Emerging Adulthood, several traditional social markers to adulthood are being postponed. Social markers such as marriage and bearing children are being replaced with markers of maturity such as autonomy and the development of a personal identity. This shift in redefining development has motivated researchers to investigate how development of identity and autonomy impacts individual's paths to adulthood. In an attempt to understand how parental influences affect children's identity development, online surveys were administered to parents of students at North Carolina State University's First Year College. The results of the survey will be cross-referenced with a pre-determined model of Parenting Support and Control to determine how each parent's parenting style may influence children emerging into adulthood.

Lin Wu[1], Deanna L. Osmond[1], Alexandra K. Graves[1], Michael R. Burchell[2], and Owen W. Duckworth[1]
Graduate Programs: Soil Science[1]; Biological and Agricultural Engineering[2]
Advisors: Owen W. Duckworth and Deanna L. Osmond

Denitrification and Molecular Detection in Riparian Buffer Soils

In North Carolina, riparian buffers are an important best management practice (BMP) in regulating the transport of nitrate in groundwater flow from uplands to surface water. Denitrification, the bacterially meditated conversion of nitrate into gaseous forms of nitrogen, is a major biogeochemical process contributing significantly to the groundwater purification. Denitrification has received much attention because it also produces nitrous oxide (N2O), a greenhouse gas that can promote ozone depletion. Extensive work has examined the denitrification rate in different riparian buffers and detected the putatively responsible denitrifying genes. However, the relationship between chemical denitrification rate and microbial activity is poorly understood. We measured the nitrate loss rate and N2O production rate as a function of organic carbon concentration given carbon types by continuous column experiments. Citric acid promoted denitrification while humic acid and alginic acid did not contribute to denitrification. From the biological perspective, we conducted real-time PCR to examine the responsible gene copy number in the soil. The results will help to link biological and chemical measurements of denitrification.

April Wynn
Graduate Program: Genetics
Advisor: Robert Franks

SEUSS*-Related Transcriptional Regulatory Complexes are Vital for Ovule Development in *Arabidopsis thaliana

Complex reproductive structures like flowers require tight regulation of gene transcription for their proper development. Reproductive success in flowering plants requires the proper specification of organ identity within the carpel, the female reproductive floral organ. After carpel identity is specified, subsequent gene regulation events direct the development of meristematic tissues on the carpel margin that gives rise to the ovules which become the seeds. These developmental events are controlled by genes that must be expressed in precise spatial and temporal patterns. In *Arabidopsis thaliana,* one such gene vital for carpel margin meristem development is *PHABULOSA.* The gene expression of *PHABULOSA* is specifically controlled by multimeric transcriptional regulatory complexes, and the identification of the transcription factors in these complexes will elucidate regulatory forces that control plant development. Two transcription factors known to synergistically interact to affect *PHABULOSA* expression are SEUSS and AINTEGUMENTA. Currently we are investigating the molecular basis of this genetic synergistic interaction during carpel margin meristem development, however other factors acing in these regulatory complexes are yet unknown. There is genetic evidence that the SEUSS-related proteins, or the three paralogues of *SEUSS* in *Arabidopsis thaliana*, have varying degrees of functional redundancy with SEUSS and that they too affect carpel margin meristem development. Through transcript profiling of *seuss* and *aintegumenta* mutants and identification of down stream targets of SEUSS we will identify putative members of these regulatory complexes and indicate their possible functional relationships in ovule development in *Arabidopsis thaliana*.

Shanshan Zhou[1,2], Eric A. Stone[2,3], Trudy F. C. Mackay[2,3], and Robert R. H. Anholt[1,2,3]
Graduate Programs: Biology[1], W. M. Keck Center for Behavioral Biology[2], Genetics[3]
Advisor: Robert Anholt

Plasticity of chemosensory repertoire in *Drosophila melanogaster*

For most organisms, chemosensation is critical for survival, and is mediated by large families of chemoreceptor proteins, whose expression must be tuned appropriately to changes in the chemical environment. We asked whether expression of chemoreceptor genes that are clustered in the genome would be regulated independently; whether regulation of certain chemoreceptor genes would be especially sensitive to environmental changes; whether groups of chemoreceptor genes undergo coordinated regulation; and how plastic the expression of chemoreceptor genes is with regard to sex, development, reproductive state, and social context. To answer these questions we used *Drosophila melanogaster*, because its chemosensory systems are well characterized and both the genotype and environment can be controlled precisely. Using customized cDNA microarrays, we showed that chemoreceptor genes that are clustered in the genome undergo independent transcriptional regulation at different developmental stages and between sexes. Expression of distinct subgroups of chemoreceptor genes is sensitive to reproductive state and social interactions. Furthermore, exposure of flies only to odor of the opposite sex results in altered transcriptional regulation of chemoreceptor genes. These genes are distinct from those that show transcriptional plasticity when flies are allowed physical contact with same or opposite sex members. We analyzed covariance in transcript abundance of chemosensory genes across all environmental conditions and found that they segregated into 20 relatively small, biologically relevant modules of highly correlated transcripts. This finely pixilated modular organization of the chemosensory subgenome enables fine tuning of the expression of the chemoreceptor repertoire in response to ecologically relevant environmental and physiological conditions.

Tim Bennett
Graduate Program: Industrial Design
Advisor: Haig Khachatoorian

The Design of a Telemedical Full-Body Imaging System to Promote Regular Skin Examinations: A Simulation of Professional Design Practices

Over one million cases of skin cancer are diagnosed annually within the United States with skin melanoma accounting for approximately 8,650 deaths a year. If detected early, the survival rate of patients with skin melanoma is 99%. Unfortunately, a low availability of dermatologists, an uneven spread of medical facilities, and a general lack of public awareness allow for an unnecessarily high rate of mortality. The objective of my research is to employ strategic design methods to uncover an appropriate solution to this issue in the form of a marketable product as a simulation of the professional product development process. A mixture of data collection and visualization methods such as product analyses, field observations, geographical mapping, behavioral mapping, PACT analyses, value propositioning, task analyses, two dimensional visualizations, and three-dimensional prototyping were used to uncover and develop potential product solutions. To further realize a solution, a brand in the form of a technologically capable manufacturer was chosen to guide product placement strategy and program vision. The resulting design is a full-body imaging system that electronically transmits high-resolution images of a patient to a doctor or dermatologist of choice. The device, intended for use in local health clinics, allows for a convenient and quick solution to citizens looking to have a regular skin examination without the hassle of having to make an appointment or travel to urban medical centers.

Peter J. Carrasquillo[1], Lion Shaw[2], Christina Clark[2], Rohan Hangekar[3], and Richard Nguyen[4]
Graduate Programs: Industrial Design[1]; Business Administration[2]; Mechanical Engineering[3]; Biomedical Engineering, North Carolina State University/University of North Carolina at Chapel Hill[4]
Advisor: Haig Khachatoorian

The Celina Autoblend: Design of and Proposal for a Closed-Loop Oxygen Blending and Delivery Module for Neonatal Oxygen Therapy

It has been known for decades that low blood oxygen saturation can lead to Hypoxia which can cause brain damage or death. For that reason almost all prematurely born infants require supplemental oxygen therapy due to underdeveloped lungs. More recently it has been found that too much oxygen can lead to Hyperoxia which can cause cell damage to the heart and lungs and cause blindness due to retinopathy. Multiple studies have shown that avoiding episodes of hypoxia and hyperoxia by maintaining very precise blood oxygen saturation (SpO2) thresholds during the first few weeks of life is vital to preventing long-term developmental problems in children born prematurely. Current methods of oxygen delivery management do not offer the level of precision that newer data show is desirable. Currently Medical Air and pure Oxygen are blended to a specific ratio in a manually controlled unit. The flow of that enriched air is then also controlled manually before being sent to the patient. The patient wears a pulse oximeter sensor that uses infrared light to measure their blood oxygen saturation level (SpO2). If the patient's SpO2 reading drops below or rises above preset thresholds an alarm sounds. False alarms are often triggered by SpO2 "signal artifacts" which have many causes such as a sensor becoming dislodged or even just the child's movement. A medical staff member then needs to respond to each alarm and, if necessary, adjust the mixture of Medical Air and Oxygen (referred to as FiO2) based on the pulse oximeter reading. This is known as an "Open-Loop System" where the medical staff member acts as the liaison between the oxygen blender and pulse oximeter. Since nurse-to-patient ratios in the NICU tend to be between 3:1 and 6:1 alarm response time can be negatively affected by workload and increase the likelihood of hypoxic or hyperoxic episodes. In response to these conditions research was conducted into the feasibility of a closed-loop oxygen blending and delivery device. The results are a proposal for such a device based on business, engineering, and design considerations. The Celina Autoblend is a device that combines a pulse oximeter, electronic oxygen blender, electronic gas flow controller, and a microcontroller unit. The Celina Autoblend would be capable of monitoring a patient's SpO2 level, of isolating and ignoring signal artifacts, of determining when adjustments to the FiO2 are necessary, and of automatically making any necessary adjustments. Additionally the Celina Autoblend is a networkable device capable of maintaining an electronic patient history that can be automatically stored to a hospital database. We propose that such capabilities would eliminate delayed responses to alarms, cut down on the number of false alarms, provide precise control of oxygen delivery, minimize the occurrence of hypoxic and hyperoxic episodes, and help staff better manage multiple patients.

Brooke Chornyak
Graduate Program: Graphic Design
Advisors: Scott Townsend and Denise Gonzales Crisp

In what ways can design mediate and augment communication for those with aphasia?

Few people think about how they use language, so by damaging discourse, aphasia reveals the complexity and skill of communication. It is vital for our society to realize the importance of language and the power it holds. Reshaping our cultural framework can't be achieved overnight however change can occur through redesigning our current interactions to accommodate varying abilities. This can be accomplished through an investigation of altering conversational pace for an increasingly reflective experience, the use of multiple modes of language and finally through supporting internal speech and thought.

Communication acts as an inclusive affordance that shapes the actions, building process, and degree of an individual's control or influence over the things that matter within a group. This degree of agency for an individual can be enabled, tailored and supported through a design approach that results in the creation of open-ended tools that allow for the audience to become designers and stakeholders, reconfiguring their lives to fit new needs.

That being said this thesis exploration will take an unconventional approach. Human knowledge about our current communication channels is limited. Our philosophies and methods for creating shared understanding will remain stagnant and exclusive if we do not challenge them in a conceptual manner. Though rooted in traditional design research methods, case studies, scenario development, concept mapping and rapid prototyping, posing questions about the feasibility of designing for our underused communication channels such as touch, gesture, body language stretches the definition of graphic design and increases the range of possibilities for meaning making.

As design progress into the second decade of the 21st century the profession must reshape itself, seeking a new role. Graphic Design, in its best possible form, might not be an entity all to itself, but an occupation that exists in a symbiotic relationship with medicine, physics, engineering, architecture, and government.

Melissa Church
Graduate Program: Art and Design
Advisor: Patrick Fitzgerald

Then/Now: 3D Virtual Space as Temporal Telescope

While Unity3D has mostly served as a tool for creating and publishing iPhone applications, there is untapped potential in the area of educational games. Unity gives developers a platform that is inexpensive and easily accessible to the general public. What value is there in using an inexpensive platform to bring innovative interaction design to a mass audience? This question, along with an exploration of successful and optimal design strategies, is the focus of this research. Using 3D models of downtown Raleigh, an experience has been created within Unity that not only shows an understanding of the software, but also contains customized graphical user interface (GUI) widgets. These widgets have been designed as smart pathways to aid in the user's decision-making process. Through the exploration of Unity's potential, the larger issues of how aesthetic and functional choices influence positive user behavior, and how this behavior enhances the educational value of a game, have been addressed. Audio, video and graphic elements showcase the effect of time on North Carolina's capital city. Through their interactions with *Then/Now*, users can view historical information in a virtual setting, thus rendering the interface a sort of "temporal telescope" through which to explore Raleigh. Multimedia is strategically placed in the same camera location as the original archived photos, giving viewers a chance to see displays of the past, and participate in a new, virtual experience. *Then/Now* does not provide a straight and narrow path, but it allows the user to navigate toward a unique perspective on Raleigh's history, while also presenting them with the opportunity to quickly "zip line" through virtual space to specific locations. Additionally, there is the potential to introduce users to Unity, an innovative and modern platform for creating educational materials.

Meghan Holliday
Graduate Program: Art and Design
Advisor: Susan Brandeis

Woven Wool to Felt: Researching the Materiality of Woven Wool Fibers through Art and Design Practice

This research project assesses the fabric properties of a woven textile with a 100% cotton warp and 100% wool and/or cotton blended weft on the TC-1 (Thread-Controller number 1) technology, a loom that allows weavers to hand-weave complex imagery with the aid of a computer. The research intends to provide hands-on experience in fabric production and manipulation using wool fibers to understand felt's properties first-hand. The experiments are designed to quantify observations for the purpose of controlling the fabric properties of future textiles woven on the TC-1. The results and findings will appeal to the textile industry, educators, scholars, and artists alike, as it will provide guidelines on how to achieve particular results using the specified materials and technology.

Amber Howard
Graduate Program: Design
Advisor: Meredith Davis

Feedforward: Interactive Design conditions that support emotive learning for enduring lifestyle change

In 2008, lifestyle diseases accounted for 50% of the reported deaths in the U.S., which were preventable by changing daily behaviors. Among the diseases, Obesity affects 32% of the current population. While many health programs provide information and tools for diet, fitness, and stress management, most participants relapse after the first year. The high relapse rate may be due in part to the disconnect between rational and emotive learning—participants "know" which behaviors are healthy, but "feel" compelled to act in accordance with unhealthy habits. Designed conditions that support emotive learning may enable participants to change deep-seated emotional biases and experience enduring lifestyle change. While cognitive neuroscientific research provides the backdrop for this study, the recent emergence of mobile technologies positions possible applications within the subtle contexts of daily life. The purpose of this study will be to test whether situated interaction with designed priming conditions can reduce personal distress biases.

I will use experimental and quasi-experimental methodologies to perform three tests, measuring for change in physiological stress response. The first test will use a Solomon Four-Group Design in a controlled setting with one session of interaction; the second test will use a pre-test post-test control group design in which participants engage daily in situated interactions for two weeks; and the third phase will use a multi-time series control group design to measure enduring influence over ten weeks.

I will conduct a paired difference statistical analysis to determine if a significant change occurs after interaction in all tests. I will also conduct a regression analysis to estimate the percentage of change in stress bias that the designed priming conditions explain. Given interaction with designed priming conditions, I hypothesize that emotional biases can change to match intended lifestyle goals and lead to enduring lifestyle change.

Paulina Jauregui Iturralde[1], Zack Cashion[2], Priyesh Malegaonkar[3], John McCaleb[4], Darlene Nyce[4], and Kaete Piccirilli[4]
Graduate Programs: Industrial Design[1]; Biomedical Engineering[2]; Integrated Manufacturing Systems Engineering[3]; Business Administration[4]
Advisor: Haig Khachatoorian

Sensory Testing Device for Use in the Manufacturing Industry

A sensory testing device has been developed from a general problem identified by a physician and approaching it to a specific need found in the market. Sensory tests used by employers provide a way to assess an applicant's sensory qualifications. Analyzing the sight, hearing, touch, taste, smell and balance senses gives information regarding the ability of the candidate to perform specific tasks required for the position. It is also a good way to ensure current employees can perform their specific job function and are not experiencing physiological damage due to work environment. For example, a warehouse worker needs good hearing to be able to hear the warning sounds emitted by a forklift backing up in their direction. Working in some environments can damage hearing, and knowing who is affected can help keep the workplace safer and save employees from long-term sensory damage.

The designed device is able to analyze senses (vision, listening and touch) and provides results in a digital format that is easy to apply to the needs of the employer. Small, hand-held computing technology is advancing at such a rate that this device is not only ideal, it is completely practical. Moreover, it's an open opportunity to expand to other sensory tests that can give a objective evaluation for an area of therapeutic interest.

The procedure used to manage this project was a interdisciplinary development program using problem-solving methods from different fields and taking care of the Voice of the Costumer data, derived directly from possible users. Then, the final product is formed of two elements, goggles and the controls. These, can join together in one unit that can be carried as a single object and can pursue individual and integrated tests for the three senses in an easy way without the need of training and time consuming processes on the part of the employer. It will help to keep a record of each employee with a low invest.

Precious Lovell
Graduate Program: Art and Design
Advisor: Susan Brandeis

The Narrative Potential of Cloth in Artistic Expression

This research explores the narrative potential of cloth and clothing in artistic expression. According to the Christian Science Monitor (12/27/2004) the traditional textile industries in many African countries have been devastated by the importation of used clothing…clothing that was originally donated to charities in the US and Europe are being sold for profit in many African countries at more affordable prices than traditional clothing and textiles. This project sought to utilize textiles, so highly revered in most African societies, to tell this story. Traditional Ghanaian textiles, as well as used clothing, in combination with the genre of quilts, were the materials and forms used. Design process was used to explore pattern, color and surface manipulation. Authenticity verses imitation was juxtaposed to determine their importance in relaying the story. Through design process, multiple outcomes were explored through hand and computer sketching, collage, fabric and paper model-making. Traditional hand printing and stitching were generated through materials and processes. The result was a three dimensional quilt portraying a tense standoff and invasion between the past and the present without a clear picture of who will be victorious in the end. The outcome of this research project suggests that narrative can be created and achieved in and through cloth and clothing to tell complex stories and serve artistic expression. The objective of this study was to inform a final project for the Master of Art and Design in the Fibers and Surface Design concentration.

Matthew Peterson
Graduate Program: Design
Advisor: Meredith Davis

Comprehension and Learning with Instructional Print Media for Middle School Science: Cognitive Load and Performative Design

K-12 science textbooks have great instructional potential because reading illustrated material requires a high degree of involvement at the cognitive level. Cognitive load theory seeks to explain the interpretative process through the architecture and significant limitations of working memory. Cognitive load theory is well established in psychology as a framework for understanding instructional print media such as textbooks. However, research designs have tended to be strictly experimental, with minimal design components, and so must be limited as to what they can conclude about authentic, classroom-based reading situations. This study seeks to extend the purview of cognitive load theory by working with complete, authentic and holistic instructional print media. Three discrete text–image integration strategies are identified and employed to produce alternate instructional print media that address the NC science course of study at the 7th grade level. A *prose primary* strategy is most often employed by textbooks, which though heavily illustrated, are driven by a dominant prose. Less common *prose subsumed* and *fully integrated* strategies are compared with this dominant model. Student (subject) interaction with the different forms is modeled through tasks in the form of review questions. The goal of this in-progress study is to probe any affects of design strategy on comprehension and learning, as

defined by cognitive load theory. The effect of familiarity with a given strategy is also important. This study will be conducted with all 7th grade students at a local middle school, in the form of regular classroom deskwork activities.

Marc E. Russo
Graduate Program: Art and Design
Advisors: Patrick Fitzgerald and James Lester

Creating Virtual Agents That Communicate Through Facial Expressions for the Unity3d Gaming Engine

Within the education and computer science research communities, there has been a growing interest in the use of interactive virtual environments to foster engaging, effective learning experiences. In these environments, students navigate rich, 3D worlds and interact with virtual characters while completing problem solving scenarios and learning curricular content. An important element of these systems are believable virtual characters that exercise multimodal communication abilities - text, audio, gesture, facial expression - to support student learning activities. However, the development of expressive, virtual characters for interactive learning environments poses a number of notable challenges. In particular, the demands of real-time game environments and the limitations of modern graphics hardware impose limitations on the design of virtual characters, and therefore impact agent expressiveness and communicative ability.

Within the last several years, the Unity3d game engine has become a tool of choice for many organizations developing educational games. While the incorporation of audio and gesture to a character is well documented in Unity3d, there is little support, or common practice, for the creation of believable facial expressions for virtual characters in the tool set. Effective communication through facial expression requires that a character be capable of emoting at least the six universal expressions (McCloud 2006; Ekman 2003). The work presented in this poster demonstrates a bone structure developed for use in the Unity3d game engine to move the eyes, lips, and brow in an attempt to approximate these expressions, while accounting for the compromises involved in working with a real-time gaming environment. This facial bone structure can be evaluated based on its ability to closely approximate the universal facial expressions, alongside its ability to meet the performance constraints of interactive virtual learning environments.

Lauren Waugh
Graduate Program: Graphic Design
Advisors: Kermit Bailey and Meredith Davis

How can interactive visualization tools in a digital writing space help citizen journalists construct an argument when articulating opinions about national political issues?

As social media becomes ubiquitous within the modern American culture, the average consumer has access to a variety of tools to create, remediate, and disseminate information.

One effect of this shift from consumption to production is the democratization of news media. With the evolution of free channels of broadcast such as blogs, social networking, forums, and participatory news sites, media conglomerates are no longer the only source of daily news. Citizen journalism has grown out of this phenomenon—citizen journalists contribute to the media landscape by writing about, photographing, and videotaping personally meaningful news and events.

Even though citizen journalists have the means to produce and broadcast their work, they don't always have an understanding of how to construct an argument, establish credibility, and compel audiences to view their work, nor do they always have the educational tools to guide them through the process. This disconnect between the pre- and post-internet world of news media has created a need for consumer guidance toward producing content with a purpose.

Design has a role to play in this education. This investigation seeks to explore how the introduction of visual thinking into the writing process could help citizen journalists learn to construct an argument. In *The Uses of Argument*, Stephen Toulmin frames the phases of an argument from a procedural rather than formal perspective. I'm applying Toulmin's model of argumentation to a series of studies exploring visual thinking through data visualization, mapping, storyboarding, annotation, and the design of conversational spaces.

This research seeks to evaluate the role of design within the writing process by proposing a set of tools to guide citizen journalists through methods of argument building.

Frim Ampaw
Graduate Program: Higher Education Administration
Advisor: Audrey Jaeger

Completing the Three Stages of Doctoral Education: The effect of financial aid and labor market conditions

Forty-three percent of doctoral students never complete their degree. This drop out is the highest among graduate and professional degree programs. Previous cross sectional studies of doctoral students' retention show the importance of financial aid in predicting degree completion. The studies did not estimate the labor market's effect on doctoral student retention. These studies also neglect the longitudinal nature of doctoral study and the multiple requirements that make doctoral education a three-stage process. This research study examines the effect of various factors including financial aid and labor market conditions on the likelihood of doctoral to complete the three stages of doctoral education: transition stage, development stage and the research stage. The research uses the 15 years of enrollment data from doctoral students who enrolled at a land grant university with very high research activity between 1994 and 1999. Using survival analyses, the research determines that students with research assistantships are more likely to complete each stage of the degree. The study also shows that higher salaries for doctoral degree holders increase the likelihood of degree completion.

Sarah Ann Butterfield
Graduate Program: Special Education
Advisor: Susan Osborne

Using Self-Recording to Decrease Verbal Disruptions by a Child with a Serious Emotional Disability (SED)

Students with emotional and behavioral disorders frequently engage in behavior that disrupts the classroom and impedes educational progress. Disruptive behavior, specifically talking without raising a hand, makes it challenging for teachers to provide effective instruction. This research investigated the use of Applied Behavior Analysis (ABA) techniques in conjunction with a self-recording intervention to decrease verbal disruptions by a child with a Serious Emotional Disability (SED). The participant was a 9 year-old, fourth grade male student, enrolled in special programs at a public elementary school in North Carolina. A self-recording slip was designed for the student to make tally marks in 2 boxes. One box was for speaking with teacher permission and raising a hand. The second box was for speaking without teacher permission and without raising a hand. A new self-recording sheet was provided at the beginning of each special education reading class. The reversal design, commonly referred to as the ABAB design was used to evaluate the intervention. This design consists of four phases: baseline, introduction of an intervention, removal of the intervention, and reintroduction of the intervention. This sequential application and withdrawal of an intervention confirms the intervention's effects on a behavior. After completing the reversal design, two additional phases were conducted to measure maintenance and generalization. Data on the occurrence of verbal audible noises were collected by the event recording method. Data were graphed to demonstrate the powerful and positive impact of the self-recording sheet on the number of verbal audible noises emitted. The number of verbal audible noises significantly decreased in a short amount of time and allowed the participant to learn a socially important skill. This study extended previous research on the effectiveness of self-recording for learners with disabilities.

Marggie D. Gonzalez-Toledo
Graduate Program: Mathematics Education
Advisor: Hollylynne S. Lee

Growth in Middle School Students' Ability to Engage in Informal Inference

Reasoning informally about statistical inference is being able to make inference about data without using any statistical formal method or procedure. A framework has been developed in order to describe how students' informal statistical inference changes while being exposed to instruction. The framework is based on the levels of the SOLO Taxonomy. A student in the pre-structural level make generalization based on their intuitions or previous experiences, show no awareness of variability, do not consider sample size, and do not believe in sampling as a process to collect data. On the other hand students in the relational level make generalizations beyond the data collected using appropriate argumentation, consider the role of variability and sample size when making generalizations, and when possible proposed an appropriate data collection process, including a description about how the results could be analyzed.

This study investigates middle school students as they were engaged solving several tasks in a 12-day instructional program in probability using a computer-base simulator. Tasks were selected across the instructional program with the objective of investigating how students' ability to engage in informal statistical inference progressed from the beginning of the program to the end. To measure progress, responses are used from six students' responses on a selection of tasks from a pre-test, pre-interview, in-class worksheets, post-interview, post-test, and a retention test given two months after the program ended. Findings indicate that some students are more aware of variability and the effect of sample size when drawing conclusions and making informal statistical inference at the end of the instructional program.

Glenda Harrell
Graduate Program: Curriculum and Instruction
Advisor: Alan Reiman

Closing the Achievement Gap: The Amazing Benefits of Two-Way Dual Language Programs for All Students

Despite thirty years of federal edicts to provide effective schooling for students who are learning English as a second language, national studies consistently report poor academic performance and high drop-out rates for English Language Learners [ELLs]. North Carolina's educational approach to the large influx of ELLs during the last decade is a product of burgeoning English-only policies, lack of interest in learning other languages, and limited bilingual resources. English as a Second Language [ESL] is the most prevalent language development program provided by schools even though there is virtually no evidence that it closes the achievement gap between ELLs and native English speakers. The few longitudinal studies of ELLs conducted in the U.S. indicate the pernicious achievement gap between ELLs and native English speakers can be eliminated only with high quality instruction in both languages, specifically Dual Language [DL] two-way immersion programs. Investigators of the most often cited longitudenal research collaborated in this initial quantitative study of six North Carolina school districts with well-implemented DL programs. End-of-Grade reading scores of third through eighth grade native English and ELL students enrolled in DL programs since Kindergarten are compared to all other students within the districts to establish baseline trends of student's performance by groups and to examine the effectiveness of DL programs for ELLs and non-ELLs. Results confirm previous findings; students in DL programs score significantly higher on state reading tests than students without this educational program. In addition to obvious benefits for ELLs, all groups of native English speakers outperform their peers in English while acquiring bilingual proficiency.

