Welcome to the 2008 Bucknell Engineering Student Research Symposium. At the core of its mission, the College of Engineering strives to prepare students for entry into the engineering profession, related fields and graduate programs, and for continuing development as highly competent professionals and responsible members of society. The engineering faculty are firmly dedicated to teaching excellence but are also actively engaged in scholarship in support of our educational mission and their disciplines. When students collaborate directly with faculty on challenging projects of significance, it brings together these two complimentary goals and enhances our ability to fulfill our educational mission. Bucknell provides extensive opportunities for such research, and students and faculty both benefit greatly from these interactions. We are proud to showcase the research activities of our engineering students, and it is a pleasure to celebrate their achievements today.

It is fitting that this symposium is held in concert with the third annual College of Engineering Celebration Dinner co-hosted by the Bucknell Engineering Alumni Association, an organization committed to enriching our educational programs and enhancing a wide range of opportunities for our students. We hope that you enjoy this opportunity to interact with our engineering students and faculty, and learn about some of the impressive research they have accomplished together this year.

Sincerely,

James G. Orbison, Ph.D., P.E.
Dean, College of Engineering
An investigation into the mobility of unmanned ground vehicles for use in urban environments is being conducted in conjunction with the Institute for Human and Machine Cognition (IHMC) in Pensacola, Florida to provide a resource for our armed forces. These vehicles will serve as substitutes for U.S. soldiers abroad in life-threatening situations. The Office of Naval Research funded this project, which explores two possible configurations for these autonomous, mobile robots. IHMC currently has both a bipedal, walking prototype and a reconfigurable, wheeled prototype. Our role in this project focused on the bipedal prototype; in an attempt to augment information capture at IHMC, we indexed the components of this prototype and visually represented the connections between them using CmapTools, a concept mapping software developed by IHMC. After transferring these connections into a binary, MATLAB matrix, we employed a macro to sort the matrix and identify potential clusters. These clusters are of interest because they represent potential platforming opportunities. Platforming within the biped and between the biped and wheeled robot types can reduce manufacturing cost and maintenance complexity. We will be using the identified clusters along with other research to enhance the design of the biped. Resources at Bucknell and throughout the area will be utilized to for ongoing support of the project.
Biography

Susan is from Middletown, New York. She is a junior, mechanical engineering major. She is the vice president of the Bucknell student chapter of the American Society of Mechanical Engineers (ASME). She is also a member of the Alpha Lambda Delta freshman honor society and the Society of Women Engineers (SWE).

Daniel is a junior, mechanical engineer from Rockwood, Pennsylvania. He is the Bucknell Engineering Alumni Association (BEAA) representative for the Bucknell student chapter of the ASME. This summer, he had the opportunity to travel to Switzerland, Germany, and France with the ENGR 290 program.
A Novel Photon Query Reordering Algorithm

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In graphics, global illumination describes rendering algorithms which are capable of simulating a wide range of light properties such as shadows, caustics, and color bleeding. While these algorithms are superior to those currently used in interactive applications, they are computationally expensive and thus are only currently used in applications which can afford to take minutes to generate a single frame, such as animated movies. Our research deals with one such global illumination algorithm, called photon mapping, in order to increase the efficiency with which it could in the near future be implemented in consumer graphics hardware. Reordering memory accesses during photon mapping makes much better use of the cache and decreases the requirements for memory bandwidth, the system weak point, by over an order of magnitude. We have developed a new reordering algorithm which uses data from an earlier stage of the photon mapping process to assign each memory query a number based on it’s position in space. We then reorder based upon these numbers, causing memory queries in each specific region of the scene to be performed at similar times. These nearby queries reuse much of the same data, thus greatly reducing bandwidth requirements. While our algorithm performs a better reordering than other algorithms in certain scenes, it is not the best. However, it requires little preprocessing due to it’s use of data already created but thrown away in earlier stages of rendering. This makes it a potentially effective reordering solution for implementation in near future interactive graphics hardware. We are still evaluating the feasibility and benefits of this algorithm.
Biography

Eli is from Oakland, California. He is a senior computer science and engineering major with a minor in math. He is a member of the Bucknell student chapter of the Association for Computing Machinery, where he serves as senior class representative following a term as junior class representative. His academic interests include computer graphics, artificial intelligence, and microrobotics.
Biography

Blank – Campbel-Copp
Solid oxide fuel cells (SOFC) are electrochemical devices that offer great promise for efficient and clean direct conversion of chemical energy into electricity. Development of a fuel electrode (anode) that is stable with exposure to reduction-oxidation (redox) cycles is one of the primary challenges for small-scale SOFC systems. This study investigated the development of novel electronically conductive ceramic materials as redox stable SOFC anodes. The conductivity of $\text{SrNb}_x\text{Ti}_{1-x}\text{O}_3$ (SNT), for $x = 0.05, 0.1,$ and $0.2$, was measured under relevant fuel cell operating and redox conditions. In addition, the electronic conductivity of porous SNT/yttria-stabilized zirconia (YSZ) composites was measured to be of order 1 S/cm, which exceeds SOFC anode requirements. X-ray diffraction (XRD) data suggest the SNT and YSZ do not react, indicating SNT could be used in SOFCs. We are currently fabricating small-scale fuel cell prototypes to characterize the performance of these novel anodes.
Biography

Kelly is from Tewksbury, New Jersey. She is a sophomore chemical engineering major and biomedical engineering minor. She is a presidential fellow at Bucknell and has been researching in the chemical engineering department since her freshman year. She has been a member of the Bucknell Chapter of the Society of Women Engineers since 2007. In the spring of 2008, she was inducted as a member of the Alpha Lambda Delta freshman honor society.

