Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Stephen Canfield, Mechanical Engineering

Supporting Professionals: Jamie Beard, CESR

Project Title: Capture Concepts and Model Development for MXER Tether Systems w/Model Development

Activation Amount: $25,000.00

Agency: NASA

The primary control of spacecraft is provided through chemical thrusters. In general, these thrusters are fixed relative to the spacecraft body, or in some situations given mobility through one or two degrees of freedom over a limited range of motion. General control of a spacecraft is then provided through a collection of thrusters located on the spacecraft that are fired in a manner such that their sum provides the desired thrust vector. The reliability of the system depends on the reliability of the individual thrusters to work together. As an alternative approach to thrust vector control on a spacecraft, the author proposes to create a gimbal thrust device that combines a rocket engine with a novel, parallel-architecture gimbaling mechanism that will provide a large workspace of controlled thrust (greater than a hemisphere if desired) with a single thruster/gimbal system. Potential advantages of this system if developed include: improved efficiency of thrust, improved reliability in rocket motor through a reduced number of required motors, decrease in overall weight, ability to design fully parallel redundant paths in thrust, and the ability to provide a wide range of engine throttling.

Principal Investigator: Gail Gentry, Craft Center

Supporting Professionals: Anastasia Azure/Michael Albanese/Juliane Shibata/Michael Hernandez, Craft Center

Project Title: Hands-On Art/Craft Experience for Elementary School Students 2006-07

Activation Amount: $4,800.00

Agency: Tennessee Arts Commission

Each fall the Appalachian Center for Craft (ACC) invites students from over 35 elementary and middle schools from the Upper Cumberland Development District to the annual "Hands-On Art/Craft Experience for Elementary School Students." Enrollment is on a first-come, first-served basis. The program takes place on 10 Fridays during the fall and accommodates 100 students on each program day. A minimum of eight teacher and/or parent chaperones accompany each school. ACC artists lead participants in four lecture/demonstrations and four hands-on art workshops.

On each Friday, four groups of 25 students each attend the four lecture/demonstrations and four hands-on art workshops. ACC day coordinators lead the students to each of their activities. In the morning, students participate in four 15-minute lecture/demonstrations including: glass blowing, blacksmithing, wheel throwing in ceramics, and woodturning. Artists explain techniques, tools, equipment, and history as they demonstrate. In the afternoon, students participate in four 30-minute hands-on art workshops including: clay handbuilding, photogram photographs, felted wool flowers, and copper wire jewelry. ACC artists lead the workshops and explain and supply all tools, equipment, and materials. Participants take all their "works of art" home with them.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Ismail Fidan, Manufacturing and Industrial Technology

Project Title: Integrating Rapid Prototyping Technology into a Manufacturing and Industrial Technology Curriculum

Activation Amount: $23,984.00

Agency: National Science Foundation

This project is providing guidance in the development of technical transfer approaches, marketing material, understanding of the incorporation of Rapid Prototyping integrated in the design process for manufacturing, and maintenance procedures for the purchased Rapid Prototyping equipment. Developed materials will be presented in various distance learning formats and disseminated through P16 teacher and student workshops.

Principal Investigator: Wenzhong Gao, Energy Systems Research

Project Title: TTU Subcontract on MSU Electric Ship Research and Development Consortium (ESRDC) Project

Activation Amount: $50,000.00

Agency: Mississippi State University

This project is to model and analyze small-scale PEM fuel cell systems used for distributed electricity generation, that would support electric power sources required for critical loads onboard all-electric ships and other naval war fighting platforms. The main research goals are to: (1) develop 1000 W fuel cell model in Matlab/Simulink and VTB Pro; (2) develop fuel cell distributed generation (DG) system models in VTB Pro; (3) perform advanced simulation of power systems with fuel cells; (4) develop hybrid control strategy. The main methods will be computer modeling and simulation. The research results can apply to distributetd generation system at higher power rating. Such DG systems can help the critical or vital shipboard loads function without power interruption if the central power unit is stuck, among other benefits to the power network.

