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Atoms to Ecosystems: Stable Isotopes in Animal Ecology

Each year billions of birds, representing hundreds of species, fly across the earth to populate regions that are habitable only seasonally. Migratory creatures do not recognize our political constructs and reveal with special clarity the biological links that bind distant geographical areas and remind us of a continent's connectedness. Many migratory bird species continue to show rapid population declines. While patterns of anthropogenic change and population flux are mostly understood for the breeding grounds in North America, it is unclear how changes on the wintering grounds are affecting these populations. White-winged doves are a migratory bird that breeds in the Unites States (US) and winters in southern Mexico. Despite intense conservation efforts, white-winged doves breeding in the US continue to decline. o investigate if wintering ground conditions are affecting these populations, we first used stable isotopes to characterize the et, habitat use, and feather isotope values of doves on the breeding grounds from Texas to Arizona. This information will assist us in linking wintering populations of doves to their breeding origins in the US. Stable isotopes allow us to make these links because of 1) differences in the type of photosynthesis utilized by plants consumed by doves across their range, 2) differences in habitat use between desert and agricultural complexes in Arizona, and 3) variation in hydrogen isotope signatures of precipitation and surface waters caused by differential patterns of temperature, rainfall, and evaporation across the landscape that are incorporated into bird feathers. Stable isotopes have revealed that across their range, doves consume a variety of plants that employ C3, C4, and CAM photosynthesis. Using carbon and hydrogen stable isotopes, we have discovered that white-winged doves inhabiting the Sonoran desert rely primarily on the fruits of the saguaro cactus for both food and water and this reliance on saguaro fruits allows us to differentiate desert doves from agricultural doves. Finally, analysis of the hydrogen isotopes of feathers grown on the breeding grounds has revealed a latitudinal gradient that allows us to differentiate populations of white-winged doves from Texas to Arizona.

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A Method for the Collocation of Tier-1 Suppliers in Build-to-Order Supply Chains

Build-to-Order supply chains have recently received increasing attention due to the shifting production strategy focus of manufacturing companies from mass production to mass customization. Products and services are no longer being mass produced for an unspecified and unknown market. They are now being mass customized to meet individual customer needs with the goal of reaching mass production efficiency. In the traditional make-to-forecast supply chains commonly associated with the mass production environment, inventories of components, subassemblies and finished products are located at different points throughout the supply chain in order to reduce the negative impact of variability in demand, processes, material flow, quality, etc. The focus of this research is the optimization of the economic benefit that the collocation of suppliers under a build-to-order production strategy offers to both the OEM, or focal enterprise, and its primary Tier-1 suppliers. Collocation of suppliers, which involves relocating a supplier's facility geographically closer to that of the focal enterprise it supports, is a feature that enables achievement of many of the benefits of a build-to-order production strategy.

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Continuing GK-12: From Aquifers to Estuaries--Tracing a Drop of Water Via an Interactive Program Linking UT Scientists with K-12 Students and Teachers
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Tracing of rapid recharge to the Edwards aquifer of central Texas using naturally-occurring and introduced tracers

Karst aquifers are formed by the dissolution of soluble rock (i.e. limestone), are among the most prolific aquifers in the world, and are a major source of potable water in the United States. Due to their highly complex nature, the interconnection between surface water and groundwater in karst landscapes is still poorly understood. We use soil infiltration tracing in conjunction with natural chemical variability to investigate the movement of dissolved constituents through soils and the unsaturated zone above the water table. We injected chemical tracers during rainstorms at soil sites five meters above and up to 35 meters laterally upslope from the monitoring site. Tracer breakthrough occurred within 24 hours of rain-flushed injection, highlighting the rapid movement of water through the soil and unsaturated zone at the study site (several meters per day). In contrast, groundwater movement within sandstone aquifers is typically measured in millimeters or centimeters per day. The elemental ratios Mg/Ca and Sr/Ca in karst aquifer waters provide naturally-occurring indicators of how long water has been in contact with the limestone bedrock (referred to hereafter as residence time). We interpret waters with low Mg/Ca and Sr/Ca ratios as having a short residence time, whereas waters with high Mg/Ca and Sr/Ca ratios have a longer residence time. A comparison of groundwater Mg/Ca and Sr/Ca ratios with chemical tracing results indicates that residence time exerts a primary control on water chemistry, even on short timescales of hours to days. The rapid movement of chemical tracers through the soil zone and unsaturated zone highlights the susceptibility of karst aquifers to pollution and has important implications on water resource management.

