FURI Research Symposium
This event is a poster session for engineering students to display and summarize findings from their research areas.

FURI Fulton Undergraduate Research Initiative
April 23, 2010

Welcome to the Spring 2010 Ira A. Fulton Schools of Engineering Undergraduate Student Research Symposium!

Since receiving the very generous $50 million naming gift from Dr. Ira A. Fulton, our Schools experienced a dynamic transformation. With the growth of our research agenda and the increased interest of our best students in the investigative activities of our laboratories and research clusters, the Fulton Investment is being used to design programs to expand the undergraduate research experience. These programs are managed under the Fulton Undergraduate Research Initiatives (FURI). The symposium—one of the FURI programs—is the culminating event of our students’ semester-long research projects.

Participants in this Symposium have been mentored by some of our best faculty, research associates and doctoral students. Most of the students participating in this symposium are being funded under the FURI programs Research Program and the Honors Thesis Program. Each of these students took the initiative to identify a research topic, seek out a mentor, submit an application and withstand a competitive selection process. Having managed their time, budgets and research, 85 students successfully participated in this eleventh offering. The symposium also highlights other undergraduate students who were funded by the FURI Travel Grant Program. In total, 86 students and their research are featured in this abstract book.

We invite you to read and enjoy the accomplishments of our very robust community of scholars. Also, on the following pages, please take the time to read about the unique characteristics of our programs and acknowledge all the contributors who have made this event possible. Finally, we congratulate all our participating undergraduate students and mentors for being part of this great program!

Sincerely,

Deirdre Meldrum
Dean, Ira A. Fulton Schools of Engineering

Christine MacLeod
Associate Director, Undergraduate Initiatives
Acknowledgements

The generous and visionary support of Dr. Ira A. Fulton in providing the financial means to make all the FURI programs possible is acknowledged and deeply appreciated.

The Barrett Honors College also deserves a special recognition for contributing financially to the FURI Honors Thesis Program. By combining our resources, we have expanded and enriched our students’ experiences.

The success of the FURI programs depends upon the willing participation and support of numerous individuals within the Ira A. Fulton Schools of Engineering. We express our sincere appreciation to Drs. Jerry Coursen, Valana Wells, Rolf Halden, Stephen Krause and Mutsumi Nakamura for their help in selecting the FURI participants.

Special thanks are extended to Christine MacLeod, the Associate Director of Undergraduate Initiatives, who graciously and conscientiously worked to make the Symposium a showcase experience for all our students, faculty and staff. To Marie Baisset, Student Assistant, for her assistance in all aspects of the FURI program. The assistance of Carol Vance and Barbara Minich in business matters is expressly appreciated. Also, to Dr. Hubele, Emeritus Faculty, for her vision of and dedication to the FURI programs.

For all the undergraduate students participating in the FURI programs, we extend our appreciation to the mentors for their guidance: It is your teaching that enables our students. Thank you! Dr. Morteza Abbaszadegan, Dr. Souyoung Ahn, Dr. Terry Alford, Dr. David Allee, Mr. Matthew Anderson, Dr. Chitta Baral, Dr. Kevin Bennett, Dr. Christopher Buneo, Dr. Winslow Burleson, Dr. Michael Caplan, Dr. Junseok Chae, Dr. Lenore Dai, Dr. Harshil Dhruv, Dr. Peter Fox, Dr. David Frakes, Dr. Michael Goryll, Dr. Christopher Guthrie, Dr. Rolf Halden, Dr. Stephen Helms Tillery, Dr. Keith Holbert, Dr. Hwei-Ping Huang, Dr. Leon Iasemidis, Dr. Ranu Jung, Dr. Kanav Kahol, Dr. Subbaro Kambhampati, Dr. Rosa Krajmalnik-Brown, Dr. Kenro Kusumi, Dr. Jeffrey La Belle, Dr. Jian Li, Dr. Jerry Lin, Dr. Michele Milaono, Dr. Barzin Mobasher, Dr. David Nielsen, Dr. Rong Pan, Dr. Robert Pfeffer, Dr. Patrick Phelan, Ms. Cynthia Pierce, Dr. Kaushal Rege, Dr. Martin Reisslein, Dr. Andrea Richa, Dr. Veronica Santos, Dr. Praveen Shankar, Dr. Henry Sodano, Dr. Kyle Squires, Dr. Kenneth Sullivan, Dr. Harvey Thornburg, Dr. Steven Trimble, Dr. Tsing Tsow, Dr. Marion Vance, Dr. Reveender Vannela, Dr. Brent Vernon, Mr. James Villarreal, Dr. Enrique Vivoni, Dr. Bryan Vogt, Dr. Weiwen Zhang, Dr. Michael Ziv-El.

To all the unnamed individuals, staff, friends and family members, who provided intellectual, emotional and logistical support, we extend our gratitude in helping to enrich our students’ experiences and for making this offering of FURI programs a success!
Participants Listed Alphabetically

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Participants by Program

Undergraduate Research

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Honors Thesis Program

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Nathan Wong

Travel Grant Program

Milad Behbahaninia  
Jonathan Plasencia
The specific goal of this honors research project is to create a microfluidic device that is able to concentrate oceanic biological samples, isolate bacteria, and then use these samples for further metagenomic analysis. The primary aim of the research will model the flow behavior of mixed microbes through the process of pinched flow fractionation—a process that utilizes continuous size separation of particles using a laminar flow profile in a pinched microchannel. The device will be tested to determine if particle separation and classification is possible in a passive and low-energy system that is sustainable in isolated deep-sea ocean environments.

The overall purpose of the research is to optimize cyanobacteria growth for use in biofuels. We are using a highly-controlled photobioreactor to compare the effects of pulse lighting on the growth rate, chlorophyll concentration, and other qualities of the cyanobacteria. Early results indicate that the pulse lighting does have a positive effect as compared to steady lighting. Further research will go into determining the effects of various parameters of the system, such as pulse frequency, on/off duration, light intensity, cell density, and so forth.

The objective of the project was to determine an appropriate sensor to measure the respiratory flow of a rat. Over the past semester, research has been performed on two sensors that characterize diaphragm performance. The sonomicrometry sensor is an invasive technique that uses sonar to measure the contraction of the diaphragm. The pneumotachometer is semi-invasive and measures the respiratory flow of a rat. The findings of the project and journal-based research determined that a rat-modified pneumotachometer would be the optimal sensor. Future work would be to use the sensor in conjunction with the adaptive controller for use in humans with spinal cord injuries.
Porous carbons are potentially attractive anode materials for lithium ion rechargeable batteries. Battery performance is dependent upon porosity, pore size and surface area of the carbon. The phase separation of poly(2-ethyl-2-oxazoline) (PEOX) and a carbonizable polymer (resol) is studied to control carbon morphology in terms of the impact of molecular weight and concentration. The combination of lower concentrations of PEOX and lower molecular weight PEOX results in the smallest pore structures. However, the pores are orders of magnitude larger than desired, and are potentially promising as electrodes in neuron sensing, which will be explored in the future.

Evidence that a Singing Impediment is Caused by Impaired Interhemispheric Coordination of Brain Activity

Milad Behbahaninia, Bioengineering
Graduation: May 2010  Hometown: Phoenix, Arizona
Mentor: Dr. Eric Vu, Bioengineering
Grand Challenge: Reverse engineer the brain

We studied the song impairment in zebra finches caused by unilateral lesion of nucleus Uvaeformis (Uva), thalamic nucleus important for song production. We observed an immediate degradation of singing premotor neural activity in HVC (nucleus encoding higher-order features), as well as a loss of coordination of singing premotor neural activity across the hemispheres. We compared HVC neural activity in lesioned birds during production of “Good” (most consistent) vs “Evil” (malformed) syllables. We discovered a significant difference in time-specific synchronizing signals between them. This provides convincing evidence that impairment of interhemispheric coordination is the physiological basis for some vocal impediments.