Mike is from Reading, Pennsylvania. He is a senior chemical engineering major and biomedical engineering minor. He is currently the secretary of the Bucknell student chapter of the American Institute of Chemical Engineers (AIChE). After graduation he plans to go to graduate school enrolled in a doctoral program. He is currently working on an honors thesis regarding functionalized degradable polyesters.
Despite extensive research, the mechanism of breast tumor occurrence, especially how tumor cells spread from the breast to other organs in the process called metastasis, is far from clear. In normal breast tissue, epithelial align along a basement membrane to form ducts and glands. In invasive breast cancers, cells begin the metastatic process by invading through the basement membrane into the surrounding tissue, called the stroma. Recent studies imply that the stroma in the breast tissue, called the micro-environment, may alter the behavior of epithelial cells. Fibroblasts are the predominant cells in the stroma. My objective is to study the role of T-lymphoma invasion and metastasis inducing gene-1 (Tiam1) in fibroblasts. Tiam1 is a protein that belongs to the Dbl family of guanine nucleotide exchange factors (GEF) which catalyzes the exchange of bound GDP to GTP and activates Rho-GTPases like the RAC proteins. Rac-mediated cell signaling is known to influence various aspects of actin dynamics, regulation of the cell cycle and migration, gene expression and cell cycle recognition.

My hypothesis is that Tiam1 signaling in human mammary fibroblasts alters the behavior of associated human mammary epithelial cells (HMEC). When co-cultured together in a 3D matrix containing extracellular matrix proteins, mammary fibroblasts and mammary epithelial cells form spheroids with fibroblasts in the interior and the epithelial cells coating the exterior of the spheroids. Previous studies in our lab have shown that in spheroid co-cultures, fibroblasts with reduced levels of Tiam1 due to short hairpin-mediated gene silencing promote epithelial cell outgrowth (invasion) into the matrix.

In my project I will study how Tiam1 signaling in fibroblasts affects the invasiveness and migratory properties of co-cultured epithelial cells. I will generate spheroid co-cultures of HMEC with human mammary fibroblasts expressing wild type or reduced levels of Tiam1 (shTiam). I will then disperse the co-cultures, separate the cells by using FACS fluorescent activated cell sorting, and analyze the isolated epithelial cells using growth and transwell migration assays. I will then use these epithelial cells to regenerate spheroid co-cultures with wild type or shTiam1 fibroblasts and do analysis on the migratory behaviors for the second time on the epithelial cells. I will also assess the active signal pathways in the epithelial cells using western blots. These studies will allow me to analyze how epithelial cells respond to different levels of Tiam1 signaling in associated fibroblasts.
Maya Chase is a Mechanical Engineer minoring in Biomedical Engineering. I got my internship through the Tufts' Sackler School of Biomedical Sciences and worked in the Molecular Oncology Research Institution of the Tufts Medical Center. I grew up in New York City on the Lower East Side of Manhattan with two medical doctors for parents. As much as I don't like admitting it, their passion for medicine has definitely influenced my love for Biology and Science in general. My interests in science and math led me to pursue a degree in Mechanical Engineering and a minor in Biomedical Engineering. I plan on going to graduate school for Biomedical Engineering and pursue a career in Biotechnology or Biomechanics. Although I am an engineer, I am also have many other interests including Hip Hop, women's rights, social justice and improving the educational systems in our country, specifically in the inner cities.
Epilepsy is a neurological disorder characterized by spontaneous synchronization of large collections of neurons. The resulting pulses of electrical activity cause the seizures that are characteristic of epileptic patients. Most research in neurophysiological problems of this type use models to simulate real neural networks. We simulated a macaque cortical network composed of spike and burst Hindmarsh-Rose nuclei with randomly distributed parameters. When a single periodically bursting nucleus was coupled unidirectionally to 20% of the network, the summed network behavior exhibited a period of normal behavior, then synchronization in 75% of the network, a period of quiescence, and a subsequent return to normal behavior; these are the phases of a typical seizure. To explain this behavior, we coupled two Hindmarsh-Rose nuclei, the first being the periodically bursting nucleus from the macaque network. Regardless of the dynamics of the second nucleus, there was a range of coupling over which the second nucleus was temporarily entrained, then shut off for some time before returning to normal. The limits of this range were dependent upon the innate behavior of nucleus two. We hypothesize that, in neural networks, the initiation and propagation of epileptiform activity is dependent upon the network topology and coupling strength, but also on the dynamics of the nuclei. Studying the underlying mechanisms of neuronal synchronization may lead to a better understanding of epilepsy, enabling more systematic design of treatments. NSF PHY-0552790.
Biography

Nate Crosby is a senior Biomedical Engineering major from Claremont, NH. He participated in the Physics REU program at Bucknell University in the summer of 2008, and his research is also supported by a Presidential Fellowship. His work was recently presented at the national Biomedical Engineering Society conference in St. Louis, MO. Nate is a member of the Alpha Lambda Delta honor society (2005), the Biomedical Engineering Society, and the Tau Beta Pi engineering honor society (2007). On campus, Nate is involved with the Bucknell Jazz Band, the SwingSet jazz combo, and the InterVarsity Christian Fellowship.
Structures are designed to adhere to different types of specified loading conditions. However, there is little guidance on how to design structures such as stadiums that undergo dynamic loading as a result of crowds moving in synchronization. It is impossible to measure the actual forces exerted by a crowd on a structure. Also, there is much uncertainty in crowd loading. Weight distribution as well as lack of synchronization contributes to difficulties in accurately identifying such loading conditions. In order to assess a structure for dynamic serviceability, it is important to accurately predict the dynamic loading. As a result, B.R. Ellis and J.D. Littler proposed a method that utilizes acceleration response data of a dynamically loaded structure to create the applied forcing function. To test this method, a computer program was written using MATLAB, computer modeling was done using SAP2000, and small scale experimental tests were conducted. This research focused on synchronized jumping. The testing was done with groups of one, two, and four persons jumping at frequencies of 1.8, 2.0, 2.25, and 2.37 Hz. After applying the mentioned Crowd Load Estimation method, it was determined that the method could be used to accurately determine a forcing function created by small groups jumping in unison.
Biography

Rob is currently a junior candidate for the Bachelor of Science degree in Civil and Environmental Engineering as well as a Bachelor of Management for Engineers. In addition to his studies, Rob has been a member of Bucknell’s student chapter of the American Society of Civil Engineers (ASCE) and has been a member of the Bucknell football team since his freshman year. He is also the Associate Editor of Bucknell’s chapter of Chi Epsilon. The past two summers he has spent time working on independent research on various topics relating to vibration serviceability of structures. This past summer, he was awarded the Michael Baker Jr. Summer Research Fellowship and presented his work to engineers at the company’s Pittsburgh office. After graduation in 2010, Rob plans to attend graduate school where he will continue his education in the field of structural engineering and work towards professional licensure.
The increasing desire to use alternative fuels in aviation has given rise to a need to study and analyze fuels like JP-900. Currently, JP-8 is being used as a commercial aviation fuel. As a possible successor to JP-8, the properties of JP-900 need to be characterized and compared with JP-8 in order to determine its feasibility as a next generation aviation fuel.