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Cross-fertility of Metrosideros polymorpha along an elevational gradient

Reproductive isolation (RI) is evolutionarily important because it is a measurable, well-documented mechanism of divergence and speciation. RI, arising due to ecological pressures, can occur sympatrically and allopatrically. Development of RI in plants can be examined by testing the cross-fertility of populations. Ohia (Metrosideros polymorpha), a highly variable native tree, dominates a broad range of habitats throughout the Hawaiian Islands. Little work has been done on cross-fertility of Ohia. This study examines cross-fertility of Ohia along a strong elevational gradient on Hawaii Island. Cross-pollination of populations are underway along an elevational gradient and in a common garden. Morphological measurements are being taken to quantify heritable differences. In the garden, two elevational categories are being used, high- and mid-elevation. Ten maternal trees with 4 inflorescences from each category are targeted. Two inflorescences receive pooled pollen from at least 3 unrelated individuals from the same elevation, and 2 inflorescences receive pooled pollen from the distant elevation. The same design will be used in 2 natural populations, using 20 maternal trees from each. Preliminary observations of increased fruit abortion from inter-elevation crosses in the garden may indicate reduced cross-fertility between trees at different elevations. Ohia is a relatively young species that shows morphological divergence along an elevational gradient. The strength of RI along this gradient remains unknown. Tests of cross-fertility will show if there is reproductive divergence occurring along the gradient due to local adaptation and/or genetic drift. Observation of RI in this species would suggest that divergence along this gradient is a means of incipient speciation.

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Of consumption and clinicians: Medical concepts of tuberculosis in nineteenth-century Scotland

By 1800, western European consumption was attributed to endogenous causes, including heredity, immorality, and other degeneracies -- etiologies that allowed researchers to make sense of differences among individuals in risk of consumption, while conceptually distancing the healthy self from a tuberculous other. As the nineteenth century unfolded, however, exogenous causes such as environment and inflammation were incorporated into medical constructs of the disease, and new ideas of consumption's causes and pathological processes suggested that the disease could be treatable. Such developments necessitated changes to notions of who was consumptive and why; academic discourse in Scotland sought to align new findings about TB with old etiologies of heredity and morality. The ways nineteenth-century medical scholars and practitioners in Glasgow and Edinburgh constructed and reconstructed diagnostic criteria and treatments for consumption in response to these challenges illustrates how people in this context conceptualized disease, classified infections and disorders, and presented disease to be recorded. For this transitional period -- which witnessed the refinement of diseases as distinct diagnostic categories, development of contagion theory, and identification of the bacteria causing TB -- the interpretation of demographic records is particularly dependent on an accurate reconstruction of consumption and TB as historical categories. Such clarification is necessary to identify how TB shaped nineteenth-century lives, but also to deepen our understanding of the disease's modern re-emergence. A nuanced understanding of the biological and social contexts within which our species has interacted with TB in the past may inform our efforts to control the disease in the future.

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Degradation of TATP, TNT, and RDX using Mechanically Alloyed Metals

Mechanically alloyed metals have been explored for the degradation of the explosives triacetone triperoxide (TATP), trinitrotoluene (TNT), and cyclo-1,3,5-trimethylene-2,4,6-trinitramine (RDX). TNT and RDX have been found to contaminate soil and water near industrial production sites. While not environmentally harmful, TATP, a peroxide explosive, has become more commonly used in terrorist acts due to the ease of synthesis and availability of reagents. TATP is also difficult to treat due to its sensitivity to heat and friction. Laboratory scale tests were designed to measure the effectiveness of MgPd in degrading TATP, TNT, and RDX. In aqueous solutions, TATP, TNT and RDX degraded with exposure to the MgPd. Other studies include using other mechanically alloyed metals, FeNi and FePd, for the degradation of TNT and RDX. MgPd and these other metals are also being tested in combination with EZVM (emulsified zero-valent metals) and BTS (bimetal treatment systems) to help degrade TNT, and RDX to clean-up contaminated water, soil, surfaces, and structures. The use of these technologies with the active metals provides in situ remediation technique for degrading these explosives.

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Scattering of a three-charge supertube off a rotating black hole in five dimensions

The low velocity scattering of a string theoretical object, called a supertube, in the vicinity of a rotating black hole has been considered by Marolf and Virmani. Those authors investigated a supertube with two charges; here we extend the analysis to the three-charge supertube. We find that, similarly to the two-charge case, there is a critical value of the circumferential angular momentum of the supertube; below this value an adiabatic merger with the black hole is not allowed. In a non-adiabatic merger, on the other hand, such a merger is possible, but only when accompanied by a potential barrier. Moreover, we find evidence that certain mergers can trigger a thermodynamic instability that may cause the black hole to fission. This instability occurs when the merger naively appears to decrease the black hole entropy, which includes circumstances somewhat more general than those described in previous work.