Tactile Sensing During Robotic Grasp: Investigation of Pressure Profile Systems Sensors

Emma Blass, Mechanical Engineering
Graduation: May 2011  Hometown: Gilbert, Arizona
Mentor: Dr. Veronica J. Santos, Mechanical Engineering
Grand Challenge: Biological and human systems

The object of this research is to determine the tactile limitations of the Pressure Profile Systems (PPS) Digitacts Sensor. Custom code calculates the center of pressure. Based on the pressure readings of individual sensor elements (or taxels), the resolution for the location of an object’s centroid is limited to the center of a single taxel. While moving different objects across the sensor, the center of pressure can be tracked over time. In the future, experiments will be refined to determine the accuracy, speed, and sensitivity of the readings.
Active Flow Control  
**Michael J. Bouey Jr., Mechanical Engineering**  
Graduation: May 2011  
Hometown: Phoenix, Arizona  
Mentor: Dr. Praveen Shankar, Mechanical, and Aerospace Engineering  
Grand Challenge: Advance personalized learning  

The Active Flow Control (AFC) project started with the goal of actively improving the aerodynamic efficiency of an internal flow through the implementation of a closed-loop control and sensor system. This project initially built upon setting up a controls and sensors exercise. A control and sensor exercise was required to be able to conduct active flow control experiments. This project has created understanding through designing, building, and implementing independently developed changes from trial and error. This project demonstrates gaining understanding through advanced personal learning. The future work includes designing and running AFC experiments that accomplish the initial goal.

Muscle Properties and Gait Kinematics After Spinal Cord Injury  
**Peter Bremer, Bioengineering**  
Graduation: May 2011  
Hometown: Flagstaff, Arizona  
Mentor: Dr. Ranu Jung, Bioengineering  
Grand Challenge: Engineer the tools of scientific discovery  

The specific aim of the research is to quantify kinematics during locomotion and active muscle property changes that occur in rodents with incomplete spinal cord injury (SCI). Such models are often used to further our understanding of SCI and its effects upon locomotion. Rigorous development of the experimental setup for testing the muscle properties has been performed and the regulatory IACUC protocol approved. Current efforts are focused on running isotonic and isometric tests to gather data for creating a computational musculoskeletal model, collecting 3D kinematics data of treadmill walking, and preparing for the SCI surgeries.

Adsorption of Gases Using Silica Aerogels (for VOCs) and Amine Modified Silica Aerogels (for CO2) in a Fluidized Bed  
**Taylor Brownlee, Chemical Engineering**  
Graduation: May 2012  
Hometown: Paradise Valley, Arizona  
Mentor: Dr. Robert Pfeffer, Chemical and Materials Science Engineering  
Grand Challenge: Sustainability  

A need exists to develop a solid sorbent that will efficiently absorb CO2. Silica aerogels with an amine modified surface configured in a gas fluidized bed may be an ideal sorbent. The amounts of CO2 absorbed for doumeen and triameen physically modified Nanogels and four chemically modified Nanogel samples have already been determined using the Cahn electronic microbalance. The two physically modified samples each absorbed 1.60 mmol CO2/g sample, whereas all of the chemically modified samples absorbed less than 0.6 mmol CO2/g sample. Further research will be done with samples of polymers in solution such as PEI.
Optimization of Membrane Biofilm Reactor Start-Up for Biological Reduction of Trichloroethylene

Katherine Cai, Chemical Engineering
Graduation: May 2013  Hometown: Chandler, Arizona
Mentor: Mr. Michal Ziv-El, Civil and Environmental Engineering
Grand Challenge: Providing access to clean water

The Membrane Biofilm Reactor (MBfR), a technology that biologically reduces oxidized groundwater contaminants, was modified for the removal of trichloroethylene (TCE). In order to minimize TCE losses due to sorption, tubing was reduced and switched to TCE compatible viton tubing, improving the system recovery from 25% to close to 100%. A syringe pump and break tube were installed to prevent backflow of the mixed microbial dechlorinating culture (MMDC) into the reactor influent bag. Additionally a methanogen-free MMDC was enriched in batch to serve as the inoculum of the MBfR in order to prevent electron diversion to methane and foster ideal growing conditions.

Wireless Monitoring of Semiconductor Wafer Cleanliness

Marco A. Carrillo Jr., Electrical Engineering
Graduation: May 2010  Hometown: Phoenix, Arizona
Mentor: Dr. Junseok Chae, Electrical Engineering
Grand Challenge: Sustainability

The research involves improving the performance of a passive wireless sensing system which monitors semiconductor wafer cleanliness during rinsing. The wireless system consists of a MEMS (Micro-Electro-Mechanical-Systems) resistivity sensor, oscillator, rectifier, switch for modulation, and inductive/RF coupling wireless elements. This research set out to determine a modulation scheme that provides a resolution good enough to detect ionic contamination in rinsing water as ions are washed away from the wafer in the range of parts per trillion (ppt). It was found that capacitive load modulation yields better results than resistive load modulation. The research now goes onto compare RF coupling and Inductive Coupling as wireless transfer schemes. These schemes are being compared theoretically and in the lab in order to decide which scheme is better and under what circumstances.


Stephen Charnicki, Electrical Engineering
Graduation: May 2011  Hometown: Scottsdale, Arizona
Mentor: Dr. Martin Reisslein, Electrical Engineering
Grand Challenge: Advance personalized learning

The project is oriented around pursuing a deeper understanding of an Ethernet Passive Optical Network (EPON). Simulations were run to determine how fairly the optical line terminal (OLT) could handle scheduling demands from “misbehaving” optical network units (ONUs) in systems operating at well over ideal maximum capacity. The OLT performed quite efficiently in the first set of simulations but new variations in the experiment are being considered to further challenge this conclusion. New trials are also being prepared to test transmission delay times as a function of total file size for a single wavelength channel, 32 ONU system.
Research investigated the effect of coating filtration media with quaternary ammonium compounds on microbial removal and organic fouling. Filtration media were sand and zeolite, and microbes were Escherichia coli. Media’s sorption properties were determined by allowing contact time between various masses of filtration media and water containing 20mg/L humic acid. Further analysis was performed by filtering tap water with microbes through a column packed with media. Results indicate coated sand has superior abilities to remove microbes, with negligible fouling effects during a 3-hour column test. Coated sand’s sorption properties and inactivity ability should be investigated to determine any limiting factors.

The aim of this project is to develop a system capable of quantifying Parkinsonian motor skill depletion in nonhuman primates. First, a wrist-worn device containing an accelerometer and two infrared LEDs was developed to measure the parameters of motion during a reaching task. A software program was then developed to capture the data, using the infrared function of a Wii remote to track the LEDs. Currently a nonhuman primate is being introduced to the device and motion data will be collected before and after Parkinson’s disease in induced. The data will then be analyzed to quantify the Parkinsonian symptoms observed.

A novel route to synthesize nanoparticle-coated carbon microspheres is examined based upon in-situ polymerization of furfural in water Pickering emulsions. Initial studies utilized SiO2 nanoparticles to stabilize the emulsion; increasing the furfural concentration results in larger nanoparticle-coated microparticles. These microparticles are carbonized by heating to 800°C in N2 atmosphere. Following this proof of concept, this approach has been extended to a functional nanoparticle: TiO2. Titania@carbon microparticles could potentially be used as electrodes in lithium ion batteries. Interestingly, much smaller microparticles are formed utilizing TiO2 in comparison to SiO2 nanoparticles at identical conditions. Future work will examine their electrochemical behavior.
In order to further knowledge and understanding of the correlation between physical activity and exposure to volatile organic compounds (VOCs), a portable device with a VOC sensor and user interface containing an accelerometer is required. A tuning fork chemical sensor and an interface for a Texas Instrument wristwatch has been developed, making it possible to detect VOC levels and transmit data to the wireless interface, as the accelerometer simultaneously collects data concerning the user’s physical activity. Future works include the optimization of the user interface and wireless communication as required, field testing, and data processing of chemical and accelerometer data.

Isothermal amplification is a simple method for the detection of microbial pathogens. The procedure is being developed to identify the biomarker Bacteroides in water samples. Preliminary culturing of Bacteroides in an anaerobic environment was carried out and the specific primer set used for isothermal amplification has been designed. The reaction has been carried out and results suggest that future work must involve system optimization. Such a protocol could pave the way to assess microbial water quality without expensive laboratory equipment, which would help to reduce the costs and time associated with protecting the public health from waterborne microbial outbreaks.