JP-900 is a coal-based fuel, with the major components being cycloalkanes such as Decalin and its derivatives (basically two ringed structures), which also has good heat sink capabilities. The thermal stability of JP-900 plays an important role, since the operating temperatures for commercial engines are increasing and a more thermally stable fuel can act as a coolant. This fuel has been laboratory tested for properties including smoke point, flash point, heat of combustion, freeze point, and thermal stability. JP-900 satisfies the minimum requirements for most properties when compared with commercial JP-8 used in aviation with the added advantage of stability at elevated temperatures.

Experiments were performed as part of an ongoing study of alternative liquid fuels at the Propulsion Engineering Research Center at The Pennsylvania State University. The experimental test setup consists of a model gas turbine dump combustor with provisions for laser extinction, emissions and combustion stability measurements. The fuel injection process is completed using a Delavan pressure atomizer, commonly referred as a peanut nozzle. Also, an air swirler is included upstream of fuel injector to promote better mixing of fuel droplets and to help anchor the flame. The soot volume fractions were determined by laser extinction measurements using an Argon-ion laser operating at 514.5 nm. The extinction measurements were made 248 mm downstream of the dump plane. The emissions setup supports measurements of CO, CO₂, O₂, NO and NOₓ.
Biography

AJ Greulich is from Westlake Village, CA. He is a senior at Bucknell University majoring in Mechanical Engineering. AJ is a member of Phi Kappa Psi fraternity. Before his research at Penn State University he interned at a civil engineering firm named Coastal Frontiers. The firm specialized in erosion control and the construction of temporary islands for offshore drilling. He is pursuing a career in engineering and eventually wants to get his masters in business administration.
ATOMIZATION, IGNITION, AND SUSTAINED CATALYTIC COMBUSTION OF LIQUID FUELS
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The United States Army is currently exploring sources of portable power that are alternatives to batteries. An option that is currently being developed involves the catalytic combustion of liquid fuels and integration with thermoelectric devices to produce electricity. A specific goal of the Army is to develop the use of JP-8, the standard military diesel fuel, in these portable devices. For this study, we constructed a new liquid fuel atomization system with a catalytic combustion reactor. This setup involved the mixing of liquid fuel and air in a nozzle and the subsequent spraying of the mixture on a Platinum-Alumina-coated monolith. A glass reactor and a stainless steel reactor were both used to house the combustion reaction in different experiments. The liquid flow rate was accurately controlled by a syringe pump and the air flow rate was accurately set with a mass flow controller. By precisely selecting the relative flow rates of liquid and air, we collected data for a variety of liquid fuels at various equivalence ratios. Ignition and sustained catalytic combustion were observed for all liquid fuels tested, including methanol, ethanol, 1-propanol, n-decane, and, most significantly, JP-8. Methanol was shown to be an effective reducing agent between experiments. Reactions taking place in the stainless steel reactor were successfully integrated with thermoelectric devices, producing approximately 0.10 W of power. The method developed in this laboratory provided preliminary proof that JP-8 undergoes self-sustained catalytic combustion when ignited in a pre-heated reactor.
Nick is from Wilmington, Delaware. He is a senior majoring in Chemical Engineering and Spanish. He has been a member of the Bucknell student chapter of the American Institute of Chemical Engineering (AICHE) since 2006. He is also a member of Tau Beta Pi, an engineering honor society; he was inducted to this organization in 2007. In the spring of 2008, he spent the semester studying in Tarragona, Spain, where he took classes in Chemical Engineering and Spanish literature.
Hydrogels are water-swollen polymers with applications as controlled release devices for drug delivery and cell scaffolds for tissue engineering. Chemically cross-linked polyethylene glycol (PEG) is one of the most commonly used hydrogels for these applications. PEG has become the material of choice because of its ability to resist nonspecific protein adsorption. Protein adsorption plays a key role in foreign body and immune responses of any material placed in the body. One of our research goals is to determine why PEG can resist nonspecific protein adsorption so effectively. We hypothesize water’s interaction with the individual monomers plays a role in this protein resistance. To this end, we synthesized polyethylene glycol dimethacrylate, a crosslinkable precursor to hydrogels, by microwave reaction of PEG diol and methacrylic anhydride. Microwave reaction yielded the dimethacrylate within five minutes and over 90% of the diols converted into dimethacrylate. Aqueous solutions of the dimethacrylates were converted to hydrogels with photoinitiator and UV light. The hydrogels were characterized with FTIR and dried to determine water content in each gel. The actual dynamics of the water with the hydrogel, the effect of crosslinking on the polymer relaxations and interactions with water were studied with nuclear magnetic resonance (NMR) measurements.
Biography

Kimberly is from Falmouth, Maine. She is currently a senior chemical engineering major and biomedical engineering minor. She is a member of the Bucknell student chapter of American Institute of Chemical Engineering (AICHE). In the summers of 2007 and 2008, she was able to gain work experience in the biotechnology industry as an intern in immunoassay research and development at IDEXX Laboratories in Westbrook, Maine. She is a member of Alpha Lambda Delta freshman honor society, as well as the Mortar Board senior honor society. In addition to academics, Kimberly is also part of Bucknell’s division I cross country, indoor and outdoor track teams and the Alpha Phi Omega service fraternity.
Polymer nanocomposites are a class of advanced materials that contain small amounts (1-5 vol%) of fillers dispersed in a polymer matrix. These “nano”fillers can greatly enhance the physical properties of the resulting composites, such as mechanical stiffness and toughness, thermal stability, electrical conductivity, chemical resistance, and reduced gas permeability. Numerous potential property improvements in polymer nanocomposites lead to a wide range of high-performance applications, from packaging to automotive parts and sporting goods. There are several different techniques to produce polymer nanocomposites, which are very different from one another, and each has notable advantages and disadvantages. Analyzing different processing methods allows for the selection of a superior process for a given nanocomposite. This becomes a fundamental piece for the understanding of processing-structure-property relationships, ultimately helping us determine if a fabricated nanocomposite has achieved the aforementioned desirable material properties. In this project, several types of polymer-graphite nanocomposites were fabricated using various processing techniques, including melt-mixing, extrusion, cryogenic compounding, and solid-state shear pulverization (SSSP). Four polymer matrices were used in the study: polypropylene (PP), polystyrene (PS), poly(methyl-methacrylate) (PMMA), and styrene-butadiene-styrene (SBS) block copolymer. Processed nanocomposites were tested for thermal, electrical, mechanical, and morphological characterization. The results were used to determine superior processing methods for the polymer-graphite nanocomposites.
Biography