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Identification of Unique Cesium Sites within Zeolites using 133Cs MAS NMR

Nuclear waste containing 137Cs and 90Sr raises concern due to their half lives of approximately 30 years corresponding to the span of human life and strontium's ability to replace calcium in mammalian bone mass. Nuclear magnetic resonance (NMR) is a bulk characterization technique that provides information about the local environment of NMR active nuclei and has recently been applied to zeolite systems. Zeolites have an ion exchange capacity such that the charge balancing cations within the cage-like structure are exchanged for cations with a smaller charge density and hydration sphere. Because of this tendency, zeolites act as a soil remediator by exchanging harmless charge balancing cations (such as sodium) with radioactive cations, such as cesium-137. In this study, NMR is used to resolve the individual chemical sites of cesium within a range of zeolites and a range of relative humidities.

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Numerical Simulation of Potential Flow using Finite Element Methods

The finite element method is a general and powerful technique used extensively in Applied Mathematics, especially in the fields of fluid dynamics and in wave propagation such as acoustic problems. Mathematically speaking, the finite element method deals with constructing approximate solutions to boundary-value problems by dividing the domain of the solution into a finite number of simple subdomains called finite elements. Then, using variational concepts, construct an approximation of the solution over the collection of finite elements. We have shown that the finite element method gives a very close estimate of the solution to differential problems when we use the Galerkin approximations. We have used this method to simulate velocity and pressure vector fields and potential flow around obstacles with Dirichlet boundary conditions.

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Reproductive ecology of selfing and outcrossing desert annual plants

Little attention has been tuned to the fact that most self-fertilizing plants are annuals. This life history strategy may potentially play a predominant role in the evolution of self-fertilization. Annual plants are thought to play a critically important role in the function and diversity of desert ecosystems, as they make up nearly 50% of the flora of the Sonoran desert and close to 70% in the Mojave desert. Despite the severe time limitation in which to reproduce, many desert annual plants appear to invest heavily in reproduction and we see a spectrum of reproductive strategies from complete self-fertilization to complete outcrossing. An ideal system in which to examine the evolution of reproductive strategies in desert ecosystems is the genus Camissonia (Onagraceae). Self-fertilization has evolved many times in this group and there are multiple examples of sister species with contrasting reproductive strategies that overlap in their range distributions. This study explores the relationship between mating system, range size, and allocation strategies within Camissonia. Allocation to reproductive structures relative to vegetative structures is reduced in selfing species, which are more likely to have greater range sizes and occupy more habitat types. In addition, within this group we see a trade-off between flower size, seed size, and seed number. Future directions will focus on the mechanisms maintaining the diversity of reproductive strategies we see within this group as well as the costs and benefits associated with selfing and outcrossing across environments.

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GdN formation through gas-phase reaction and reactive inert gas condensation

Spintronics is an emerging field that utilizes electron spin as well as electron charge to transfer data. Specifically, ferromagnetic semiconductors with Curie temperatures above room temperature are of interest as they aim to make use of the electron spin in semiconducting devices. Low Curie temperatures, small magnetization, or both, however, plague current materials. GdN is a compound that offers promise, as it is a ferromagnetic semiconductor with a Curie temperature predicted to be above room temperature.

Although formation of GdN offers many challenges, we report the formation of GdN via two different routes: gas-phase reaction and reactive inert gas condensation (RIGC). In the former, Gd in the form of bulk Gd flakes and melt spun ribbon were heat treated in a nitrogen atmosphere after light ball milling. The ball milling was used to break up the passivating layer of Gd_2O_3 that acts as a diffusion barrier for nitrogen incorporation into the structure. Both Gd starting materials successfully produced a large fraction of GdN, although some remaining Gd was observed. The melt spun ribbon more readily formed GdN, likely due to the finer grain size that improved diffusivity. GdN formed by RIGC was nominally phase-pure, as revealed by x-ray diffraction. However, magnetic measurements indicated residual hcp Gd.