In this study, patterns of physical action were investigated in order to gain insight into the complex physiological processes of the brain underlying movement. Specific patterns of movement of a learned behavior may potentially indicate the most efficient pathway of the action. The goal of this research was to record the paths of motion involved in an action, and compare these motions from individual to individual. This was accomplished by quantifying the movement of bowing a violin using a bow and violin installed with LED lights calibrated to a motion capture system. The angles and velocities of motion were then calculated and compared between experienced and inexperienced violinists.
Aneurysm Treatment with Polymer Gels
David Eaton, Bioengineering
Graduation: May 2011   Hometown: Houston, Texas
Mentor: Dr. Brent Vernon, Bioengineering
Grand Challenge: Engineer better medicine

The objective is to examine the properties of two gels to determine if they can be used to embolize brain aneurysms. For the first gel, in vitro degradation tests were done to determine how the Young’s Modulus changed over time at different temperatures and for different swelling amounts. The ultimate compressive strength was also measured for some samples. For the second gel, rheology was performed in order to determine how several variables affect the gelling reaction rate. Swine studies will have to be done on the first gel; compression and degradation studies will be done on the second gel.

Analysis of Traffic Instabilities in Congested Traffic
Taylor Ehrick, Civil and Environmental Engineering
Graduation: May 2010   Hometown: Phoenix, Arizona
Mentor: Dr. Soyoung Ahn, Civil, Environmental and Sustainable Engineering
Grand Challenge: Restore and improve urban infrastructure

The objective of this research is to analyze macroscopic traffic behavior of stop-and-go driving, including its lane-specific characteristics and relation to freeway geometry. Vehicle count and speed data from State Route 99 near Sacramento, California were analyzed by taking the second-order difference of the cumulative vehicle count and speed with a moving time window to quantify the magnitude of stop-and-go oscillations. The preliminary findings indicate that stop-and-go oscillations exhibit lane-specific behavior. Further research will verify the preliminary findings at different freeway sites.

Prototyping of Patient-Specific Heat Models
Fariha Ejaz, Bioengineering
Graduation: May 2010   Hometown: Gilbert, Arizona
Mentor: Dr. David Frakes, Bioengineering
Grand Challenge: Advance personalized learning

Current tangible models for surgical education and planning are primarily limited to generic cases that are not patient-specific. These are of limited value since every individual is different and the general models are not based on real patient data. This project is designed to address current limitations through creation of patient-specific cardiovascular models that include conventional color coding. These models will aid in surgical planning and education. Recent advancements in rapid prototyping (RP) make it possible to prototype complex geometries with embedded color-coding, which is important for this project. Ultimately, we expect that these tools will improve surgical outcomes.
**Study of Cooling Effects in a Stirling Engine Heat Exchanger Using Cross-Flow, Counterflow, and Parallel Flow**

**Erin Eppard, Mechanical Engineering**  
Graduation: May 2011  
Hometown: Phoenix, Arizona  
Mentor: Dr. Patrick Phelan, Mechanical Engineering  
Grand Challenge: Make solar energy economical

The objective of this research is to identify current limitations on cross-flow cooling used in Stirling engine coolers and compare the cross-flow cooling efficiency to the efficiencies of counter flow and parallel flow configurations. Models of the cooler and test stand have been constructed in order to best simulate cooling of oscillating gas inside a Stirling engine. Heat transfer calculations indicate that counter flow produces the most efficient heat exchange and future experiments will provide data to determine cooling efficiencies and quantify heat transfer along the length of the heat exchange tubes.

**Exploration of Seasonal Rainfall Along Mountainous Watersheds in Sonora, Mexico**

**Laila El-Ashmawy, Civil and Environmental Engineering**  
Graduation: May 2011  
Hometown: Lewisville, Texas  
Mentor: Dr. Enrique Vivoni, Civil, Environmental and Sustainable Engineering, School of Earth and Space Exploration  
Grand Challenge: Engineer the tools of scientific discovery

Drastic changes in precipitation brought about by the North-American Monsoon are described by analyzing nine rain gauges across a mountainous watershed in Sonora, Mexico (elevations ~600 to 1600 m). Through Matlab programming, seasonal trends are compared between rainfall frequency and conditional average rainfall of sites at differing elevations. Daily analysis suggests that higher elevations experience greater rainfall amounts than lower elevations during winter months, and less frequent rain during summer monsoons. Hourly analyses will reveal the diurnal cycle of rainfall frequency and amount. Studying seasonal rainfall trends will decipher the elevation-control on ecosystem distributions, providing knowledge to inform local water managers.

**Cavitation Suppression with Piezoelectric Device**

**Aaron Estes, Mechanical Engineering**  
Graduation: May 2011  
Hometown: Phoenix, Arizona  
Mentor: Dr. Michele Milano, Mechanical Engineering  
Grand Challenge: Engineer the tools of scientific discovery

The capacity for energy harvesting piezoelectric devices to minimize pressure changes in its proximity was examined. A piezoelectric material coupled with an energy harvesting circuit and a piezoelectric voltage sensor were exposed to a common pressure wave. The sensor’s reaction to pressure fluctuations was analyzed with the circuit on and off. Results suggest that an energy harvesting piezoelectric device delays cavitation inception in its proximity by minimizing local pressure changes responsible for the growth and collapse of cavitation bubbles.
An emerging class of unmanned aerial vehicles (UAVs) is being motivated toward more unconventional configurations, which create much more complicated control and stability issues. The project seeks to design simple closed-loop control systems to help stabilize the flight of an unconventional design and high-lift capability UAV. Current research is into the implementation of closed loop controls for the pitch and roll of a model aircraft on a specially-designed test stand. This information will then be utilized in the creation of a feedback-control system for an airborne model.

The goal of this work is to synthesize and characterize materials for a resorbable, thermoreversible drug delivery device which degrades and releases drugs in response to biomolecules. Synthesized materials based on poly(N-isopropylacrylamide) were designed in order to have increased solubility in the presence of collagenase, an enzyme secreted by migrating cells. Two model enzyme-sensitive polymers were successfully synthesized, as shown by NMR spectroscopy. NMR confirmed the increased solubility of the polymers after enzyme action. Future goals include characterizing the effect of polymer structure and composition on the thermoreversible properties.

The project was intended to determine the effect on electrical performance of solar panels exerted by changing temperatures. To accomplish this, a cryostat was mechanically and electrically modified to allow the lab’s solar cells to be connected. Next, the cryostat assembly was calibrated using a reference cell with known characteristics in order that the approximate light reaching the cell was equivalent to the light from the sun. A switch box was built to allow external control of the devices embedded in the cell. The next step will be to test live devices across varying temperatures.
Lytic Peptides as Cancer Therapeutics
Jennifer Gamboa, Chemical Engineering
Graduation: May 2011    Hometown: Centennial, Colorado
Mentor: Dr. Kaushal Rege, Chemical Engineering
Grand Challenge: Engineer better medicines

KLA, a lytic peptide, can sensitize prostate cancer cells to apoptosis induced by death receptor agonistic antibodies. This research involves an investigation into gold nanorod-mediated delivery of the KLA peptide, since peptides by themselves are easily degraded and rapidly cleared in vivo. Gold nanorods, with light absorption properties, were conjugated with methoxy (polyethylene glycol)-thiol for stabilization and then KLA was attached and tested with PC3TR prostate cancer cells. Results have shown the stability and effectiveness of gold nanorod-KLA complexes in inducing cancer cell death, indicating the potential of the nanoparticle-mediated approach for combined imaging and delivery of peptides.

Fully-Autonomous Modular Flight Control System
Mark Garrison, Electrical Engineering
Graduation: May 2011    Hometown: Glendale, Arizona
Mentor: Dr. Michael Goryll, Electrical Engineering
Grand Challenge: Prevent nuclear terror

The goal of this project is to produce an autonomous flight control system for small, inexpensive remote control helicopters. To this end, a circuit board has been designed and built to fly a 13” helicopter. This board employs an accelerometer and flash to record data from flight which will be used to develop the control algorithm. So far, minor flaws in the board assembly are preventing the device from recording data. Currently, these problems are being fixed and firmware is being developed to record the flight data. Once installed on the helicopter, different control algorithms will be tested during flight.