Paul, also known as P.J., is from Clarks Summit, Pennsylvania. He is a fifth year student pursuing dual MS/BS degrees in chemical engineering. P.J. is a member of the Bucknell student chapter of the American Institute of Chemical Engineers (AIChE) since 2005, in which he has previously served as social chair and vice president. He has not only had extensive research experience with Professor Wakabayashi (graduate research) and Professor Raymond (undergraduate research) but also has industrial experience at Armstrong World Industries as a Process Engineering Intern in the summer of 2007. Upon graduation, P.J. plans to start his professional career in an industry where he can apply his chemical and materials engineering knowledge to real-world research and manufacturing.
Content-addressed memory (CAM) error detection can be implemented in sub-45nm VLSI architecture by adding pass-transistor parity chains onto the standard 10-transistor NORCAM architecture while maintaining acceptable performance levels. A 4-transistor parity bit chain was implemented on each cell in a chain across each memory word. PSPICE was utilized to perform theoretical analysis of sub-45nm NORCAM arrays to determine performance limits of the proposed system: threshold voltage variances between 0.5 and 1.0V were applied to determine failure rates both with and without the parity bit chains. The parity chains were shown to have improved the performance of the system markedly without significantly hindering the performance of the system above certain threshold voltage levels, consistent with ITRS benchmarks set for coming years.
Biography

Zaf is from Englewood, NJ. He is a senior electrical engineering major and current president of the Bucknell student chapter of the Institute for Electronics and Electrical Engineers (IEEE). He serves as an intern in the Office of Development & Alumni Relations as well as a student government representative for his class.
The passive dynamic bipedal walker is a robot designed to have a low energy walking gait that utilizes aspects of natural walking. This is often referred to as controlled falling because the robot is in a state of dynamic equilibrium in which forward momentum is used to conserve energy input. Passive dynamic walkers require less actuation to control their motion than robots in constant static equilibrium. A completely passive walker is capable of using only the force of gravity to maintain motion down a slight incline. Two dimensional walkers are completely stable in one direction and in order to do so they often times have two sets of legs. In this type of walker each set of legs needs to swing past the other during a step. The feet need to be lifted out of the way to prevent scuffing. This is accomplished by ankle actuation to lift the feet during each step. The primary objective of this work was to complete work on the walker at Bucknell built by a senior design team in 2007 and to have it walking (ideally for a duration dependent on battery life) by the end of the summer. There were several main issues that needed to be worked on before this goal could be accomplished. First, the electronics needed to be put together and packaged in a way that they could easily be attached to the walker. The next issue was programming the robot to be able to walk indefinitely using sensors and motor actuation. Lastly, there were many mechanical issues that presented themselves throughout the testing process and a great deal of time went into correcting these issues.
Biography

Matthew is a junior mechanical engineering major and philosophy minor at Bucknell University. He is from Brighton, Michigan. Matt is a recipient of the Presidential Fellowship Scholarship and has been doing various work through the program throughout his time at Bucknell. During the summer of 2008 and part of the spring, Matt performed his research on the bipedal walker at Bucknell University with Professor Keith Buffinton. He has been a member of the Bucknell student chapter of the American Society of Mechanical Engineers (ASME) since 2007. Additionally, Matt is an active member of the Penn Gamma chapter of the Phi Kappa Psi fraternity at Bucknell.
Preparation of a Gel Form of Heart Extracellular Matrix

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Negative left ventricular remodeling post-myocardial infarction (MI) can lead to a decrease in cardiac function and eventual heart failure. Various studies to treat MI have investigated the injection of cells directly into the infarct wall, although many studies have shown poor survival rates. The objective of this study is to develop an in situ engineered cardiac tissue gel form composed of native heart extracellular matrix (ECM), evaluate the ability of this gel platform to support isolated neonatal cardiomyocytes in vitro, and investigate whether the gel will act as a biological scaffold for the adhesion and growth of transplanted cardiomyocytes upon injection in vivo. We have found that decellularized heart ECM readily forms a gel and can be plated with cells once retrogradely perfused with sodium dodecyl sulfate and triton-100x detergents, crushed, minimally digested with pepsin, neutralized, and finally brought up to 37°C. An injectable gel could potentially conform to any three-dimensional shape and improve cell transplant survival to aid in the regeneration of heart tissue. Our study shows that the gel self-assembles when brought to physiological conditions and could be delivered to the left ventricle with minimally invasive techniques.
Biography

Rob Littlefield is a senior biomedical engineer who spent this past summer at University of California San Diego developing novel biomaterials for the treatment of heart disease post myocardial infarction. Interested in cardiology, tissue engineering and nanotechnology, Rob is hoping to continue his studies at graduate school next year while staying within the bioengineering field.
SMALL-MOLECULE DIFFUSION THROUGH A HYDROGEL IN A MICROFLUIDIC DEVICE

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Hydrogels are used extensively in the biomedical industry because of their biocompatibility properties. The unique structure of a hydrogel can affect the diffusion process. The diffusion of particles through a hydrogel’s cross-linked polymer structure swollen in an aqueous environment is relevant to applications such as drug delivery and modeling transport in parts of the human body. Interactions between the diffusive species and the hydrogel network are studied in a homogenous environment (semi-infinite slab) at the hydrogel-water boundary in a microfluidic device.