Erin Thomas Horne
Graduate Program: Curriculum and Instruction
Advisor: Alan Reiman

The Contributions of Teachers' Roles to Beginning Teachers' Perceptions of Success

Beginning teachers leave the profession at an alarming rate. Role expansion and role intensification have become more predominate in the profession as a result of numerous reform and accountability movements, including No Child Left Behind. However, research suggests that social supports and engagement in multiple roles can buffer the effects of stress and work intensification. The purpose of this study was to investigate the relationships between beginning teachers' perceptions of success, work role satisfaction, commitment, and retention intentions while understanding the influence of role intensification and multiple roles on these relationships. North Carolina State University's College of Education graduates that were employed as teachers during the data collection were the population of interest. A single time survey design was used to evaluate teachers' perceptions of Mentor Support, Colleague Support, Administration Support, Classroom Management, Encouraging Student Success, Curricular and Instructional Resources, Assignment and Workload, Parental Contacts, Satisfaction, and Commitment through the *Perceptions of Success Inventory for Beginning Teachers* (Corbell, 2008). In addition, beginning teachers were surveyed regarding additional roles (i.e., parent, spouse, caregiver, student, etc.) and role intensification (high stakes testing). Path analysis determined whether the measurement model was an accurate representation of this data. The measurement model was not a reasonable depiction of the relationships. Other findings of interest included: 1) Mentor Support accounted for the least amount of variance in beginning teachers' perceptions of success; and 2) this study replicated the original model validated by Corbell (2008). Replication of the original *PSI-BT* model with a teacher preparation institution's graduates encourages its use as a cost-effective means for tracking graduates in the field, their perceptions of success, and retention intentions. In addition, teacher preparation programs can use similar data on their graduates to adapt their programs to the challenges that beginning teachers from their programs report facing.

Tara D. Hudson
Graduate Program: Higher Education Administration
Advisor: Alyssa Bryant

Tragic Accident or Wrongful Death? Assessing the Effectiveness of MIT's Responses in a High-Profile Student Suicide Crisis

Given the prevalence of mental health issues and suicidal ideation among U.S. college students, higher education institutions are likely to face a student suicide crisis at some point. The messages college administrators send in the aftermath of a student suicide crisis have the potential to placate or exacerbate the outrage that stakeholders feel; thus, these messages have the potential to minimize or aggravate the reputational and financial damage that institutions face in the wake of a student suicide. The purpose of this research was to explore the effectiveness of specific crisis communication strategies in reducing the impact of a high-profile social legitimacy crisis resulting from a student suicide, using the case of the six-year crisis at Massachusetts Institute of Technology (MIT) sparked by sophomore Elizabeth Shin's death in 2000. Case study methodology was chosen for this research as it is well suited for exploring real-world, "how" questions. Data were drawn from MIT press releases and internal publications, news media accounts of the crisis, and legal documents in *Shin v. MIT*. Two theoretical frameworks drawn from the crisis communication literature, Situational Crisis Communication Theory (SCCT) and Benoit and Brinson's (1994) typology of image restoration strategies, were applied to assess the effectiveness of MIT's response during the crisis. The results of this research show that MIT administrators

chose minimally effective response strategies, chiefly excusing and scapegoating, which prolonged the crisis and likely increased the reputational and financial damage that resulted. By choosing more appropriate response strategies such as sympathy and apology, MIT may have been able to reduce the impact of the crisis. In the interest of risk management, college and university administrators can use the findings of this case study to inform their own planning for a student suicide crisis.

Amanda Lambertus
Graduate Program: Mathematics Education
Advisors: Hollylynne Lee and Karen Keene

Characterizing Gender Diverse Graduate Mathematics Departments: A Collective Case Study

The 1990s saw an overall decline in the number of students pursuing graduate mathematics degrees (Kirkman, Maxwell, & Rose, 2007). But, women and non-Asian minorities have been consistently underrepresented in the field regardless of the numbers of students enrolled in graduate programs. In order to help the mathematics field flourish, a healthy (diversified) mathematics community is needed. Several universities across the nation have been recognized for their success rates in contributing a diverse pool of Ph.D. level mathematicians, especially women.

The purpose of this study is to examine these successful graduate mathematics departments that graduate a relatively large percentage of women doctorates. The research design consists of four phases, each designed to gather different types of data using a variety of instruments and participants. Graduate students from all six departments participated in an open-ended on-line questionnaire. Directors of Graduate Programs, graduate students, and faculty members participated in qualitative interviews. Data were also collected from the departmental and university websites.

Using the Communities of Practice framework (Wenger, 1998, Wenger et al., 2002) as a theoretical lens, a collective case study of six graduate departments, and an in-depth case study of one department, I was able to highlight and give detailed descriptions of six characteristics of these departments. Findings indicate that the graduate mathematics departments provide a variety of structures for supporting their students and faculty members, and that the departments foster relationships through opportunities for interaction. In addition, faculty and graduate students are attracted to these departments for both personal and universal reasons. The characteristics outline one possible approach to ensuring the success of all students in the field not just women.

Sheryl Long
Graduate Program: Curriculum and Instruction
Advisor: Carol Pope

Preservice Teachers' Perceptions of Film in English Language Arts Instruction

While film has long been included in English language arts instruction, it has typically been relegated to the position of supplementary resource and considered a nontraditional text. The pressure to redesign English language arts studies to address twenty-first century literacies demands difficult choices about what textual forms to include and calls for a reassessment of film's importance. Preservice teachers offer an interesting perspective on this question because they are at an important juncture in their experience with the English language arts. They are completing years of study in which they have been the recipients of English language arts instruction. Now students of a teacher preparation program, they receive direct instruction from faculty who are closely attuned to the theoretical movements within the discipline. Simultaneously, they are engaging in fieldwork that allows them to observe K-12 teachers' instructional practices. As they form their own philosophies of English language arts instruction, they must reconcile these multiple perspectives into a personal understanding that will shape the ways in which they teach – in effect, their refined understandings represent the future of English language arts instruction.

This qualitative study utilizes a multiple case study approach to explore preservice teachers' perceptions of film in English language arts instruction. The participants in this study were five preservice teachers who were enrolled in an adolescent literature course in a large public university. Data include interviews, participant observations, and student documents. Initial findings suggest that preservice teachers tend to regard film as a supplemental text for reading and literature instruction but are eager to use digital video for composing student-created texts.

Gemma F. Mojica
Graduate Program: Mathematics Education
Advisor: Jere Confrey

Preparing Pre-service Elementary Teachers to Teach Mathematics with Learning Trajectories

In the past two decades, research on learning has focused on understanding how students think and how that thinking becomes more sophisticated over time. Some researchers have verified sufficient consistency and robustness in their findings, which have been articulated in the form of learning trajectories (Clements & Sarama, 2004; Confrey, Maloney, Nguyen, Wilson, & Mojica, 2008). While an articulation of such constructs has contributed greatly to the knowledge base of how students learn and has been useful at

the level of curriculum, assessment, and standards development (Corcoran, Mosher, & Rogat, 2009), it is unclear how learning trajectories (LT) can be incorporated into the practice of teaching. Thus, bringing LT into the classroom through teacher education is one critical area of knowledge that should be investigated. This study addresses to what extent and in what ways can pre-service elementary teachers (PSTs) use a learning trajectory for equipartitioning (EPLT) to build models of student thinking. Over an eight-week period, within an elementary mathematics methods course, 56 (PSTs) participated in this design study, where instructional activities were implemented to assist PSTs in using LT to build models of student thinking and in learning to enact instructional practices. Activities included: the articulation of the EPLT; engagement with equipartitioning tasks; instruction in the conduct of equipartitioning clinical interviews; and, instruction in the analysis of videos of equipartitioning clinical interviews. Data included the following: video & audio recordings of class meetings, researcher's notes of class meetings and PSTs' school-based experiences, pre- and post-test data, PSTs' clinical interviews and analysis of interviews, and other artifacts. Findings from this study indicate that PSTs used an EPLT to 1) deepen their understanding of mathematics and knowledge for teaching mathematics; 2) build more precise and adequate models of student thinking; and 3) incorporate models of student thinking into instructional practices.

Thomas Perrine Warren
Graduate Program: Educational Research and Policy Analysis
Advisor: Lance Fusarelli

What is an Early College High School?

A successful secondary public school reform model, the Early College High School (ECHS/ECH), has recently gained greater national attention due to the creation and continued funding from the Bill and Melinda Gates ECHS Initiative in 2001. This mixed methods research study examines the educational philosophies and policies, infrastructures, processes, and outcomes of three ECH's in rural and metropolitan areas of a mid-Atlantic state in order to answer the overarching descriptive research goal: *investigate what policies and philosophy shape the form, process, and outcomes of the local ECH organizations*. Phase One examines ECH policies as reported by national and state organizations through semi-structured interviews of leaders of these organizations to answer sub-question one: *How are ECH's designed differently from traditional high schools?* Phase Two utilizes semi-structured interviews to investigate school leaders' input about policies and processes at the school that address sub-question two, *Is school leadership in ECH's different from traditional public high schools?* Phase Three utilizes a Q-Methodology procedure to develop a concourse of statements from ECH school leaders that teachers' answers to will inform on what processes are effective in their schools and why school personnel view them as successful, in order to answer sub-question three, *How does local ECH process align with state- and national-level policies and philosophy?* Phase Four of the study examines public domain assessment data for students in participant ECH's with state averages to answer sub-question four, *How do local ECH's perform on select, state-required assessment outcomes?* In the study, an inclusive research perspective on the alignment between national ECH policies and local ECH high school performance as practiced by schools participating in the study is examined via a conceptual vision that includes quantitative and qualitative inquiry methods. Preliminary findings should indicate that ECH's provide successful educational outcomes on key traditional education output metrics.

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Advisor: Mervyn Kowlaksy

Novel Polymer Optical Fiber Sensors for Large Strain Measurement Applications

Large strain measurement has been always an important goal in civil and mechanical engineering which was not achievable before (using traditional strain measurement devices). The goal of this work is to develop novel single mode Polymer Optical Fiber (smPOF) large strain sensors which have several advantages. They have high failure strain, are more flexible, do not require a protective coating to prevent moisture ingress, and could be mounted on the surface or embedded inside of structures. The POF large strain sensors have considerable applications in performance-based assessment, health monitoring of civil engineering infrastructures, and highly flexible space structures. Because of the large light attenuation in solid smPOFs, small lengths of the fiber would need to be cleaved and coupled to silica optical fibers (SOFs) for practical applications. Series of cleaving methods such as Focus Ion Beam and Hot Knife were developed and tested on our smPOFs. Subsequently, efficient cleaving and coupling methods have been successfully proposed and tested for sensor development. In this study, smPOF sensors were successfully fabricated, calibrated, and proved the ability of tensile strain measurement up to 10%. A Mach–Zehnder interferometer setup on a mobile data acquisition system was used to record phase shift of the sensors in each step of the test. To test the sensors, two experimental test protocols were followed: a) tensile loading up to10% of strain and b) tensile loading up to 4% of strain and deloading to 3% of strain (potential of compression strain measurement). The experimental results exhibited an excellent correlation in experimental results. The phase shift-strain relationship was used as a calibration curve and for considering nonlinear strain-optic effects in smPOF sensors. Finally, the calibrated smPOF sensors precisely measured the large strains (around 9%) in an aluminum capon to introduce themselves as a new generation of strain sensors.

Bushra Anjum
Graduate Program: Computer Science
Advisor: Harry Perros

Using Percentiles to Assure Quality Web Audio/Video Experience

Quality audio and video experience is the prime concern and expectation of every Internet user in the current age. For example, users of Skype would like a good quality of experience, that is, their two way communication should be smooth, free from stalls and disruptive delays. To ensure this, the underlying network needs to provide some form of guarantees on the transmission, most importantly on packet delay which is the time it takes to transfer a packet of data end-to-end (from one user to another). This packet delay affects the quality of experience of the users. If it varies widely, then the video image becomes pixelized and even interrupted. However, the underlying network is not a single entity! Present day networks are formed of many smaller, regional networks that connect and collaborate with each other to provide an end-to-end communication service. Resultantly, the guarantee on the end-to-end delay is broken down to the guarantees on the individual constituent networks. The guarantee that each constituent network provides is in the form of a statistically bounded delay. That is, 99% of the time its delay is below a fixed value, say 20 msec. So, now the main problem faced by the networking providers for users who are far apart, is how to make sure that the percentile of the end-to-end delay is below a value that is considered safe for a good video connection.

This leads to two interesting mathematical problems. First, how to add up percentiles so that to calculate the percentile of the end-to-end delay, and secondly, given a budget for the end –to-end delay, how can this be partitioned equitably over the constituent networks.

Surprisingly, nothing is known about adding and partitioning percentile of a variable, what we refer as “percentile calculus”. Individual percentiles cannot simply be added to make up the end-to-end percentile. The individual percentiles and the end-to-end percentile have a non linear, non additive relationship. By using various statistical distributions of the delay, we have obtained an expression for adding percentiles. Also, we have developed simple optimization techniques for partitioning a percentile to a number of individual percentiles.

Other than networking, there is a plethora of situations in practice where knowledge of the percentile calculus could significantly improve our ability to solve problems, such as optimizing the power consumed in a data center, and minimizing the time it takes for a large enterprise software, such as Amazon.com, to respond to a query.

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Graduate Programs: Chemical and Biomolecular Engineering[1]; Textile Engineering Chemistry and Science[2]
Advisors: Saad A. Khan and Russell E. Gorga

High Performance Multicomponent Nonwoven Fibers: Role of the Interface in Tailoring Properties of Polypropylene/Poly(lactic acid) Composites

Polypropylene (PP) is a leading commercial, fiber-forming polymer due to its high strength and low cost. However, PP lacks reactive groups that provide opportunities for surface functionalization and limits use of PP to passive applications including disposable wipes and medical garments or filler materials. Further, PP is petroleum based and products made from it contribute to tremendous landfill accumulation. Poly(lactic acid) (PLA) is a more expensive and brittle fiber-forming polymer, yet is biodegradable and biocompatible, has chemical moieties that provide possible routes for chemical functionalization for applications such as filtration and wound care, and can be produced from renewable feedstocks. Attempts to exploit the benefits of both polymers in a single fiber have led to spinning blends of PP/PLA. However, despite thermal compatibility between PLA and PP, phase separation of the two polymers leads to lower tenacity than in PP or PLA single component fibers. Our approach to creating nonwoven fibers that can be functionalized and rely on renewable resources has led us to spin bicomponent fibers (not of blends of PP and PLA), but co-spun from the molten state in a core-sheath configuration (two discrete layers-one for each polymer). We hypothesize that we can mitigate any loss of interfacial strength by the addition of a copolymer to improve adhesion at the polymer-polymer interface. We show that by spinning core-sheath PP/PLA composite fibers, we can achieve finer fibers and increase initial modulus relative to PP single component fibers without reduction in fiber tenacity. We can also tailor the crystallinity and crystal morphology of one polymer by co-spinning with a second polymer and by changing core versus sheath position. With the addition of the block copolymer to the PLA phase, we found no loss in elongation-to-break or fiber tenacity.

Ahmed El Saghir
Graduate Program: Nuclear Engineering
Advisor: Steven Shannon

Numerical Techniques for EEDF Extraction from Langmuir Probes

One of the most valuable plasma characteristics that can be obtained from a Langmuir probe is the Electron Energy Distribution Function (EEDF). EEDF extraction from Langmuir probe data is an ill-posed problem due to the integral relationship between electron current and the probe voltage. Also, unlike the more widely used point-by-point extraction of the second derivative

relationship, the integrated relationship between electron current and EEDF is used, instead of a relatively small fraction of the integrated data in the point-by-point method. Both curve fitting of experimental data and reconstruction of the integral problem through methods such as Tikhonov regularization address this to some measure, with regularized solutions offering an advantage in overall EEDF accuracy over curve fitting. Tikhonov regularization also can distort the overall shape of the reconstructed distribution, particularly at high energies and energies below the distribution peak.

In this paper, a methodology for obtaining EEDF's from digitized Langmuir probe data is presented. This methodology uses a hybrid TSVD / modified Tikonov filter technique to minimize both noise amplification and distribution distortion brought about by integral reconstruction. Previous results using standard regularization methods are compared to this hybrid approach to demonstrate the benefits and limitations of this reconstruction technique. Implementing these numerical techniques result in better EEDF reconstruction for both the low and high energy portions of the distribution. Analysis shows that single parameter regularization cannot simultaneously capture both the low energy portion of the distribution and the high energy tail due to the very different slope characteristics of these two regions.

Nimish Gera and Balaji M. Rao
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Advisor: Balaji M. Rao

The hyperthermophilic Sso7d protein as a scaffold for engineering binding proteins

The ability to create affinity reagents that specifically bind to (or recognize) a molecular target is critical for applied biotechnology as well as fundamental research in biology. Antibodies are the most commonly used affinity reagents but are expensive to produce and typically have low stability. Hyperthermophilic proteins are known to have an exceptionally high thermodynamic stability. Therefore, as an alternative to antibodies, we are investigating the use of small protein domains from hyperthermophilic organisms as scaffolds or "templates" for generating affinity reagents. We chose Sso7d, a small (7 kDa) DNA binding protein from *Sulfolobus solfataricus* as a candidate scaffold protein. This protein is highly stable (T_m~98°C), has no cysteines and is expressed at high yields in *E.coli*. Using a combinatorial yeast surface displayed library of 10^8 mutants, we investigated the ability to reliably and efficiently generate affinity reagents based on the Sso7d scaffold for a diverse set of target species. The selected targets included a small organic molecule (FITC), a peptide (beta catenin C-terminal peptide), and proteins of varying size and/or multiple subunits (streptavidin, hen egg lysozyme, immunoglobulins of different species). These targets also allowed us to test the ability of our binders to differentiate between closely related targets (immunoglobulins of different species).We successfully obtained binding proteins for all these different targets. The mutant binding proteins could be produced at high yields in *E.coli*. The binding affinities of these proteins were determined. Differential scanning calorimetry experiments confirmed the stability of the isolated mutant proteins.

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Advisor: Edward Grant

A Wearable Monitoring System for Continuously Assessing the Health of the Peripheral Vasculature

Compression stockings can be used to non-invasively treat and manage chronic venous disease, deep venous thrombosis (DVT), and lymphedema. However, recent studies have revealed differences between the pressure profiles quoted by manufacturers and those measured in practice. Many of these differences can be attributed to the elastic nature of compression stockings, which cannot be captured using current measurement devices (i.e., the HATRA and the HOSY). Additionally, the mechanism by which compression improves vascular health is not fully understood because the tools and tests needed for vascular assessment have remained in-clinic. In concert with this need, wireless health monitoring technology has emerged as a viable means to assess and treat many chronic conditions. These systems are generally organized in a hierarchical fashion, with the first level including various physiological sensors, the second level consisting of a portable data storage device, and the third level being comprised of an Internet-accessible database.

Unfortunately, there are currently no portable systems that meet the unique needs of vascular health assessment. At the sensor level, applicable modules could include blood flow velocity, leg volume, skin temperature, etc. This physiological data, as well as other relevant indicators (activity level, pressure profile, etc.), could then be aggregated using a mobile computing device. At the top-most layer, data from a variety of patients could be collected and stored, and data mining techniques used to look for trends. Analysis of these trends could lead to the development of a model that could be used as (1) a diagnostic aid, (2) a way to study the effects of different treatments, (3) a research tool, and (4) a basis for creating a control algorithm to adjust the amount of pressure applied by a therapeutic compression device.

Ping-Lin Hsiao
Graduate Program: Computer Science
Advisor: Christopher G. Healey

Document Clustering, Summarization and Visualization

Managing and analyzing a large set of documents is a complex and time consuming task. Besides the large volume of text, another critical issue is similar information that may exist across multiple documents. This issue leads to two problems:

1. Documents with similar content are located in different parts of the collection. Analysts must remember what they have read previously to identify similarities to the current document under investigation.

2. Analysts must spend time reading each document in its entirety. For similar documents, analysts are repeatedly reading the same information.

An analyst's efficiency and effectiveness could be significantly improved if similar documents were clustered together with repeated information identified automatically. The goal of this research is to ease the effort needed to understand and analyze a large set of documents. Our method is capable of performing the following three operations:

1. Organize documents into meaningful topic clusters.

2. Compress text from similar topics into English language summarizations.

3. Visualize documents in a multidimensional space with an interactive interface.

Ameya Joshi and Thomas Ward
Graduate Program: Mechanical Engineering
Advisor: Thomas Ward

Experimental investigation of rate enhancement impulsively heated batch sedimentation process

Suspensions of nearly mono-disperse spheres, subjected to impulsive-constant temperature heating from below, are studied in a batch sedimentation process. Experiments are performed on suspensions with a range of concentrations and different temperatures, to analyze the effects of varying temperatures on the rate of settling, shock formation and shock velocities. CCD imaging is used to observe and study the settling phenomenon. The Kynch theory of sedimentation (Trans. of Far. Soc., 1952) explains shock formation in low concentrations suspensions and states that particle speed is completely determined by the local density only. We extend this study to include both heating and high concentration suspensions, with concentrations of 40% and 50%. Higher concentration suspensions (greater than 20%) are characterized by a single shock. Two distinct shocks are observed for all the experiments involving heating from bottom with an exception for the non-heated setup where only one shock is observed. Experiments show a deviation in the settling behavior of the suspension with an increase in impulse temperature and concentration which suggest that other models for shock formation and temperature profiling may be more appropriate for high concentration studies.

Ali Kefeli and Reha Uzsoy
Graduate Program: Industrial and Systems Engineering
Advisor: Reha Uzsoy

A Cut Addition Algorithm for Tractable Nonlinear Production Planning Models

We present an iterative algorithm to solve production planning models with nonlinear clearing functions. Clearing function models are nonlinear optimization models that capture queueing behavior at resources in an aggregate manner. Compared to conventional linear production planning models, these models have various advantages: they not only produce positive dual prices when utilization is below one, but also exhibit more realistic behavior, such as holding finished inventory at utilization levels below one and congestion due to work-in-process inventory buildup. However, previous studies have shown that an arbitrary piecewise linear approximation to such models can cause loss of information at higher utilization levels. We propose an iterative cut addition algorithm where the outer linear segments are added as they are needed. This method allows the user to achieve a predetermined sensitivity level from the model while keeping the computational burden to a minimum.

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Advisor: Richard J. Spontak

Selectively Solvated Block Copolymers upon (Electro)Mechanical Deformation

Robotic devices are currently constructed on the basis of metal or plastic frames, and are generally activated through the use of motors and gears. However, such devices are energetically inefficient and expensive to fabricate, especially on small size scales. The aim of electroactive polymers (EAPs) is to replace bulky hydraulics and pneumatics with inexpensive, lightweight and energy-efficient polymeric materials. One promising class of EAPs – dielectric elastomers – consists of polymer networks that exhibit shape memory. In this study, we employ selectively solvated triblock copolymers for this purpose, since the copolymer nanostructure endows the material with physical crosslinks that stabilize a supramolecular network. We first demonstrate that these materials display high levels of electrical actuation at relatively low electric fields, and behave much like human muscle. Close examination of electromechanical stress-strain responses reveals that a modulus, which we introduce as the electromechanical modulus, provides a systematic means by which to compare dielectric elastomers. Addition of a midblock-selective co-solvent to the system permits considerable variation in property development. Dynamic rheological analysis confirms that the viscoelastic signature of these materials exhibits time-composition equivalence, which means that the time domain can be extended over orders of magnitude by simply changing the composition of the solvent pair. Such behavior, attributed to the interplay between the elastic network and the viscous matrix, is unique among polymeric systems. Lastly, to discern if the physical crosslinks, i.e., glassy nanoscale micelles, remain intact upon (electro)mechanical deformation, small-angle x-ray scattering has been performed on biaxially strained specimens, and the resultant scattering patterns have been analyzed in terms of both their structure and form factors. While the micelles do not appear to change significantly upon deformation, the intermicellar interaction changes from being strictly repulsive to partially attractive, which indicates that the micellar coronas interpenetrate, upon straining.

James Lavin and Shawn Richardson
Graduate Program: Industrial and Systems Engineering
Advisor: Russell King

Wake County Mattress and Furniture Recycling Case

In 2007, the United States generated 254.1 million tons of municipal solid waste (MSW). Of this the category of durable goods, broadly described by EPA as those goods with an anticipated usable life of greater than 3 years, totaled 45.4 million tons (17.9 percent of total MSW generation). Furniture, furnishings, and textile products account for over 21 million tons or close to 50%. In an effort to help alleviate this problem we are working with Wake County Solid Waste Management to start a pilot program for recycling mattresses and upholstered furniture. Various alternatives are being considered with different levels of commitment from the County. They may want to do all of the work in-house or they may want to outsource the work to an existing recycler. Other considerations are how much collection we are going to do. If we have more sites collecting then we have more impact on the environment but additional shipping costs are incurred. Trade offs are made between the amount of collection and the volume of products removed from landfills. The ultimate goal is to make money or break even while still helping the environment.

J. P. Lien
Graduate Program: Mechanical Engineering
Advisor: Gregory D. Buckner

A Real-Time Model for Piezoelectric Stack Actuators using Hysteretic Recurrent Neural Networks

Piezoelectric stacks are a type of linear actuator used in applications requiring high bandwidth and micro/nanoscale positioning. The electromechanical behavior of these actuators is non-linear, hysteretic, and rate-dependent, so developing accurate models is challenging. Practical actuators are typically polycrystalline (i.e. not homogeneous) which further increases the complexity of the problem. Models developed so far typically fall into two categories: those based on statistical mechanics use measurable properties of the devices being modeled, but are often computationally intensive, requiring the solution of coupled, stiff differential equations. Those using traditional mathematical models of hysteresis (such as Preisach kernels) are more efficient, but their parameters typically have no physical basis, making them difficult to interpret. We have developed a model using a novel type of neural network, called a Hysteretic Recurrent Neural Network (HRNN), which is computable in real time while also maintaining much of the intuition of physics-based models. The HRNN is composed of neurons that incorporate hysteresis and rate-dependence (similar to kernel methods), but its overall structure mimics the physical description of the material. In this work, individual HR neurons are shown to agree with existing models of ideal single-crystal piezoelectric behavior. The combination of many such neurons into a network is further shown to predict the heterogeneous behavior of polycrystalline materials. Specifically, a model is trained which can approximate the strain and polarization of an unloaded commercial stack actuator at multiple excitation rates. The model is executes on a PC platform at rates over 100Hz, fast enough to support its application to real-time control.

Qian Lv
Graduate Program: Computer Science
Advisor: George N. Rouskas

Internet Service Tiering as a Market Segmentation Strategy

Today's telecom services tend to be elastic, that is, different customers perceive different values for a same service. The customers' behavior with respect to pricing for a service may vary widely accordingly. The ISPs are facing the difficulty of choosing suitable service tiers (levels) for the customers. In this paper, we consider Internet broadband access as an elastic service whose value varies across segments of the user population. We consider the problem of segmenting the market and mapping each market segment to a corresponding service tier. We focus on how to optimally determine the service tiers and the corresponding prices such that the ISP's profit is maximized. We study three different cases: 1) single tier; 2) multiple fixed tiers; and 3) multiple unfixed tiers. We then develop two efficient dynamic programming (dp) algorithms, for case 2) and 3) respectively, to address the problem of determining optimally both the service tiers and their prices. In our simulation, we compare the dp algorithm with the uniform and exponential tiering structures which are adopted by current ISPs. We show that introducing multiple tiers of service can be an effective market segmentation strategy that can lead to an increase of profits for the ISP. Our approach provides new insights into the selection and pricing of Internet tiered services, and our results indicate that exponential tiering structures adopted by current ISPs are far from optimal.