Development of a Rocket Deployed UAV
Bradley Goodman, Aerospace Engineering
Graduation: May 2010    Hometown: Great Falls, Montana
Mentor: Dr. Marion Vance and Mr. James Villarreal, Mechanical and Aerospace Engineering
Grand Challenge: Engineer the tools of scientific discovery

Current Unmanned Aerial Vehicles (UAVs) being used by the military have one major drawback, they are relatively slow to deploy. To address this issue, research is being carried out into the development of a rocket launched UAV known as the Rapid Ascent Reconnaissance Vehicle (RAR-V). With the design of the airframe completed and construction underway, the majority of research done this semester has gone towards high fidelity flight simulation and performance estimation.
Integrated Fiber-Wireless (Fi-Wi) Access Network: Simulation and Validation
Omar H. Habib, Electrical Engineering
Graduation: May 2010  Hometown: Phoenix, Arizona
Mentor: Dr. Martin Reisslein, Electrical Engineering
Grand Challenge: Enhance virtual reality

The overall goal of this research project is to stimulate the performance of fiber-wireless (FiWi) networks in a very wide spectrum including the design, packet transmission, coding and decoding techniques, and algorithms. CSIM and omnet++ network simulators have been used to stimulate, and verify the performance of the EPON and wireless network configuration. Future work will analyze network delay and stability. Discrete and continuous data frames will be examined using the help of the mathematical models and equations. Developing a code to use both simulators simultaneously will be considered as well.

Quantitative Assessment of the Effects of Endovascular Therapies on Cerebral Aneurysm Fluid Dynamics: an In-Vitro Flow Study
Walter Hafner, Bioengineering
Graduation: May 2011  Hometown: Snowflake, Arizona
Mentor: Dr. David Frakes, Bioengineering
Grand Challenge: Biological and human systems

The rupture of a cerebral aneurysm, a serious medical emergency, carries a 50% mortality rate. This study aims to quantitatively assess the effectiveness of embolic coils and stents in mitigating aneurysmal fluid dynamics. A blood analog solution seeded with 8-micron fluorescent Rhodamine-B particles was circulated through an idealized silicon model of a basilar tip cerebral aneurysm. Volumetric 3D flow velocity data were acquired over a range of physiologic conditions after stent and multi-coil deployment using particle image velocimetry. Analysis of aneurysmal neck-plane fluid dynamics will now be used to compare stents and embolic coils.

Accuracy of Visual Depth Perception When Not Controlling Movement
Tina Hakimi, Bioengineering
Graduation: May 2012  Hometown: Ahwatukee, Arizona
Mentor: Dr. Christopher Buneo, Bioengineering
Grand Challenge: Reverse engineer the brain

This project examines visual depth perception in the absence of hand movement. The goal is to understand if previous experiments in which vision was ineffective in improving arm position depth resulted from ineffective visual depth perception or ineffective visual control of action. Tests were conducted in a virtual reality environment matching the position of a visual target with a second visual target without arm movement. Preliminary analysis suggests visual depth perception alone is extremely accurate for most depths but becomes less accurate for more distant targets. Future analyses will focus on where exactly this point of inaccuracy lies.
Design, Development, and Evaluation of a CPR Feedback Simulator
Susannah Harding, Biomedical Engineering
Graduation: May 2011   Hometown: Mesa, Arizona
Mentor: Dr. Kanav Kahol, Biomedical Informatics
Grand Challenge: Biological and human systems

The CPR feedback simulator was designed to be a portable, low cost CPR practice aid. It used Nintendo Wii technology to detect the exact position of a mannequin’s chest while CPR was being performed. Knowing and recording the chest position allowed real time feedback through the execution of algorithms while CPR was being performed. Each data collection trial consisted of 60 seconds of chest compressions recorded by the CPR simulator. During this minute, the simulator gave feedback of compression rate, compression depth, and chest recoil from a screen. The design of the CPR simulator consisted of a stationary Nintendo Wii remote used to detect the position of a dynamic infrared light strapped to the user’s wrist. A program on the computer received the chest position from the Wii via Bluetooth. It then used the recorded data to calculate the compression rate, depth and recoil. This feedback was displayed on a screen which allowed the user to extensively improve upon their CPR skills while practicing CPR. The simulator was validated with over 100 test subjects both experienced and inexperienced in CPR, and was found to significantly improve the technique of the user.

MRI Quantification of Singular Glomerular Function
Megan Henriksen, Bioengineering
Graduation: May 2011   Hometown: Russell, Minnesota
Mentor: Dr. David Frakes, Bioengineering
Grand Challenge: Advance health informatics

The goal of this work was to calculate glomerular function through the use of contrast agents and image processing techniques. Specifically, the number of functional glomeruli and collective glomerular volume are calculated. These are determined using custom software written in Matlab to segment and analyze ex vivo MR image data. Results are quantified for normal and diseased kidneys, and for variable levels of contrast agent. Currently MR Images from a 19T MRI machine are being segmented. Future work will focus on in vivo application for early detection of kidney disease.

Characterizing Object Textures According to Stick-slip Vibration Frequencies
Albert Hsia, Bioengineering
Graduation: May 2011   Hometown: Avondale, Arizona
Mentor: Dr. Veronica Santos, Mechanical and Aerospace Engineering
Grand Challenge: Engineer the tools of scientific discovery

Human fingers can distinguish between textures according to their vibration signatures. This work uses an artificial sensor to characterize stick-slip vibrations for different textures. Weighted texture plates were dragged across an artificial skin surface to induce vibrations which were detected by an accelerometer. Spectral analyses were used to relate vibration frequencies to texture, contact force, and movement speed. Preliminary studies demonstrated that vibration frequencies and magnitudes changed at different drag speeds. Future work consists of incorporating vibration sensing mechanisms onto a robotic hand or prosthesis that will detect whether or not the gripped object is slipping.
Development of Alginate Based MRI Detectable Microgels

Ameya Jategaonkar, Bioengineering
Graduation: May 2012   Hometown: Rochester, New York
Mentor: Dr. Kevin Bennett, Bioengineering
Grand Challenge: Engineer better medicines

The objective was to develop MRI detectable microgels that report on their structure. Alginic acid was labeled with cationized ferritin, then crosslinked with Ca2+ ions to develop alginate gel beads. These beads were placed in solutions with varying concentrations of Ca2+. They were analyzed using a Bruker 1.5 T relaxometer. When the beads were placed in solutions with low Ca2+ concentrations, they swelled. This was reported by the relaxometer as roughly a 34% increase in T2 relaxation. Electrospraying reduced the bead diameter to a few hundred microns. Emulsion techniques can be explored to further reduce the diameter of the beads.

Identification and Quantification of Fatty-Acid Consuming Bacteria in Synechocystis sp. PCC 6803-Based Photobioreactors Using Bacterial 16S rDNA and Selective Plating

Galen Toby Johnson-Bates, Chemical Engineering
Graduation: May 2012   Hometown: Scottsdale, Arizona
Mentor: Dr. Rosa Krajmalnik-Brown, Civil and Environmental Engineering
Grand Challenge: Develop carbon sequestration methods

The objective was to identify and quantify bacteria in Synechocystis sp. based photobioreactors using bacterial 16S rDNA fingerprinting methods. DNA from culture samples containing Synechocystis, among other microorganisms, underwent PCR amplification and T-RFLP analysis to monitor shifts in microbial ecology over time. Also, a plating assay was developed to quickly detect fatty acid scavengers using free fatty acids as sole carbon and energy source. Conclusively, photobioreactor cultures consist mostly of Synechocystis while in “healthy” state, and diversify significantly when the culture’s health is compromised. Future research should include additional analysis of community DNA and optimization of the plating assay.