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The Morphological Characterization of Motor Neurons

This ongoing study will allow for the Nanoscience Technology Center to co-culture central nervous system (CNS) motorneurons (MN) from fetal spinal cord stem cells (FS) with muscle tissue and use this in-vitro system for further studies of the motorneuron-muscle interactions at the neuromuscular junction. The success of these studies would allow us to produce an in vitro model of this neuronal network. However, there is a gap in the scientific literature about the morphological characterization of MNs, especially for MNs differentiated from human stem cells. Once those morphological parameters are uncovered, the identification of MNs and the studies about their neuronal pathways will be greatly facilitated. In our current co-culture we do not simply just have MNs differentiated from the stem cells, there are many types of nerve cells which includes somatic MNs, visceral MNs, interneurons, astrocytes, etc. The question is how we can visually identify somatic MN, or any MNs for that matter, from the rest of the nervous material in the culture. It is known that MNs are cholinergic, exhibit excitatory projections to muscle and form neuromuscular junction. It is also known, from the literature, that molecular markers such as ChAT and Hb9 can be used to identify MNs and MAP2 can uncover the dendritic morphology of neurons. The morphology of ChAT/Hb9 positive cells can then be characterized by using computer software and other methods of measurement analysis. If a better understanding about the MNs' morphological characteristics, which set them apart from the rest, can be gained, then it would be easier to distinguish MNs from other cells with greater ease.

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A Stable Isotope Study of the Soil Water Budget Along a Climate Gradient In a Snowmelt Dominated system

Climate is complexly linked to the soil water budget in that it controls water and heat fluxes to the soil as well as influencing soil formation and soil properties. In this study, stable isotopes are combined with climatic monitoring to investigate how the soil water budget and styles of soil water movement vary across a climate gradient. Precipitation, snowmelt and soil water are being monitored at sites along a climate gradient in central Washington State. The hypothesis underlying this research is that the style in which water percolates through the soil (e.g. piston flow vs. preferential flow), the rates of evaporation versus transpiration, and the timing of deep soil water/groundwater recharge varies predictably during different hydrologic seasons across this climate gradient. Soil water is collected and analyzed by two methods: 1) direct equilibration of soil cores with CO2 to determine the isotopic composition of total soil water; 2) suction lysimeter for mobile soil water isotopes. Comparisons are made between the isotopic composition of direct precipitation and that of these vadose zone waters. Stable isotope comparisons are combined with climatic measurements to determine amounts and residence times of mobile versus stationary soil water and to quantify evaporation rates, transpiration rates, and downward percolation fluxes. These parameters are in turn related to site characteristics such as precipitation, soil properties, and vegetation type/density. Thus, this research explores how the soil water budget in a snowmelt-dominated system is influenced by climate. This project includes an outreach program involving K-12 teachers and students associated with WATERS from schools located in the Yakima River water shed.

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Evaluating genetic connectivity in the brooding brittle star Astrotoma agassizii across the Drake Passage in the Southern Ocean

Studies examining population structure and genetic diversity of benthic (bottom-dwelling) marine invertebrates in the Southern Ocean have emerged recently. However, many groups remain unstudied, echinoderms being one example. The brittle star Astrotoma agassizii is distributed widely throughout Antarctica and southern South America. This species is a brooding echinoderm without a planktonic larval stage, and therefore may have limited dispersal. In this study we wanted to evaluate hypothesized barriers to gene flow in the Southern Ocean, such as depth, geographic distance and the Polar Front, a region between Antarctica and South America marked by large temperature change and high-flow velocity. Two mitochondrial genes were sequenced and compared from populations of A. agassizii from Antarctica and South America. Populations separated by the Polar Front were shown to be isolated and belonged to separate genetic lineages lacking morphological distinction. However, within lineages, genetic continuity was displayed across a large geographic range. Therefore, despite lacking a planktonic larval stage, A. agassizii can disperse across substantial geographic distance within continental shelf regions. These results indicate that geographic distance alone may not be a barrier to dispersal, but rather the combined effects of distance, depth and the Polar Front act to prevent gene flow between A. agassizii populations in Antarctica and South America. Similar levels of genetic diversity and divergence likely exist within other Southern Ocean invertebrates. Additional work is needed to further document biodiversity in this isolated biogeographic region in order to more fully understand the dynamic physical processes and extreme environmental conditions driving this diversity.

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Groundwater Exploration in Rural Uganda

The following paper discusses a geophysical survey conducted outside of Makondo, Uganda. Through the Humanitarian Engineering program at the Colorado School of Mines, a working relationship was formed with St. Denis, a secondary school in Makondo, Uganda. Because the number of students is growing, water demands have outgrown the current supply. Several engineering solutions have been analyzed; however this paper discusses only the groundwater geophysical survey. Based on preliminary information, a DC resistivity survey was decided as the most efficient method for collecting data. The goals of the survey were threefold; one, locate the water table; two, find information about the local geology; and three, determine if the groundwater was contaminated. Dipole-dipole and Schlumberger sounding arrays were placed in three separate areas. Once the data was collected, the data were analyzed using a 1-D inversion. The resulting inversion located the water table and suggested that the groundwater was not contaminated. Using this data, a well location was proposed for future construction.