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Custom Low Intensity Pulsed Ultrasound System Designed for *In Vitro* Cell Culture Investigations

Procedures for treating bone loss, defects, trauma and disease often require replacement bone tissue or the use of bone substitutes. One aspect of functional bone tissue engineering involves controlling the proliferation and osteogenic differentiation of a patient's stem cells with the desire to create an autologous bone graft *in vitro* for use in treatment of bone defects. Low intensity pulsed ultrasound (LIPUS) is a newly investigated stimulus for controlling this differentiation. However, the parameters of LIPUS have not been optimized for increasing osteogenic differentiation and commercial LIPUS systems have very little control over parameter selection. In order to study the potential effects of LIPUS on cell response, *in vitro*, a custom ultrasound system was designed and built to give precise control over an extensive range of values for each stimulus parameter. Design criteria included making the system automatable, insuring that the system can be used with standard incubators, and reducing the amount of laboratory space required to house the system. Two sets of experiments were done to validate the custom ultrasound system by investigating the effects of changing the pulse repetition frequency (PRF) parameter setting, which has not been previously studied, for inducing osteogenic differentiation of human adipose derived adult stem cells (hASCs) and human bone marrow derived mesenchymal stem cells (hMSCs), two common stem cell sources for creating bone constructs *in vitro*. Three PRF settings were tested (1, 100 and 1000 Hz) and the results from both sets of experiments indicate that, of those tested, the 1 kHz PRF resulted in the highest calcium accretion per cell. The custom LIPUS system was successfully designed to allow extreme parameter variation and the results of the validation experiments promote using LIPUS as a stimulus to induce osteogenic differentiation of stem cells and the need for further LIPUS parameter optimization.

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Advisor: Peter L. Mente

Differential Gene Expression of Chondrocytes From a Porcine Impact Injury Model Using Suitable Reference Genes

Injury to articular cartilage is a known risk factor for developing Osteoarthritis (OA). This study evaluated gene expression changes following an impact injury to porcine articular cartilage. Porcine patellae were impacted either axially (2000N) or with a shear impaction (500N axial load followed by a lateral displacement) in a hydraulic load frame. Impacted and non-impacted control specimens were cultured for either 3 or 14 days. RNA was isolated from full thickness cartilage slices collected from the area under the impaction site and gene expression was measured using quantitative realtime RT-PCR. The geometric mean of four housekeeping genes (*gapdh*, *ppia*, *actb*, *sdha*) was used to normalize the results of our target genes. Ten OA related target genes were evaluated at 3 and 14 day timepoints: *fth-1*, *ftl*, *col1a1*,*col2a1*, *mmp-3*, *timp-1*, *timp-2*, *chi3l1*, *mig-6*, and *cxcl-16.* One-way ANOVA was used to test for significant ($P < 0.05$) differences. Relative gene expression at 14 days was compared to 3 days. In the control specimens: *timp-1* was significantly down-regulated at 14 days (p=0.04, FC=0.23); *timp-2* was significantly down-regulated (p=0.03, FC=0.14); and *mig-6* was significantly down-regulated (p=0.02, FC=0.08). In the axial specimens: *col1a1* was significantly up-regulated (p=0.001, FC=353.21); *mig-6* showed a trend towards down-regulation (p=0.09, FC=0.35); and *cxcl16* showed a trend towards up-regulation (p=.08, FC=1.44). The changes seen in the control specimens are likely due to culture effects. In the axial specimens

significant up-regulation of *col1a1* at 14 days may indicate the chondrocytes are reverting to a more fibroblastic state. There were no significant changes in the shear specimens examined, however, *mmp-3* trended towards down-regulation, and correspondingly *timp-1* trended towards up-regulation. The changes in the shear specimens could be due to early degradative effects diminishing by 14 days. Research is ongoing to evaluate these and other genes at the other timepoints.

A. Evren Ozcam[1], Richard J. Spontak[1,2], and Jan Genzer[1]
Graduate Programs: Chemical and Biomolecular Engineering[1]; Material Science and Engineering[2]
Advisors: Richard J. Spontak and Jan Genzer

Universal polymeric coatings based on functional silicones

Development of a universal and facile polymeric coating is a holy grail due to the wide variety of surface characteristics that must be considered in the design, deposition and application of coatings. In this work, we first consider the versatility of coatings prepared by the chemical coupling of trichlorosilane (TCS) to the unsaturated sites of poly(vinylmethyl siloxane) (PVMS). The resultant PVMS-TCS coating can be readily deposited as a functional organic layer on substrates ranging from hydrophobic to hydrophilic. Spin-coating PVMS-TCS onto a substrate results in a uniform layer, which can be further stabilized by cross-linking in the presence of moisture. Exposing the coating to moisture likewise generates surface-bound hydroxyl groups that are amenable to further chemical modification. Alternatively, treating the PVMS-TCS coating with a combination of ultraviolet/ozone (UVO) increases the population of surface-bound hydroxyl groups, as well as the elastic modulus of the coating. Several case studies demonstrating the remarkably diverse properties of PVMS-TCS functional coatings will be presented. In particular, PVMS-TCS is found to serve as a convenient and effective precursor for the deposition of organosilanes and the subsequent growth of polymer brushes, even on hydrophobic surfaces. In addition, PVMS-TCS can also be employed as a compatibilizing medium for functional silicone elastomer multilayer coatings. The applicability of PVMS-TCS and PVMS-TCS/UVO coatings has been broadly tested by altering the properties of various surfaces, ranging from poly(ethylene terephthalate) to glass, with semifluorinated organosilanes and organosilane-based initiators for surface-initiated polymerization. The physical and chemical characteristics of these unique PVMS-TCS coatings have been interrogated by a battery of experimental probes, including optical microscopy, near-edge x-ray absorption fine structure spectroscopy, x-ray photoelectron spectroscopy, Fourier-transform infrared spectroscopy, contact-angle measurements, atomic force microscopy, ellipsometry, and surface nanoindentation.

David Padgett
Graduate Program: Aerospace Engineering
Advisor: Andre P. Mazzoleni

Applications of Granular Gas Shock Wave Detection to Computational Fluid Dynamics

One of the most important practical factors in the world of computational fluid dynamics is the speed at which a solution can be generated. Therefore, techniques that can reduce computation times are of great interest to the CFD community. One method of decreasing computation times is to "seed" a solution with known approximate values to the final flow field variables in order to decrease the steps required to attain desired CFD convergence. For supersonic problems, the location of shock waves can help reduce CFD convergence time by allowing the CFD mesh to be optimized before the calculations take place. In order to approximate the locations of shock waves on aerodynamic bodies, a flowing, low-density granular gas was simulated using an event-driven code. The granular gas was modeled as a collection of hard spheres interacting only through collisions. An approximate relationship between the shock wave locations in air and shock wave locations in the simulated granular gas was determined, and the granular gas simulations were used to generate optimized CFD meshes. Preliminary results indicate CFD time savings of approximately 50% for flow over a wedge.

Parth H. Pathak
Graduate Program: Computer Science
Advisor: Rudra Dutta

Impact of Power Control on Capacity and Performance of Wireless Mesh Networks

We are experiencing convergence in terms of software applications and device hardware where more and more wireless interfaces (e.g. Wi-Fi, GSM, Bluetooth, FM, GPS etc.) are being integrated in mobile devices. Low cost and high speed Internet access is the key to realize the true potential of such integrated services. Wireless Mesh Networks (WMNs) are quickly emerging as the right solution for low cost Internet access in metropolitan area networks. Their qualities like low-cost rapid deployment, robustness and incremental coverage make them suitable for community wireless networks and campus area networks. In a WMN, mesh routers operate as access points to provide connectivity to clients and also communicate with other mesh routers over multiple wireless links to forward their data to Internet gateways. In this research, we study transmission power control in mesh routers and its impact on data rate, connectivity, relay load and power consumption. We prove that when mesh nodes are assigned power levels in proportion to their forwarding load, significant traffic load balancing can be achieved. This results into improved data rate and wider

connectivity while reducing the power consumption of devices. We characterize the relationship of network capacity with traffic pattern and network topology, and present a model which can be used to estimate the throughput with varying power levels in different topologies and traffic patterns. On the practical stand, we have built an indoor WMN testbed (CentMesh) using low cost commodity computers and 802.11 radios in our department building. The modular and flexible design of this open-source CentMesh software will allow researchers to test their protocols on actual mesh network with minimum efforts. In the next phase of CentMesh, we plan to extend the deployment to outdoor environment where mesh routers will be installed on equipment poles over a large area of Centennial campus.

Anthony Rice[1], Ramon Collazo[1], Seiji Mita[2], James Tweedie[1], Jinqiao Xie[2], Rafael Dalmau[2], and Zlatko Sitar[1]
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Advisor: Zlatko Sitar

Homoepitaxial deposition of AlN on (0001)-oriented AlN substrates by MOCVD

Single crystalline AlN is a promising substrate material for AlGaN based UV photodetectors and UV light-emitting diodes owing to the similar thermal expansion coefficients and the small lattice mismatch. In this study, AlN thin films were deposited on single crystalline (0001)-oriented, Al-polar AlN substrates by metalorganic chemical vapor deposition (MOCVD). All AlN substrates used in this study were mechanically polished for planarization, and a number of the substrates were subsequently chemo-mechanically polished (CMP). Decoration of the substrate microstructural defects, such as scratches, voids, and low-angle grain boundaries, by the epilayer suggests nucleation of AlN grains at these sites. Atomic force microscopy characterization of regions away from such macroscopic defects showed uniform terraces consistent with a step-flow growth mode. Step widths of the terraces varied with substrate miscut away from AlN (0001), ranging from ~100 nm to ~350 nm for wafers with ~13° to <1° miscut, respectively. Triple axis high-resolution x-ray diffraction measurements of the (0002) Bragg peaks (i.e., 2θ-ω scans which are highly sensitive to lattice dilations) of AlN thin films deposited on CMP wafers indicated that the films were epitaxial and strain-free. On the other hand, AlN films deposited on wafers that were not CMP exhibited shoulders on the (0002) 2θ-ω scan peaks, suggesting that the AlN epitaxial layers were strained, likely due to re-nucleation on the mechanically damaged surfaces. Calibrated secondary ion mass spectrometry analysis of homoepitaxial films indicated a significant reduction in the incorporation of unintentional impurities relative to the substrates: the concentrations of carbon, oxygen, and silicon were 3×10^{18}, 5×10^{18}, and less than 1×10^{18} cm^{-3}, respectively; while the concentrations of these impurities in the bulk substrates were ~1×10^{19} cm^{-3}.

Alan Rominger
Graduate Program: Nuclear Engineering
Advisor: J. Michael Doster

Fast Valving for Small Nuclear Reactors

Small Nuclear Reactors (SNR) offer benefits in planning and flexibility and are most attractive in areas that are growing economically and have a small or poorly connected electric grids. There are several challenges associated with siting a nuclear unit in small grids, one being maintenance of grid stability. Fast valving is a method of aiding grid stability in the event of a severe grid upset by rapid open and closure of steam valves, which has established uses in large grids with many interconnections. Another attractive application of such aids is use in small electrical grids where evolutionary small nuclear reactors may be employed. The present work aims to address the usefulness of different forms of fast valving for SNR deployment situations. Requirements for plant load shedding capability and plant system protection are of importance, as well as plant instrumentation and coordination of controllers. In order to address these issues, computer simulation is used to evaluate the nuclear plant response to events on the electrical grid. Plant primary system dynamics are represented by a code that describes the IRIS, an established SNR design with an electric output of 335 MW. Additionally, other codes were developed and integrated into the simulation to represent the dynamic behavior of power systems beyond the plant including a row-by-row one-dimensional model of the turbine steam path using fundamental turbomachinery equations, a generator model using three rotor circuits, and power flow for a 1066 MW grid with other hydroelectric and steam generating units. Small increase-in-load scenarios and decrease-in-load scenarios, caused by a three-phase fault and a line-end fault respectively have been investigated and mitigate action by the ordinary plant program has been demonstrated.

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Advisor: John R. Stone

Using Clustering Analysis to Characterize MEPDG Traffic Data in North Carolina

The Mechanistic-Empirical Pavement Design Guide (MEPDG) is a recently developed methodology to design pavements using more project-specific inputs such as traffic data, climate data, and materials data for estimating damage over a specified pavement service life. This research presents approaches to generate major traffic inputs including regional average truck axle load distribution factors

(ALF), monthly adjustment factors (MAF), vehicle class distributions (VCD), and hourly distribution factors (HDF), for North Carolina. The results support Mechanistic-Empirical Pavement Design Guide (MEPDG) procedures. Weigh-in-motion data support the analysis and generate seasonal factors. To evaluate whether or not the effect of different traffic factors on pavement performance is significant, damage-based sensitivity criteria were developed in cooperation with the North Carolina Department of Transportation. Based on the sensitivity analysis results, the HDF is found to be insensitive to pavement damage, thus the average statewide HDF values may be used as input to MEPDG. The sensitivity results also showed that the ALF, MAF, and VCD are sensitive to pavement damage. To generate these factors, different approaches are presented which are characterized by their simplicity and accuracy. Hierarchical clustering analysis based on MAF and ALF is used to develop representative seasonal traffic patterns for different regions of the State. Findings show that seasonal truck traffic has distinct regional characteristics. A simplified decision tree and a related table are developed to help the pavement designer select the proper representative patterns of ALF and MAF. To develop VCD factors, the approach uses 48-hour classification counts and a seasonal factoring procedure to convert the 48-hour classification counts into annual averages. These averages are used to generate site-specific VCD factors, which are more accurate than regional averages and result in more accurate pavement design.

Urvir Singh
Graduate Program: Electrical Engineering
Advisor: Mesut Baran

Load Estimation for Distribution Feeder Monitoring and Management

Load Estimation is an indispensable tool for distribution system studies, since knowledge of load profiles along the feeder has direct influence on system planning and operation activities. The main difficulties in the load modeling result from the random behavior of loads, diverse load shapes, limitation and uncertainty in the information on loads. Usually on the distribution feeder, measurements for all the loads are not available all the times (meters are not installed at all the customer sites or due to some meter failures). Hence in that case a load estimation technique is required which can estimate the missing data about the customers. A load estimation technique aims to model and predict those missing values based on the available historical data from those customers and other real-time data pertaining to those factors, which influence power consumption.

This study explores a new technique of load modeling and estimation on distribution systems. With the emerging AMI technology real-time data about customer loads will be available and hence an estimate of loads on the distribution feeder can be made for system monitoring and control. With this data, a load model predicting the real-time load variations can be made. A statistical approach is followed to build such a harmonics-based model with auto-correlated errors (a time series model).

Colin Tschida
Graduate Program: Mechanical Engineering
Advisor: Larry Silverberg

Truss Design With Biologically Inspired Optimization

This poster develops a stage of an evolutionary design process for truss structure optimization that mimics elements of the cytoplasm growth stage in biological cells. The method treats the structure as a multicellular organism and each structural element as a cell. In this method, each cell changes only its own properties, responds to internal and external stimuli, cell changes and their timing contain levels of randomness. The poster discusses the method's computational efficiency and its ability to converge to novel topologies. As an illustration, an evolutionary design of a truss is presented in which the truss starts off cantilevered, is attracted to a wall (first differentiation) and, when it reaches the wall, reinforces itself (second differentiation). The truss is shown to resemble a Michelle truss after the first differentiation and then to resemble an arch after the second differentiation.

Salomon Turgman Cohen and Jan Genzer
Graduate Program: Chemical and Biomolecular Engineering
Advisor: Jan Genzer

Monte Carlo study of confinement effects on controlled radical polymerization reactions

Grafted polymer layers are useful in the modification of surfaces for applications in bio-sensor devices, colloidal stabilization, adhesive promoters and bio-fouling prevention. These applications require fine control of the properties of the grafted layers such as the grafting density and the molecular weight. The preferred method for synthesizing these layers is through controlled radical polymerization (CRP) reactions, yet little is known regarding the effectiveness of CRP to form well-defined polymers in confined geometries. We aim to investigate the effect of geometrical confinement and solvent conditions on the ability of CRP schemes to yield polymers with narrow molecular weight distributions. To this end, bulk- and surface-initiated CRP in implicit solvents are simulated using a stochastic Monte Carlo algorithm and the bond-fluctuation model. We study the effect of system properties such as bulk vs. surface initiation, surface density of initiators, solvent quality and kinetic parameters on the molecular weight and

polydispersity index (PDI) of the resulting polymers. We implement variations in the solvent conditions by including truncated inter- and intra-molecular potentials between bonded polymer segments and we achieve variations in the surface density of initiators by changing the linear dimensions of the simulation lattice while keeping the total volume of the lattice constant. In order to determine the effect of geometry and steric hindrance on the polymerization we monitor the sizes and shapes of the growing polymers, the number of reactive species located near the polymer chain-ends and the concentration profiles of monomers, polymers and chain-ends as a function of distance from the substrate. Our results indicate that confinement during polymerization reduces access of monomers to the polymer chain-ends leading to deterioration in the capacity of CRP to yield monodisperse polymers and discrepancies in the grafting densities of the precursor initiators layers to those of the resulting grafted polymers.

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Advisors: Dieter Griffis and Maurice Balik

The Sputtering Behavior of Polymeric Materials in Focused Ion Beam Micromachining

Topographical and morphological studies of the surfaces and cross-sections of polymers are essential to model their functional properties, but focused ion beam (FIB) based polymer characterization has only recently been explored. The development of optimal nanomachining methodologies is essential to extending the application of FIB technology to polymeric materials. Recently, a FIB in situ technique was developed for cross sectioning and imaging the cross sectional morphology of the polymeric components in a bicomponent polymeric fiber with the island-in-the-sea (I/S) structure (Wong *et al.*, in press). The application of this technique on two I/S fibers composed of bicomponent combinations of linear low density polyethylene (LLDPE) and nylon 6 (PA6) or polylactic acid (PLA) and an EastONE™ proprietary polymer is presented. Topographical contrast as a result of differential sputtering is exploited. The sputter rates of these polymers obtained under normal incidence Ga^+ ion bombardment are studied under varying vacuum and chemical environmental conditions. When combined with the high surface specificity and high signal-to-noise obtained using Ga^+ ion induced secondary electron (ISE) imaging, the FIB is shown to provide a useful approach for efficient characterization of the cross-sectional morphology of bicomponent polymeric fibers without the necessity of staining or other sample preparation required for previously employed imaging techniques.

Feng Xu, Qingquan Qin, and Yong Zhu
Graduate Program: Mechanical and Aerospace Engineering
Advisor: Yong Zhu

Size Effects on Mechanical Properties of Semiconductor Nanowires

Semiconductor nanowires are key building blocks for nanoelectronic and nanoelectromechanical devices. We characterized the elastic, inelastic and fracture behaviors of both Si and ZnO nanowires. The mechanical testing was performed using a nanomanipulation probe as actuator and an AFM cantilever as load sensor inside SEM. For Si nanowires, the Young's modulus and fracture strength of silicon nanowires with diameters between 15 and 60 nm and lengths between 1.5 and 4.3 mm were measured. The nanowires, grown by the vapor-liquid-solid process, were subjected to tensile tests in-situ inside a SEM. The Young's modulus decreased while the fracture strength increased up to over 12 GPa, as the nanowire diameter decreased. The fracture strength also increased with the decrease of the side surface area; the increase rate for the chemically-synthesized silicon nanowires was found to be much higher than that for the microfabricated silicon thin films. Repeated loading and unloading during tensile tests demonstrated that the nanowires are linear elastic until fracture without appreciable plasticity. For ZnO nanowires, both Young's modulus and fracture strength increased with the decrease of the diameter. In-situ TEM mechanical testing based on a MEMS testing stage, is currently being employed to correlate the crystalline structure and defects evolution with the measured elastic and fracture behaviors. The experimental methods can be applied to characterize the mechanical properties of other one-dimensional nanostructures.

Attila Altay Yavuz
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Advisor: Peng Ning

BAF: An Efficient Publicly Verifiable Secure Audit Logging Scheme for Distributed Systems

Audit logs, providing information about the current and past states of systems, are one of the most important parts of modern computer systems. They are used to monitor critical system events such user activities, remote loggings and program executions. Due to their obvious forensic value, audit logs are the main targets of an experience attacker. Particularly, providing security for audit logs on an untrusted machine in a large distributed system is a very challenging task, especially in the presence of active attackers. In such a system, an active attacker compromising the machine can erase the traces of her malicious activities remaining undetected, or they can even accuse innocent users by modifying log entries. Therefore, it is critical to have *forward security* such that when an adversary compromises a machine; she cannot modify or forge the log entries accumulated before the compromise.

Unfortunately, existing secure audit logging schemes have significant limitations that make them impractical for real-life applications: Existing Public Key Cryptography (PKC) based schemes are computationally expensive for logging in task intensive or resource-constrained systems, while existing symmetric schemes are not publicly verifiable and incur significant storage and communication overheads.

In this research, we develop a novel forward secure and aggregate logging scheme called *Blind-Aggregate-Forward (BAF) logging scheme*, which is suitable for large distributed systems. BAF can produce publicly verifiable forward secure and aggregate signatures with *near-zero computational, storage, and communication costs* for the loggers, without requiring any online Trusted Third Party (TTP) support. We prove that BAF is secure under appropriate computational assumptions, and also demonstrate that BAF is significantly more efficient *(in the order of hundreds)* and scalable than the all-previous approaches. Therefore, BAF is the best available solution for secure logging in both task intensive and resource-constrained systems satisfying the needs of real-life applications.

Ji Zhang
Graduate Program: Mechanical Engineering
Advisor: Tiegang Fang

Optical diagnostics of diesel spray combustion in a high-pressure high-temperature constant volume chamber

Due to the critical environmental issues, the higher standard of emission regulation nowadays presents significant challenges for diesel engine development. Starting from 2010, the emission from newly manufactured heavy duty engines are restrained into the low levels: Nitrogen Oxides (NO_x): 0.2 gm/(hp-h); Particulate Matter (PM): 0.01 gm/(hp-h), which is about 10% of 2002 standards. Understanding the diesel combustion process is crucial for emission control. The overall objectives of this project is characterized by three phases: (I) to fabricate an optical accessible high-pressure high-temperature constant volume chamber; (II) to study varied operation conditions to understand the instantaneous process during the combustion event; (III) to study the biofuel combustion in current diesel technology. This understanding will be helpful in: (1) explaining the emission formation in different conditions; (2) validating the numerical simulation of in-cylinder combustion in terms of key radicals distribution and heat release rate, etc.

To study the diesel spray combustion, high-pressure high-temperature environment with 21% volume O_2 is created in the chamber by igniting configured premixed acetylene/oxygen/air mixture. Then diesel fuel is injected by a common rail fuel injection system with injection pressure up to 1350 bar. The fuel injection pressure is monitored and controlled by a PID control code. Chamber pressure signal is recorded to analyze the heat release process. High speed images starting from the start of injection to the end of combustion are recorded by using a high-speed digital video camera and are used to identify important physical parameters such as lift-off length, spray structure development, soot luminosity, etc. The whole experiment process is automatically controlled and synchronized by LabView to ensure the repeatability. To date, the project is between Phase I and II. The preliminary results showed the validation of this experiment system. The typical spray combustion process is characterized by fuel evaporation, premixed combustion and mixing-controlled combustion. The soot formation is mainly attributed to the mixing controlled combustion phase. The laser induced diagnostics will be introduced soon to identify the OH* and CHO* radicals for different fuels, which helps understand the chemical kinetics further.

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Advisor: Julie S. Ivy

Understanding the Risks of Progressive Disease – A Case Study on Mortality Risk for Breast Cancer Patients

For most studies regarding decision making and cost-effectiveness analyses for progressive diseases, it is important to understand and characterize how the disease progresses and what the final outcomes will be for various stages of disease.

We model breast cancer progression and focus on the estimation of mortality probabilities for white and African American. Breast cancer is the second leading cause of cancer death in women. Breast cancer risk changes with age; and older patients, when they have two or more comorbidities, may be at greater risk of dying. Our goal is to calculate the probability of dying from breast cancer as well as dying from a specific comorbidity as a function of patient age, race, breast density (a breast cancer risk factor) and cancer stages at detection. We use Carolina Mammography Registry (CMR) data, which is a population-based screening registry, for the survival analysis. Data including patient demographics, cancer information and vital status is collected from CMR.

A Cumulative Incidence function with confidence interval estimation is used to calculate the mortality probabilities. We propose methods for incorporating both left and right censoring in our survival analysis. Left censoring refers to situations in which the true start time of the disease at a specific stage is unknown. It is only observed at diagnosis. Right censoring occurs when mortality for a patient is not observed either at the end of the study time or when the patient withdraws from the registry. The adjustment to the survival time is essential for quantifying the true mortality probabilities for breast cancer patients. This study quantifies the risks for breast cancer patients in the presence of competing risks, and the methods could be applied to other progressive systems.

Rebecca Ayers
Graduate Program: Public Administration
Advisors: Jerrell Coggburn and Branda Nowell

Looking for Results: Implementing Federal Agency Strategic Plans through Performance Appraisal Programs

The use of performance appraisal programs as a management control tool for implementing organizational goals is important for increasing organizational performance. This research examines the extent to which Federal agency program organizational factors and strategic plan characteristics predict performance appraisal goal alignment and to what extent and under what conditions performance appraisal goal alignment supports the successful implementation of strategic plans in a Federal agency. Two aspects of goal alignment were explored in three regression models: (1) actual embedding of strategic plan goals in performance plans and (2) employee knowledge of how their work relates to the agency's goals and priorities. Successful goal alignment was measured through program performance. This research uses the U.S. Office of Management and Budget's Program Assessment Rating Tool section four "Program Results" ratings as an independent rating of program performance. Data for this research also comes from the U.S. Office of Personnel Management's Performance Appraisal Assessment Tool, Federal Human Capital Survey, and ratings of agency strategic plans. Results of the analyses indicate that when measuring performance appraisal plan alignment, leadership support of the program is a key determining factor. When measuring employee perceptions of alignment, communication of the organization's goals, the climate fit for achieving results, and if the strategic plan was written directly for the agency program are predicting factors. When testing the modifying affects of an overall quality performance appraisal program, there is a significant interaction between performance culture and performance appraisal plan alignment and employee alignment as it relates to program performance. The relationship between goal alignment and program performance is stronger under conditions of low performance culture. The results reaffirmed the important role of goal alignment to program performance. This study helps to unpack further the "black-box" that management capacity, especially human resources management, is important to organizational performance and effectiveness.

James D. Baker
Graduate Program: Psychology/Ergonomics
Advisor: Shari A. Lane

Testing for cognitive and physiological effects of musical expectancy manipulations

Emotion induction has long been regarded as a fundamental effect of listening to music. However, cognitive science methodologies have only recently become suited to the goal of understanding the underlying psychological mechanisms by which music achieves its distinctive emotion induction. The present research explores findings and theories surrounding musical expectancy, which is widely accepted as an essential mechanism to an emotional response to music. Modern studies show that music often triggers a pattern of physiological activity analogous to that of the autonomic nervous system's initial general adaptation syndrome, more commonly referred to as the fight-or-flight-or-freeze response. This autonomic response is central to a recently developed psychological theory of expectation, called ITPRA (for Imagination-Tension-Prediction-Reaction-Appraisal). Though ITPRA is a theory to be used for explaining all expectation-related emotions, it has been proposed as a framework explicitly for understanding emotional responses to music. Drawing from ITPRA theory and the scientific findings with which it clusters, we can hypothesize that a manipulation of musical expectancies will produce autonomic responses that can be observed via physiological measures, such as skin conductance response recordings. Furthermore, we can hypothesize that these autonomic responses will surface as fluctuations in cognitive measures, such as vigilance. To test these hypotheses, the proposed experiment makes use of modern theoretical tools for predicting, quantifying, and manipulating musical expectancies. Because individual differences, cultural differences, and many extraneous variables have been found to afflict past psychomusicology experiments, the proposed experiment's music variable is designed with regards to research on evolutionary perspectives of the origin of music.