Hyperthermic Ablation of Cancer Cells Using Gold Nanorods

David Kay, Bioengineering
Graduation: May 2010   Hometown: Tucson, Arizona
Mentor: Dr. Kaushal Rege, Chemical Engineering
Grand Challenge: Engineer better medicines

Previous work in this project has involved applying laser to thermally ablate cancer cells treated with polymer-coated gold nanorods (GNRs). The objective of this semester’s work has been to continue using circular dichroism to demonstrate the denaturing of proteins responsible for this cell death following induced hyperthermia. This has been done by gathering the initial ellipticity curves of proteins, and comparing these curves to proteins that have been heated using GNRs and laser application. Thus far, bovine serum albumin, lysozyme and lactalbumin have been investigated, and future work will involve calmodulin.
**Numerical Analysis of Airfoils with Dynamically Variable Angle of Attack**

Carlin J. Kersch, Aerospace Engineering

Graduation: May 2011    Hometown: Portland, Oregon  
Mentor: Dr. Christopher Guthrie, Aerospace Engineering  
Grand Challenge: Exploration

The objective of this project was to investigate the properties of airfoils in unsteady conditions undergoing pitching moments using computational fluid dynamics. The results of the CFD analysis of the airfoils was then compared to an analytical model of the system, the Theodorsen classical solution. So far, an edge grid with proper spacing for the airfoil has been generated and used to create a 2-D grid for the airfoil using Solidmesh. Future work will consist of extending the work to encompass airfoils with changing cambers.

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**Electrochemical Detection of Escherichia Coli in an Integrated Biosensor**

Kenneth Lan, Bioengineering and Biology

Graduation: May 2011    Hometown: Tempe, Arizona  
Mentor: Dr. Jeffrey La Belle, Bioengineering  
Grand Challenge: Advance health informatics

The objective of this study is to develop an electrochemical sensor component to detect the bacterium Escherichia coli. Prototype sensor components were constructed by immobilizing antibodies specific to E. coli onto commercial gold disk electrodes. The electrodes were then exposed to E. coli samples of varying concentrations and characterized by electrochemical impedance spectroscopy. Future work will involve demonstrating detection in impure samples of bacteria such as those obtained from blood or urine, transferring the technology from gold disks to cheaper PCB boards, and integrating the sensor electrode into a multi-component microbial sensor.

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**Ultra-Sensitive Gas Sensors Using Mesoporous Carbon Films and High Precision Time Interval Measurements**

Kevin LaRosa, Electrical Engineering

Graduation: May 2012    Hometown: Newbury Park, California  
Mentor: Dr. David Allee, Electrical Engineering  
Grand Challenge: Security and defense

The goal of this experiment is to make use of carbon nanofilms that have variable resistances when certain gaseous chemicals are passed over them in conjunction with a frequency counter to determine the concentration of the chemicals with more accuracy than the typical ohmmeter setup. The environment controlled chamber with electrical and chemical feedthroughs has been fabricated and used to find the conductivity of eleven different films. A voltage-to-frequency converter circuit has been constructed and only needs to be mounted in a Faraday cage and then final measurements can begin.
Ordered Porous Carbon Monoliths for Electrochemical Application
Andrew B. Larson, Chemical Engineering
Graduation: May 2011  Hometown: Glendale, Arizona
Mentor: Dr. Bryan Vogt, Chemical Engineering
Grand Challenge: Energy storage

The morphology of surfactant templated ordered carbon monoliths and thin films should significantly influence the physical and electrochemical properties, which are critical for energy storage applications. The size of the pores is impacted by the carbonization temperature due to contraction, so a systematic investigation of the influence of processing temperature on pore size (from porosimetry), electrical conductivity (from 4-pt probe) and modulus (from nanoindentation) enables optimization of the processing conditions for the desired application. Future work will focus on examination of electrochemical properties to determine property-structure relationships.

Object Hardness and Grasp in Non-Human Primates
James LeBeau, Bioengineering
Graduation: May 2011  Hometown: Tempe, Arizona
Mentor: Dr. Stephen Helms-Tillery, Bioengineering
Grand Challenge: Reverse engineer the brain

The objective of this research is to develop a malleable/compressible force-sensing device to test the grasp of non-human primates. This device combined with a Vizard generated virtual reality, phase space, and neural recordings using deep tissue electrodes, are being used in investigating the relationship between neurological activity and grasp of different hardness of objects. This project is part of an overall effort in neural prosthesis design and advancement in prosthetic sensation.

Novel Active Pixel Sensor Readout Circuits with High Gain and Optimized Noise Performance for Use in X-Ray Imaging and Spectroscopy
Edward H. Lee, Electrical Engineering
Graduation: May 2012  Hometown: Philadelphia, Pennsylvania
Mentor: Dr. David Allee, Electrical Engineering
Grand Challenge: Prevent nuclear terror

The intended goal is to design and test several active pixel sensor (APS) readout circuits that have very low noise, high gain, and signal linearity that will be used for X-Ray and Neutron imaging and spectroscopy. Several creative features of the three designed circuits that will be manufactured in FDC’s Fab-line by April and June include 1) use of pre-amplifier stage (enhancement-mode inverter) before the source-following stage to boost gain and 2) cascode configuration to boost thermal noise performance. These optimized designs were created by the frequency-noise simulation developed from the previous semester. By April, the circuits will be tested.
The success of non-viral gene delivery systems has been challenging in clinical applications because of their poor gene transfer efficiency. The current research being explored is characterizing a library of small molecules that could potentially enhance polymer-mediated gene delivery in certain prostate cancer cells. Prior experiments using this synthesized polymer in combination with histone deacetylase inhibitor molecules, compared to commercially available polymers, has shown a nearly 3000-fold higher transgene expression in these prostate cancer cells. This characterized library of molecular agents will continued to be tested in a high throughput manner to enhance the transgene expression in prostate cancer cells.

This research focuses on determining the efficacy of deep brain closed-loop stimulation for seizure control in a rat model of epilepsy. Electroencephalographic (EEG) recordings from epileptic rats are analyzed on line and in real-time via in-house developed seizure prediction software, which issues warnings of impending seizures and then triggers an electrical stimulator to deliver electrical stimuli for seizure abatement. The efficacy of the software and stimulation will be measured by: a) reduction in seizure frequency following the closed-loop stimulation, and b) decrease in brain synchronization. Work along these lines in two rats has started and results look very promising.

Glioblastoma multiforme (GBM) is a type of aggressive brain tumor that rapidly invades tissue surrounding the primary tumor site. Current methods either deliver drugs in too low of a concentration throughout the brain tissue, or in too localized of an area for proper treatment. As such, drug delivery could be improved through convection enhanced delivery (CED), which relies on pressure gradients created by catheters in the brain. COMSOL Multiphysics© was used to predict the delivery of the drug to the brain while varying catheter placement. Three dimensional delivery models have been developed along with preliminary methods for quantifying tumor coverage.
The goal of this research is to develop a polyphonic transcription engine. Thus far, a single note model consisting of dynamic Bayesian networks intended for polyphonic articulatory piano transcription has been developed. Additionally, a fundamental frequency likelihood model has been developed. For the single note model, an investigation of individual note's partial decay rates was necessary. Matlab was used to analyze the partial decay rates of individual notes being played with different lengths and volumes on a piano. Future work is to be done in the refinement of the single note model before scaling up to the polyphonic model.

The research focuses on management and organization methods to increase the performance of renewable energy research and development projects. Performance metrics have been emphasized in order to quantify and track the value added by exploratory research projects. Research has been conducted within a case study project that is developing and optimizing two new thermal energy storage technologies for commercial use in concentrating solar power plants. Results from this case study demonstrate the importance of including experts from the construction industry within the project team in order to maximize the real world economic potential of exploratory renewable energy technologies.

The goal of this research is to connect the robot with Game as Life, Life as Game (Gallag) research project. The multi-threading robot server enables Gallag users to control the robot from a simple iPhone interface. The framework built from previous semesters is carefully reviewed in order to create more robust multi-threading application. The future work will include a better job scheduling system, so multiple users can request robot to perform tasks simultaneously.
The domain of biological research is extremely large, with thousands of articles published each day. As such, no research group has the time or resources to thoroughly read each article to find discoveries that are related to their work. To promote collaboration between researchers, the Collaborative Bio Curation project was created using Natural Language Processing to assist researchers with finding published articles related to their fields. The system creates an interactive database of biological entities taken from published articles to enable domain focused searching within the articles. Further work is focused on expanding the domain to biological pathway research.

The objective of this work is to understand reflex-like grip responses in humans so that similar reflexes can be implemented in artificial hands. IRB-approved human subject experiments have been completed in which a grasped object was perturbed, but a new experimental setup was required to minimize the effects of subject anticipation of the perturbation direction. The new setup allows for fully randomized perturbation testing without interfering with the motion capture of the subject’s hand. The apparatus has been designed and constructed, and is ready for implementation in human subject experiments.