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The supply of larval fishes from the Gulf of Mexico to nursery habitats within the Everglades National Park (ENP) near Chokoloskee Island

Everglades National Park (ENP) is the largest subtropical wilderness in the US, yet represents only a portion of the habitat that existed a century ago. Although efforts to restore the once expansive ecosystem are underway, the area faces numerous challenges: increased nutrient loads, interrupted & decreased water supply, invasive species, and contamination by heavy metals. Thus, assessing the status of organisms within the ENP is critical to the success of restoration efforts. My graduate research examines the spatial and temporal recruitment patterns of larval fishes from the Gulf of Mexico to the northern ENP. Study objectives include 1) determining which fish species recruit to and utilize the northern ENP as nursery habitat & 2) examining which environmental or hydrologic parameters influence the supply of fishes to the area. To assess the temporal and spatial patterns of fish recruitment, daily plankton samples were taken during the summer 2006 from three sites within the ENP. Larvae were identified to the lowest possible taxa and measured for standard length. Species abundance was compared to environmental parameters (water level, temperature, salinity) and lunar phase to determine which factors might underlie larval transport. Over 200,000 fishes from 32 taxa were collected with the bay anchovy 78.5% of the total catch. The most speciose families were Sciaenidae and Carangidae. As a Graduate Fellow in Florida Tech's InSTEP program, I am able to share my research with students that represent future scientists, businessmen/women, and consumers. Through classroom presentations and laboratory activities highlighting some of the challenges faced by the ENP, I reveal how global issues, such as climate change and urbanization, may affect marine populations worldwide.

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Power and Performance Management of Virtualized Computing Environments Via Lookahead Control

There is a growing incentive to reduce the power consumed by large-scale data centers that host online services such as banking, retail commerce, and gaming. Virtualization is a promising approach to consolidating multiple online services onto a smaller number of computing resources. A virtualized server environment allows computing resources to be shared among multiple performance-isolated platforms called virtual machines. By dynamically provisioning virtual machines, consolidating the workload, and turning servers on and off as needed, data center operators can maintain the desired quality-of-service (QoS) while achieving higher server utilization and energy efficiency. We implement and validate a dynamic resource provisioning framework for virtualized server environments wherein the provisioning problem is posed as one of sequential optimization under uncertainty and solved using a lookahead control scheme. The proposed approach accounts for the switching costs incurred while provisioning virtual machines and explicitly encodes the corresponding risk in the optimization problem. Experiments using the Trade6 enterprise application show that a server cluster managed by the controller conserves, on average, 26% of the power required by a system without dynamic control while still maintaining QoS goals.

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Effects of Genetic Diversity on Population Success

Biodiversity can positively affect a system's performance and function and manifests across many levels of organization including functional diversity within an ecosystem, species diversity within a community, and genetic diversity within a population. While diversity effects at higher levels are well studied, an understanding of their importance at the population level are just beginning to emerge. The genetic diversity of a population should profoundly affect its success. Positive diversity effects are proposed to occur via complementarity effects when increased diversity decreases intra-specific competition and increases resource partitioning, allowing for more efficient resource use. Sampling effects occur when increased diversity increases the chance a system contains a highly functioning or productive genotype. Finally, environmental selection alters genetic diversity of a population over time. To examine these mechanisms we first conducted a meta-analysis to assess whether genetic diversity conveys these effects. We quantitatively reviewed literature that examined the effects of intraspecific competition on growth/fitness and function of populations comprised of genetically-similar and genetically-dissimilar individuals. Across the studies, we found no effect of increasing genotypic diversity on measures of growth/fitness and a significant positive effect of increased diversity on function indicating that diversity may strongly affect important ecological processes. Currently, we are testing these mechanisms by manipulating the genetic diversity of Avena barbata populations grown under differing resource environments to examine the relative importance of ecological and evolutionary mechanisms (and their interactions) on population success over time.