Neha Chhabra
Graduate Program: Communication
Advisor: William Jordan

From Singlish to English: Achieving Social Change in Singapore through 'Positive Communication'

The extensive use of "Singlish," a local variant of English has led to a decline in English language standards in Singapore. To combat the pervasive use of this homegrown language and promote the use of Standard English, the Singapore government launched a *Speak Good English Movement (SGEM)* in 2000 and published the book *English As It Is Broken* in 2007 to address the public's queries on the correct use of English. This paper achieves several objectives: first, it employs Fisher's Narrative Paradigm to analyze the effectiveness of this book in facilitating the development of positive communication habits and advancing the movement's objectives of promoting the use of Standard English. Second, the paper examines the usefulness of the Narrative Paradigm as a predictor of message effectiveness. Third, the paper assesses the success of the campaign to date and offers suggestions on how the movement can design more effective messages to motivate Singaporeans to adopt Standard English as a lifestyle choice. The analysis indicates that *English As It Is Broken* presents a good case for using Standard English as the book passes the twin tests of

narrative coherence and narrative fidelity. Notably, differences in reader characteristics, critical reasoning skills and motivation determine the degree to which the book makes an impact on readers. As a theory, the Narrative Paradigm has validity and value; however it cannot conclusively determine the effectiveness of the 'Speak Good English' message as it is limited by external factors such as differences in the way audiences analyze, interpret and react to messages. Overall, greater steps must be taken to reinforce the message of good English use and the paper recommends that SGEM adopt a two-fold approach in terms of redefining their target audience and matching messages more precisely to the orientations of these specialized groups.

Sarah L. Cunningham
Graduate Program: Sociology and Anthropology
Advisor: Scott Fitzpatrick

Bone Weathering in the North Carolina Piedmont: Pigs as Proxies for Human Juvenile Remains

While a great deal of study has been done to understand soft-tissue decomposition and the information it can provide researchers and law enforcement in death investigation and victim identification, hard tissue decomposition, or bone weathering, has been largely overlooked. The process of bone decay can provide just as much information to scientists and investigators. Eight juvenile pigs were used as proxies for juvenile human remains to better understand the local environmental effects on bone and establish a regional North Carolina Piedmont time since death timeline.

Malathie P. Dissanayake
Graduate Program: Developmental Psychology
Advisors: Amy Halberstadt and James W. Kalat

Cross-Cultural Investigation of Emotion Differentiation and Positive Interpersonal Relationships

Emotion differentiation, the tendency to detect subtle differences in emotions, is important for individuals in their daily life. Distinguishing various emotional experiences may benefit individuals in understanding others' emotions, developing empathetic understanding and selecting appropriate responses to others' feelings. Also, understanding well-differentiated emotions may help individuals maintain and improve their interpersonal relationships. The proposed study examined the role of emotion differentiation in predicting positive interpersonal relationships in individualistic and collectivist cultures. The major objective of this study was to replicate and expand upon previous findings identifying a relationship between emotion differentiation and relationship quality in adults using multiple methods. Second, it focused on how the relationship between emotion differentiation and relationship quality may vary across three cultures that vary by individualism and collectivism. Third, it also examined the link between relationship quality and life satisfaction in adults and how it varies across three cultures. The sample of this study consisted of 607 participants: 308 Sri Lankans, 103 Indians, and 196 Americans. Seven measures-- emotion differentiation, emotion categorization task, positive and negative affect, beliefs about emotions, relationship quality, positive relations with others, and life satisfaction-- were used to examine emotional differentiation, interpersonal relationship quality, value of emotion, and individuals' feelings about their lives. Findings suggested that there was a significant relationship between emotion differentiation and relationship quality. There were significant differences in emotion differentiation and relationship quality among three cultural groups.

Amanda Gissel, Lori Foster Thompson, and Samuel B. Pond III
Graduate Program: Industrial-Organizational Psychology
Advisor: Lori Foster Thompson

A Theory-Driven Investigation of Prospective Applicants' Intentions to Submit Video Résumés

Video résumés are a quickly growing trend, yet little is known about why some job seekers submit them while others do not. In order to fully understand contemporary personnel recruitment and selection practices, it is important to examine what encourages candidates to voluntarily pursue the submission of a video résumé when given the opportunity. This study used the Theory of Planned Behavior to explain and predict video résumé submission intentions and behaviors. Two web-based surveys were administered to 158 college students. The first survey collected data on several potential predictors. Participants then read two popular press news articles and watched a news report about video résumés to educate and familiarize them with the concept. Afterwards, they completed Survey 2, which collected data on attitudes toward and intentions to submit a video résumé. Results indicate that (a) attitudes toward video résumés, (b) subjective norms (i.e., social pressure to submit video résumés), and (c) perceived behavioral control (i.e., self-assessed ability to create/submit video résumés) influence people when they are deciding whether to submit video résumés to prospective employers. Results largely supported the Theory of Planned Behavior model, with attitudes and perceived social norms functioning as particularly important determinants of intentions to submit video résumés. Personality also played a role in that relatively narcissistic people with a high self-opinion had especially favorable attitudes toward submitting video résumés and strong perceptions of behavioral control. As the first study to investigate prospective applicants' inclinations to create video résumés, this research offers an important contribution to the personnel selection literature. It also

extends what is known about the Theory of Planned Behavior because it is the first study to use a relative importance analysis to statistically compare the influence of the theory's antecedent constructs.

Verónica González
Graduate Program: Spanish Language and Literatures
Advisor: Jim Michnowicz

Rhotacism and Lateralization in Puerto Rican Spanish

The pronunciation of /r/ as /l/, for example "Puelto Rico" has been stigmatized as a factor of the lower socioeconomic class (Lipski, 2008:124); however it is a factor that is not only associated with Caribbean Spanish in general, but more so with the Puerto Rican culture (Holmquist, 2003). Tomás-Navarro (1948) analyzed Puerto Rican Spanish (PRS) around the island and found out that the use of *r* was dominant in the southeast area, whereas the use of *l* was more dominant in the northeast area (80). This project will analyze the use of the (r) and (l) variants in word-internal and word-final position in the (PRS) of Waterbury, Connecticut based on recorded sociolinguistic interviews for at least 30 minutes. There were a total of 12 participants, 6 men and 6 women, ranging from 18-73 years of age. A total of 787 tokens were analyzed through the use of the Multi-variate statistical analysis. The results show that lateralization is favored in word-final position; and when followed by nasals, liquids, a pause, and affricates. It also shows that lateralization is also favored in stressed syllable position and by the younger generation; as well as by women. The overall results show that the adults and the older generation are using the standard [r]; whereas the younger generation (57%) prefers the use of [l]. Young speakers may be focusing more on being able to communicate and preserving the Puerto Rican identity rather than using the standard form.

David Gruber
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Jason Swarts

Decoding the Language of Brain Decoding

Functional magnetic resonance imaging (fMRI) has enabled neuroscience researchers to visualize patterns in the brain that can help them predict, with surprising accuracy, what a person is thinking (Hansen, et al., 2006; Haynes, et al., 2007). This fMRI research, known popularly as "brain-prediction" or "mind-reading," initiated a flurry of news articles between February of 2007 and March of 2008. Often embedded with pictures from the science fiction film "Minority Report" and framed by fear-laced titles such as "German Scientists Reading Minds Using Brain-Scan Machines" (Fox News, 2007), these news articles demonstrated that not all fMRI advancements would receive the same amount or the same type of coverage in the media. Thus, this project examines how brain-prediction, as a particularly controversial fMRI research agenda, has been presented to the general public. Using verbal data analysis in conjunction with a critical rhetorical analysis, this project locates recurring grammatical features from a collection of popular news articles and then explores the rhetorical implications of those features in this context. Ultimately, this project concludes that the articles under examination display a pattern of consistently distancing researchers from the negative implications of the research and, through an over-reliance on non-human actors, promote a narrative of technological determinism.

Niambi Hall-Campbell
Graduate Program: Psychology in the Public Interest
Advisor: Craig C. Brookins

Culture in Context: A Mixed Method Study of Bahamian Culture, School Climate and Culturally Relevant Pedagogy in Bahamian Secondary Education

As school systems become increasingly diverse, the call for culturally relevant pedagogy and evidence of effectiveness are increasing. A number of studies examine the relationship between teacher's pedagogy and student outcomes however examples of the relationships between the climate in which teachers are located and culturally relevant pedagogy are scarce. This research will represent the first of its kind to study this relationship in a Bahamian context. In this mixed-methods study, Bahamian secondary education teachers (N = 226) were surveyed to determine the relationship between school climate (Hoy et. al, 2002), efficacy to enact culturally relevant pedagogy (as perceived in both Bahamian and American settings) and beliefs in the positive outcomes of using culturally relevant pedagogy (Siwatu, 2007) in Bahamian secondary education. Qualitative analyses including focus groups and semi-structured interviews were conducted to situate the ecological context of Bahamian education and devise Bahamian measures of culturally relevant pedagogy. Preliminary results demonstrate the validity and reliability of the scales on this nascent population and implications for school effectiveness research in The Bahamas are discussed.

Jacquelyn Harvey
Graduate Program: Communication
Advisor: Melissa Johnson

A picture is worth a thousand words: An analysis of Frank Warren's 'postsecret' phenomena

The ways we choose to self-disclose information have changed rapidly in the past few years due to digital media advancements in society. The internet has created a new avenue for individuals to reveal personal information in an anonymous fashion, ultimately freeing them of the necessity to self-disclose in the progressive stages outlined by social penetration theory. This creates an importance in looking at how and why humans self-disclose so differently between face-to-face and online interactions. Due to this phenomenon, the current research study analyzed the website 'Postsecret.com' in an effort to uncover online self-disclosure tactics and how they have changed over the past few years. Methods for this research included using social penetration theory coupled with hyper personal theory to examine how Post Secret has been used as a tool that allows individuals to disclose private and often delicate information in a guilt free manner. This ultimately liberates them of the need to let go of secrets they feel unable to speak of in a face to face interaction. Findings indicate that strategies involved in the Post Secret phenomena allow individuals to use both sense making and identification procedures in processing the message sets that are presented on the website. Individuals then use this information to create meaning within our own lives and identify or empathize with others who are disclosing information as well. Therefore, Post Secret challenges individuals to look for the motivation and meaning behind these representations and then decipher how this can be used to help others and perhaps even ourselves. Numerous individuals have been influenced by the Post Secret project and this paper broadens the understanding of just how powerful and meaningful these messages can be.

Amy Heishman
Graduate Program: English
Advisor: Rebecca Walsh

Baptized by Drowning: Southern Identity and Magical Realism in the works of Lewis Nordan

The United States is known as a violent nation and in no other region is this more true than the South. Its histories are a plethora of violent assassinations, ritual lynchings, and beastly brutalities. Some acts cannot be judged more evil than another, and yet some murders shape the world while others are forgotten by the time the morning paper makes its way to the recycling bin. In literature, better authors have managed to examine the particular nature of Southern violence with respect and intensity. One such author is Lewis Nordan and his novels Wolf Whistle and Sharpshooter Blues. Each novel examines a region boiling under a dark, complex history and the resounding effects of one murder on many. Wolf Whistle unpacks a completely destructive Southern identity, an identity that is tied to false notions of protection and rift with violence. Similarly, The Sharpshooter Blues is a more personal and self aware look at the same problem; Nordan examine an individual's ability to deal with situations they find wholly intolerable. However, what separates Nordan from a Southern, Falknerian tradition of Southern literature (one that presents stories in brutal realistic fashion) is the powerful and purposeful use of magical realism. Nordan uses magical realism as a coping mechanism, a way to rewrite Southern delusions about its romantic past amidst a nasty reality in hopes that something more substantial emerges. Nordan's magical realism is mixed with local authenticity, suggesting a 'magisicism' that is not dependent on region, but rather on style.

Ruchi K. Patel and Ashley J. Hoffman
Graduate Program: Industrial/Organizational Psychology
Advisor: Bart Craig

Individual and Situational Characteristics Predicting Personal Web Usage at Work

The use of the Internet for personal reasons at work has become a major issue for employers. Not only is it possible that personal internet use may lead to wasted time and money for organizations, it is also possible that this internet usage could put organizations at risk due to loss of productivity, distraction of employees, and potential information technology hazards, such as viruses. Cyberloafing and Personal Web Usage (PWU) are critical components of counterproductive work behaviors (CWB). However, researchers have not previously examined the individual and situational characteristics associated with these behaviors. The current study examines various individual and situational characteristics, including the type of PWU behavior exhibited, the familiarity of the employee with computers and the internet, the amount of autonomy the person has within their job, the amount of privacy a person is afforded in their current position, and the self-reported level of conscientiousness. The authors found that conscientiousness predicted PWU, but no other variables frequently associated with CWB were related to any of the PWU dimensions. Researchers believe this may be due to a small sample size. Further research will be conducted to determine a possible link with various populations of interest.

Patricia Tavares Infantino
Graduate Program: Spanish Language and Literature
Advisor: James Michnowicz

The Process of Devoicing of The Voiced Palatal /ž/ in the Spanish Dialect of Buenos Aires

The Argentine dialect is well known amongst many other Spanish dialects due to its voiced and devoiced palatals: /ž/ and /š/ (Chang, 2008; Fontanella de Weinberg, 1979). Many Spanish speakers can recognize the Argentine dialect, although this dialect is found in Buenos Aires Metropolitan Area. Nevertheless, the devoiced palatal variety is spreading all over the Argentine territory (Lipski, 2007).

The purpose of this project is to study the devoicing of the voiced palatal /ž/ in the Spanish dialect spoken in Buenos Aires, Capital of Argentina, and how native speakers of this particular dialect manifest this linguistic variation. According to Fontanella de Weinberg (1979), the voiced palatal appeared in the Rioplatense dialect in the XVIII Century, and this variation has undergone changes throughout the centuries through a devoicing process.

For this study, ten Argentines between the ages of 18 to 63 years old, born and raised in Buenos Aires, Federal Capital, were interviewed. Five of them are female and five are male. Their educational level was taken into consideration for this study because the devoicing of the voiced palatal is socially stigmatized. Our hypothesis was that the group of women who were over 50 years of age would not devoice the palatal because of the social stigma behind it. Nevertheless, data suggest that there is a process of devoicing of the voiced palatal taking place amongst women who are over 50 years old.

Felysha L. Jenkins
Graduate Program: Psychology in the Public Interest
Advisor: Mary Wyer

Career Commitment and African American Women in Undergraduate Sciences: Defining the Path to Success in Science, Technology, Engineering, and Mathematics (STEM) Fields

There is research on the underrepresentation of African American women in science, technology, engineering, and mathematics (STEM) but less on what creates success for them. Without devising an intervention that emphasizes the benefits of science and science careers for African American females, the numbers of African American women who pursue baccalaureate degrees in STEM will continue to demonstrate disappointing numbers.

This study will contribute to understanding how African American women are successful in obtaining baccalaureate degrees in the sciences despite the obstacles and barriers they face. It is striking that these theories rely on a "deficit model" that implicitly reasserts the notion that African American women are deficient, rather than talented, able, and motivated. A more equitable (and accurate) approach would be to look beyond the individual level to multiple levels of analyses. Cultural context, college climate, and individuals' psychological strengths each likely make unique contributions to the persistence rates of African American women in STEM (Hanson, 2007). In this two-stage study, the first stage will examine the career commitment of an African American female population that is a subset a national sample. In particular, it will explore if there are differences in career commitment for African American women in STEM versus those who are not. Stage two will be a more comprehensive model featuring additional variables. Specifically, through surveying students from multiple institutions of higher education, including Historically Black Colleges and Universities (HBCUs) and Predominately White Institutions (PWIs), the study will examine how African American undergraduate women's self-efficacy, gender, ethnicity, and college climate interact to promote career commitment. There is a paucity of research at the crossroads of race and gender in STEM. This project will focus on a population at that crossroads: African American women obtaining STEM degrees.

G. Jason Jolley
Graduate Program: Public Administration
Advisor: G. David Garson

Diffusion of Innovation of Supply-Side Economic Development Policy: Explaining the Determinants of Local Government Enterprise Zone Adoption

Despite the widespread study of diffusion of policy innovation among states, little is known the factors influencing adoption or the pattern of innovation among local governments. This study utilizes logit regression and Cox regression (also known as Cox proportional hazards modeling) to examine the predictive factors of local government enterprise zone adoption in Illinois. Utilizing counties as the unit of analysis, the demographic, economic, political, and regional diffusion factors influencing adoption of enterprise zones are examined over a 23-year period from 1981 to 2003. Representation by a sponsor of the enterprise zone legislation and having an unemployment rate higher than the state average are the strongest predictors of enterprise zone adoption within a county's borders. Counties represented by a bill sponsor are 6.67 times more likely to adopt an enterprise zone compared to a county not represented by a bill sponsor. Likewise, each unit difference in higher unemployment rate compared to the state average means a county would be two times more likely to adopt. The findings support the importance of policy entrepreneurs,

especially state legislators, in driving policy innovation in their districts. However, the enterprise zones were designated in counties with a higher than average unemployment rate suggesting those counties in economic need were more likely to receive the intended benefit. Consistent with prior studies of diffusion of innovation, the data reveal a pattern with some early adopters, many middle adopters, and fewer late adopters. When plotted, the data resembles a logistic "S" curve and natural breaks in the data exist for early, middle, and late adopters.

Jason Kalin
Graduate Program: Communication, Rhetoric, and Digital Media
Advisor: Jason Swarts

Genetic Information and the Constitution of Medical Subjects: Critical Junctures in Genome Sequencing

Genome sequencing is becoming increasingly sophisticated and economically feasible, thus helping to user in an era of personal genetic medicine. Turner (2005) argues that certain discourses surrounding genetic medicine exemplify what she terms *critical junctures*, which are "technological and cultural shifts that transform the idea of information" (p. 332). In her study, Turner identifies two critical junctures in genetic medicine, wherein the individual medical subject is elided or neglected in favor of genetic information. However, given the advancement of genome sequencing, this study argues for a third critical juncture, wherein medical subjects are being reconstituted through genetic information as embodiments of their genes, and more importantly, as potentially in control of their genes. What becomes important is not only what the companies can do with genetic information, but also what individuals can do with their own genetic information. This study analyzes how the third critical juncture is being communicated in popular news sources to better understand how genome sequencing may be received by the public. Using discourse analytic techniques to analyze popular news articles, this study discusses how the discourse surrounding genome sequencing along with the technology itself constitutes medical subjects. Furthermore, this study explores the technological, medical, and social consequences of genome sequencing, including its potential to change what it means to have a healthy body and to lead a healthy life. Indeed, the discourse of the news articles suggests that genome sequencing can be deeply unsettling because genetic information seems out of the individual's control—which contradicts the claims made by genome-sequencing companies. Consequently, genome sequencing, because its results are still inconclusive, should be approached cautiously.

Christopher M. Kelley and Anne Collins McLaughlin
Graduate Program: Human Factors and Ergonomics
Advisor: Anne Collins McLaughlin

Feedback Requirements for Learning: An Investigation of the Role of Cognitive Resources and Task Demands

Introduction. Research on the amount of feedback required for learning has been investigated for decades with ambiguous results (*cf.* Schmidt & Bjork, 1992; Van Merrienboer & Sweller, 2005). **Objectives**. The current study investigated a model that postulates feedback requirements are based on the cognitive resources of the learner and demands imposed by the task (McLaughlin, Rogers, & Fisk, 2006). **Method.** To test this model, a study was conducted that explored the potential interaction of the learners' cognitive resources and the demands of the task. Cognitive resources were controlled for by comparing samples of populations with known differences, older and younger adults (Horn & Cattell, 1967; Salthouse & Babcock, 1991). To control for task demands, a simple rule-based cue learning identification task was created in which participants learned how to successfully identify fake Windows popups. Successful identification of popups was based on 2 cues: a visual cue and a verbal cue. The visual cue required the use of participants' fluid abilities while the verbal cue tapped into their crystallized intelligence. Participants were randomly assigned to one of two feedback conditions. The primary analysis was conducted using a repeated measures multivariate analysis of variance. An additional post hoc analysis was performed to examine if performance on the 2 cues differed between age groups or feedback conditions. **Results.** Results indicated younger adults benefited from increased feedback support, while older adults benefited from increased feedback support with the visual cue, but decreased feedback support with the verbal cue. One explanation for the current findings is feedback support requirements are connected with the demands of the task and specific cognitive ability levels of the learner.

Scott Kirkland
Graduate Program: Sociology and Anthropology
Advisor: Scott Fitzpatrick

The Effect of Space on Health and Well-Being: An Environmental Assessment for Home-like Long Term Care Settings

The aim of this presentation is to further understand the effect of rice agriculture on dental health in Thailand and Southeast Asia. An analysis of dental pathology frequencies were conducted using recently excavated remains from the Iron Age site of Promtin Tai in Thailand. Carious lesions, attrition, antemortem tooth loss, and abscessing were scored and the frequency rates were then compared to other sites within Thailand. Because of the low rate of pathology at Promtin Tai, only carious lesions and attrition could be used for comparisons. Preliminary work suggests that carries and attrition rates are lower at this site than other known sites

within Thailand. The total caries rate of 0.5 percent at Promtin Tai represents a statistically significant difference in total carries rates between the coastal, central, and Khorat Plateau regions of Thailand. Because this is the first site in the central region to be analyzed for dental pathology, comparisons can only be made to sites from the Khorat Plateau (Eastern Thailand) and coastal Thailand of a similar time period. This new analysis may give insight about how the transition to rice agriculture effects the dentition and furthers the knowledge of dental health within Iron Age Thailand and Southeast Asia.

Meagan A. Kittle
Graduate Program: English
Advisor: Rebecca Walsh

Gendered Nature in a Digital Realm: An Ecofeminist Analysis of Conservation Websites

Recent feminist movements have begun to question society's automatic assumption of nature as "feminine." Women have become more conscious of equating the environment with femininity, the influence that language and visual representations that gender nature have had on society, and the repercussions of maintaining this patriarchal mindset. Gendered language is not limited to a single mode of discourse, but is found in multiples modes of media representations. While Internet use commonplace in America nowadays, we have yet to fully understand how this digital discourse continues traditional stereotypes or modifies them in someway. This presentation compares the use of gendered language in representations of nature on the websites for two national conservation societies through ecofeminist and cyberfeminist lenses to determine if and how natured continues to be "gendered" through digital means. The websites of The Nature Conservancy and The Sierra Club were studied for their American base, high volume of Internet traffic, and significant representation of nature in the United States. It can be inferred from both sites that traditional references to feminized nature, such as the commonly used phrases "Mother Earth and "Mother Nature," are still understood and even expected by website visitors, thus prompting the groups to incorporate such usages on their pages, though their actual inclusion within the site is quite limited. Guest contributors, whose content neither organization takes responsibility for, tend to use the greatest amount of gendered language and representation of nature in the writing, which includes editorials and blog posts. Overall, both conservation groups appear to make a conscious effort to use gender-neutral language and graphics in their representations and discussion of nature in their online content, which may result from their heightened awareness of other sensitive socio-political issues.

Kristin Lee
Graduate Program: Technical Communication
Advisor: Stan Dicks

Ethics and Informed Consents for Clinical Trials

Ethics in Informed Consents for clinical trials has long since been a hot topic in the medical field. The problem becomes what is ethical to one person, may not be ethical to another and that difference of opinion is represented in the Informed Consent based upon who writes the document. Informed Consents have many different guidelines that suggest an opportunity such that individual writer's ethical sensibility does have an impact on the document as they can choose between a standard guideline, and a guideline that will differ for each different patient. This project focuses on the ethical issues that the Informed Consent is trying to address, what the medical writer's have to keep in mind when producing the document, and the philosophy of ethics that seems to offer the best approach for thinking about these documents.

Ethics are vital; not only to Informed Consents, but to clinical trials as a whole. The process that pharmaceutical companies and clinical research organizations must go through to have an Informed Consent approved ensures that they are ethical. Even after the medical writers finish compiling the Informed Consent and it is approved both internally and externally by the client and without that approval, the study will be placed on hold until the medical writers can successfully revise the document.

Medical writers are there to protect study patients. Without them, there would be no Informed Consent and patients would have to rely on the doctors to treat them and take care of them. The medical writers have to rely on their own ethical philosophy and the guidelines of their choosing to help them create a document that will protect patient rights and regulate what can and cannot be done. The guidelines will give the writers a starting point and headlines that must be covered, but it is the sole responsibility of the medical writer to produce what is written under those headlines. Patients need to be aware of their rights as the risk taker when they enter into a trial and this document allows that to happen. It also encourages patients to ask questions and take all of the time they need to make the decision because ethically, such a big decision should not be rushed. Without understanding the purpose of the Informed Consent and the sincere relevance to the information within it, patients would risk the potential of losing the rights to their own body.

As long as the medical field is producing more drugs, Informed Consents will be extremely important. Since ethics will forever be a part of Informed Consents, the question then becomes: is it ethical to allow someone to sign an Informed Consent that gives a doctor the right to inject an unapproved drug into another person's body for research?

Avizia Long
Graduate Program: Spanish Language and Literature
Advisor: Jim Michnowicz

The role of explicit web-based phonetics instruction and practice on student pronunciation of Spanish

Both the teaching and practice of pronunciation in foreign language (FL) university courses tends to lose emphasis in favor of increased listening, speaking, reading, and writing practice despite consensus on the importance of pronunciation instruction and practice for overall communicative competence (Elliott 1995; Hockett 1950; Kaulfers 1928; Moreno-Lacalle 1918). Previous studies examining the role of formal instruction in pronunciation have yielded mixed results. Though researchers have successfully designed models of pronunciation instruction resulting in considerable improvement by FL learners (Elliott 1995; Lord 2005; Neufeld 1977), the challenge lies in developing a model of pronunciation instruction both practical and efficient for classroom use. This study seeks to confront that challenge by examining the pronunciation of beginning FL learners receiving explicit phonetics instruction and practice in a web-based learning environment. The following six problem areas for second language (L2) Spanish speakers are taught outside of the classroom via computer-mediated instruction: (1) the five basic vowel sounds of Spanish, (2) avoiding the schwa, (3) vowels side-by-side, (4) the consonant sounds p, t, and k, (5) the consonant sounds b, d, and g, and (6) the letter h. Both pre-test and post-test recordings of a word list and reading sample by 36 beginning L2 Spanish learners were analyzed quantitatively using SPSS to determine the effectiveness of web-based phonetics instruction and practice on the improvement of pronunciation. Results confirmed that participants improved their pronunciation of the vowels [e i o u] and silent h [Ø], however there was no significant difference in improvement between the treatment and control groups. Data analysis also revealed that subjects got worse in their pronunciation of the voiced fricatives [β γ] and voiceless stops [p t k]. The present study provides a discussion of data analysis in each problem area of student pronunciation as well as areas for further research.

Sonya Massengill
Graduate Program: Rhetoric and Composition
Advisor: Ann M. Penrose

Preparing Students across Ability Levels for College Level Writing: An Application of the Toulmin Model to Arguing about Literature

In a society in which college education has become almost a prerequisite for social, political, and economic success, strategies for equipping students at all ability levels to communicate logically, coherently, and persuasively are essential. A review of composition research reveals inequities in secondary English instruction, suggesting that some students receive instruction more closely aligned with college-level writing expectations than others. Whereas lower-track students are frequently assigned personal writing, higher-track students more often engage in argumentative and analytical writing tasks. This problem is complicated by the fact that the challenge to find time for teaching both literature and composition continues to be a practical reality of the secondary English curriculum.