This project worked toward the development of a point-of-care device that can detect and identify bacteria in human blood in a matter of minutes. Materials were tested for suitability, and a pumping mechanism was developed. Several sample processing strategies were evaluated, and one (the use of membrane filters) was thoroughly evaluated. Early results show that it may be possible to separate and detect bacteria from blood in less than ten minutes. Future work includes testing the system with spiked and clinically relevant samples and moving to a cross-flow configuration.
The research goal is to find a more efficient way to remove organic contaminants from water. Batch experiments testing the adsorption kinetics and equilibrium adsorption capacity show that hydrophobic aerogels are much more efficient than current adsorbents at removing organic chemicals from water. An inverse fluidized bed has been set up to test whether fluidizing the aerogels further improves adsorption. Solutions of several different soluble organics in water, oil in water emulsions, and eventually actual industrial wastewater will be pumped through the fluidized bed and the inlet and outlet organic concentrations measured to determine the amount of organic adsorbed.

The objective of this research is to harvest clean energy from mechanical vibrations through the use of piezoelectric materials. This semester, the research has been focused on the generation of piezoelectric nanocomposites and testing their mechanical properties. Research has been done on creating nanocomposite materials, specifically plastic thin films, with embedded PZT nanowires. Currently, the mechanical properties of these composites are being tested using tensile strength tests. Future work in this area will include testing the efficiency of electrical energy production from the piezoelectric nanocomposites.

Developing a viable neuroprosthetic hand requires a focus on sensation in addition to motor control. The goal of this research is to understand sensation by evaluating performance in object discrimination tasks. The goal for this semester was to present objects of different textures to a subject, and record the forces applied to the textured grip plates. Sensors on the object were calibrated to translate the voltage output to applied force, and data recorded from grasps executed by the subject. Future work will include recording neural activity in somatosensory cortex during the experiment to see the effects of different textures.
Adsorption of Volatile Organic Compounds by Silica Aerogels

Stephanie Ochoa, Industrial Engineering
Graduation: May 2011  Hometown: Portland, Texas
Mentor: Dr. Robert Pfeffer and Ms. Teresa Rosa, Chemical Engineering
Grand Challenge: Develop carbon sequestration methods

Hydrophobic silica aerogels are used as a sorbent to remove volatile organic compounds (VOCs) from waste gases in a fluidized bed. Aerogels have a low density, very high surface area, high porosity, and are easily fluidized. The hydrodynamic characteristics of the silica aerogels (65-150µm) were measured, including pressure drop, minimum fluidization velocity and bed expansion in a 3-inch fluidized bed. The aerogels were able to adsorb ethanol from a nitrogen gas stream. Future work will include hydrodynamic and adsorption studies of other VOCs in a smaller 1-inch fluidized bed, and in a packed bed for comparison.

The Efficacy of Bleomycin Analogs as Sensitizing Agents for TRAIL-Induced Apoptosis in Prostate Cancer Cells

Christine Parsons, Chemical Engineering
Graduation: May 2010  Hometown: Vancouver, Washington
Mentor: Dr. Kaushal Rege, Chemical Engineering
Grand Challenge: Engineer better medicines

The proposed research explores the apoptotic efficacy of a set of Bleomycin (BLM) analogs as sensitizers of tumor necrosis factor–related apoptosis-inducing ligand (TRAIL) as combination treatments in prostate cancer cells. Research indicates that BLMA2 works synergistically with TRAIL to induce greater apoptosis as a combination treatment compared to the sum of the individual treatments in the PC3-PSMA cell line. Preliminary results may indicate that this synergistic effect is seen in another prostate cancer cell line (PC3). Future research involves determining the mechanisms of sensitization, including clustering of TRAIL (death) receptors, mitochondrial depolarization, overexpression of TRAIL receptors, and activation of caspases.

Self-Assembly of Two-Dimensional Multi-Component Colloidal Lattices at the Water-Air Interface

Brian Perea, Chemical Engineering
Graduation: May 2012  Hometown: Denver, Colorado
Mentor: Dr. Lenore Dai, Chemical Engineering
Grand Challenge: Engineering the tools of scientific discovery

The objective of this research is to self-assemble multi-component colloidal crystal lattices and provide a fundamental understanding of their formation and properties. One and two-component Langmuir-Blodgett films were prepared at the air/water interface from dispersions of hydrophobic polystyrene microspheres. Particles of different hydrophobicities featured surface pressure-surface area (m-A) isotherms with unique characteristic curves defined by their respective surface pressures and compressibility. Isotherm characteristic curves were found to be independent of barrier speed during lateral compression/relaxation cycles. The characteristic curve of the two-component film suggests combined interfacial properties of the one-component systems. Future work will strive to optimize conditions for the formation of crystal lattice structures with large interparticle spacing.
Developing a Virtual Surgical Planning Tool for the Tetralogy of Fallot
Jonathan Plasencia, Bioengineering
Graduation: May 2011    Hometown: Phoenix, Arizona
Mentor: Dr. David Frakes, Bioengineering
Grand Challenge: Engineer better medicines

Surgical outcomes for tetralogy of Fallot, a congenital heart disease, have the potential to benefit greatly from virtual surgeries paired with computational fluid dynamic simulations. Anatomical models were created to predict the pressure drop across the pulmonary valve. A preliminary simulation was run at peak systole by applying a no-slip boundary condition and assuming a rigid vessel wall. A pressure drop of 9.24mmHg and a resistance of 22.5MPa·s/m³ were determined at the valve. Additional models need to be created and future simulations should include wall motion and pulsatile flow.

Low-Dose Radiation-Induced Fiber Optic Attenuation
Julian Prokofiev, Materials Engineering
Graduation: May 2013    Hometown: Riga, Latvia
Mentor: Dr. Keith Holbert, Electrical Engineering
Grand Challenge: Energy, security and defense

As fiber optic cables become a more popular choice for signal transfer, data describing the fiber’s response to stress becomes invaluable – particularly stress induced from low-dose radiation commonly found in space and nuclear reactors. To test optical fiber resilience in such an environment, a similar radiation condition was re-created on campus, with constant monitoring of the signal attenuation. The results have shown significant deviation from previous models developed to predict the cable degradation, derived from previously conducted, higher dose-rate experiments. To verify the present results, more data are needed, most likely under an even lower dose-rate than is currently employed.

Diatom Shells on Silicon as Natural Nanopore Membranes
Hannah Rabiah, Electrical Engineering
Graduation: May 2011    Hometown: Scottsdale, Arizona
Mentor: Dr. Michael Goryll, Electrical Engineering
Grand Challenge: Biological and human systems

The objective of this research was to determine how diatom shells on silicon can be used as natural nanopore structures, particularly for lipid bilayer support. Initially, this involved observing the standard method of painting lipid bilayers onto a plastic macropore. This process was repeated on the natural nanopore structure, where it was determined that the layers formed Gigaohm seals, were more mechanically robust than on the plastic and exhibited similar breakdown voltages. In the future, the lipid bilayer formation will be attempted on diatoms with a chemically modified surface and ion channel incorporation into the bilayers will be studied.
The aerospike nozzle is a type of rocket nozzle that can achieve perfect nozzle expansion at any altitude below its design altitude, increasing overall rocket performance. While numerous computational flow investigations and static test firings have been done with aerospike nozzles, there is a definitive lack of test flight data. In order to quantify the benefit of an aerospike nozzle to a rocket’s flight in terms of payload capacity and specific impulse, numerical simulations of flights of high-powered sounding rockets equipped with conventional bell-shaped nozzles were compared to flights of identical rockets in identical conditions, but equipped with aerospike nozzles.

Organic photovoltaics have showed a lot of promise in low-cost applications but are not yet commercially feasible due to instability and low efficiency. The goal of this research is to investigate the performance of various organic materials that would dramatically affect power conversion efficiency. Materials are characterized by their electrical and optical properties. Furthermore, a different technique was used to fabricate these organic photovoltaics. The method of spin coating has enabled this project to examine heavier molecules and polymers in solution that were not possible with thermal evaporation. Future work will include optimizing factors that affect thin film uniformity.