Closed-face microfluidic devices are fabricated using photolithography. The hydrogels are characterized by their equilibrium water content. Unsteady diffusion within the microfluidic device is monitored and recorded using a digital microscope. The information is analyzed with techniques drawn from digital microscopy and image analysis, and a diffusion coefficient is obtained.

These diffusion coefficients are related to those obtained from NMR analysis.
Biography

Andrew Litzenberger is a senior chemical engineering major, currently enrolled in Bucknell’s 3-2 combined MS BS program. He has been a member of the Bucknell student chapter of the American Institute of Chemical Engineering (AICHE) since 2007. Andrew spent the summer of 2008 doing research on Bucknell’s campus. He went abroad in the fall of 2007 to the University of Queensland, in Brisbane, Australia.
CRYOGENIC MILLING OF CLASSICAL POLYMER NANOCOMPOSITES:
POLYPROPYLENE-CLAY AND -CARBON NANOTUBE HYBRIDS

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Polymer nanocomposites are of scientific and technological interest due to the numerous potential physical property improvements compared to the neat polymer or the conventional macrocomposites. Due to the very small loading of the nanofillers, these polymer hybrids have a wide range of high-performance applications at relatively low cost. The two widely studied systems are polymer-clay and polymer-carbon nanotube nanocomposites. Clay, commonly known as layered silicate, is an inorganic material composed of closely-packed silica and alumina layers approximately 1 nm apart. Carbon nanotubes, on the other hand, are bundles of rolled graphene sheets with diameters on the order of nanometers. Many of these polymer nanocomposites have been made by melt-state processing, in situ polymerization, or solution blending. Recently, solid-state processing of polymer nanocomposites has been gaining popularity in the research community. This method imparts high shear and/or impact forces to the materials below the melt and/or glass transition temperature of the matrix and the filler, thereby achieving separation and dispersion of the filler.

This paper investigates the feasibility of cryogenic milling as a polymer nanocomposite fabrication technique. Cryogenic milling is a batch-scale mechanochemical process in which a tungsten carbide bar repeatedly impacts the materials inside a cylinder at the cryogenic temperature (~77K). Two polypropylene-based hybrid systems were investigated: one system contains pristine montmorillonite filler, while the second incorporates industrial grade, multi-walled carbon nanotubes suitable for eventual scale-up for mass-production. The processing parameters, such as milling time and cryogenic soaking time, were varied for evaluation of their effects upon the final structure and properties of the resulting hybrids. Micro- and nanostructure of the processed samples were probed using X-ray diffraction and electron microscopy methods. Thermal properties were measured by differential scanning calorimetry, while mechanical characterization was conducted using a uniaxial tensile test.
Biography

Austin came from Keene, New Hampshire to pursue a degree in chemical engineering at Bucknell University. He is currently in his senior year of the endeavor. Over the past summer, Austin worked with Eddie and Professor Wakabayashi in the development of polymer nanocomposites. Following graduation, he plans on using his background in chemical engineering to pursue a career in patent law.

Edwin, commonly called Eddie, is originally from Anaheim, California. He is currently in his senior year and will be graduating in the spring with a degree in chemical engineering. Eddie is the class of 2009 student representative and an engineering tour guide. Over the past two summers, he has been a research assistant with Professor Wakabayashi and a process engineering intern with SPEC Services, Inc. After graduation, Eddie hopes to obtain a job as a process engineer with a chemical or materials company.
Reconfigurable hardware is hardware that can be “designed” on a computer and immediately employed. Much like software, reconfigurable hardware allows the designer to easily make changes, while still working on the level of application-specific hardware, making it desirable for research applications. The specific type of reconfigurable hardware technology used in this project is the Field Programmable Gate Array (FPGA). Performing digital signal processing (DSP) with an FPGA is practical when time is a concern, since DSP is often complex and time-consuming, and the FPGA can be configured process data using hardware, where operations can be performed in parallel. This is much faster than using a processor, which can only handle one task at a time. Thus, it is very advantageous to use reconfigurable hardware to process data for noise removal, which involves complicated algorithms. To upload and download data to the circuit board, an Ethernet connection to a computer was used. Driver software was written to run on a processor embedded in the FPGA fabric, allowing it to communicate with the Ethernet send/receive chip built into the Xilinx ML310 circuit board used. With the ability to transfer data to and from the board, various data processing algorithms were tested both in hardware and software to verify the speed advantages of processing data in hardware. Hardware resource usage and the processing and storage of different memory types were investigated. The framework created will hopefully be used to implement all or part of a noise reduction algorithm in hardware.
Biography

David is from Middletown, New Jersey. He is a senior electrical engineering major with French and physics minors. He is a member the Bucknell branch of the Institute of Electrical and Electronics Engineers (IEEE). He has worked in the past as a laboratory teaching assistant for the electrical engineering department at Bucknell. David is also a member of the Tau Beta Pi engineering honor society and a member of the Alpha Lambda Delta honor society.
Silica aerogels have potential to be used for numerous applications, including thermal and acoustic insulation for launch vehicles, space suits and aircraft. The low-weight, highly porous structure of an aerogel results in a tortuous pathway that greatly reduces thermal conductivity resulting in a lightweight, insulative material. The underlying silica matrix of the aerogel tends to be very rigid and brittle, which restricts the current applications. Aerogels have been cross-linked with various polymers to enhance structural integrity showing promising results. Previous studies have shown an increase in strength of two orders of magnitude, while only doubling the density. It is also desirable for the aerogels to be flexible. For that purpose, organic linking groups have been added to the underlying silica structure. It is expected that this will help the aerogel recover after compression and exhibit more flexibility. In this study, the effect of cross-linking aerogels with di-isocyanate after adding the organic linking groups is being investigated. A design of experiments approach was used to vary the total silicon concentration, the percent organic linker, the percent amine modified silane, and the concentration of di-isocyanate in the polymer solution to determine the effect that each parameter has on the aerogel’s properties.
Biography