This research examines how explicit instruction using Stephen Toulmin's 1958 model for argumentation influences the abilities of twelfth-grade students across three ability levels (AP, Honors, and College Preparatory) to generate effective argumentative essays about literature. For this study, a four-week unit providing explicit instruction in the Toulmin model and using the model as a framework to guide class discussion about literary texts was used as the experimental treatment. A pretest-posttest design required students in three twelfth-grade classes (n=66) to generate arguments about complex literary texts. Gain scores were used to determine improvement in argumentative writing, and fine-grained analysis of a subset of purposively selected essays was used to determine the relationship between the Toulmin model and effective argumentative texts. Preliminary results using a holistic measure of persuasive arguments about literature suggest that the experimental treatment resulted in improvement across ability levels, with the largest gain among students at the Honors level.

Sarah McKone
Graduate Program: English, Technical Communication
Advisors: Stan Dicks and Jason Swarts

Characteristics of Digital Classrooms: Researching Parallel Themes in the Active Learning Debate and Distance Education Theory

As higher education moves from traditional classrooms to virtual ones, educators are adapting in order to accommodate an online classroom environment. The debate about successful methodologies in online courses echoes themes of a still-relevant instructional theory from the late twentieth century: Active Learning. As voices from the active learning debate began to question some of higher education's long-standing pedagogical practices, many argued that the new classroom techniques disrupted professors' leadership roles within the classroom. This argument has been voiced again today by professors who are leery of the fast-approaching online environment.

Principles of active learning theory are now widely accepted and utilized in post-secondary traditional courses because they effectively improve students' understanding of course material. However, as I will demonstrate, active learning principles are just as

important in online courses and can be implemented within them through instructional technologies. By first reviewing current literature about both active learning and distance education theory, this project attempts to respond to the following research questions: In what ways can professors enhance the impact of their role in online classroom environments? How can professors utilize their role in the online classroom environment to foster and encourage active learning?

The crux of the research demonstrates that when instructors move traditional courses into distance education environments, they are most successful after devoting time to: considering the many factors of online education; determining the best media for the environment; and, developing classroom instruction within the online course that encourages students, suits the course material, and fosters active learning. As will be demonstrated, these successful instruction designs implement theories that are parallel to those originating decades ago through the active learning debate; importantly, principles from active learning theory need to be considered during the development of an online course.

David Mirfin, Jr.
Graduate Program: Communication
Advisor: Craig A. Smith

A Tale Of Two Bushes: The Iraq War Arguments of George H. W. Bush and George W. Bush

This paper is a rhetorical analysis of both President George H. W. Bush and George W. Bush, dealing specifically with their wartime speeches during the Persian Gulf War and the Iraq War. This paper looks at the styles of each of the Presidents Bush, as well as their speechwriting teams. It moves into how both Presidents used either the atonement or simulated atonement strategies in order to sell their particular war to the American people. It also looks at how each of them created their enemies to further the war in another attempt to have the support of the citizens.

Rachel L. Nice
Graduate Program: School Psychology
Advisor: Mary E. Haskett

The Relation between Parenting Behavior and Self-Regulation among Maltreated Children

Children with a history of maltreatment are likely to display a host of negative social, academic, and mental health outcomes; however, some children are resilient despite a history of maltreatment. One process that may lead to positive outcomes for some maltreated children is appropriate self-regulation of behavior and emotion. Studies of non-maltreated children indicate that sensitive, positive parenting plays an important role in the socialization of self-regulation skills, but the association between parenting and self-regulation among maltreated children is unclear. The current study sought to clarify this association by investigating parenting behaviors and child self-regulation in a sample of eighty-six 4- to 7-year-old maltreated children and their parents. Parenting measures included parent-child interactions coded for sensitivity, intrusiveness, positive regard for the child, and negative regard for the child. Child self-regulation was measured using teachers' ratings of three domains of behavioral self-regulation (inhibition of inappropriate behavior, successful shifting between situations, and emotion-related self-regulation) on the Behavior Rating Inventory of Executive Function (Gioia, Isquith, Guy, & Kenworthy, 2000). Initial findings indicated that overall parenting quality was significantly related to some aspects of self-regulation, but not to others. Further analysis will determine whether the strength of this association is age-related. Although further research is necessary to clarify the causal nature of these links, results may suggest that despite a history of abuse, positive parenting behaviors in abusive families may play a role in their children developing appropriate self-regulation skills in the early school setting. This line of research may help to identify effective components of existing and future interventions for this population.

Adrianne M. Offenbecker and D. Troy Case
Graduate Program: Anthropology
Advisor: D. Troy Case

Accessory Navicular: A Heritable Accessory Bone of the Human Foot

The accessory navicular is a supernumerary bone of the human foot located medial to the navicular tuberosity. It represents a secondary center of ossification that has failed to fuse to the main body of the navicular. Three forms of the accessory bone have been identified: type I is an independent ossicle that is often embedded within the tibialis posterior tendon; type II is a triangular accessory bone that attaches to the navicular tuberosity by means of a cartilaginous or fibrocartilaginous bridge; and type III represents a fused type II, which forms a hook-like protuberance extending from the tuberosity. The type II accessory navicular is the most common of the three forms and is the most readily identifiable in skeletal material since it causes the navicular tuberosity to become abnormally flattened and porous. The purpose of this study was to determine the frequency of this congenital defect among various populations and to assess its utility in identifying probable relatives in archaeological cemeteries. In total, the skeletons of 497 Danes, 460 Euro-Americans, 300 African Americans, 100 Japanese, and 205 Europeans were examined for the presence of the type II accessory navicular. The frequencies for the four groups were statistically indistinguishable from one another,

ranging from 2% in the African-American sample to 5% in the Japanese sample. Since several family pedigrees have documented the accessory navicular as being an inherited skeletal defect, the relatively low frequency found in the present study makes this trait a potential indicator of intracemetery genetic relatedness.

Seb M. Prohn[1], Julie Grossman[2], Suzie Goodell[3]
Graduate Programs: Psychology[1]; Soil Science [2]; Food, Bioprocessing, and Nutrition Sciences[3]
Advisor: Craig C. Brookins

Convergence & Contradiction: Assessing Community Garden & Community Nutrition Service-Learning Experiences Through a Mixed Methods Approach

Constrained by time and a nascent understanding of evaluation, service learning measurement has often been dictated by relatively crude designs and discrete methods. As a consequence there has been a dearth, especially in the applied sciences, of systematic evidence tracking students' service-learning experiences. This research aimed to explore assessment alternatives by tracking students from two N.C. State service-learning courses that focused on community gardening and nutrition education in low-income Raleigh, NC neighborhoods. Researchers sought to increase understanding of the effects of service-learning experiences by using questionnaires, focus groups, field observations, personal reflections and a quasi-experimental design. Beyond studying students' civic, social and psychological growth, researchers examined how the 'reality' of reported service-learning experiences was mediated by the context under which data was collected. Preliminary examinations of several psycho-social indicators, showed no significant change over multiple time points within and between treatment and control groups. However, qualitative data suggested service-learning students were substantially impacted by their memorable experiences. The convergence and contradictions of the mixed methods data helped researchers better understand the complexity of service-learning experiences and provided detailed feedback to guide future restructuring of service-learning courses in the applied sciences.

Jennifer Spellmeyer
Graduate Program: Social Work
Advisor: Willa Casstevens

The Effectiveness of Networking Processes for Establishing Sustainable Health and Wellness Resources for the Psychiatric Clubhouse Setting

The research reported here is part of a larger project still in process. The aim of the larger project is to create sustainable health and wellness programming within psychiatric Clubhouse facilities in the Triangle area. Clubhouse programs are relatively small non-profit agencies designed to provide community membership and psychosocial rehabilitation to adults diagnosed with severe and persistent mental disorders. Many individuals with these diagnoses also experience physical challenges. It therefore becomes especially important for these individuals to adopt healthy lifestyles. The research reported here explored the effectiveness of the networking processes utilized to establish resources for achieving identified health and wellness project goals. The networking processes used included phone calls, emails, referrals, in-person contact, and in-person follow-up. Effectiveness was determined by whether resources were ongoing, as demonstrated by initial success in establishing the link, member participation, and whether the resource was accessible for continued or future use. It was found that the most successful process for locating and establishing resources was a combination approach: phone calls that were followed by emails or phone-calls made up the most successful approaches; emails or in-person contacts, when used independently, were the least successful.

Meghnaa Tallapragada
Graduate Program: Communication
Advisor: William J. Kinsella

Public engagement in developing countries: A proposal for engagement for nanotechnology in water purification

Water crisis is one of the pressing issues the world is dealing with today. The death toll among people, particularly children, and for various water-bound creatures due to water contamination is alarming. It has become natural to turn to science and technology to help solve all our problems. Nanotechnology, a relatively new field, is offering effective and more efficient methods of purifying water in comparison to the already existing filtration systems. However, this nouveau technology brings with it a bundle of risks and uncertainties. On one hand the world is suffering with high levels of water contamination resulting in disturbing situations; on the other hand science and technology are offering a potential helping hand with nanotechnology which is bound with certain qualms. If nanotechnology is to be considered in order to help the current situation then public engagement is a vital process that needs to be addressed. The most affected areas that are suffering from water contamination are rural areas in developing countries. This paper develops a public engagement model after reviewing literature on collaborative deliberative processes and counter publics theory. This model is an application of Western theories modified to suit non-Western developing nations. The model has been specifically designed keeping in view the water contamination crisis in Bangladesh, but it has the potential to be extended to rural areas in other developing countries as well.

Jenny Vojtko
Graduate Program: Spanish Language and Linguistics
Advisor: Jim Michnowicz

Spanish Language Maintenance and Shift in Raleigh, North Carolina

Due to a 595% increase in the Hispanic population between 1990-2005 (Lacy 2007), Raleigh, North Carolina provides a good location to analyze Spanish language maintenance and shift. Previous studies have shown that positive attitudes toward the minority language may lead to language maintenance whereas a negative association between the minority language and social factors will lead toward language shift (Fishman 1966, Sexton 2000). The goal of the present study is to examine the attitudes held by Hispanic immigrants toward Spanish and English in an attempt to determine the extent of Spanish language maintenance or shift to English. The researcher administered 91 two-part surveys to Hispanics in Raleigh. First, the participants rated 30 statements regarding their attitudes toward Spanish and English on a 5-point Likert scale. Secondly, the informants selected their main reasons for speaking Spanish from a set of twelve possible options which correspond to four sociolinguistic dimensions (communicative, instrumental, sentimental and language loyalty). Additionally, each informant provided personal demographic data including age, gender, length of time in the U.S, occupation, language use, marriage to a Hispanic, and an open question about what it means to be Hispanic. Preliminary results show that the informants' responses are mostly neutral, with some shift to English in progress combined with continued maintenance of Spanish. Informants are primarily using Spanish in the public domain to communicate with friends and family and many want to maintain their culture and not forget their language, but they also want their children to speak English fluently. Further analysis of the demographic variables above will determine the role that each plays in language maintenance and shift.

Yuanjing Wang and Adriana de Souza e Silva
Graduate Program: Communication
Advisor: Adriana de Souza e Silva

Towards a Global View of Network Locality

Network locality (Gordon & de Souza e Silva, 2009) is a concept that addresses how being connected to the Internet actually increases an individual's awareness of localities, and connections to physical spaces. For example, now with the aid of GPS-enabled phones and mapping interfaces, it is possible to find place specific information and to locate people nearby. We call these devices and software that allow us to embed local knowledge and information into digital networks net-local interfaces. This paper explores the social and cultural appropriation of net-local interfaces in the context of East Asian countries, such as China, Japan and South Korea. Within this context, we explore three types of net-local interfaces: location-aware phones, mapping software and other interfaces utilized for civic and political engagement. This paper is part of the forthcoming book *Network Locality: How digital networks create a culture of location*, co-authored by Eric Gordon and Adriana de Souza e Silva (Blackwell Publishing, 2011).

Jaymi Allen, Nisha Keskar, Daniel Pietrzak, and Debra Rezeli
Graduate Program: Business Administration
Advisor: Sangkil Moon

Recommendations for Increasing Member Participation: North Carolina League of Municipalities

Concerned with member defection, The North Carolina League of Municipalities (NCLM) determined a need to establish a deeper understanding of its membership participation habits and programmatic needs. Analysis using secondary data was conducted to derive correlations and segmentations among member demographics, participation and various other factors. Results showed four segmented groups allowing for the identification of members most likely to defect. However due to limited data availability, other analytical models proved to be less than significant. The team concluded further analysis of NCLM members could only be done by methodically collecting targeted information. Based on the team's recommendation, NCLM initiated an internal marketing research project conducting three, member panel interviews. The team continued these same member panels using a sample demographic of 12 NCLM members and focused questions on: General Membership, Programs and Events. Focusing on the panel topics and results, the team constructed a targeted survey questionnaire. Utilizing 82 sets of data, the team's analysis yielded three recommendations for NCLM: hiring additional field representatives, targeted marketing, and the creation of customized plans for NCLM members. These recommendations will ensure: growth of member participation in all programs, member retention and NCLM ability to have a sustainable fiscal future.

Michael Bailey and Subramani Yetur
Graduate Program: Business Administration
Advisor: Jeffrey S. Stonebraker

Development and Piloting of a Should-Cost Model for Full Truck Load Goods Movement for American Airlines

American Airlines (AA), a subsidiary of the AMR Corporation, is the world's largest airline in passenger miles transported. Though its goal is passenger transportation, AA must support itself with ancillary functions not related its core business. One of these includes freight shipping maintenance equipment and in-flight service items for passengers. At any given time the system inventory for these goods can reach over $1 billion, creating a web of complexity as goods move point-to-point worldwide. The Supply Chain Resource Cooperative at North Carolina State University was presented with an opportunity by AA to explore the costs associated with its full truckload (FTL) freight movement in the United States. The FTL point-to-point shipments are often with contracted carriers, but sometimes on a spot basis. A should-cost FTL model to assess bid quotes for its point-to-point freight shipments considering various cost drivers was the core objective of the project. In the process, we: researched the long-haul trucking industry, collected data on the cost factors that trucking companies consider when submitting FTL shipping bids, developed, implemented, and field tested the model. Long haul trucking service is provided by companies of varying sizes like: large trucking company, independent owner/operator, small trucking firm. The model thus developed factored in all these parameters and as many as 37 cost drivers as researched by the team. The model was field tested by AA with real time data, and modifications to the model were done in an iterative process to accommodate all the user acceptance features. The should-cost FTL model provides a detailed cost breakdown in per mile increments and will be employed during the bid process to ensure AA does not overpay or underpay its FTL suppliers.

L. Savanna Farris and Roby B. Sawyers
Graduate Program: Accounting
Advisor: Roby B. Sawyers

Indexing Income Taxes for Inflation in North Carolina

With inflation, the purchase price of commodities increases over time. Absent a consideration of income taxes, if taxable income increases at the same rate of inflation, real purchasing power does not change. However, if income tax rate brackets, and standard deduction and exemption amounts remain static and are not adjusted for inflation, real purchasing power decreases over time.

While the federal government has adjusted tax brackets, standard deductions and exemption amounts for inflation for over 20 years, many states (including North Carolina) have not, resulting in hidden tax hikes on many taxpayers. This study examines the impact on North Carolina taxpayers of not indexing for inflation the North Carolina standard deduction, personal exemption and tax brackets.

Using the federal indexing rules as a model, annual inflation adjustments were made using changes in the Consumer Price Index for All-Urban Consumers issued by the Bureau of Labor Statistics. An inflation adjustment factor was calculated and applied to North Carolina's standard deduction, personal exemption, and tax brackets.

The results show the dramatic impact of North Carolina's policy. In 1989, the combined standard deduction and personal exemptions for a married couple with two children was $13,000. Due to statutory changes, the North Carolina amounts had increased to $16,000 by 2009. However, had the 1989 amounts been indexed for inflation, the combined amounts would have equaled $22,700.

As an example of the impact, in 1989 a North Carolina family of four with taxable income at the federal poverty level ($12,674) would have paid no North Carolina income tax. By 2008, that same family of four earning poverty level income of $22,025 would have faced a North Carolina tax bill of $402. Had North Carolina indexed its standard deduction and exemption amounts, no tax would have been due.

Matthew Kutch
Graduate Program: Economics
Advisor: Alvin E. Headen, Jr.

Are Complementary and Alternative Medicines Cost-Effective in Treating Common Mental Health Disorders? A Survey Approach

Using survey data, this study produces estimates of incremental cost-effectiveness ratios and measures of uncertainty, regarding use of complementary and alternative medicine (CAM) combined with traditional therapies (pharmacotherapy and/or psychotherapy) in the treatment of five common mental health disorders. BACKGROUND: A recent, large-scale nationally representative survey estimated the 12-month prevalence for any mental health disorder at over 25% of the adult population (Kessler et al., 2005). Traditional therapies include both psychotherapy and pharmacotherapy. Past studies indicate that patients with mental health disorders use complementary and alternative medicines, such as acupuncture, chiropractics, herbal remedies, massage therapy, homeopathy, energy healing, and biofeedback, at a greater rate than the general population. Unlike past cost-effectiveness analyses that use either a narrow definition of CAM or randomized controlled trials, this study uses a broad definition of CAM and

survey data. A secondary question is how well this self-reported survey data produces cost-effectiveness analysis results for CAM. METHODS: This study uses the Medical Expenditure Panel Survey (MEPS), a panel survey of medical use, expenditure, and health status for the civilian noninstitutionalized U.S. population. The primary measures of effect are based on self-perceived mental health status. Cost-effectiveness is determined by estimation of the incremental cost-effectiveness ratios and construction of bootstrapped cost-effectiveness acceptability curves. The incremental net benefit method is estimated to control for differences in demographic groups. RESULTS AND DISCUSSION: The evidence suggests complementary and alternative medicine is cost-effective for a range of values of effect for some mental health disorders. Differences in cost-effectiveness by demographic subgroups can be masked by the aggregate incremental cost-effectiveness ratio. CONCLUSION: Complementary and alternative medicine is a cost-effective additional treatment for some common mental health disorders. Notwithstanding the issue of sample self-selection, survey data provide another type of data that policy-makers can use to inform decisions regarding adoption of new treatments.

Feng Qiu, Jean-Philippe Gervais, and Barry Goodwin
Graduate Program: Agricultural and Resource Economics
Advisor: Barry Goodwin and Jean-Philippe Gervais

An Empirical Investigation of the Impacts of Government Program Payments on Farmland Rental Rates

We rely on the ARMS data to construct an appropriate rental rate for three different types of leasing arrangements (cash rental, share, and hybrid). Unlike previous studies which focused strictly on cash rents, we focus on pure rents and propose a consistent and efficient estimation of the impacts of various government programs on farmland rental rates. The data used in this study come from three sources: the 2002-2007 ARMS dataset, the 1988-2007 Regional Economic Information Systems (REIS), and unpublished county level government program payments from the United States Department of Agriculture (USDA) over the 1998-2007 period. The empirical analysis is based on the income approach which estimates the farmland rental rates on current values of various streams of cash flows; i.e. considering the net returns from market and different types of government subsidies. The empirical procedure corrects for selection issues that are documented in Qiu, Goodwin, and Gervais (2009). Six farm programs are evaluated in this study. They are Direct Decoupled Payments (DDP), Agricultural Disaster Payments, Loan Deficiency Payments (LDP), payments under the Conservation Reserve Program (CRP), the Market Loss Assistance payments (MLA), and a final category including all other payments. The preliminary empirical results confirm that government support programs have significant impacts on rental rates and the effects vary by types of subsidies and leasing arrangements. For example, the DDPs have large positive effects on all three types of rents, while the disaster payments have negative impacts on the cash rentals. Given the increased reliance on contracting in agriculture and the complex mix of leasing arrangements that is emerging in US agriculture, this study should appeal to policy makers that try to understand the impacts of government programs on the organization of markets.

Ruirui Sun
Graduate Program: Economics
Advisors: Robert Clark and Melinda Morrill

Education Level, Financial Knowledge, and Resources of Advice: Different Roles and Impacts in Retirement Planning

In wealth accumulation models, workers aim to maximize discounted lifetime utility and keep savings from current work to sustain their life after retirement. Besides personal savings, pensions and social security are also sources of income after retirement. In order for workers to make retirement plans, their financial knowledge, along with the understanding of employer-provided plans and advice gained from multiple sources, is essential. Furthermore, as have been illustrated in many previous studies (e.g., Mitchell, Utkus, 2003; Bernheim, Garrett, Maki, 2000), education level is positively correlated with and somehow effective in adequate retirement planning and preparedness. However, it is unclear whether there exist casual relationships among financial knowledge, education level, and actual retirement planning.

Samples from three large companies of retiring employees who attended pre-retirement seminars are analyzed. The results so far show the importance of financial knowledge while making retirement plans. I compare the characteristics of employees with different levels of “comfort” towards their own retirement plans. However, the influence of education level on retirement planning remains insignificant in the data, yet it appears to be contributive on post-seminar financial score. There are also regression models presented to test the relationships between financial scores and employees’ degree of comfort with their retirement plans. Finally, combined with the results of employees’ commonly-used sources of advice, I am working to develop behavior economic theorems to explain how employees use their knowledge and social relations in planning (or not planning) for retirement.

Cengiz Tunc
Graduate Program: Economics
Advisor: Denis Pelletier

Life Cycle Portfolio Allocation: Constant Relative Risk Aversion vs. Epstein-Zin Recursive Preferences

The main idea of this research is to compare and assess the performance of two utility functions in a life cycle macroeconomic model. In a realistically calibrated life cycle model, households decide initially on consumption and then on the allocation of their remaining wealth in both risk-free bond market and risky stock market. In this life cycle model setup, I will specifically compare and contrast intensively used Constant Relative Risk Aversion (CRRA) with Epstein-Zin (EZ) type recursive preferences. Although intensively used in economics, CRRA utility function assumes that relative risk aversion (RRA) is the inverse of the elasticity of intertemporal substitution (EIS). However, risk aversion gives information about how households deal with uncertainty across possible states of the world while EIS is about mere time preferences. EZ type recursive preferences, on the other hand, disentangle RRA from EIS.

Another goal of the paper is to analyze the behavior of households when I introduced a bequest motive. I will analyze the life cycle consumption and asset allocations decisions of households when they have a strong willingness to bequest their wealth to their inheritors at the terminal period of the life cycle. Using a simple bequest motive structure as in Gomes and Michaleides (*Journal of Finance*, 2004), I will show how the bequest function shapes the households decisions on allocation of wealth to financial assets while making a special emphasize on the performances of CRRA and EZ utility functions.

C.J. Anderson[1], M.N. Peterson[1], D. Cobb[1], E. Sills[2], and H. Bondell[3]
Graduate Programs: Fisheries and Wildlife Sciences[1]; Forestry and Environmental Resources[2], Statistics[3]
Advisor: M. Nils Peterson

Assessing Willingness of North Carolina Hunters and Anglers to Increase License Fees

A significant portion of funding for many state wildlife management agencies is generated by hunting and fishing licenses. Since the 1930s, the consumer price index has increased twice as fast as the price of hunting and fishing licenses in many states including North Carolina. The North Carolina Wildlife Resources Commission (NCWRC) is evaluating options to increase license revenue without greatly decreasing the number of hunters and anglers willing to purchase licenses. As a component of this evaluation, we conducted a mail survey of 3,000 randomly selected North Carolina hunting and fishing license holders (March and April, 2009). We had a 34% (n = 844) adjusted response rate. Using contingent valuation, we found that any increase in license fees would result in at least a 20% decrease in number of sportsmen willing to purchase a license and result in revenue loss. Based on our respondents' willingness to pay fee increases, increasing the Sportsman License and Comprehensive Inland Fishing License by $15 and the State Inland Fishing License by $10 would decrease revenue from these three licenses by $4,023.162. After addressing strategic bias, the same fee increases generated $3,300,712 in additional revenue. Over 80% of respondents were willing to pay a $5 increase however only 64.1% felt it would be fair; other fee increases yielded similar results. Restoration of depleted fish and wildlife populations were the most popular justifications for fee increases. Results will assist the NCWRC in proposing fee structure changes in future legislative sessions.

Carrie E. Banks
Graduate Program: Parks, Recreation and Tourism Management
Advisors: Yu-Fai Leung, Stacy Tomas, and Samantha Rozier Rich

Disentangling the Influence of Community and Place Attachment on Resident Attitudes toward Tourism Development

While a wealth of research examining residents' attitude toward tourism exists, relatively little has been conducted with respect to attitudes and residents' attachment to their community. Exploring the possible links between resident attachment and attitude toward tourism may hold the key to understanding the antecedents of resident attitude. The purpose of this research was to explore the concepts of community attachment (attachment to social ties and relationships) and place attachment (attachment to the physical landscape) as they relate to one another and effect resident attitudes toward tourism development. Using Ashe County, NC as a study area, a 47-item intercept survey was used to explore attachment and attitudes. The survey measured three main constructs: community attachment, place attachment and resident attitude toward tourism development. The data were collected in summer 2009. An exploratory factor analysis of the attachment items reduced into two dimensions: community attachment and place attachment. Subsequent Pearson Correlation tests found significant correlation between the two types of attachment. In addition, community attachment and place attachment were significantly correlated with resident attitudes toward tourism, especially in the areas of economic benefit and urbanization or overcrowding. For example, residents with higher levels of both community attachment and place attachment were more likely to agree that tourism was causing overcrowding in their community. Finally, a resident's percent of life lived in the study area was found to be a statistically significant predictor of community attachment and 11 of 13 resident attitude items. Successfully disentangling community attachment from place attachment, allowed this study to gain insights into how each type of attachment influences resident attitudes toward tourism.

David K. Barker[1], Steven E. McKeand[1], Ross W. Whetten[1], Fikret Isik[1], and Sunkyu Park[2]
Graduate Programs: Forestry and Environmental Resources[1]; Wood and Paper Science[2]
Advisor: Steven E. McKeand

Genetic Potential of Loblolly Pine for Hydrolytic Conversion to Ethanol

The development of alternative fuels can help to alleviate environmental issues such as air pollution and can reduce the dependency on fossil fuels. Ethanol is one such alternative fuel, and it can be made from a variety of feedstocks including woody plant matter (i.e., lignocellulosic biomass). To date, corn has been the main feedstock supplying production facilities, but it is not an ideal resource for fuel production because of its status as an important food crop. Woody plant matter is a viable alternative as it is widely available and is not a staple food.

As the most productive tree species in the southern US, loblolly pine (*Pinus taeda* L.) has great potential as a feedstock species for ethanol production, but production of ethanol from loblolly pine wood is challenging. Many different chemical and physical wood properties are genetically controlled traits, and variation in properties affecting ethanol production may exist. Currently, 23 clonal varieties of loblolly pine, selected for a diverse range of chemical/wood properties, are being converted into ethanol via enzymatic hydrolysis. Preliminary results are encouraging. The best clone out of ten already tested with a dilute acid pretreatment yielded almost 13% more sugar per gram than the average. These sugars once released can be fermented to create ethanol. This variation in sugar yields among pine varieties suggests there are significant genetic differences that can be used to improve conversion to ethanol.