Assessing the effects of therapy on neurological disorders is a challenging problem. One potential solution is to use functional magnetic resonance imaging (fMRI) to quantify neurological performance before and after therapy. In this study, fMRI signals were analyzed using different signal processing techniques to characterize neurological performance before and after consumption of caffeine. Changes in the relationship between visual cortex activity and motor cortex activity were quantified to provide a blueprint for assessing the effects of therapy on neurological disorders.
**Canopy Trek**

Shane Sandler, Mechanical Engineering  
Graduation: May 2011  
Hometown: Phoenix, Arizona  
Mentor: Dr. Winslow Burleson, Computer Science Engineering  
Grand Challenge: Engineer the tools of scientific discovery

Canopy Trek intends to help raise awareness of forest canopy climate with an automated sensing robot. Continued development on the robot from last semester includes a redesigned descent mechanism. Additionally, full rebuilding of the robot has begun allowing for the descent to be dialed in and tested. Soon, the robot will be finished so that it can be tested and deployed full-scale.

**Apparatus for Testing Grip Control Algorithms of Artificial Hands**

Chad W. Ripley, Mechanical Engineering  
Graduation: December 2010  
Hometown: Arlington, Texas  
Mentor: Dr. Veronica Santos, Mechanical and Aerospace Engineering  
Grand Challenge: Biological and human systems

Researchers are developing control algorithms for artificial hands, in conjunction with novel tactile sensor arrays, to improve grip control by replicating the reflex-like grip response patterns of human hands. In order to test and improve these algorithms, an apparatus has been developed to impose repeated rotational perturbations on objects grasped by an artificial hand. A MATLAB graphics user interface allows the user to specify a force profile that is imparted to the grasped object using pulleys, cables, and stiff springs. Future work will include autonomous repetition of perturbation conditions.

**Development of Cell Culture in the Lizard Species Anolis carolinensis**

Jonathan Sankman, Bioengineering  
Graduation: May 2012  
Hometown: Phoenix, Arizona  
Mentor: Dr. Michael Kaplan and Dr. Kenro Kusumi, Bioengineering and School of Life Sciences  
Grand Challenge: Engineering the tools of scientific discovery

The development of cell culture in Anolis carolinensis is vital for understanding the mechanisms responsible for tail regeneration in lizards. Preliminary culture tests performed with mouse myoblasts (C2C12 from ATCC) have been conducted. Cells were grown in Dulbecco’s Modified Eagle Medium (DMEM) with 10% fetal bovine serum (FBS). The cells were differentiated into myocytes using DMEM with 2% horse serum for a period of five days. Results confirmed that the cells had morphological features characteristic of myocytes. Future research will involve the isolation of specific cell lines from Anolis carolinensis to enable the functional analysis of the regenerating lizard tail.
Effectiveness of Young Driver Training
Vanessa Soronson, Industrial Engineering
Graduation: May 2010 Hometown: Tempe, Arizona
Mentor: Dr. Rong Pan, Industrial Engineering
Grand Challenge: Education

This project evaluates the effectiveness of current young driver training programs in improving the skills and attitudes in young drivers. Crash data from 19 states has been gathered and compared to the licensing laws in those states, and verified a correlation between changing licensing laws and crash rates. However, multiple law changes may contribute the most significant effect on crashes. Currently, the research team is working on conducting focus group studies with high school students to determine what types of programs would make the most impact on their driving behavior.

Transposition of Diaphragm Pacing Technology for Use in a Rodent Model
Benjamin D. Speck, Bioengineering
Graduation: May 2010 Hometown: Peoria, Arizona
Mentor: Dr. Ranu Jung, Bioengineering
Grand Challenge: Biological and human systems

The project objective was to develop a rodent diaphragm pacing procedure that was scalable to a human subject with a spinal cord injury. Work over the past semester has consisted of researching the current surgical methods for implementing this technology in humans and canines, and subsequently altering these methods to correspond to a rodent. Specific factors of interest were the anesthetics/analgesics used, surgical pathway, and nerve motor points on the rodent diaphragm. Future work will include applying the rodent diaphragm pacing with an adaptive control system in order to compensate for diaphragm fatigue in rodents with spinal cord injuries.

Self-Stabilizing Dynamic De Brujin Graph
Phillip Stevens, Computer Science / Mathematics
Graduation: May 2011 Hometown: Salt Lake City, Utah
Mentor: Dr. Andrea Richa, Computer Science
Grand Challenge: Information and physical infrastructure

We have been working to show the connectivity and routing properties of a new self-stabilizing network, the Dynamic De Bruijn graph. We have shown that the network remains weakly connected when a node leaves. We also showed the expected routing time is low, and that we can use distances between nodes to estimate the size of the network. Additional research is needed to show that the routing time is low with high probability, and to simulate the network on a computer.
Experimental investigation of swirl injectors in a small-scale N2O/HTPB hybrid rocket engine will further enable the characterization of a variation of injector designs and their effects on engine performance. Using prior research performed through computational fluid dynamic (CFD) analysis, experimental results are compared for validation of analytical predictions. Further use of these experimental results provides the ability to derive an empirical formula to describe the effects of swirl injection on motor performance.

Designing the optimum prosthetic hand involves the integration of sensation and motor control. The primary purpose for this project is to study patterns of neural activity that occur in response to vibratory stimulation of the fingertips in a non-human primate. One goal is to facilitate training the subject by modifying an existing experimental apparatus with parts designed using Solidworks software. Another goal is to identify patterns of neural activity in the somatosensory cortex associated with sensation in the fingertips through analysis with Neuroexplorer and Matlab. Future research will involve using these identified neural patterns to recreate the sensation of touch.

This project aims to understand global climate change through a series of scaled-down fluid system experiments using a rotating tank. The rotating cylinder with differential heating mimics the key effects of pole-to-equator temperature gradient and earth's rotation on global atmospheric circulation. A rich set of contrasting flow patterns were produced by the experiments when the two key parameters of rotation and temperature contrast were changed. This demonstrates the sensitivity of our climate system to small external perturbations. This project contributes to the Grand Challenge in the critical aspect of sustainability.
Programming the Nutrient Injection Module
Patrick Trang, Computer Science
Graduation: May 2013  
Hometown: Tempe, Arizona
Mentor: Dr. Rolf Halden, Civil and Environmental Engineering
Grand Challenge: Sustainability

The objective of the project is to enhance the capabilities of the in-situ Microcosm Array (ISMA), a tool which enables one to compare multiple remediation technologies in situ without impacting the quality of the contaminated site. Specifically, the goal is to build a user-friendly computer interface for one of the components of the ISMA, the Nutrient Injection Module (NIM). This involved using LabView™ in order to design and test a control program for the NIM which allows the user to specify desired flow rate and total run time. Future work will focus on enhancing the capabilities of the control program.

Design of a Photovoltaic Driven Vapor Compression Refrigeration System
Clay Tyler, Mechanical Engineering
Graduation: May 2011  
Hometown: Chandler, Arizona
Mentor: Dr. Patrick Phelan, Mechanical and Aerospace Engineering
Grand Challenge: Energy and sustainability

The purpose of this research is to design a complete photovoltaic (PV), solar power driven air conditioner that will condition a room space for use as a solar lab. The primary work has been to set up the new solar lab to be used for future solar research and to research the design of a photovoltaic cell power system. Therefore in the design of the system, the optimum tilt angle, total radiation, and total number of panels needed has been formulated. Future work will be to implement and install the PV driven air conditioner and improve upon the efficiency of the unit.

H.264 Video Traffic Characterization and Transmechanisms
Jonathan Francis Vahabzadeh, Electrical Engineering
Graduation: May 2011  
Hometown: Scottsdale, Arizona
Mentor: Dr. Martin Reisslein, Electrical Engineering
Grand Challenge: Enhance virtual reality

The two overlying goals are to thoroughly characterize video traffic variability and to develop and evaluate video transport mechanisms. The general findings are that prioritization is beneficial for frame dependent transmission, and that a buffer can be used to greatly increase the number of transported streams. The recent focus has been to add randomization in the frame transport order and use larger, more diverse video traces to multiplex. Also, the frame independent simulations have been updated to account for frame loss prior to transport. In the future it will be interesting to investigate active buffer management.
**High Temperature Carbon Dioxide Separation Membrane**

**Armando Villarreal, Chemical Engineering**

Graduation: May 2011  
Hometown: Culiacan, Mexico  
Mentor: Matthew Anderson and Dr. Jerry Lin, Chemical Engineering  
Grand Challenge: Energy and sustainability

The performance of a dual-phase membrane capable of separating carbon dioxide at high temperatures was studied. CO₂ that permeated through the membrane was then reacted with methane to make precursors for liquid fuel synthesis. The membrane and nickel catalyst used to reform the CO₂ were characterized. Afterwards, experiments at high temperature in the absence of a catalyst using different mole fractions of CO₂ showed a flux of 0.15 mL/min cm² at 850°C for each case. Dry reforming in the presence of the nickel based catalyst showed reasonable conversion and selectivity. Further high temperature experiments are recommended to optimize membrane performance.