Renee is a senior chemical engineering major and biomedical engineering minor. She is a member of Bucknell’s chapter of American Institute of Chemical Engineers (AICHE) and Society of Women Engineers (SWE) since 2006. During the summer of 2007, she interned at Frito Lay, Inc. under the direction of a processing engineer at a manufacturing plant in York, PA. During the summer of 2008, she gained research experience through NASA’s Summer Internship program at the Glenn Research Center located in Cleveland, Ohio. She has also been a teaching assistant for Bucknell’s chemical engineering department since 2007.
Spectator-induced dynamic loading has the ability to generate structural responses not possible through static loading. This type of loading, particularly coordinated rhythmic loading, is not completely understood and is the topic of this literature review. When spectators move rhythmically in either the horizontal or vertical direction at or near the natural frequency of a structure, structural resonance can occur causing the structure to move in a vibratory motion. Depending on the magnitude of the response, panic and distress could ensue among the crowd. Experimental testing and observation of structures where dynamic loading occurs has allowed researchers to formulate mathematical models to simulate periodic loading due to rhythmic motions such as jumping, bouncing, stamping and swaying to be applied in structural design and serviceability. While the basic models maintain key similarities, there are certain differences such as equation components within these models that must be addressed. There are also other variables not addressed in the mathematical models present during spectator-induced dynamic loading that affect the ability of a crowd to synchronize. Current structural safety and serviceability standards and recommendations such as those created by the British Standards Institute and the Institution of Structural Engineers give guidance toward solving dynamic loading issues, but discrepancies still arise and some topics remain unresolved. This literature review organizes the current state of knowledge on dynamic loading from the perspectives of a variety of disciplines including biomechanical and civil engineering. It systematically summarizes these subjects and notes the areas related to spectator-induced dynamic loading that call for further research.
Biography

Kyle is a junior Civil and Environmental Engineering major from Landisville, PA. He is a member of the Bucknell student chapter of the American Society of Civil Engineers (ASCE) and is also a member of the varsity Cross Country and Track and Field teams at Bucknell. After graduation, Kyle plans to pursue a career in Structural Engineering.
Geoenvironmental containment refers to practices used to prevent migration of subsurface contaminants through the use of physical barriers. For example, soil-bentonite cutoff walls often are employed as a containment method in site remediation applications to minimize migration of existing subsurface contaminants as well as for groundwater flow control during construction.

Because of the nature of the contaminants being contained and the lack of alternative treatment technologies, it is often necessary for soil-bentonite cutoff walls to have a long performance lifetime (i.e., tens to hundreds of years). These vertical cutoff walls are often subjected to little or no post construction testing or monitoring. The lack of testing warrants further discussion because little is known about how these walls function on a macro level. Specifically the state of stress that exists within a vertical cutoff wall is known to be less than that predicted by a geostatic stress distribution, but the actual value is a highly debated topic. Since the state of stress is directly related to the permeability and permeability is often the largest design constraint for these walls, it is important to be able to accurately predict the state of stress within these walls. Given the long time span of these walls and soils tendency to consolidate over time the state of stress must also be predicted as it changes with consolidation. The above considerations warranted a study using multiple in-situ testing methods, each with its own unique advantages and flaws. Bucknell’s recently acquired drill rig was used in this endeavor to determine if or how the properties of vertical cutoff walls change over time.

The slurry wall tested during the summer of 2008 is located in Birdsboro, PA. The wall was built around a municipal wastewater treatment plant for flood control. Immediately upon the completion of construction a cone penetration test (CPT), vane shear test, and Marchetti dilatometer test were completed at two locations within the wall. These same tests were conducted five days after wall completion. In order to gain an understanding of the drying and consolidation behavior seven moisture probes were installed in the wall at two foot increments. These probes have and will continue to give a measure of the volumetric water content vs. depth. An undisturbed sample of the newly constructed wall was taken using a Shelby tube sampler. Future data sets are planned, but to date have not been completed.
Biography

Daniel is from Pittsburgh, PA. He is a recent Bucknell graduate (2008) and is currently pursuing his master’s degree in Civil and Environmental Engineering under Jeffrey Evans. Last year he was President of Bucknell’s chapter of Chi Epsilon, a national Civil Engineering honor society. He is also a member of Bucknell’s chapters of Tau Beta Pi and ASCE (American Society of Civil Engineering). He is an associated member of ADSC (American Drilling Society). His research centers around investigating the long-
Optimizing VEX Robotics Design Systems for Intelligent Tasks

Ivory Sarceño, Advisor: Dr. Corinna Lathan
Co-Principal Investigator: James Drane
Team Lead: Yuridia Robeson
Research Associates: Michael Cato, Joseph Logrande, Ivory Sarceño
Thanks To: NASA Robotics Academy 2008, Innovation First, and Anthrotronix Inc.

This year the makers of VEX Robotic Design Systems, Innovation First (IFI) wanted to make a shift from promoting engineering and robotics through remote-controlled robots, or tele-operated robots. They want students to become more aware of the capabilities of robotics, which is why they are pushing for autonomy. Innovation First asked the Robotic Innovators of Tomorrow (R.I.O.T.), the team of interns from NASA, to complete four tasks for them; four tasks that were essential for executing their plan.

The four tasks entailed 1) improving the technical documentation of the sensors currently available in their kits to make it easier for kids to understand, but at the same time provide enough information for it to be useful for college students as well, 2) researching and composing a spreadsheet of Integrated Circuits that would be ideal for new sensors, 3) coming up with three robotic competition games targeting middle school, high school, and college students to promote science, technology and robotics, and 4) create new showcase robots using the VEX Design Systems that show some of the intelligent tasks can be performed using the kit.