Kevin Bigsby
Graduate Program: Forestry and Environmental Resources
Advisor: Melissa McHale

A Spatially Explicit Analysis of CO_2 Sequestration Across Cities, Lifestyles, and Socioeconomic Groups

Recently, for the first time in earth's history the population of urban areas surpassed rural populations. Urban areas are beginning to be understood as distinct ecosystems that are distinguishable from natural ecosystems because they include not only biophysical inputs, but also the actions of individuals and institutions; both of which influence ecosystem processes. Although they comprise only 2.4% of the earth's terrestrial surface, urban areas contribute to 80% of global CO_2 emissions. Because there is increasing social and market demand to account for carbon pools and fluxes I explore the relationship between the spatial pattern of CO_2 sequestration in Raleigh, Durham, and Chapel Hill, NC and the affect socioeconomic groups, lifestyle indicators, and biophysical variables have on this process. A spatially explicit representation of carbon sequestration is created by regressing carbon sequestration values derived from Urban Forest Effects Model survey plots against high resolution land cover classification and interpolating across the study area. The carbon sequestration values, socioeconomic variables (e.g., household income, house age, ethnicity, etc.), lifestyle indicators (PRIZM market segments), and biophysical variables (e.g., elevation, aspect, rainfall, etc.) are analyzed in a multivariate framework controlling for various confounding factors to identify the drivers of this system. The results contribute to the theory of urban ecology by allowing comparisons to be made about an ecosystem process across cities, socioeconomic groups, and lifestyles groups. The results also provide insight into the impact of development on carbon pools and fluxes along the urban rural interface to aid policies directed toward minimizing ecological impacts as urban areas continue to expand.

Emily B. Blackman, Christopher S. DePerno, Christopher E. Moorman, and M. Nils Peterson
Graduate Program: Fisheries and Wildlife Science
Advisors: Christopher S. DePerno, Ron W. Heiniger, Christopher E. Moorman, and M. Nils Peterson

Agricultural Wintering Habitat as a Limiting Factor for American Woodcock in the Southeast: Thirty Years of Agroecosystem Change

American woodcock (*Scolopax minor*) are a species of concern because of the long term annual decrease in their population. On the wintering grounds, woodcock commonly forage for earthworms in crop fields at night; recent changes in agricultural practices may have contributed to population declines. Our objectives were to: 1) determine nocturnal winter habitat use across different field types; 2) compare soil health and earthworm abundance across different field types; and 3) compare current woodcock use of no-till agromanagement systems with historical use of bed and furrow agroecosystems in eastern North Carolina. We surveyed woodcock in 72 fields; field types included no-till soybean (n=35), winter wheat (n=14), disked corn (n=9), corn with standing stalks (n=6), conventionally tilled soybean (n=3) and cotton (n=3). In 30 of the same fields we collected soil and earthworm samples. Soil samples were analyzed for nitrate content, percent organic matter, and pH, and earthworms were tallied by species. Woodcock used corn fields with standing stalks and no-till soybean fields more frequently than other field types. More earthworms were detected in no-till and conventionally tilled soybean fields than in other field types. Woodcock may use corn fields with standing stalks for cover from predators and weather and no-till soybean fields because of the relatively high abundance of earthworms. Future work includes additional analysis of soil health data to provide further insights into woodcock winter habitat use. We will repeat nocturnal

woodcock surveys and soil and earthworm collection, capture and band woodcock, and attach radio transmitters to verify nocturnal habitat use and assess diurnal habitat use.

M. Colter Chitwood, Christopher S. DePerno, and Suzanne Kennedy-Stoskopf
Graduate Program: Fisheries and Wildlife Sciences
Advisor: Christopher S. DePerno

Physiological analysis of white-tailed deer in coastal North Carolina

Generally, deer management focuses on population-level parameters (e.g., abundance, sex ratios), but popularity of Quality Deer Management has elevated interest in individual-level health parameters (e.g., kidney fat, body weight, serum analysis). Measures of health can be used by state agencies, private managers, and hunters to determine the success or failure of management strategies. In coastal North Carolina, information about the health of deer is lacking. In July 2008 and March 2009, we collected 60 female white-tailed deer from a 78,000-acre pocosin forest managed intensively for timber and hunted almost exclusively with dogs. Blood was collected via cardiac puncture and analyzed for standard serum chemistries, fructosamine, and emerging tick-borne diseases. Also, we obtained spleen and adrenal gland weights, kidney fat index (KFI), femur marrow fat index (MFI), and abomasal parasite count (APC). Serum chemistries were within expected ranges with the exception of potassium, which was high. Fructosamine was a good indicator of glucose regulation. Levels of KFI and MFI were poor-to-fair depending on the sampling period. Spleen and adrenal gland weights were similar between periods and APC was low in both periods. Three deer from the July sample tested positive for *Bartonella vinsonii berkhoffii*, a strain associated with dogs and previously unreported in white-tailed deer. Our results create baseline data for physiological condition of white-tailed deer in coastal North Carolina and indicate that deer in this habitat are healthy but live lower on the relative health scale than deer from more productive habitats.

Yekaterina Kuntukova[1] and Chris Dreps[2]
Graduate Programs: Natural Resources[1]; Forestry and Environmental Resources[2]
Advisor: April James

Comparing Slate Belt and Triassic Basin reference hydrologic conditions for headwaters of the Neuse River Basin

Recent literature demonstrates the need for a broad-scale classification of catchments to explain variation of hydrologic regimes across the landscape. Examination of catchment similarities and differences is especially relevant for the Piedmont region of North Carolina where reference hydrologic conditions remain undefined and significant differences in landscape characterization exist. Our research focuses on identifying and contrasting factors such as bedrock geology, soil type, and topography that control hydrological processes at two headwater catchments in the Piedmont region of North Carolina, one within the Carolina Slate Belt and the other within the Triassic Basin geologic region. Although located only 5 miles apart, with the same climate and similar mixed pine-hardwood vegetation, observations of stream flow, soil moisture, and shallow groundwater indicate that the two watersheds have very different hydrologic regimes. The objectives of this study are i) to quantify the differences in the hydrologic regimes and ii) to illustrate key differences in catchment characterization (e.g. geology, soils, topography, and drainage network). In this poster, we compare the hydrologic regimes of each watershed analyzing monthly water balances, soil moisture profile dynamics, saturated hydraulic conductivity, and storm-event hydrologic response. Initial analyses show that the watersheds store and release water in very different ways. Surface hydrology appears strongly controlled by shallow clay layers in the Umstead Farms (Triassic) site, while topography and bedrock appear to play a greater role in generating flow in the Hill Forest (Slate Belt) catchment. This research has significant and timely implications for stormwater management in the Falls Lake Reservoir, which currently fails to meet federal standards for nutrients and sediment. Innovative stormwater management techniques attempt improve stream water quality and restore “pre-development hydrologic conditions” on developed sites. Catchment classification framework analyses can help water resource managers identify the dominant factors that influence hydrologic processes at the local scale.

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

Micromechanical modeling of the cell wall of genetically modified aspen (*Populus tremuloides)* wood

Genetically modified trees offer a unique opportunity to investigate the effect of chemical composition on the hygro-mechanical properties of the gross wood and the wood cell wall. Extensive evaluation of the various micro- and macro-mechanical properties of genetically modified aspen (*Populus tremuloides*) wood was carried out and severe reduction in both the ultimate compression strength and the modulus of elasticity was found for the genetic group with reduced lignin content compared to a control (wild type quaking aspen). The degree of reduction could not be explained by the differences in morphological, physical, and structural properties including cell size, cell wall thickness, cell wall density, microfibril angle, etc. Therefore, a three-dimensional finite element model was developed to assess the effect of the three major chemical components (cellulose, hemicelluloses, and lignin) on the micromechanical properties. A two-step homogenization approach was used to link the microstructure and composition to the

macro-mechanical properties. During the first step, a representative volume element was developed that provided homogeneous properties to each cell wall layer by incorporating the effect of varying microfibril angle and chemical composition. The cell wall layers were then homogenized to obtain a uniform cell property. Afterwards, the cells were embedded in a matrix material (compound middle lamella) and were used for the macro-mechanical modeling. Two scenarios were tested: 1. the reduction in lignin content enhanced the hydrophilicity of the hemicelluloses by reducing the elastic properties of the matrix, and 2. the elastic properties of the compound middle lamella were reduced, allowing for greater flexibility to the layer. The results revealed that the chemical composition has significant effect on the hygroelastic properties of genetically modified aspen wood with reduced lignin content.

Yari Johnson
Graduate Program: Forestry
Advisor: Theodore H. Shear

Improving wetland restoration with help from North Carolina's natural forested wetlands

Wetland restoration projects across the United States are failing. Restored sites commonly lack the species and hydrology of the targeted community being restored. A better understanding of natural wetlands would help restoration project designers achieve community composition and hydrologic regimes that more closely resemble natural conditions. I investigated two different methods to identify patterns in hydrologic regime useful to restoration design. The first method was based on success criteria commonly used by North Carolina wetland mitigation projects. The second method was based on The Nature Conservancy's Indicators of Hydrologic Alteration. In order to test these two methods, I collected hydrologic and compositional data across the natural variation of nonriverine wet hardwood forest stands, a rare wetland community type commonly restored in North Carolina. My results show that hydrologic parameters from the first method, based on current success criteria used in North Carolina, are not related to community composition. Hydrologic parameters from the second method, *e.g.* the maximum water table level over a 3-day span, explained much of the variation in nonriverine wet hardwood forest community composition. My results found that clear relationships do exist between hydrologic regime and community composition. Hydrologic parameters that are related to community composition need to be used as success criteria in future restoration designs. This will ensure that projects establish the appropriate hydrologic regime necessary to foster the desired wetland community type.

Christopher D. Kollar and Yu-Fai Leung
Graduate Program: Parks, Recreation and Tourism
Advisor: Yu-Fai Leung

Mountain Biking's Demand for Challenge: Assessing Technical Trail Features and Their Impacts

Mountain biking, with an estimated population of 50 million, has recently developed into one of the predominate outdoor recreation activities in the United States. Mountain bikers are using trails and parks whether or not managers are ready for their associated impacts. Research on the impacts of mountain biking is very limited hence frameworks for managing mountain bike use are non-existent. This study focuses on the assessment of technical trail features found in parks designed for mountain bike use. Technical trail features are natural or foreign objects that are found in parks to provide varying levels of challenge to mountain bike users. Legend Park, a city park found in Clayton, NC was used as the research site due to its array of natural and built technical trail features and its popularity amongst Triangle area mountain bikers. The 8.1 mile trail system was spatially measured using the Garmin Oregon 550 GPS unit. Every technical trail feature was photographed, geotagged and plotted on Google Earth using Garmin Waypoint Manager software. Due to the lack of existing frameworks, a feature identification guide, field assessment guide, and protocol were developed specifically to measure impacts related to the presence of technical trail features. Also, a Circular Observation Zone (COZ) model was designed specifically for technical trail feature assessment. The overall assessment was divided into two sections. The first measured physical characteristics, safety and managerial concerns of the features themselves. The second measured environmental impacts caused by the features within the COZ. Information from this study could provide management a way to monitor and assess the impacts of technical trail features in parks and other recreation areas. Differences between natural, built and enhanced trail features may provide insight into developing more environmentally sustainable trail features to the benefit or riders and park resources. The protocol developed in this study could be used as a framework for future mountain bike research not only in the United States but throughout the world.

Joelle M. Laing and Theodore H. Shear
Graduate Program: Forestry and Environmental Resources
Advisor: Theodore H. Shear

Massive Wind Damage in the Great Dismal Swamp: How Do We Manage for Atlantic White Cedar Recovery?

In September 2003 Hurricane Isabel swept through eastern North Carolina and Virginia, destroying most of what formerly ranked among the most extensive remaining stands of Chamaecyparis thyoides (Atlantic White-cedar, cedar). As Atlantic White-cedar

communities are dependent on irregular, large-scale disturbances, the hurricane event can be viewed as an opportunity for perpetuating cedar populations in the Great Dismal Swamp. However, the success of cedar regeneration in the Dismal Swamp has been influenced by the management strategies employed by Great Dismal Swamp National Wildlife Refuge (active management) and by the adjacent Dismal Swamp State Park (passive management). In this study we investigated the regeneration success of Atlantic White-cedar five years following Hurricane Isabel by sampling five stands at the Dismal Swamp State Park withstanding varying impact from the storm and previous windthrow events. We then compared our findings to regeneration surveys completed at the adjacent Great Dismal Swamp National Wildlife Refuge. Atlantic White-cedar seedling densities were up to 100 times higher in the actively managed Wildlife Refuge compared to seedling densities at the passively managed State Park. To determine the outlook for future Atlantic White-cedar regeneration and management options in the State Park stands, we sampled the seedbank to quantify viable cedar seed and we sampled the vegetation at the State Park. The stands at the State Park are now dominated by Acer rubrum (red maple) with a dense shrubby understory. Since viable cedar seeds were still present in the seedbank (>800,000 seeds/ha), we conclude that future seedling establishment is possible at the State Park. However, active management is essential for achieving sufficient seedling densities and survival for regenerating a mature cedar stand.

Xiaomeng Liu[1], Jan Genzer[2], and Behnam Pourdeyhimi[3], and Orlando J. Rojas[1]
Graduate Programs: Wood and Paper Science[1]; Chemical and Bimolecular Engineering[2]; Textiles[3]
Advisor: Orlando J. Rojas

Amphiphile adsorption on ultrathin films of cellulose and textile polymers

Amphiphilic polymers are often used to adjust the interfacial properties of surfaces. For example, nonionic triblock copolymers with molecular segments with different affinities are effective steric stabilizers in dispersions; understanding the relation between bulk and interfacial behaviors of such macromolecules is the key in the design of new functionalities. Although there have been several detailed studies on the adsorption of E-P-E block copolymers on solid mineral surfaces, i.e., silica, mica, graphite as well as their functionalized forms, little is known about the behavior the same copolymers on cellulose and textile surfaces. Therefore, we are using ultrathin films of PP, PE, Nylon, PET and cellulose as substrates for related inquiries. The morphology, chemical composition, thickness, and surface energies of the substrates were characterized. Specifically, we investigated the interactions between typical polymer and textile substrates and the structure of adsorbed layers. The dynamics of adsorption and interactions were also studied by using the quartz crystal microbalance and surface plasmon resonance techniques. Our results are used to explain the stability of organic films before and after drying and the relationship with their functional properties.

Wen-Chih Lo
Graduate Program: Wood and Paper Science
Advisor: Richard Venditti

Evaluation of Paper Mill Waste Sludge Fractionation Methods to Improve the Cost Effectiveness of a Sludge to Ethanol Process

Even though the paper industry is one of the most effective existing biorefineries, it is estimated that waste sludge is produced at a rate between 4 to 10% of the total paper production. About 50 percent is landfilled or lagooned, 25 percent incinerated, and others were utilized in land applications and other beneficial usage. With gas prices climbing each day, there is an exciting potential to use recycled paper mill sludge as a feedstock for bio-products and biofuels. Due to the high carbohydrate content, the paper mill sludge is a potential feedstock for bio-conversion into ethanol. The prior pretreatments during pulping and papermaking make the resulting fibers in the sludge very amenable to conversion to ethanol, a significant economic advantage over other lignocellulosic materials which need intense pretreatments. On the other hand, the sludge also contains high level of inorganics such as calcium and aluminum salts, which can decrease the potential in ethanol making. By utilizing a simple and cost effective process to remove ash from the sludge the technical and economical feasibility of ethanol production would be improved significantly. Currently detailed analytical work at lab scale is being conducted to evaluate methods to remove sludge from the ash. Promising separation technologies are being evaluated in this aspect, including screening, cleaning, flotation, and clarification.

Justin McVey
Graduate Program: Fisheries and Wildlife
Advisors: Chris Moorman and David Cobb

Dietary Overlap Between Red Wolves (*Canis rufus*) and Coyotes (*Canis latrans*) in Eastern North Carolina

North Carolina is currently home to both red wolves (*Canis rufus*) and coyotes (*Canis latrans*). Both species are relatively recent additions. The non-native coyote began appearing in the late 1930's and red wolves, which were once inhabitants of North Carolina but declared extinct in the wild in 1980, were reintroduced to the Albemarle peninsula in North Carolina in 1987. The wolf reintroduction in North Carolina offers a unique opportunity to investigate the food habits of the sympatric congenerics inhabiting the same area. Information on the food habits of the two species also will aid in management of coyotes, red wolves, and their prey. The objectives of this study are to identify and compare food items and percentages that comprise the diet of coyotes and red

wolves and to determine if the food items of large canids change seasonally. Non-paved roads will be surveyed once a month for 12 months. All scats of large canids will be collected. Samples of each scat will be sent to a laboratory at the University of Idaho for analysis. This analysis will determine if the scats are from coyote, wolf, or other canid origin. Once a scat is identified as coyote or wolf, it will be analyzed for content. Prey species in the scat will be identified by hair, bone, tooth, claw, and hoof fragments. Vegetation will be identified using field guides. Frequency of occurrence of each prey item will be estimated. Currently 986 samples have been collected and 539 have had DNA analyzed. Out of that 539 that have been analyzed, 166 have been identified as canid (red wolf or coyote). Diet analysis of those 166 is in progress.

Yan Pu
Graduate Program: Wood and Paper Science
Advisors: Richard Venditti and Hasan Jameel

Auto-hydrolysis Pretreatment of Mixed Hardwood to Produce Fermentable Sugars

The hot-water extraction of lignocellulosic biomass provides a potential sustainable way to produce bio-based fuels. In order to obtain a fundamental understanding of the extraction of hemicelluloses and other components under different conditions, mixed hardwood chips were subjected to hot-water extraction at temperatures from 150º C to 180º C, for 1 hour and 2 hours. Solid contents for both extracted liquids and solid residues were measured. Sugar composition analysis of the extract before and after the acid hydrolysis treatment was carried out. Acetic acid, furfural and HMF were measured by HPLC. The heating value of original wood and solid residues were determined by a standard bomb calorimeter method. It was determined that the mass losses in the system increased with higher extraction temperature, due to the greater amount of volatile products formed. The optimal overall sugar yield of 10 grams out of 100 grams of original material was obtained at 160º C for 1 hour. The hemicelluloses were more efficiently extracted from the wood by the hot-water extraction process under higher temperature and longer retention time, but greater degree of sugar degradation was also caused at the elevated temperatures. After the hot-water extraction, the solid residues were determined to have higher heating value, especially at higher temperatures and longer extraction time. The total heating value that could be recovered from the residues after the extraction process was about 75%.

Amy Raybuck
Graduate Program: Fisheries and Wildlife Sciences
Advisor: Christopher Moorman

Small Mammal and Herpetofauna Response to Silvicultural Treatments for Oak Regeneration in the Southern Appalachians

Upland, mixed-oak forests in the Southern Appalachians are threatened by widespread oak regeneration failure. Cessation of anthropogenic disturbances during the last century has led to forests dominated by shade-tolerant species. Silvicultural disturbances used to mimic historical conditions that sustained oak regeneration, especially those that reduce the canopy significantly, may affect ground-dwelling wildlife. Our objectives were to measure small mammal and herpetofauna response to silvicultural treatments used to promote oak regeneration in western North Carolina. We implemented an herbicide treatment and prescribed burn in fall 2008/spring 2009 and a shelterwood harvest in fall 2009. Prior to treatments in May to August of 2008 and 2009, we trapped animals using single-arm drift fences and Sherman live traps. We captured 1024 shrews, 237 salamanders, and 187 mice. In 2009, the first year post-treatment, we captured 966 shrews, 249 salamanders, and 309 mice. Shrew captures increased 2% in control units and 16% after prescribed burns, but decreased 24% following herbicide treatments. Salamander captures increased 6% in control units, 160% after prescribed burns, and 21% following herbicide treatments. Mouse captures increased 231% in control units, 71% after prescribed burns, and 160% following herbicide treatments. Higher salamander and mouse captures in 2009 likely occurred because of increased rainfall. Higher shrew and salamander captures following prescribed burns may have resulted from higher movement rates and surface activity due to increased food availability and associated increases in detection probability. Following prescribed burns, mouse captures increased less than in controls, possibly because of short-term declines in food or cover. Our research will aid in developing management strategies that balance silvicultural practices and wildlife conservation.

Shari Rodriguez[1], M. Nils Peterson[1], Fred Cubbage[2], Erin Sills[2], and Howard Bondell[3]
Graduate Programs: Fisheries and Wildlife[1], Forestry and Environmental Resources[2], Statistics[3]
Advisor: M. Nils Peterson

Assessing the Feasibility of Implementing Conservation Incentive Programs with Private Landowners in North Carolina

In the United States, privately owned rural lands are critical for conserving endangered species (ES). Over 90% of ES in the United States rely on private lands for habitat. Thus, engaging private landowners in conservation incentive programs, such as conservation easements and conservation contracts, is essential if ES conservation efforts are to succeed. North Carolina (NC) is a good place to study and apply incentive programs because more than 80% of NC is privately owned and rapid urban sprawl threatens wildlife

habitat on private lands. The objectives of this study are to 1) gauge landowner interest in voluntary incentive programs for ES habitat conservation; 2) compare levels of interest of set duration conservation contracts vs. perpetual conservation easements; 3) rate the importance of ES conservation and other conservation activities on 7 point likert scales, and 4) determine socio-demographic predictors of landowner interest in incentive programs. To address the objectives, we conducted a survey of North Carolina Farm Bureau (NCFB) county advisory board members (*n* = 548) in 49 counties. We received 441 completed surveys for a total response rate of 80.5% (margin of error = 2.9%). Just over 40% of respondents indicated they would place their property in a conservation easement, whereas 58.6% showed interest in the corresponding conservation contract. While landowners ranked ES conservation among the lowest conservation issues, 46.4% indicated they would place their property in a conservation contract for ES habitat (preferred duration = 10 years). Both social responsibility value orientation and percent of income generated from property were positively related to interest in a conservation contract for ES habitat. Social responsibility value orientations may predict interest in ES conservation contracts because ES conservation provides a public benefit. The higher level of interest in conservation contracts (for open space) vs. conservation easements may reflect a preference for obligations based in contract law over restrictions based in property law. Percent income generated from property may predict interest in ES conservation contracts because landowners who rely on their land for income may be inclined to consider all possible income sources, especially on a short-term basis that leaves their future options open. The results to this study will provide key background information for conservation agencies hoping to use conservation easements and/or conservation contracts to maintain ES habitat, fight urban sprawl and conserve working lands.

Jordan W. Smith
Graduate Program: Parks, Recreation and Tourism Management
Advisor: Roger L. Moore

The Green in the Growth Machine: Laissez-Faire Racism, Central Place Theory, and Access to Open Space

In recent years, urban planners and scholars as well as policy makers have become increasingly concerned with equitable access to open space in urban areas. Given that racial minority groups have less access to political and economic power, and that the provision of open spaces occurs through political and economic mechanisms, there is a general concern that access to urban open space is not equitable. In this research, I explore two competing hypothesis to explain racial minorities' marginalized access to parks, open space, and greenways. The first hypothesis couples Molotch's "growth machine" theory (1976) with the more contemporary theory of laissez-faire racism (e.g., Bobo, Kleugel, & Smith, 1997). Specifically, urban space is conceptualized as contested terrain being sought after by local elites. These local elites are thought to utilize their political and economic will to co-opt government decision making authority and ensure access to open space is made available to the white population at the expense of racial minorities. The second hypothesis adapts Christaller's central place theory (1933) and posits that access to open space is determined by the simple fact that as cities develop, open spaces tend to be located at the periphery of the urban core. To empirically test these hypotheses, I examine Raleigh, North Carolina as a case study. Secondary data were gathered from Wake County and the U.S. Census Bureau. These data contain each census block's racial composition as well as its proportion of land utilized as open space. Both a global regression model and a geographically weighted regression model are utilized in the analysis. The results do not support the laissez-faire racism theory; however, the data do support the central place hypothesis. These findings reveal that disparities in access to political and economic power, while certainly real and consequential, do not always play a vital role in determining social groups' access to open space in urban areas.

Timia D. Thompson[1], Myron F. Floyd[1], William R. Smith[2], Jason N. Bocarro[1], Perver Baran[1], Robin Moore[3], and Nilda Cosco[3]
Graduate Programs: Parks, Recreation and Tourism Management[1]; Sociology[2]; Landscape Architecture, Natural Learning Initiative[3]
Advisor: Myron F. Floyd

Gender-Specific Models of Correlates of Physical Activity Among Children in Neighborhoods

Prevalence of obesity and inactivity among children in the United States remain important public health challenges. Ethnic and gender disparities are of particular concern. Public parks are increasingly recognized a viable settings in communities to promote physical activity among children. However, research evidence on how parks and recreation areas contribute to physical activity among children is limited. In order to prescribe policies and practices to increase physical activity among children and adolescents in park environments, additional studies are needed to examine various factors that influence park-based physical activity. The purpose of this study was to examine individual, social and environmental factors related to park-based physical activity among children and to test whether the influence of these factors varies by gender. Data were obtained by direct observations of park use in 20 neighborhood parks in low income and African American neighborhoods in Durham, NC. Field staff trained in the System for Observing Play and Recreation in Communities (SOPARC) conducted park use observations during an 8 week period (May 21st – July 15, 2007). Park features were measured using the Environmental Assessment of Public Recreation Spaces (EAPRS) audit tool. Features serving as primary supports for physical activity were categorized as recreation facilities (e.g., trails, playground equipment). Secondary features (e.g., tables, benches, signs) were treated as park amenities. Separate gender specific binary logistic regression models were used to compare effects of the predictor variables on physical activity. Analyses showed that older boys (13-18 years old) were much less likely to be moderately or vigorously active within parks than older girls. Both boys and girls seemed to

benefit from free play and informal organized activity; however, formal organized activities appeared to benefit girls more than boys. In terms of park attributes, the number of recreational facilities was positively associated with moderate to vigorous physical activity for girls, but not boys. Conversely, park amenities were more strongly associated with less moderate to vigorous physical activity for girls than for boys. Ultimately, results from this study suggest how park environments might be modified to increase physical activity among children regardless of gender.

Jack Peng-Yu Wang
Graduate Program: Forestry and Environmental Resources
Advisor: Vincent L Chiang

Unlocking Bio-fuel Industry through Comprehending Lignin Biosynthesis

Cellulosic ethanol is a renewable bio-fuel produced from lignocellulosic biomass, such as wood and grass. The abundance in biomass renders bio-ethanol commercialization beneficial, and could potentially remedy much of the issues concerning the use of petroleum. However, in lignocellulosics, lignin is structurally intertwined and cross linked with cellulosic polymers, making these polysaccharides inaccessible to enzymes or chemicals for conversion into fermentable sugars.

Lignin is a plant cell wall phenolic polymer. Manipulation of its biosynthesis for desirable structure to allow for better access to the cellulosic polymers is a promising approach to maximizing the efficiency of cellulosic ethanol production.

Lignin is comprised of mainly two types of monolignol subunits, guaiacyl (G) and syringyl (S) in differing ratios. The frequencies of these monolignols dictate the reactivity of lignin, hence the extent of processing required to degrade lignin for better accessibility to polysaccharides. In lignin biosynthesis, S/G lignin monomer ratios are regulated through a single gene family encoding coniferaldehyde-5-hydroxylase (CAld5H). We have identified through transcriptome analysis and expression profiling two putative lignin *CAld5H* genes in the genome of *P. trichocarpa*; and for the first time, revealed a novel coordinated regulation of metabolites leading to differing S/G lignin monomer ratios.