**Development of a Pathogen Detection Device Utilizing Optical Microscopy**

**Aman Verma, Bioengineering**

Graduation: May 2010  
Hometown: Scottsdale, Arizona  
Mentor: Dr. Jeffrey La Belle, Bioengineering  
Grand Challenge: Advance health informatics

This research investigates how different parameters relate to theoretical surface area coverage and capture of E. coli using a monoclonal antibody. Different sputtering geometries, slide surfaces, and antibody immobilization and Gram staining techniques were investigated. Various concentrations of E. coli were added to the slides, then Gram stained and imaged. Cell counting was performed and compared to theoretical surface area calculations after varying the above parameters. It was determined that immobilizing E. coli on poly-L-lysine slides with antibody immobilized on the surface led to greater cell capture. These results will be incorporated in the creation of a pathogen detection device.

**Development and Fabrication of a Fluidics Device for Point-of-Care Infection Diagnosis**

**John Wake, Bioengineering**

Graduation: May 2010  
Hometown: Phoenix, Arizona  
Mentor: Dr. Jeffrey La Belle, Bioengineering  
Grand Challenge: Engineer better medicines

This project aims to design a fluidics device which receives a patient sample of blood, and filters and delivers the blood to a specialized point at which bacteria in the blood may be detected, and designs the fabrication method for such device. Initial designs were developed using CAD software, and different materials were researched. Prototypes have been produced which were molded using SEBS, a flexible thermoplastic, and have proved successful in transferring the required volume of liquid across the device. A fluidics device has been incorporated into a CCD system with external housing and control. Future work will include testing the device with blood, and refining the specifications of the device accordingly.
Generating plans in stochastic planning environments is a difficult and time consuming process even with state of the art planners such as FF-Hindsight. This research applies a series of adaptive sampling methods around FF-Hindsight to improve the quality of plans returned by the planner, as well as allowing the planner to modify the time it takes to make a decision on an action and base it on difficulty of the problem. By creating a pool of samples and distributing these based on a variety of selection methods, the planner can be more capable of solving a variety of planning problems.

This project evaluates the potential for using groundwater recharge to remove dissolved organic carbon (DOC), with the goal of providing a sustainable alternative to the use of activated carbon in drinking water treatment plants. Historical discharge and DOC data from the SRP canal system was gathered, and a mass balance analysis was performed. Results show the south canal historical average DOC concentration (4.34 mg/L) could reduce to 3.32 or 2.49 mg/L, by respectively pumping 100,000 or 200,000 acre-ft/year of groundwater. Conclusively, recharged groundwater is an effective DOC removal method. Further research is recommended using data from additional groundwater recharge sites.

The purpose of this project is to explore the productive capability of a novel approach towards the biosynthesis of (R)- and (S)-3-hydroxybutyrate, a chemical compound that serves as a building block in the production of vitamins and antibiotics. This new approach reassimilates acetate byproduct into the production process, which will minimize losses and enhance productivity. To date, the pathway genes of interest have been amplified via PCR and cloned into suitable expression vectors. Enzyme activity is soon to be tested in vitro and in vivo within recombinant E. coli, and the full pathway will be assembled within a production host.
The proposed Western Canal Water Treatment Plant will treat water using crystallactor technology, which produces the calcium carbonate pellets used in this experiment as a possible fine aggregate. After analyzing the contents of the pellets, they were used to replace sand in contents of zero, 10, 20, and 30 percent, and ages of seven days and 14 days. The compressive and flexural strengths of the concrete made with the pellets were compared with the zero percent pellet replacement. For the future, testing concrete with higher content percentages and an age of 28 days might be insightful.

The goal is to apply high-fidelity visualization techniques to the dataset obtained from direct numerical simulation of the flow over a golf ball. Thus far, two processes for running Fieldview Parallel on the Saguaro supercomputer have been established. Successful visualizations of the instantaneous flow and animations of the temporally-evolving solution have been generated and the process for submitting batch processes to generate animations has been refined to require less user-input. These achievements have provided an efficient approach to visualization of enormous datasets. Suggested further work includes using newly developed Fieldview tools for insight into better use of the solver code.
# Students and Mentors

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</table>
Michael P. Verdicchio (Computer System ’06 – FURI Spring ’05-Spring ’06)
Currently 4th year Ph.D. student at ASU in Computer Science.

Patrick Kelley (Computer Systems ’06 – FURI Spring ’06)
Working at eBay Inc. on Information Security.

Rustan Sharer (Biomedical Engineering ’06 – FURI Spring ’05-Spring ’06)
Medical student at the University of Arizona College of Medicine—Phoenix.

Sarah Kennedy (Biomedical Engineering ’06 – FURI Spring ’05-Spring ’06)
Currently at the University of Arizona College of Medicine—Phoenix in Partnership with ASU.

Alper Karul (Chemical Engineering ’08 – FURI Spring ’08)
Process Engineer, Medical Products Division, W.L. Gore and Associates, Flagstaff AZ.

Drew Jones (Aerospace Engineering ’08 – FURI Spring ’08)
Aerospace Engineering PhD student with specialty in Orbital Mechanics at University of Texas, Austin.

Jere Harrison (Electrical Engineering ’08 – FURI Fall ’07-Spring ’08)
Graduate student at UCLA.

Alex Weir (Chemical Engineering ’09 – FURI Fall ’07)
Masters Degree in Environmental Engineering at ASU.

Brandon Blakely (Bioengineering ’09 – FURI Fall ’07-Spring ’09)
PhD candidate at University of Pennsylvania.

Daniel Bishop (Bioengineering ’09 – FURI Fall ’06-Fall ’08)
Currently finishing my first year of an MD/PhD (bioengineering) program at University of Pittsburgh and Carnegie Mellon University.

David Latshaw II (Chemical Engineering ’09 – FURI Fall ’08-Spring ’09)
Currently pursuing my Ph.D. at North Carolina State University where I research the aggregation of the protein amyloid beta and its role in Alzheimer’s Disease.

James Long (Bioengineering ’09 – FURI Fall ’07-Spring ’08)
Working in bioinformatics at the Translational Genomics Research Institute, Accepted to medical school for the class of 2014 at the Uniformed Services University of the Health Sciences.

Stephen Vossler (Bioengineering ’09 – FURI Spring ’08-Spring ’09)
First year as a Stanford Medical Student.

Zbigniew David Czupak (Civil Engineering ’09 – FURI Spring ’08-Spring ’09)
Graduate School pursuing MS in Geotechnical Engineering under supervision of Ed Kavazanjian. Planning to defend in Spring of 2011.

Jose Benavides (Electrical Engineering ’05 – FURI Spring ’05)
Working with with MCT Inc at NASA Ames Research Center in Moffett Field, Ca for over two years working on controls-oriented modeling of hypersonic aircraft.

Justin Reed (Bioengineering ’08 – FURI Fall ’07-Fall ’08)
Product Support Engineer at Illumina in San Diego. Involved in supporting the field engineers and other customer facing employees when new products and/or specifications are put in place.

Christine Leon (Bioengineering ’09 – FURI Fall ’07-Spring ’09)
Pursuing a master’s degree in Bioengineering and will attend the University of California-Berkeley beginning in Fall 2010 in their joint Ph.D. program with UCSF and was awarded the Chancellor’s Fellowship.

Philbert Hukson (Biomedical Engineering ’08 – FURI Fall ’06-Fall ’07)
Research Associate at Ventana Medical Systems, Inc., in Tucson, AZ.
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