The team was also asked to come up with new ideas for HEX bugs - small autonomous robotic bugs that interact with their environment and show the power of robotics. In the end, all of the tasks were successfully complete. All the sensors were given new technical data sheets with a more extensive analysis but in an easier to understand usage of language. Compasses, accelerometers, gyroscopes were all researched and ideal Integrated Circuit chips were chosen to develop new sensors. Five showcase robots were created that showed how cool autonomous robots can be, and new ideas for Hex bugs were given to Innovation First.
Biography

Ivory Sarceño is from Washington, DC. She is a freshman mechanical engineering major at Bucknell University. She participated in the NASA Robotics Academy 2008 Summer internship program and was given the opportunity to do the research for the project mentioned above. Although Ivory was only a high school student, she was selected due to her prior experience with FIRST Robotics and Botball in High School.
The purpose of this project is to create a neural network to differentiate different types of documents. Neural networks are loosely modeled from the human brain and can recognize data after being trained. The neural network created in this project is able to take data derived from various computer science course descriptions, along with other random web pages taken from Bucknell’s website after being trained, it is able to differentiate between the documents from each category. To do this, I used an existing program to harvest various web pages and built an inverted index. After this was done, each term and document pair was assigned a value representing its relevance within that document. Since the objective of this network is document classification, the value we used was the term frequency, or the number of times the term appeared in the document, times the document frequency, or the total number of documents of that category that the term appeared in. This value was used because a term that appears many times in most of the documents in a category will be a useful term for differentiating one type of document from another. The values of the terms that, on average, have the highest relevance within a document type are then entered into the neural network, and it is trained to be able to tell the difference between the types based on these values. Initial results show that this model is able to differentiate documents of different types.
Biography

Ryan is from New Jersey. He is a junior Computer Science Engineering major and has been a member of the student chapter of the Association for Computing Machinery since 2007. He is also a Presidential Fellow at Bucknell and a TA for the computer science department. He is also a member of CHOICE, which is Bucknell’s substance-free living organization.
One goal of the material science and tissue engineering communities is to find man-made materials that mimic the mechanical, structural, and biological properties of the natural ones they are substituting. A promising bone substitute material must be biocompatible, porous enough to allow for cellular and vascular integration and exhibit a stiffness, strength and toughness similar to that of natural bone. To achieve a porous structure and a similarly high stiffness to bone we propose to use a composite of ceramic particles imbedded in a polymer matrix hydrogel. This project focused on the first step in creating these composite materials, optimizing the polymer-based hydrogel which was made of chitosan, the de-acetylated form of chitin. Chitin was the polymer of choice because in its natural form, the polymer matrix comprising the exoskeletons of arthropods, it resembles the mechanical properties of bone. The chitosan hydrogels were further stabilized with the natural cross-linker, genipin, the supplementation of gelatin, and the neutralization of the hydrogels with NaOH post-congealing. The produced hydrogels were subjected to manual property testing and observation using environmental scanning electron microscopes (ESEM) in their moist form and using SEM for lyophilized samples. The proposed material will be further mineralized with hydroxyapatite to provide the target properties. This project is unique because it is promising not only as an injectable material for bone substitution but also for cartilage replacement in a less-mineralized form.
Biography

Jenell Smith is a senior Biomedical Engineer at Bucknell University from Mechanicsburg, Pennsylvania. In the summer of 2008 she had the opportunity to do tissue engineering research with Dr. Ulrike Wegst through the Drexel Research Experience in Advanced Materials (DREAM) REU program at Drexel University. In the summer of 2007 she worked with Eric Tillman, Assistant Professor of Chemistry, at Bucknell University on research dealing with controlled polymerizations resulting in the publication of the manuscript entitled "9-Bromoanthracene Photodimers as Initiators in Controlled Radical Polymerization: Silane Radical Atom Abstraction Coupled with Nitroxide Mediated Polymerization" in the Journal of Polymer Science Part A: Polymer Chemistry. She is a member of Tau Beta Pi (The Engineering Honor Society), The Biomedical Engineering Society (BMES), and The Mortar Board (The Senior Honor Society). Jenell is also an active member in her sorority, Alpha Chi Omega, and currently holds the position of V.P. Recruitment.
Real-time data must be received on-time for applications like Voice over Internet Protocol (VoIP), streaming media, and online games to function correctly. The efficiency of a real-time data network is thus measured by the amount of data packets that are received on-time. For this study, our task was to design and implement a real-time data network performance analysis tool, a computer program that would create User Datagram Protocol (UDP) packets to be sent and received by nodes in the network and track if the packets were received on-time, late, or not at all. By examining the list of on-time, late, and dropped packets the ability of the data network to handle real-time traffic can be measured. This study was designed to test one specific type of network, a Mobile Ad-Hoc Network (MANET). MANETs are a type of network that computers can use to communicate with one another directly. Unlike wireless and wired networks, MANET computers connect through wireless network cards to other computers in the MANET. In order to have communication between two computers, the source computer must connect through other members of the network until it reaches the destination computer. However, the source, destination, and the intermediate computers in the path between the source and destination are mobile and thus may move during the communication. This may result in the path from a source to destination computer changing or breaking completely. Through our experiments, we tested the performance of multiple MANET worst-case scenarios.
Jared is from Dornsife, Pennsylvania. He is a senior computer science major and classics minor. He is a member of the Bucknell student chapter of the Association of Computing Machinery (ACM) since 2006. He is a member of Delta Upsilon fraternity, initiated in 2006. Within his fraternity, he is the producer of the DemiePlay, a theatrical performance written and performed by the brothers of Delta Upsilon whose proceeds are donated to charity. He is also involved in many other community service and philanthropic events through his membership in Delta Upsilon and personal motivation.
Field-programmable gate arrays (FPGAs) are programmable digital logic chips with high-speed computing capabilities whose functionality can be reprogrammed an unlimited number of times without physically manipulating the FPGA. The ML310 board is an embedded development platform that is based on the Virtex-II Pro FPGA.

The focus of this project was to port a custom Linux image to the ML310. Having Linux on the ML310 allows for user interaction with the system’s hardware. The advantage of customization is specialization. Software configured for a specific hardware design runs more efficiently than general purpose software since it only includes what is necessary to accomplish its intended function. The process of porting Linux involved creating a custom base hardware system, building a cross-compiler, configuring and compiling a custom Linux kernel, and constructing a root file system.