Our acquired understanding of *CAld5H* serves as the basis for more precise genetic manipulation of lignin S/G ratios in lignocellulosics biomass. Such manipulation will allow us to generate bio-fuel specific plants with favorable lignin traits for high reactivity and ease of degradation, minimizing the energy required in lignocellulose processing for cellulosic ethanol.

Zhouyang Xiang
Graduate Program: Wood and Paper Science
Advisors: Ilona Peszlen and Perry Peralta

Changes in Mass, Compression Strength, and Chemical Composition of Genetically Modified Aspen during Bio-treatment by Lignin-selective White-rot Fungus

Wood with decreased lignin content is known to be able to reduce the energy requirement in the pulp and paper and the bio-fuel industries. Bio-pretreatment with fungi is expected to further reduce the energy cost. With this prospect, a study was initiated to explore how a lignin-selective white-rot fungus decays transgenic wood with modified lignin content and structure. The primary objective of the study was to evaluate the changes in mass, compression strength and chemical components during incipient decay of transgenic aspen (*Populus tremuloides)* by a lignin-selective white-rot fungus, *Ceriporiopsis subvermispora*. One type of aspen without any genetic modification, another type with genetically reduced lignin content, and a third type with genetically increased syringyl/guaiacyl ratio were decayed by the fungus. Each type was divided into four groups: a control group, a sterilized group, and two groups colonized with the fungus. One of the colonized groups was exposed to the fungus for two weeks and the other for four weeks using a Liquid Culture Inoculation method for colonizing small-diameter wood. Mass loss was measured and compression properties were evaluated. Wet chemistry methods were applied to determine the lignin and cellulose contents. In addition, a high-performance liquid chromatography technique was used to obtain the different amount of sugars. The results comparing the different wood types and exposure groups will be discussed in this presentation.

Mamiko Arai
Graduate Program: Biomathematics
Advisor: Charles E. Smith

The effects of noise on the Fitzhugh-Nagumo neuronal model

Information is conveyed in the nervous system by signals called action potentials. Neurons transfer the information using the firing frequency and the temporal pattern of the action potentials. However, neurons are subject to noise, and the timing of the action potential varies due to the internal and external noise. A nonlinear system of differential equations known as the Fitzhugh-Nagumo (FN) is used to describe the physiological state of a nerve membrane. Two different kinds of noise are added to the FN model to investigate the effect of noise on the action potential. They are Gaussian white noise and Poisson noise. Gaussian white noise represents many small synaptic inputs and Poisson noise represents a few large synaptic inputs. The effect of the noise on the

coding for the same mean stimulus is compared by simulation. We then used level crossings theory and statistical methods to investigate the difference between the models with different noise types.

Kenneth Ball
Graduate Program: Mathematics
Advisor: Dmitry Zenkov

The Hamilton-Pontryagin Principle and the Hamel Equations

The Hamilton-Pontryagin principle originated in a recent work of Yoshimura and Marsden. The key idea is that the Euler-Lagrange equations can be derived by extremizing the action of a mechanical system while taking variations of coordinates, velocities, and momenta independently. In this poster we describe a novel derivation of Hamel equations (the equations of motion projected onto a frame of non-commuting vector fields) and the Hamel coefficients that appear in these equations using the Hamilton-Pontryagin formalism. We provide context for this derivation in the case of a rigid body system using both Euler angles and a generalized coordinate system in the body frame. We also provide brief overviews of the basic ideas of variational mechanics, the Hamel equations, and mechanics in the Hamilton-Pontryagin space as they relate to our derivation.

Yi-Feng Chen, Thushari Jayasekera, and Marco Buongiorno Nardelli
Graduate Program: Physics
Advisor: Marco Buongiorno Nardelli

Thermal Transport and Thermoelectric Properties of Graphitic Nanostructures: Graphene Nanoribbons

Graphitic nanostructures such as graphene, nanoribbons and carbon nanotubes have shown to be potential candidates for device applications that may revolutionize the future of nanoelectronics. However, very little is known about their thermal properties. In fact, understanding the heat transfer at the nanoscale is essential for optimal thermal management, heat removal in device applications and the design of novel thermoelectric materials. In this presentation, we will discuss an efficient approach to compute the phonon contribution to thermal transport in a broad range of carbon nanostructures using models based on analytic force constants and the non-equilibrium Green's function formalism. In particular, we will discuss the thermal and thermoelectric behavior of graphene nanoribbons (GNR), and show how the geometry of the systems can be exploited to design unique behaviors at the nanoscale.

Jennifer D'Antonio and Reza A. Ghiladi
Graduate Program: Chemistry
Advisor: Reza A. Ghiladi

Oxyferrous Dehaloperoxidase Catalyzes the Oxidation of Trihalophenols in the Presence of Hydrogen Peroxide via Compound II Formation

Dehaloperoxidase (DHP) is a bifunctional protein which possesses both an oxygen transport function and peroxidase activity. Herein, we describe the reaction of oxyferrous DHP with hydrogen peroxide leading to the first characterization of authentic DHP Compound II. In the presence of trihalophenol substrate, this reaction leads to catalytic turnover forming dihaloquinone product, representing the first known peroxidase cycle capable of commencing from an oxyferrous starting oxidation state *in vivo*. The mechanistic implication is that dehaloperoxidase does not require a functional switch to perform both of its biologically relevant activities.

Joseph D. DeSousa
Graduate Program: Chemistry
Advisor: Bruce M. Novak

Beyond Biguanide: Extending the Guanidine Family

Organonitrogen compounds are ubiquitous in chemistry and nature; however compounds with high nitrogen content are rare. One such class that has enjoyed an increased interest in recent years is guanidine and biguanide derivatives. The guanidine functionality, $HN{=}C(NH_2)_2$, is a highly basic group with a pKa of the acid salt at 13.5 and contains over 70 % of its mass as nitrogen. Guanidine's utility comes from its capacity to be substituted with upwards of five different functional groups. This allows for a virtually endless combination to fit many applications such as molecular recognition of acids, as base catalysts for chemical reactions, and a substitute for harsh alkaline compounds. Biguanide, the linear dimer of guanidine, has been exploited in the pharmaceutical industry for years, namely in the form of the drugs Metformin and Proguanil. Polymers of biguanide are commercially available and are used as non-chloride disinfectants and topical wound sterilization. However, longer derivatives of biguanide are not readily available due to undesirable side products during synthesis and challenges in synthetic control; we here outline two approaches toward the construction of longer, linear derivatives of guanidine by top-down and bottom-up methodologies. The top-down

approach was attempted by the hydrogenolysis of benzyl groups from poly(dibenzylcarbodiimide) polymer to reveal a polyguanidine, or polyguanide, core. The resulting polymer was a thermally stable material to temperatures in excess of 900°C in oxygen. The bottom-up methodology involves a Merrifield-type strategy where the guanidine is expanded to larger derivatives. This allows for explicit control of the size of the target compound with minimal byproducts. Both of these strategies have shed new light on the nature and chemistry of guanidine and expanding the family of biguanides.

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

Synthesis of Water-Soluble Porphyrin-Peptide Conjugates

The synthesis of porphyrin-peptide conjugates (PPCs) is of broad interest given the range of potential applications of such molecules. Photodynamic therapy and boron neutron capture therapy represent two areas within the realm of (photo)medicine in which porphyrin-peptide conjugates could be exploited as selective targeting agents for anti-cancer or anti-viral therapeutics. Further, PPCs could serve as novel water-soluble biomimetic catalysts whose reactivity might shed insight into aspects of hemoprotein enzyme mechanisms.

We have investigated a possible route for the synthesis of small libraries of PPCs employing popular Click chemistry to couple a water-soluble A_3B-porphyrin containing a meso-ethynyl-phenyl functional group to a synthetic peptide bearing azidophenylalanine. Synthetic challenges were overcome by using a combination of Zn pre-metallation to prevent copper insertion into the porphyrin, solid phase peptide synthesis to precisely control the site of coupling, use of selected peptide protecting groups that are robust to the coupling conditions yet are removed under conditions which also yield the desired free base porphyrin, and purification via reversed phase HPLC to isolate the porphyrin-peptide-conjugate in high purity.

Dennis Onyeka Frank
Graduate Program: Mathematics
Advisor: Hien T. Tran

A Reduced ODE Model of Acute Inflammatory Response: Derivation and Parameter Estimation of an Endotoxin Model

The initial reaction of the body to bacterial infection or severe tissue trauma is an acute inflammatory response, such response helps to annihilate threat posed by endotoxins and thus restore health. In a previous work by Roy et al, an 8-state ordinary differential equation (ODE) model of the acute inflammatory response system to endotoxin challenge was developed. Endotoxin challenges at 3, 6 and 12 mg/kg were administered to rats, and experimental data for pro-inflammatory mediators such as interleukin-6 (IL - 6) and tumor necrosis factor (TNF), as well as anti-inflammatory mediator such as interleukin-10 (IL-10) were obtained. In this work, we developed a reduced ODE model by categorizing state variables with similar behavior or functions into the same group. We employed sensitivity analysis to find parameters that were sensitive to the reduced model; the subset selection method of ``SVD followed by QR factorization with column pivoting'' was used for parameter identifiability analysis, we then estimated the parameters identified from subset selection. Experimental data on endotoxin challenges at 3 and 12mg/kg were used to calibrate both models (original, and reduced models), and challenge level 6mg/kg for model prediction. Model comparison and validation were done by comparing curve fittings of the original, and the reduced models against existing experimental data, Akaike's Information Criterion (AIC) was also introduced to make quantitative comparison. Finally, results obtained from comparing both models showed that the reduced model had comparative or better performance over the original model.

Jon D. H. Gaffney
Graduate Program: Physics
Advisor: Ruth Chabay

Possibilities: A Framework for Modeling Students' Deductive Reasoning in Physics

Students often make errors when trying to solve qualitative or conceptual physics problems, and while many successful instructional interventions have been generated to prevent such errors, the process of deduction that students use when solving physics problems has not been thoroughly studied. In an effort to better understand that reasoning process, I have developed a new framework, which is based on the Mental Models framework in psychology championed by P. N. Johnson-Laird.

The "Possibilities Framework," which models student deduction as a search of possibility space, resulted from a unique research project that centers on a ``selection task,'' wherein participants chose the correct solution to physics problems from three plausible options. Participants not only performed the selection task individually on four problems, but also discussed in groups the reasoning they used in making their choices and attempted to reach a consensus about which solution was correct. Those groups also worked together to perform the selection task on three additional problems.

The results from the selection task suggest that the Possibilities Framework is viable for describing student deduction on physics

problems. As a result, errors in reasoning can be interpreted as a failure to flesh out all of the possibilities that result from the underlying physical premises. This suggests potential instructional interventions for student difficulties on conceptual problems that range from simply overlooking potentially relevant physical quantities to actively oversimplifying the situation. In this presentation, I describe this new framework, identify some of its strengths, and highlight some suggested instructional interventions.

Alyssa Marie Hopkins
Graduate Program: Marine, Earth, and Atmospheric Science (Oceanography)
Advisor: Carrie Thomas

A surface to seafloor investigation of phytoplankton on the western Antarctic Peninsula during the summer of 2009

The continental shelf waters of the western Antarctic Peninsula (wAP) have warmed over 1°C since 1950, concurrent with a reduction in areal extent and duration of sea-ice coverage during the austral spring. In the context of continued warming, it has been suggested that simultaneous changes in mixed layer stability will alter the succession, assemblage, and size spectra of phytoplankton populations that serve as the of the dominant food source for pelagic grazers such as *Euphasia superba*, or 'krill'. Modifications to the food supply at the surface will also affect sedimentation rates, and strong evidence of coupling suggests this will likely have an impact on organisms in the benthic system as well. To evaluate how phytoplankton populations at the surface contribute to the benthic food supply, we sampled the mid-shelf water column of the wAP (63 to 68°S) during the 2009 summer season (January to March) during the Palmer Long Term Ecological Research (LTER) and FOOD for the Benthic ANtarctic Continental Shelf 2 (FOODBANCS 2) cruises. Pigment datasets were derived using HPLC analysis from comparable locations during each cruise, and were processed using the CHEMTAX matrix factorization program to estimate the contribution of each algal class to total chlorophyll *a*. Diatoms represent the dominant algal class in each data set, but there was a significant difference in the contribution of type 4 Haptophytes (*Phaeocystis*), Mixed flagellate, and Cryptophyte groups. Net tow samples were analyzed using Laser Diffraction Particle-size Analysis (LDPA) and revealed a gradient in median particle size, with 50% of the sample volume consisting of particles less than 42.9µm in diameter (d_{50}) in the north, and increasing to 98.7µm in diameter at the southernmost station. Pigment analysis in the sediment suggests the preservation of chlorophyll *a* at depth in the seabed. Microscopy revealed the presence of *Chaetoceros* spp. resting spores in the sediment which, if viable, could represent additional source of chlorophyll *a* at depth. These findings suggest that the decreasing size spectra up the thermal gradient is significant, and given the known size sensitivity of diatoms to thermal stress, could represent an important reduction in sinking rates and transfer efficiencies of this preferred food source (diatoms) to the benthic system.

Elizabeth Johnson
Graduate Program: Marine, Earth, Atmospheric Sciences (Paleontology)
Advisor: Mary Schweitzer

The microbial role in preserving soft tissue within fossil bone by actualistic experimentation

Microbial processes assist in preserving soft tissues by inducing anoxia, chemically altering the pH of local microenvironments, and acting as passive nucleation sites through either cell bodies or biofilm secretions to induce mineral precipitation. These microbially mediated processes greatly increase the rate of mineral precipitation compared to abiotic conditions, and therefore, may play a role in early diagenetic mineralization correlated with exceptional fossil preservation. Here, we report the results of several actualistic experiments designed to test the hypothesis that microbes play an important role in early diagenesis to preserve vertebrate remains.

Chicken tibiae were de-fleshed and chemically degreased (simulating pre-burial exposure) or untreated (simulating rapid burial). Bones were subsequently buried in sand and allowed to degrade resulting in strong or weak sand adhesion directly adjacent to bone fragments. Scanning electron microscopy (SEM) revealed the presence of biofilms on adhered sand grains suggesting microbial decay of organics result in strong sand adhesion.

Experiments with chicken bone and muscle tissue in liquid media showed calcium dissolution from chicken material to liquid media. Microbial degradation of organics resulted in production of carbon dioxide gas. Carbon dioxide dissolution and calcium liberation from tissues coupled with microbially driven pH increase provides a new mechanism for calcium carbonate precipitation of vertebrate tissues. Mineral precipitation combined with sand grain adhesion may lead to sand cementation by mineral precipitation directly around bone, removing it from future degradative mechanisms, and possibly increasing the preservational potential of soft tissues within bone.

Letisha McLaughlin
Graduate Program: Physics
Advisors: Stephen Reynolds and Kazimierz Borkowski

X-ray Observations of the Supernova Remnant G296.8-00.3

Supernova remnants (SNRs) play a central role in the distribution of heavy elements and kinetic energy in their host galaxies. However, studies of these processes are mostly limited to a few well-studied or young SNRs analyzed assuming spherical symmetry. G296.8-00.3, found in the southern constellation Crux, is a very large and asymmetric remnant which may offer insight into the not-so-ideal case of a stellar progenitor exploding into an inhomogeneous medium. Additionally, this remnant has been observed to have faint X-ray emission coincident with the brightest features seen at radio and infrared wavelengths. I present the ongoing analysis of the peculiar structure and spectrum of supernova remnant G296.8-00.3, as studied with data collected by the three EPIC telescopes aboard the XMM-Newton X-ray Observatory. The source spectra have been fitted with various models describing the interaction of a strong shock wave with ambient material. Parameters derived from the best fits, including the ionization state, plasma temperature, and elemental abundances, will be used to derive pressures, densities, and other properties of G296.8-00.3.

Lara Pagano
Graduate Program: Marine, Earth and Atmospheric Sciences
Advisor: Ryan Boyles

A Comparative Study between FLEXPART-WRF and HYSPLIT in an Operational Setting: Analysis of Fire Emissions across complex geography using WRF

Fire emissions have direct impacts to life and property. The prediction of smoke plumes from wildfires using dispersion models is an important challenge for meteorologists and fire weather specialists. Transport and dispersion (T&D) models are frequently used by the meteorological community to understand and predict the trajectories of anthropogenic, natural and accidental chemical releases of hazardous materials. There are several reputable T&D models that can handle a wide range of applications under the direction of global, synoptic or mesoscale forecasts. One such application is the forecast of smoke emissions from wildfires which is important to operational air quality and meteorology communities.

It is important to understand the strengths and weaknesses of the available dispersion models under critical conditions. A comparative study between two dispersion models, HYSPLIT and FLEXPART-WRF, during recent wildfire events across complex geography is presented to identify the sensitivities of each dispersion model and the operational benefits of utilizing each model for smoke emission forecasts. Two fire events, one along the coast of North Carolina and the other within the Appalachians, were investigated for this analysis. Simulations are analyzed to identify the relative performance of each dispersion model given identical meteorological input. The dispersion models are evaluated for accurate dispersive simulations and also on their ability to support operational forecast needs.

Amongst both case studies, HYSPLIT disperses particles to the north (right) of FLEXPART. This discrepancy can have a significant impact on emergency managers and the public at large. Analysis shows that air concentration and dry deposition differences are statistically significant between the two dispersion models. The high resolution (4 km) model is a slight improvement compared to the 12 km solution.

John J. Sakon
Graduate Program: Physics
Advisor: Keith R. Weninger

Detecting the conformation of individual proteins in live cells using single molecule FRET

Dynamic conformational changes are important for function in many proteins. Single-molecule spectroscopic methods allow access to such conformational dynamics as well as transient associations of biomolecules. Unfortunately, these methods are difficult to employ *in vivo* and biomolecular function in purified assays can be different than in native environments. Molecular crowding, regulatory interactions and cellular feedback networks all obscure the physiological relevance of many quantitative *in vitro* studies. As a result, we worked to combine single-molecule fluorescence resonance energy transfer (smFRET) measurements, which can report molecular conformations at nanometer resolution, with single-particle tracking in live cells to measure the *in vivo* dynamics of individual proteins. We site-specifically labeled recombinant SNARE proteins with donor and acceptor fluorescent dyes such that smFRET signal could determine the dynamic folding of these proteins into complexes after injection in cells. Individual proteins rapidly incorporated into SNARE complexes with native proteins at the cell membrane, displaying their promiscuity *in vivo*. The detection of biologically relevant subpopulations of these complexes demonstrates the potential of this method to reveal dynamic interactions within cells previously inaccessible through any other means.

Robert D. Schmidt and David A. Shultz
Graduate Program: Chemistry
Advisor: David A. Shultz

Magnetic Bistability in Cobalt bis(Dioxolene) Complexes: Long-Lived Photoinduced Valence Tautomerism and Light-Induced Thermal Hysteresis

Molecules presenting intramolecular electron transfer accompanied by a single-site spin-crossover are called "valence tautomers." The quintessential valence tautomeric equilibrium is *ls*-$Co^{III}(SQ)(Cat)L_2$ ↔ *hs*-$Co^{II}(SQ)(SQ)L_2$, where SQ/Cat is a substituted semiquinone/catecholate (dioxolene), and L is usually a diamine ligand. Several complexes of this type are known to demonstrate this valence reorganization in response to external stimuli, such as temperature and pressure. In some cases this conversion can be induced by irradiation of a Co^{III} charge transfer band, generating the Co^{II} form, which is stable at temperatures sufficiently low enough to afford slow relaxation kinetics. There exists only a handful of examples whose stability ranges are very small (10 – 50 K), and decay begins as soon as the light stimulus is removed. The thermal- and photo-induced valence tautomerism of a series of $Co(dioxolene)_2(4\text{-X-py})_2$ complexes (4-X-py = 4-(X)pyridine, X = -H (**1**), -OMe (**2**), -Me (**3**), -CN (**4**), -Br (**5**), $-NO_2$ (**6**)) is described. The thermal valence tautomerism is only observed for complexes **4, 5,** and **6** where each is accompanied by a hysteresis loop of ca. 5 K. When a crystalline sample of **4, 5,** or **6** is held at 10 K in a SQUID magnetometer and irradiated with white light (λ = 400 - 850 nm), the *hs*-Co^{II} tautomer is formed. When the light source is removed, and the sample slowly heated, the *hs*-Co^{II} tautomer persists until ca. 90 K, approximately 40 K higher than the thermal stability of previously reported complexes. Below 50 K, the *hs*-Co^{II} tautomer displays temperature-independent relaxation to the *ls*-Co^{III} form, and above 50 K, this relaxation is thermally-activated with activation energy, $\mathbf{E_a} \approx 1525\ cm^{-1}$. The coordination geometry, pyridine substitution, and crystal packing forces conspire to produce unmatched kinetic and thermal stability for three new valence tautomers from 10 – 50 K, with residual *hs*-Co^{II} persisting until ca. 90 K.

Ubie Sullivan and David A. Shultz
Graduate Program: Chemistry
Advisor: David A. Shultz

Intramolecular Electron Correlation in Radical Systems

The emerging field of molecular electronics research utilizes not only the electron's charge, but also its spin -- so called "spintronics." Before major advances can be realized, a stronger understanding of the mechanisms through which unpaired electrons communicate is necessary. The focus of research in the Shultz group is to explore interactions between unpaired electrons within molecules. To this end, we use sterics and electronics to design molecular architectures that elicit novel responses to perturbations of the system. Structure-property relationships of exchange-coupled systems represent a relatively unexplored frontier in chemistry and it is within this frontier that our work is of paramount importance.

Christopher Swank
Graduate Program: Physics
Advisors: Robert Golub and Paul Huffman

The Search for the Neutron Electric Dipole Moment Using a Solution of Neutrons and Helium-3 in Superfluid Helium-4

The discovery of a neutron electric dipole moment (nEDM) would have profound implications on fundamental physics. The measurement of a nEDM would be direct evidence for the violation of time-reversal symmetry (T) and implies violation of conjugate parity symmetry (CP) via the CPT theorem. Current sources of CP violation do not account for the baryon asymmetry of the universe. Measuring a nEDM would be measuring new physics. Next Generation nEDM searches, notably the He-3 nEDM search, are designed to detect a nEDM on a level of 10^-28 e*cm. Severe constraints are placed on extensions to the Standard Model, eg. SuperSymmetry, if a nEDM is not detected at this level. A nEDM is measured by nuclear magnetic resonance techniques. The magnetic dipole moment of the neutron is well known, a nEDM in a strong electric field will precess with a defined frequency. The presence of a nEDM will present itself as a frequency shift with the shift linear to the strength of the applied electric field. A measurement nEDM < 10^-28 e*cm requires advanced nuclear magnetic resonance techniques and an intimate knowledge of systematic errors, especially errors resulting in frequency shifts linear to the electric field (E). Recent past experiments exploited the co-magnetometer technique to drastically reduce the effective inhomogeneity of the magnetic holding field (B), previously the main source of error. However a new subtle frequency shift was dominant over a nEDM frequency shift, termed the Geometric Phase Effect. This effect is due to E, B's transverse gradient, and the velocity-position correlation function of the spins. Measurements of the he-3 velocity-position correlation function in rectangular cells via longitudinal relaxation in main field gradients are taking place at triangle university nuclear labs (TUNL). The measurement may verify theories and enable the tuning of this effect to negligible values via temperature control.

Qiang Wang
Graduate Program: Mathematics
Advisors: Amassa Fauntleroy and Loek Helminck

Classification of K-orbits of Unipotent Elements in Symmetric Space for SL(n, F)

Given an involution, a linear automorphism, square of which is the identity operator, we can define so-called "twisted action" on a linear algebraic group (LAG) G. Symmetric space P=G/K for G is the image of the twisted action, where K is the fixed-point group w.r.t. the given involution. We study classification of K-orbits of unipotent elements in P. R.W. Richardson proved in 1982 that we have only finitely many K-orbits of unipotent elements in P if the underlying field is algebraically closed. The problem we are working on are the cases that we have arbitrary field instead, and canonical form(s) we can take/have as representatives from each K-orbit for special linear group SL(n,F). The study of K-orbits of unipotent elements is important because it corresponds to roots in the root system theory in Lie Algebras theory and in LAG theory. We've classified K-orbits for inner involutions completely, but have not done for outer involutions, which are completely different from inner ones. We also propose some interesting open problems like generalization of Singular Value Decomposition (SVD), which is more and more important and useful in our study and in practice (like image processing).

Linda G. Waters[1], Thomas G. Wolcott[1], Daniel Kamykowski[1], and Geoff A. Sinclair[2]
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Advisor: Thomas G. Wolcott

The effect of nutrient constraints on cellular division rates and their consequences for maintenance of a benthic subpopulation of the bloom forming dinoflagellate *Karenia brevis*

Populations of the toxic dinoflagellate *Karenia brevis* that remain near the benthos in deep shelf water in the Gulf of Mexico could potentially be the source for toxic bloom occurrences near shore. A biophysical dynamic simulation model and migrating aquatic drifters were combined to assess the potential for the existence of a solely benthic population. Planktonic vertical migration responses to nutrient and light limitation may result in benthically oriented behavior in conditions found on the West Florida Shelf (WFS). The biophysical dynamic simulation model indicated a nutrient concentration >1.5µM N within a nutrient layer extending >2m from the benthos was needed to permit growth for a dark adapted *K. brevis* population in an oligotrophic water column with a benthic nutrient source. However, growth rates are more dependent on the duration of exposure to nutrients than on nutrient concentration. If nutrients extend at least 3m from the benthos in a water column up to 45m deep, then light levels sufficient for growth (>40µmol quanta m^{-2} s^{-1}) are still within accessible swimming distance for dark adapted cells. Using autonomous drifters that modulate their depth based on organism-like vertical migration responses to the external environment, field experiments showed a benthically-oriented movement pattern in response to natural light distributions and a near benthic nutrient concentration. Behaviorally controlled migration therefore resulted in behavioral trapping of a slowly growing population near the benthos. Our average measurements of water from the bottom two meters of the water column in a potential bloom forming region of the WFS were higher than required for growth in our model, suggesting that nutrient distributions in the coastal ocean could support a benthic population offshore in up to a 45m water column. Under upwelling conditions, such populations could be advected inshore to frontal convergence zones and form toxic "red tide" blooms.

Jenelle Willett
Graduate Program: Chemistry
Advisor: Christopher B. Gorman

Cyclization of Poly-Cyano Oligomers; Formation of Isoquinoline Derivatives

Polycyclic aromatic molecules are good candidates in the fabrication of organic, thin film devices such as organic light emitting diodes and photovoltaics (solar cells). We are exploring ways to extend strategies for the formation of isoquinolines via a single ring closing to the cascade cyclization of longer molecules. No methodologies have yet been reported for such cascade cyclizations. The results of several different nucleophile- and electrophile-initiated cyclizations for the formation of these fused aromatic products will be presented.

Joseph B. Zambon[1], Ruoying He[1], John C. Warner[2], and Brandy Armstrong[2]
Graduate Programs: Marine, Earth and Atmospheric Sciences, North Carolina State University/University of North Carolina[1]; U.S. Geological Survey, Woods Hole Science Center, Woods Hole, MA[2]
Advisor: Ruoying He

Investigation of Hurricane Ivan Using the 3-Way Coupled Ocean-Atmosphere-Wave Sediment Transport (COAWST) Model

Tropical Cyclones (TC) are fundamentally connected to the oceanic, atmospheric and wave environment in which they exist. While these environments are drastically modified by the existence of the TC and vice versa, currently most TC prediction numerical

models do not consider the dynamic interactions between the atmosphere, ocean, and wave. As a result, improvement of solutions provided by the individual numerical models representing the atmosphere, ocean, and waves is sought in this study through coupling these models together.