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Derangements, Skew Tableaux, and Hats

A classical problem in combinatorics is this: Suppose n men go to a restaurant and each checks his hat. How many ways can the hats be returned so that no man receives his own hat? This number is called the nth derangement number and dates back to the 1700's. More generally, it corresponds to the number of fixed point free permutations on n elements. A more modern concept in combinatorial representation theory is that of a standard Young tableau. This is an array of n blocks arranged in left justified rows with row i containing at most the number of blocks as in row i-1. The blocks are filled with the numbers 1 through n so that the numbers increase along the rows and columns. Further, you can subtract a smaller tableau from a larger to create a skew diagram. These labeled skew diagrams have a connection to the derangement number. Define a hook to be a row of j blocks which has been bent at position 2, 3, . . . or j. Create a particular skew diagram by taking the union of k hooks where the southeast corner of the last box of the ith hook touches the northwest corner of the (i+1)th hook. Please see the picture. The set of such standard labeled skew diagrams on n elements is in bijection with the set of fixed point free permutations of n elements. Hence, the set of standard skew diagrams is counted by the classical derangement number. This result has applications in algebraic combinatorics. In a 2003, Bjorner and Welker take a concept of commutative algebra, the Rees product, and apply it to poset topology. The bijection described above allows us to compute the mobius function of the rees product of the Boolean algebra with the chain and the mobius function of the rees product of the cubical lattice with the chain.

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Coupled mechanical-optical characterization of cellular mechanics in 3D culture

The mechanics of living cells and their structural proteins is difficult to measure because of the complexity of living tissues. Measurements of cells on 2D substrates are easier to obtain, but such cells adopt morphologies that can bear little resemblance to those found in a living tissue. A device was developed to measure force while stretching tissue constructs over the objective of a confocal microscope. This device was used to characterize cell and extracellular matrix (ECM) mechanics by testing fibroblast populated collagen gels. These bio-artificial tissue constructs provide a realistic environment similar to living tissue. Type I collagen and varying levels of stained 10 day chicken embryo fibroblast cell concentrations were cultured and incubated for 3 days prior to testing. Each gel was preconditioned and then stretched to a 10% displacement in HEPES buffered DMEM. Experiments were repeated after treatment with 0.05% w/v deoxycholate in PBS. Confocal images were taken of cells before each stretch and after the stretch once the viscoelastic relaxation had reached a steady state. From these data effective cell and ECM moduli were estimated. The fibroblast cell elastic modulus ranged from 10-350 kPa depending on cell concentration in the tissue construct. At low concentration the cells had a greater stiffness than the ECM, but the stiffness of the cells decreased while the stiffness of the ECM increased with cell concentration. Some strained cells released from the ECM in constructs with cell concentrations near that required to form a continuous network (the percolation threshold).

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Tiling Microarrays: Possibilities and Challenges for the Future

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The recent completion of several genome projects (e.g., human, mouse) has made it possible to design studies which investigate the entire set of genetic information (i.e. the genome) of an organism. Microarray technology is a relatively new and powerful tool which complements genomic knowledge by allowing the study of an entire genome on a small slide or chip. One common and important type of microarray experiment involves the study of gene expression. Specifically, microarrays have been used to identify genes which have significant expression differences between healthy and diseased cells. These results are having an important impact on the medical field as scientists continue to investigate the role of genetics in many diseases. A promising new type of microarray, called a tiling array, offers a unique way to study the genome. Many microarrays allow the study of annotated regions (e.g., genes) of a genome, but exclude un-annotated regions. Tiling arrays differ in that they are designed to cover an entire genomic region of interest, including un-annotated regions, in an unbiased way. Statistical methodology has played a crucial role in the design and analysis of microarray experiments throughout the development of the technology. The emergence of tiling arrays poses new statistical issues to address the differences in the array design. In this poster, microarray technology will be introduced and statistical issues will be discussed from the perspective of a gene expression tiling array experiment and respective statistical analysis.

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Breakdown characteristics of metal gate/HfO2 based multi layer gate stacks

Hafnium Oxide based high-k (high dielectric constant) gate stacks are considered to be the potential candidates to replace SiO2 in complementary metal oxide semiconductor (CMOS) technology, specifically in the area of low power applications. Because high-k gate dielectrics can be several times thicker, they reduce the gate leakage by over 100 times. This will help in reducing the heat of the chips. The next generation of transistors (45nm) with high-k dielectric also has an interfacial layer (typically SiO2) between high-k and the substrate. To incorporate high-k in CMOS devices, reliability studies need to be done systematically for high-k layer and interfacial SiO2 layer. The soft spot in leading breakdown (BD) mechanisms in high-k/interfacial layer (IL)/metal gate stack has been claimed to be trap generation in the interfacial SiO2 layer. But to understand the breakdown characteristics of high-k/SiO2 gate stack completely it is important to study separately the role of SiO2 interfacial layers and bulk high-k gate dielectrics without any interfacial layer, while maintaining same growth conditions. My work compares the individual breakdown characteristics of HfO2 and in-situ steam generated (ISSG)-SiO2 MOS structures to high-k/IL/metal gate stack.