This project yielded a basic system running Linux 2.6 that did not have support for the Peripheral Component Interconnect, a bus to which many peripheral devices, such as the Ethernet Network Interface Controller and Universal Serial Bus, are connected to. Future work involves adding support for necessary peripheral devices to the system and taking advantage of the on-board FPGA’s high-speed computing capabilities to improve the performance of certain computations.
Biography

Juliana is from Kensington, Maryland. She is a senior computer science and engineering major. She is treasurer of the Bucknell chapter of the Association for Computer Machinery and a teaching assistant for the Computer Science Department. Outside of the classroom, she is the cartoonist for The Bucknellian, the president of the women’s club lacrosse team, and a Technology Desk assistant. Her research project was supported by Bucknell University’s Program for Undergraduate Research.
Capsule Formation and Separation in a Microfluidic Device
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Microfluidic devices can be used for many applications, including the formation of calcium-alginate capsules through a suspension polymerization in an oil solution from aqueous droplets of calcium chloride and sodium alginate. Calcium-alginate capsules have many potential uses, such as immunoisolation of cells. The high surface tension between the droplet of calcium chloride and sodium alginate necessitates the use of a surfactant and an elastomeric device with a judiciously chosen geometry. After creating the capsules, it is necessary to separate them out of the oil solution and into an aqueous solution. A common method of separation is centrifugation, which can damage both the capsules and the cells inside. The use of a microfluidic device with channel walls of disparate hydrophobicity has been shown to stabilize co-laminar flow of an oil phase and an aqueous phase. The disparity of hydrophobicity is accomplished by defining one side of the microfluidic device with a hydrogel. Due to the difference in surface energy within the channel, the aqueous stream is stabilized near hydrogel and the oil stream is stabilized near optical adhesive. The surface energy difference has shown promising results in separating the calcium-alginate capsules from the oil phase and into the aqueous phase.
Biography

Janet is from Cherry Hill, New Jersey and is a Junior Chemical Engineering major. She hopes to eventually obtain a career within the pharmaceutical industry or work in the field polymer or material science.

Renee is a senior chemical engineering major and biomedical engineering minor. She is a member of Bucknell’s chapter of American Institute of Chemical Engineers (AICHE) and Society of Women Engineers (SWE) since 2006. During the summer of 2007, she interned at Frito Lay, Inc. under the direction of a processing engineer at a manufacturing plant in York, PA. During the summer of 2008, she gained research experience through NASA’s Summer Internship program at the Glenn Research Center located in Cleveland, Ohio. She has also been a teaching assistant for Bucknell’s chemical engineering department since 2007.
Poster #27

Enhancing the Credibility of Wireless Network Simulations with Experiment Automation

Bryan Ward and Christopher Kenna. Advisor: Prof. Felipe Perrone
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The last few years have witnessed a growing consensus around the notion that many papers discussing wireless network simulation are plagued by issues that weaken their scientific value. A number of articles have shown evidence of this crisis of credibility and identified many of its causes. In this paper, we show that the methodology flaws in wireless network simulation can be avoided with the use of a framework for experiment automation. We describe the rationale that drove us to develop tools for component-based simulators intending to guide the experimental process from first to last stages. We conclude that a framework that imposes the right constraints on the experimenter can lead to more credible simulation studies. The framework we present helps the construction of consistent models, the definition of model parameters, the design and the execution of experiments, the analysis of output data, and the preparation of data for the dissemination of results that allow experiments to be reproduced.
Biography

Bryan is sophomore from Springfield, Virginia. He is simultaneously pursuing a BS in computer science and engineering and a BA in mathematics. A 2007 graduate from Thomas Jefferson High School for Science and Technology in Fairfax Virginia, he has been the class of 2011 representative to the Bucknell student chapter of the Association for Computing Machinery (ACM) since the fall of 2007. Bryan was inducted into the Alpha Lambda Delta freshman honor society in 2008. He conducted research in collaboration with Professor Felipe Perrone at Bucknell over the summer of 2008, and was sponsored by the university to travel with Dr. Perrone to Avignon, France to present this work at the IEEE International Workshop on Selected Topics in Mobile and Wireless Computing (STWiMob 2008).
Fluorescent quantum dots (QD) are collections of semiconducting atoms on the order of a few nanometers. Their emission properties are dictated by their sizes, and the surface state and traps of their surfaces. Quantum dots are an emerging alternative to traditional dyes for solar cells and bio-imaging because of their high quantum efficiency, stable emission, and ability to control their solubility and biological affinity through changing the chemistry of the QD ligands. One drawback of QDs is the requirement of oxygen and water free synthesis conditions, and difficulty in producing high quantum efficiency water soluble particles. We present a general method of synthesizing water soluble core-shell QDs. The water soluble core-shell QDs are synthesized by microwave heating from commercially available precursors in the presence of water and oxygen in a matter of minutes. This methodology allows for the controlled synthesis of an array of different QD’s, and the ability to tailor the chemical functionality of the QD surface with ligands. We are developing QDs to determine structure-property relationships of nanoparticle surface chemistry to intracellular localization for improved targeted therapies.
Biography

Jason is a junior biomedical engineer from Maywood, NJ, and the vice president of the Bucknell student chapter of the Biomedical Engineering Society (BMES). This past summer, he stayed at Bucknell and performed research in the Chemical Engineering Department as part of Prof. Erin Jablonski’s nanofabrication lab team with his advisor Prof. Brandon M. Vogel. He is continuing his research during the school year with student researchers, Danielle Woodhead and Jeweliet Yost. Though he is not a chemical engineer, he finds his research relevant because of its planned application in bio-imaging. His other nonacademic activities include Resident Assistant for First Year students, BSG 2010 representative, Chi Phi Fraternity member, Special Olympics Chair (Internal), and Habitat for Humanity Webmaster.
About the Bucknell Engineering
Student Research Symposium

The Engineering Student Research Symposium was born out of the desire to replicate, for students, the national-level conference experience without leaving campus. Originally funded through the General Electric Faculty For the Future program, all engineering students who have conducted research with a Bucknell faculty member or at an off-campus program were invited to submit abstracts for publication. Students then prepare their work in the form of a poster to be shared an educated national audience (you!). This allows students to exercise their presentation and networking skills in a manner similar to that found at larger conferences without ever leaving campus. Audience members will also benefit, by having a chance to learn more about the exciting work pursued by Bucknell engineering students.

We hope that you enjoy this sixth Bucknell Engineering Undergraduate Research Symposium, and we welcome your comments and suggestions on how this activity might improve for the future.

We wish to thank Dean Orbison, Angi Fritzges, and General Electric for their help bringing this symposium to reality.

Dr. Margot A. S. Vigeant, Associate Professor, Chemical Engineering
Dr. Karen T. Marosi, Associate Dean of Engineering
Lois A. Engle, Assistant to the Dean
Poster session organizers