We utilized the newly developed Coupled Ocean-Atmosphere-Wave Sediment Transport (COAWST) modeling system to understand the dynamic couplings of the ocean, atmosphere, and wave during Hurricane Ivan (2004). The coupling scheme exchanges the following fields between the three numerical models: sea surface temperature, ocean currents, wave heights, lengths, periods, bottom orbital velocities, and atmospheric momentum and radiation fluxes. The translation of Hurricane Ivan (2004) across the Gulf of Mexico provides a realistic scenario in which a number of important dynamical interactions between the Tropical Cyclone (TC) and ocean are present during an extreme hurricane. These interactions are examined by using model sensitivity experiments, represented by enabling or disabling features of both uncoupled and coupled models. Hurricane Ivan's simulated track and intensity, its effect on the 3-dimensional ocean states, along with comparisons with in-situ observations will be presented. We find that representing realistic 3-dimensional ocean through the model coupling is critical for TC hindcast and forecast applications.

Sangwon Chung[1,2], Mike Gamcsik[2], and Martin W. King[1,3]
Graduate Programs: Fiber and Polymer Science, North Carolina State University[1]; Biomedical Engineering, North Carolina State University/University of North Carolina at Chapel Hill[2]; College of Textiles, Donghua University, P. R. China[3]
Advisors: Martin W. King and Mike Gamcsik

Tissue Engineering Scaffolds with Multi-Grooved Fibers

The appropriate design of tissue engineering scaffolds is critical to restoring native functionality, which will determine the success of these structures. Structures containing multi-grooved fibers with high surface area have gained interest due to their significantly enhanced fluid transport and capillary action. In addition, scaffolds with high surface areas mimic biological environments that replicate native tissue function. In this study, a novel scaffold structure utilizing multi-grooved fibers was proposed to serve as a matrix for cell attachment and proliferation. The objective was to evaluate the effect of the increased surface area and groove size on the cell behavior as well as on the mechanical properties of the scaffold. Multi-grooved cross-sectional fibers were produced using a bi-component spinning system. Polylactic acid (PLA) was used as the main "retained" polymer and EastOne™ water dispersible polyester was used as the "sacrificial" component to create the grooves. The EastOne™ component was effectively removed by scouring in deionized water at 80 $\pm$ 5°C. The overall diameters of the fibers were approximately 10 μm. To determine cytotoxicity and cell viability, the MTT assay was carried out. Assay results up to 12 days confirmed that the cells were viable on both types of scaffolds. The initial reading at Day 1 showed superior cell attachment over the multi-grooved fibers, but this difference became negligible after 3 and more days of culture. SEM analysis also confirmed positive cell attachment to both types of PLA fibers. This study has shown that the use of PLA multi-grooved fibers provides an effective novel application for use in tissue engineering scaffolds as the increased surface area of the grooved fibers appears to promote the initial attachment of cells. Analysis of mechanical properties is currently under investigation.

Eugene Farley Douglass
Graduate Program: Fiber and Polymer Science
Advisors: Richard Kotek, Alan Tonelli, Peter Hauser, and Steve Kelley

Cellulose - Polysaccharide Membranes Cast from a Novel Green Solvent System

A new solvent system was developed in previous work to make novel fibers from cellulose; this study takes those results to a new level. Current industrial methods for making cellulose membranes are relatively expensive, use toxic or dangerous solvents, and have environmental concerns regarding hazardous waste production. It was determined there was a need to see if this novel system could be used for membrane production. If these membranes could be produced, characterization of these membranes would be appropriate.

Methods used were: a dissolution technique, a coagulation and washing process was developed with a non-solvent (or with non-solvents) to remove the solvent system for recycling, and then a process for drying the final membrane was developed. The resulting dried membranes were then characterized with Scanning Electron Microscopy, Wide Angle X-ray Scattering, and Tensile tests to show similar membranes to current materials could be produced.

The membranes developed have been both porous and nonporous in morphology. These membranes could be either pure cellulose, or cellulose blended with another polysaccharide to make a composite with unique properties. Results showed it was possible to produce porous membranes for separation purposes, and these materials are strong, flexible, and comparable to current systems.

Jinmei Du
Graduate Program: Fiber and Polymer Science
Advisors: Stephen Michielsen and Hoon Joo Lee

Liquid Drops on Solid Surfaces between Flat Surfaces and Fibers

A surface having a water contact angle greater than 150o and a very low roll-off angle is called a superhydrophobic surface. Compared with water, liquids having low surface tension such as various oils easily wet solid surfaces. Therefore, superoleophobicity is commonly required for clothing and carpets, which are easily contaminated by oil but are not easy to clean.

Understanding the ability of a liquid to transfer from a flat surface to fibers could provide basic information enabling the design and preparation of superoleophobic or oil self-cleaning materials. Based on the literature review, we found that a LaPlace pressure difference will change the shape of droplet and even move it when the force caused by this pressure difference overcomes the resistive forces such as gravitational and viscosity forces. The final shape and location of droplets on different materials or different geometrical structures are determined by the system free energy. Based on laboratory observations and the prediction of the ability of a liquid to transfer, it was found that the theory can be used to predict and explain low surface tension liquid (oil) transfer and the final location of the liquid. We found that if a low surface tension liquid on a flat substrate touches a cylindrical fiber resting on the flat substrate and normal to it, the drop should move such that it lies on both the flat substrate and the fiber. However, the liquid does not climb the cylindrical fiber or transfer to its tip. If subsequently the fiber is raised, then the droplet may remain with the flat substrate, transfer to the fiber tip, or transfer to the fiber body.

The theoretical equations derived from Carroll's equation and our laboratory observations proved that droplets do move along a conical fiber. In future work, the critical relationships between liquid motion and droplet size, surface tension, conical fiber geometry should be obtained to provide information on liquid transferring ability.

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Zhan Lin
Graduate Program: Fiber and Polymer Science
Advisors: Xiangwu Zhang and Wendy Krause

Carbon Nanofiber-Supported Platinum and Platinum-Ruthenium Nanoparticles for Use as Anode Electrodes in Direct Methanol Fuel Cells

To meet ever-increasing energy demands and tackle daunting environmental pollution, direct methanol fuel cells (DMFCs) have recently attracted much attention, since they can provide green power for electric vehicles and electronic portable devices by methanol conversion. In this study, platinum and platinum-ruthenium/carbon nanofiber composites (Pt/CNFs and PtRu/CNFs) were prepared by depositing Pt and PtRu nanoparticles onto electrospun carbon nanofibers (CNFs) using polyol processing technique, respectively.

Pt/CNFs were first prepared by depositing Pt nanoparticles directly onto CNFs, and the morphology and size of Pt nanoparticles were controlled by 1-aminopyrene functionalization and HNO3 + H2SO4 acid oxidation, respectively. The noncovalent functionalization of CNFs by 1-aminopyrene is simple and can be carried out at ambient temperature without damaging the integrity and electronic structure of CNFs. The resulting Pt/CNFs were characterized by running cyclic voltammogram in 0.5 M H2SO4 and 0.125 M CH3OH + 0.2 M H2SO4 solutions, respectively. Results show that Pt/CNFs with 1-aminopyrene functionalization have Pt nanoparticles with smaller size and better distribution, compared with those treated with HNO3 + H2SO4 acid. Moreover, Pt/1-aminopyrene-functionalized CNFs possess the properties of higher active surface area and improved electrocatalytic performance towards the oxidation of methanol.

PtRu/CNFs were also prepared by alloying Ru into Pt using the procedure described above, and their electrocatalytic ability toward the methanol oxidation was also studied. The results show that PtRu/CNFs with 1-aminopyrene functionalization have better electrocatalytic ability toward the methanol oxidation than that of Pt/1-aminopyrene-functionalized CNFs, since the introduction of Ru into Pt promotes the oxidation of CO to CO2, and hence reduces CO poisoning toward Pt electrocatalyst.
In summary, Pt and PtRu nanoparticles deposited on CNFs by 1-aminopyrene functionalization and the polyol processing technique exhibit good electrocatalytic activity toward the methanol oxidation, and can be used as anode electrodes in DMFCs.

Priyadarshini Malshe[1], Stephen Michielsen[2], and Hoon Joo Lee[1]
Graduate Programs: Textile and Apparel, Technology and Management[1]; Textile Engineering, Chemistry and Science[2]
Advisor: Hoon Joo Lee

Design of Superhydrophobic and Oleophobic Textile Surfaces

Many of the important inventions are historically the ones achieved while trying to mimic nature. The first superhydrophobic surface was developed in an attempt to mimic the wetting properties of a lotus leaf, which possesses a very high contact angle and low roll off angle with water. The concept of superhydrophobicity, as discussed elaborately by Cassie and Baxter in early 1940s, has been known to mankind for almost seven decades. Many researchers have created artificial, robust, super-hydrophobic surfaces.

Creating a super-oleophobic surface is very challenging, since there is no known natural super-oleophobic surface and thereby, nothing to mimic.

As studied by many researchers, super-repellency can be created artificially by an optimum combination of low surface energy and surface roughness. The focus of this research is to find an optimal combination of low surface energy material and a surface with a high proportion of air voids that can be applied onto a textile substrate. Rough surfaces rather perform higher liquid contact angles than smooth surfaces due to a high proportion of air voids. Careful modeling is required to obtain surfaces with a high void fraction. A robust super-oleophobic surface, once developed, can have application in a multitude of areas, such as protective clothing for medical and military uses.

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Maryam Mazloumpour[1], Ahmed El-Shafei[2], and Peter J. Hauser[2]
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Durable Nanolayer Graft Polymerization of Functional Finishes Using Plasma

The purpose of this work, is to undertake new research thrusts leading to the design and formulations of durable water, oil, repellent, antimicrobial, antiviral, finishes with superior performance for textile materials including nonwoven substrates that can be used for different purposes of medical and hygiene products, separation/filtration media and bio-separation applications. In the first phase of the research different hydrophobic monomers in combination with crosslinkers will be attached to the nonwoven substrates via atmospheric pressure plasma (APP) procedures producing a polymeric nanolayer (10-30 nm) to provide oil and water repellency with different degrees which suits best the post application of the substrate. In next phase a second copolymer nanolayer of known antimicrobial and antiviral materials will be grafted with APP on the fluorocarbon layer to achieve antimicrobial and antiviral functionalities. The surface of the treated substrates will be analyzed using ATR-FTIR, SEM, ATM, AFM, and XPS, and the treated substrates will be evaluated for, fluid repellent properties, fuel filtration capability and antimicrobial, antiviral properties using standard test methods.

Archana Mohan Krishnan, Stephen Michielsen, and Hoon Joo Lee
Graduate Program: Textiles
Advisor: Hoon Joo Lee

Development of a Superoleophobic Textile Surface

The development of a superhydrophobic surface is under study to incorporate the same effect for low surface tension liquids such as chem-bio agents. This can be achieved in two ways: by lowering the surface energy of a solid or by modifying the surface structure wherein the roughness is increased.

The wetting characteristics of liquids such as dodecane and kaydol on nylon and polypropylene monofilaments will be studied by observing their apparent contact angles, advancing and receding contact angles, roll-off angles, and the breakthrough pressure at which complete wetting occurs. The relationship between contact angles, surface texture, surface tension, and re-entrant models with global and local minimum free energies are major concentrations in this study. The existence of a Cassie state at local minimum i.e. meta-stable Cassie-Baxter on surfaces with Young contact angles less than 90° is analyzed and developed to impart low-surface tension liquid-repellency. This is an intermediate region during the transition from the non-wetting heterogeneous interface to a fully-wetted homogeneous regime. All surfaces which satisfy the Cassie-Baxter equation are not meta-stable solid-liquid-air composites. The local liquid curvature between adjacent fibers is important and this depends on the robustness factor which is defined by dimensionless design parameters of the rough surface. In designing a liquid-phobic surface, the geometric angle has to be taken into account as this is responsible for the effect that the net traction of all the forces will produce on the liquid-air inter-phase. Marmur's proposition of the transitory existence of a composite regime at a local minimum of free energy rather than a global minimum also aids the design of a re-entrant model.

The potential benefits of such a textile surface in military uniforms can be led to the in-depth research of non-wetting characteristics of geometrically modified surfaces. The ultimate goal would be the development of a bio-mimetic system of a non-wetting textile surface, which supports liquid on air spaces, a liquid which would normally wet a smooth surface; a system that emulates the self-cleaning effect of the lotus leaf.

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Molecular Dynamics Simulation Study on the Effect of Cellulose Surface Properties on Oily Contaminant Adhesion

Cleaning and washing of cellulosic materials are commonly performed but associate phenomena such as particle and soil deposition and detergency are little understood. An understanding of the impact of the surface properties of cellulosic materials on its oily contaminant adhesion phenomenon would help to develop optimized removal processes and formulations that are applicable to wide variety of applications including consumer hygiene, military protection, and medical textiles. We are addressing these issues by simulating with molecular dynamics the interactions of oily contaminants on amorphous and crystalline cellulose surfaces. These simulations indicate that adhesion increases with the increase of secondary bonding forces such as hydrogen bonding on the cellulose surface, regardless of whether it is in a crystalline or amorphous state. Changes in crystal orientation and molecular roughness of the surfaces can also influence oily contaminant adhesion. We found that by changing the crystal orientation from 100 to 001, the number of oxygen atoms available on the surface decreased threefold, which contributed not only to the secondary bonding forces but also making the surface have more positive charge, resulting in an increase in contaminant adhesion. Thus, formulation of an intelligent contaminant prevention mechanism would require careful consideration of these factors and their magnitude into its model. Factors such as temperature and ambient humidity are also discussed due its importance with surface contamination due to secondary bonding forces.

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Hydrostatic and oleostatic properties of superoleophobic nonwoven materials

A soldier has to often cover difficult terrain to reach his target. The superoleophobic combat uniforms can provide resistance to the chemical and biological warfare agents when used per se. The chem-bio warfare agents can enter the combat uniform because of various military exercises that a soldier executes in a battle environment. Battle exercises such as crawling on the ground can cause the chem-bio warfare agents to seep through the surface of the fabric and come in contact with the soldiers body. This can be lethal depending on the amount of this agent coming in contact with the soldiers' body. This research aims at reducing penetration of liquids through nonwoven fabrics by understanding the hydrostatic and oleostatic properties of these fabrics.

Dodecane is used to measure the oleostatic properties of the fabric as it is having a very low surface tension 25 N/m which implies it is readily absorbed in most cases. The pressure at which the liquid enters the fabric is measured and proper chemical treatments are given to the nylon nowoven fabric to improve its hydrostatic and oleostatic properties. The AATCC 127 test method commonly known as the Suter test is used to study the water resistance of the nonwoven fabric under hydrostatic pressure.

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Development and optimization of an alternative electrospinning process for high throughput

Nanofibrous materials, such as those fabricated through electrospinning, have diverse applications including filtration, tissue scaffolding, autonomous sensors within textiles (smart textiles), and fuel cells. In the standard electrospinning process, in which fiber growth originates at a droplet suspended from a charged syringe needle, the fabrication rate is very slow (0.01 - 0.1 g/hr). This low throughput limits commercial applications, despite the high potential use for fibers of this size (~100 nm). Most previous approaches to increase production have involved parallel arrays of needles or other nozzles where the polymer solution is confined and fed at a constant rate through an aperture. Recently scale-up approaches utilizing a different paradigm, an unconfined system where electrospinning occurs from a bath of polymer solution, have been developed. Confined systems involve more complex machined parts and can be significantly limited by nozzle clogging; however, unconfined systems generally produce nanofibers with both a larger average diameter and a large diameter distribution. In this work, we investigate the simplest unconfined geometry: electrospinning from a polymer solution in an uncontrolled, gravity-assisted flow down a flat plate. Our approach uses the sharp edge of the plate to generate the high electric fields needed for successful electrospinning. We demonstrate successful growth of fibers with a similar diameter and diameter distribution as in a confined geometry and an increase in throughput (by a factor of 6). We analyze and compare the electric field magnitude, homogeneity and polymer jet profiles in several different electrospinning configurations, and hypothesize about the cause of the increased diameter in unconfined geometries. Also we study the influence of feed method, electric field intensity, and working distance on fiber diameter within this edge plate geometry. Finally, we will discuss application of this fundamental understanding to electrospinning directly from a bath of polymer solution.

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Design of ultraoleophobic surface for military uniforms

The main effect of ultraoleophobic farm worker uniforms is (1) When a low surface tension toxic liquid lands on a farm worker uniform surface, its apparent contact angle is larger than 150^{o} and it easily rolls off; (2) Toxic liquid cannot penetrate the farm worker uniform to harm farmers. In our research, we are designing a surface that repels low surface tension liquid and makes the liquid easily roll off.

From Wenzel and Cassie-Baxter models we observe that there are two ways to design and ultraoleophobic surface: (1) by creating a high free energy solid surface through chemical modification and (2) by geometrical modification. Both ways have been adopted in our research. We first obtain a solid surface with high free energy through chemical modification. Then we focus on obtaining ultraoleophobicity through geometrical modification of the chemically modified surface. When a low surface tension liquid is placed on a solid surface, the metastable Cassie-Baxter state is the only solution to ultraoleophobicity. To make it metastable we designed a reentrant conical fiber surface on fabric which has many layers of conical fibers standing on the fabric. The apparent contact angle on these designed textile surface is high. In addition the liquid easily roll off because there is little contact between the liquid and solid textile surface. High robustness can be obtained through proper parameter design, which means high pressure is needed to make the liquid penetrate into the surface texture. The most incredible property of the surface is that even if the liquid enters the Wenzel state because of high pressure, when the pressure is removed, the liquid returns to the metastable Cassie-Baxter state. This is due to the Laplace pressure driving force on the lateral surface of conical fibers, which pushes the drop back to the surface. These properties obtained can protect first responders, farm workers and their families safer from toxic liquid.

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Small Molecule-Mediated "Phenotypic Engineering" Reveals a Role for Retinoic Acid in Anuran Gut Evolution

Changes in feeding strategy enable organisms to undergo adaptive evolution and are often accompanied by novel digestive organ morphology. Understanding embryonic gut morphogenesis in related species with marked differences in diet and digestive anatomy may reveal the mechanisms by which novel trophic specializations arise during evolution. Most anuran tadpoles, such as the African clawed frog, *Xenopus laevis*, are filter feeders with a primarily herbivorous diet, a rudimentary stomach, an anterior gastroduodenal (GD) loop, and very long coiled intestines. However, tadpoles of the South American frog *Lepidobatrachus laevis* are obligate carnivores and have a digestive tract with a large, compartmentalized stomach, posteriorly shifted GD loop, and short, uncoiled intestines. We investigated the developmental mechanisms that underlie the dramatic variation in digestive organ morphology in these two anuran larvae by employing a novel small molecule-mediated phenotypic engineering strategy to transform the morphology of the GD loop in each species to resemble the other. We found that treating *Xenopus* embryos with retinoic acid (RA) inhibitors results in the development of a posteriorly shifted GD loop similar to that found in *Lepidobatrachus* tadpoles. Reciprocally, treating *Lepidobatrachus* embryos with ectopic RA induces the development of an anteriorized GD loop resembling that found in *Xenopus* tadpoles. The inhibition of retinoid synthesis and signaling also posteriorized the expression of a marker of GD looping morphogenesis, *Pitx2*, in *Xenopus* embryos while ectopic application of RA shifted *Pitx2* expression anteriorly in *Lepidobatrachus* embryos. Therefore, RA signaling may have precipitated a posterior shift in Pitx2 expression in *Lepidobatrachus*, which facilitated the evolution of a novel foregut anatomy and the transition to larval carnivory. These results demonstrate the utility of chemical phenotypic engineering as an effective way to uncover evolutionary developmental mechanisms in non-model organisms.

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Cyclin-Dependent Kinase 4 levels affects the number of hair follicle Stem Cells in mouse epidermis

The pRb/Cdk/cyclin/p16 pathway has been found altered in human neoplasias. In particular the Cyclin-dependent kinase 4(CDK4) has been found mutated in familial melanoma, amplified or overexpressed in human gliomas, sporadic breast carcinomas and sarcomas.

We have previously demonstrated CDK4 ablation inhibits chemically-induced mouse skin papillomas, whereas forced expression of CDK4 in mouse epidermis (K5-CDK4) accelerates malignant progression to Squamous Cell Carcinomas (SCC). However, the mechanisms by which changes in CDK4 expression levels control skin tumorigenesis have not been established. In this model topical

application of DMBA and TPA results in clonal expansion of slow cycling stem cell population localized at the bulge area of the hair follicle. We hypothesize CDK4 deletion or overexpression affects tumorigenesis by altering the characteristic and/or the number of Keratinocytes Stem Cells (KSC). To address this, we employed the K15-EGFP transgenic mouse, which expresses EGFP under the keratin15 promoter in the bulge area of the hair follicle, to generated K15-EGFP/K5-CDK4 and K15-EGFP/CDK4$^{-/-}$ mice.

Flow cytometry analysis of K15-EGFP/K5-CDK4 keratinocytes show 4-fold decrease in the number of KSC compared to K15-EGFP control mice. In contrast, K15-EGFP/CDK4$^{-/-}$ show 4-fold increase in the number of KSC compared with control siblings. Quantification of mRNA in the KSCs showed 3 to 5-fold increase in the CDK4 levels compared to non-Stem cell population, no significant changes were detected in CDK2, CyclinD1 and p27^{Kip1}mRNA levels.

We also determined an increase number of Labeled-Retaining-Cells (LRC) in the hair follicle of CDK4$^{-/-}$ and decreased LRC in K5-CDK4. These results are consistent with our hypothesis changes in CDK4 expression affects the asymmetric cell division of KSC population favoring an increase in the transit-amplifying(TA) cell pool and decrease of the KSC pool in K5-CDK4 and the opposite in CDK4$^{-/-}$. As a result, this model predicts the number of TA/progenitor cells correlate with the susceptibility to papilloma development.

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Differential Expression of Genes Involved in Determining Myofiber Phenotype in Turkeys

Turkey skeletal muscle presents an important model for studying mechanisms responsible for vertebrate skeletal muscle development and function. Skeletal muscle is composed of metabolically heterogeneous myofibers that exhibit high plasticity at morphological and transcriptional levels. The objective of this study was to elucidate the differential gene expression between skeletal muscles at two different stages of post-hatch development. Microarray analysis was performed to assess genetic differences between three functionally diverse skeletal muscles (Anterior latissimus dorsi-ALD, Posterior latissimus dorsi-PLD, and Biceps femoris-BF) in 1-week and 19-week old male turkeys. Gene expression was assayed using a mixed model ANOVA with Bonferroni correction for multiple testing. A total of 170 differentially expressed genes were identified in the analyzed muscle samples. Ingenuity pathway analysis and Gene Go analysis software were utilized to identify top gene networks and metabolic pathways involving differentially expressed genes. The only age-related differences were observed in ALD muscles, where four genes (Col3a1, Ctnna1, Sfrs3, Atp2a1) were over-expressed in 1-week old ALD (ALD1) as compared 19-week old ALD muscles (ALD19). The largest differences were observed between ALD and PLD muscles, where 32 genes were over-expressed and 82 genes were under-expressed in ALD1-PLD1 comparison; and 70 genes were over-expressed and 70 under-expressed in ALD19-PLD19 comparison. The largest number of genes over-expressed in ALD muscles code for extracellular matrix proteins such as dystroglycan and collagen. Furthermore, a number of genes involved in glycolytic metabolism were under-expressed in ALD muscles as compared to BF and PLD muscles. Interestingly, PLD and BF muscles were very similar on both regulatory and metabolic levels. The gene analysis revealed that phenotypically “red” BF muscle has high expression of glycolytic genes usually associated with “white” muscle phenotype. The results of this study present significant insight on biochemical pathways responsible for skeletal muscle morphological, contractile, and metabolic characteristics.

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In Vivo Natural Killer Cell Response in Cats Chronically Infected with Feline Immune Deficiency Virus

Natural Killer (NK) cells are a critical component of the innate immune response against opportunistic infections. In addition, they play an important role determining the type and strength of the adaptive immune response. NK cells have been implicated in modulating the host immune response to HIV infection. A decrease in NK cell number and function in HIV patients have been correlated with disease progression. However, it is unknown how HIV infection causes NK cell dysfunction. Using the well-defined Feline Immunodeficiency Virus (FIV) model, we evaluated NK cell proliferation and function after localized infection with *Listeria monocytogenes* (Lm). Chronically FIV-infected and control cats were treated with BrdU to allow measurement of cellular proliferation during Lm challenge. The Lm-infected draining lymph node (LN) and its contralateral uninfected LN were harvested three days post Lm infection and NK cells were assessed by flow cytometry for proliferation and apoptosis. The ability of ex vivo NK cells to produce perforin and IFN-γ was analyzed using a FACS based assay. Lm burden within the LNs was also assessed. Control cats cleared Lm from the draining LN more efficiently than FIV-infected cats, recruited more NK cells to the draining LN, and produced more perforin than NK cells from FIV-infected cats. FIV-infected cats did not control Lm infection in the draining LN, had fewer NK

cells in the draining LN, and those that were present were actively proliferating and had a higher frequency of apoptosis. Our data suggest that NK cells from chronically FIV-infected cats are less efficiently recruited to the draining LN, have a reduced perforin accumulation and a high proliferative and apoptotic rate. These perturbations may contribute to NK cell dysfunction and are associated with reduced ability to clear an intracellular opportunistic infection.

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Hereditary Cerebellar Degeneration in Scottish Terriers: Clinical Description and Genetic Analysis

Hereditary cerebellar degeneration (HCD) has been described in several purebred dogs. The HCD can cause neurological deficits associated with cerebellar cortical degeneration in Scottish Terriers (ST). Subsequently to a 2001 case report, new cases of HCD in ST have been increasing. The aims of the study were: to determine the prevalence and clinical and histopathological features; to describe mode of inheritance, and to identify the genetic etiology of HCD. Owners of affected dogs were contacted for a description of clinical signs, age of onset, and disease progression. Medical records, videotapes of gait, and brain imaging were evaluated. When possible, the brain was examined histopathologically. Prevalence of the disease was estimated. Pedigree and litter analysis were performed to determine mode of inheritance. DNA samples were also obtained to perform genotyping for genetic linkage and association studies. Sixty-two affected dogs were identified from five different countries. Gait abnormalities were noted in the first year of life in 76% of dogs, which progressed slowly. Twenty-seven dogs were dead and only one dog was euthanized because of cerebellar degeneration. Affected dogs exhibited signs of cerebellar disease characterized by a wide based stance, dysmetria, intention tremor, and difficulty negotiating stairs. MRI findings showed atrophy of the cerebellum. A significant loss of granular and Purkinje neurons, and the thinning of the molecular layer with the accumulation of polyglucosan bodies (PGBs) were seen histopathologically. Degeneration was more pronounced dorsally throughout the cerebellum, but less severe ventrally. Prevalence of HCD was estimated at 1 in 1,335 AKC registered dogs. Genetic analysis results were consistent with an autosomal recessive mode of inheritance. In conclusion, new cases of HCD with a relatively mild phenotype have emerged in Scottish terriers. Linkage and association studies in this breed are currently underway to identify the causative mutation.

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