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Effects of 3D Action Video Gameplay on Mental Rotation Ability and Visuospatial Chemistry Problem Solving Skill

It is known that many students have problems processing the visual and spatial aspects of science problems. For example, chemistry is well known for the challenging spatial concepts found in the area of molecular geometry. Research is being conducted to explore both the effects of 3D action video game play on visuospatial performance and the correlation of visuospatial performance to performance in 3D spatial science problem solving. Participants follow a pretest-treatment-posttest schedule. During pretest and posttest phases, participants complete the Purdue Visualization of Rotations test and a custom assessment of spatial chemistry problem solving skills. Prior to group assignment and treatment, participants are classified according to video game experience and pretest scores. Treatment-group participants play Portal, a 3D action video game from Valve Corporation where advancement is dependent on users' spatial problem solving abilities. Control-group participants play Tetris, a 2D puzzle video game where blocks of various shapes must be manipulated. It is thought that repeated exposure to 3D spatial problem solving challenges, in the form of a 3D action video game, will enhance users' 3D spatial problem solving performance. This enhanced performance may allow participants to solve spatial science problems, such as those found in molecular geometry, more easily as a result. This research project is designed to evaluate changes in spatial problem solving skill level and transfer of those changes to spatial science problem evaluation performance.

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Facilitating Communication in Software Engineering by Incorporating Version Control Systems into Immersive, Collaborative Virtual Environments

The incapacity for efficient communication is one of the most significant factors that hinder progress, particularly in multi-site or even global software engineering projects. Adding additional team members often only serves to aggravate the problem by incurring increased communications and training overhead. While attempts have been made to incorporate collaboration mechanisms into common software development tools, few have been regarded as having substantially ameliorated the communications problem. What would the results be if, instead of building collaboration mechanisms into existing software tools, these software tools were built atop a rich multi-user communications platform? Second Life is software that provides a massively multiplayer 3D environment that allows users to design and script their virtual world to whatever they like. Since the client code for Second Life has recently gone open source, integrating Second Life with Subversion unlocks a powerful possibility in migrating the frontend for a version control system into a shared, virtual environment. This allows developers that are continents apart to collaborate under a virtual roof in ways that are easier and more innovative than ever before. The virtual presence of other avatars denotes other developers who are currently working on the project, and by using Second Life's chat, directed 3D audio, and video conferencing capabilities the expanded opportunities for collaboration yield enhanced efficiency and productivity.

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Evaluation of neural cell activity on zinc oxide nanoparticle substrates

Zinc oxide (ZnO) nanoparticles offer a number of properties that are of interest in the field of neural tissue engineering. Materials that exhibit nanoscale surface dimensions have been shown to promote neuron function while simultaneously minimizing the activity of cells that inhibit central nervous system regeneration. Studies demonstrating enhanced neural tissue regeneration in electrical fields and on conductive scaffolds have led to interest in piezoelectric materials, such as ZnO. It has been speculated that ZnO nanoparticles have increased piezoelectric properties over ZnO particles with diameters on a micron scale. The present study assessed the feasibility of micropatterning ZnO nanoparticles for investigating the adhesion and organization of neural cells on piezoelectric nanomaterials. ZnO nanoparticles embedded in polycarbonate urethane were micropatterned into rows with micrometer dimensions. Scanning electron microscope (SEM) images of the micropatterned surfaces were observed to assess nanoparticle orientation. The adhesion and organization of neural cells on the micropatterned surfaces was also assessed with SEM. This study represents the first step in assessing piezoelectric nanoparticle scaffolds for neural tissue engineering. Successful production and evaluation of scaffolds suitable for neural cell culture offers a means to evaluate their potential for incorporation into nerve guidance channels of greater efficiency.

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Investigation of Dual Airborne Laser Scanners and Visible Light Imagery for Detection of Moving Vehicles in an Aircraft External Hazard Monitoring System

To ensure aircraft safety during precision approach procedures detailed information pertaining to hazards located on the runway and surroundings area must be known. In order to identify possible safety threats, aircraft must be equipped with sensors capable of detecting all significant hazards in a variety of weather conditions and landing scenarios. This thesis is an investigation into one such method of aircraft external hazard monitoring. First potential hazards along with their defining characteristics are identified and examined. A study into the capabilities of various sensors potentially suited to detect these hazards is also preformed. Finally one such hazard monitoring implementation involving two airborne laser scanners along with a visible light camera is presented. The goal of this implementation is to detect a ground vehicle driving on the runway during precision approach. Experimental flight tests at the Ohio University Airport have been preformed to collect laser range data of a mobile hazard. Hazard detection and recognition is accomplished with digital surface model elimination and region-growing based feature extraction. The inclusion of an inertial measurement unit and a GPS receiver into the data collection system allow for the precise georeferencing of the hazard.

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AFM/FTIR: A New Technique for Materials Characterization

The morphological and chemical structures of polymer systems can be studied using many different analytical techniques. Scanning probe microscopy, including the atomic force microscope (AFM), has developed into an outstanding technique for providing information regarding the surface properties and topography of materials on a nanometer scale. However, scanning probe microscopy does not provide any direct information regarding the material composition. Fourier-transform infrared spectroscopy (FTIR), on the other hand, is a powerful technique for determining the composition of a variety of materials, including polymers. However, the spatial resolution of FTIR spectroscopy is limited to approximately one micrometer. The long-term goal of our research is to develop a NEW instrument to determine the morphological properties and composition of polymer systems on a nanometer scale. Our group is also interested in the molecular structure of interphase regions in adhesive bonds. We would like to use the new AFM-FTIR instrument to characterize both surface properties and composition of interphases on a nanometer scale. Our approach is to combine the inherently high spatial resolution of an AFM with the powerful chemical characterization of FTIR spectroscopy. We have obtained initial AFM-FTIR spectra of a variety of polymers, including polystyrene, polycarbonate, polypropylene, polyethylene terephthalate, and several epoxy adhesive systems. This research could be brought to the classroom through discussion of refraction (bending) of light, since FTIR spectroscopy uses light to characterize materials. Trigonometry is used to describe how light is bent based on its interaction with the medium it is passing through and is important for many FTIR spectroscopy techniques.

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Use of an environmentally-derived inoculum to improve anaerobic digester performance under shock conditions

Anaerobic digesters are used to treat organic waste as the process reduces pathogens, and produces a good fertilizer and methane-containing biogas which may be used as a fuel or for electricity production. Anaerobic digesters are typically operated at neutral pH and warm temperatures because outside of this narrow range of conditions the digesters often stop operating. Anaerobic digesters are often very sensitive to sudden changes in temperature or pH which requires close maintenance, and the addition of heat and buffering chemicals to the reactors increases operating costs of the digesters. This has widely limited anaerobic digesters as a source of alternative energy while performing waste treatment. In wetlands, the production of methane from organic matter takes place under a wide range of temperatures and pH suggesting that a wetland soil may be a better inoculum for an anaerobic digester than a traditional one. Lab-scale anaerobic digesters were inoculated with either a traditional digester sludge, an acidic wetland soil, or a mixture of these two inocula. The digesters were exposed to sudden changes in temperature and pH, and response to these shocks was measured chemically and microbiologically. The acidic wetland soil inoculum performed better under shock conditions than either of the other two inocula, and was able to recover to normal operating levels after each shock. In addition, the digesters inoculated with the traditional inoculum performed better with each additional shock suggesting that the reactor microbial community was becoming more tolerant of the shocks. These results suggest that digester performance may be improved both by using different inocula and by periodically shocking the system to adapt the microbial community to later shocks.

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The Effect of Tibiofemoral Alignment on the Stresses in the Knee

Osteoarthritis (OA) is a degenerative disease of articular cartilage that affects millions of people. Local biomechanical factors may severely affect initiation and progression of knee OA due to changes in loading conditions at the knee. The frontal plane tibiofemoral alignment effects the varus moment at the knee and biomechanical studies have shown the varus moment is a key determinant in the load distribution at the knee and has been linked to OA progression. A normal knee will have a tibiofemoral angle approximately 7º valgus. Deviation from this angle leads to a knee joint with varus (< 7º, bow-legged,) or valgus (knocked-kneed, >7º) condition. The goal of this investigation was to determine the influence of the frontal plane tibiofemoral angle on the stresses at the knee. In this investigation, three subjects with different tibiofemoral angles were put through a motion analysis procedure developed to assess the frontal plane tibiofemoral angle and determine the force and moment reactions at the knee. The motion analysis results were used in subject specific 3-D knee finite element analysis (FEA) models created from magnetic resonance images (MRI) to determine the stress and contact area at the knee cartilage. The results showed the varus moment at the knee was larger for a varus knee compared to a normal knee and valgus knee. The FEA models showed the individual with a varus knee condition had a greater contact area and greater maximum stress at the knee cartilage compared to a normal knee condition and valgus knee condition. These results could be used by health care providers to suggest preventive measures to slow or prevent the initiation and progression of OA.