Principal Investigator: Robert Qiu/P. K. Rajan, Electrical and Computer Engineering

Project Title: Time-Reversal Based Ultrawideband MIMO (UWB-MIMO) for Low Cost, High Data Rate Communications

Activation Amount: $73,481.00

Agency: National Science Foundation

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Donald Visco, Chemical Engineering

Project Title: Exploring the Effects of Self and Cross-Clustering on the Thermodynamics of Strongly Associating Systems

Activation Amount: $21,226.00

Agency: American Chemical Society

In our opinion, a detailed accounting of the self and cross-association interactions in strongly associating mixtures where both components can hydrogen bond will lead to a robust and predictive thermodynamic model. The previous sentence, which is the hypothesis upon which this research is based, will be addressed throug exploration of the mixture of water and hydrogen fluoride (HF). We have chosen this mixture since a robust model describing this industrially important system is currently lacking. From our experience, a path that explores the association schemes of this mixture provides the most likely way to produce a useful and thermodynamic model. All available experimental equilibrium data in the literature for the pure components and the mixture will be used in formulating/correlating/assessing the model. In this pathway, this work will also produce ab initio studies and generate results from molecular simulations, which can provide molecular level information of the association patterns and properties of this mixture. Such a meshing of theory, experimental work, molecular simulation and ab initio studies in order to produce an industrially practical equation of state is the state-of-the-art approach to complex model development. Note that if our hypothesis is found to be true (based on completing this research), then this will encourage additional examination of models for other strongly associating mixtures with such substances of Hcl and H2SO4, as well as mixtures of those substances with hydrocarbons.

Principal Investigator: Glenn Cunningham, Mechanical Engineering/Kenneth Currie, Manufacturing Center

Project Title: Tennessee 3-Star Industrial Assessment Center

Activation Amount: $6,702.00

Agency: U. S. Department of Energy

The proposed Industrial Assessment Center (IAC) represents a unified and collaborative approach to industrial assessments that will not only span the entire state of Tennessee but also cover some of the more IAC underrepresented areas of Kentucky, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Arkansas, and Missouri-all within a 150 mile radius! By utilizing the strong institutional bond between three of the six four-year universities under the authority of the Tennessee Board of Regents, the Tennessee 3-Star IAC will draw upon the engineering and technology resources of Tennessee Technological University (lead), the University of Memphis (satellite), and East Tennessee State University (satellite). The proposed IAC is referred to as the Tennessee 3-Star IAC to signify the historical geographic/economic/political divisions within the state: West Tennessee (Memphis), Middle Tennessee (Cookeville), and East Tennessee (Johnson City). By encompassing lead/satellite centers within each division, the Tennessee 3-Star IAC will reach an estimated population base of approximately 10 million and a manufacturing employee base of 1.0 million--once again within a 150-mile radius. Within the state of Tennessee, there are approximately 750 manufacturing concerns with less than 500 but more than 100 employees, and the Tennessee Valley region has been virtually untouched by previous IAC assignments (within the last 10 years) due to excessive geographic distance.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Nasir Ghani, Electrical and Computer Engineering

Supporting Professionals: Robert Craven/Tony Greenway, Energy Systems Center

Project Title: Collaborative-Hybrid Multi-Layer Network Control for Emerging Cyber-Infrastructures

Activation Amount: $175,000.00

Agency: U. S. Department of Energy

The U. S. Department of Energy (DOE) has been actively deploying a wide range of high-speed and optical networking infrastructures to meet the needs of its scientists, particularly in the field of large-scale scientific computing, i.e., e-science. Notable examples include the Energy Sciences Net (ESNet) and UltraScience Network (USN) projects. Concurrently, the U. S. National Science Foundation (NSF) is also funding large networking testbeds, such as Internet2, they Hybrid Optical and Packet Infrastructure (HOPI) project, and the NSF Dynamic Resource Allocation via GMPLS Optical Networks (DRAGON) project. Although these initiatives have made significant progress, their focus has been confined to specific infrastructures and technologies. However, as e-science demands continue to grow, there is a pressing need to achieve service provisioning across multiple network types. This requires a degree of study, analysis, and collaboration beyond what this community has been able to focus on to date.

This timely project addresses these very challenges and seeks to consolidate and extend the results of these individual projects into a more unified, holistic solution. The specific technical goals will develop novel end-to-end architectures traversing multipe networking technology layers and will pursue two highly-complimentary phases-theoretical network design and real-world testbed development. The former will focus on the development of advanced network simulation capabilities in order to facilitate structured design and evaluation. The latter will develop specific software and experiments to validate the findings in real-world scientific networks. In all, the findings will provide decision makers with the necessary information to make judgments regarding next-generation "production" e-science networks. The project will be conducted by three co-principal investigators (co-PI's), including Dr. Nasir Ghani from Tennessee Tech University, Mr. Tom Lehman from University of Southern California Information Sciences Institute East, and Dr. Rick Summerhill from Internet2. In addition senior staff members from DOE national labs, including Oak Ridge, and various NSF projects will also actively partake in the efforts. Overall, this project will play a vital role in the advancement and adoption of networking solutions for the scientific computing and also commercial networking sectors. More broadly, the project will train a highly-skilled cadre of networking scientists and maintain national preeminence in the field.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Steven Click, Civil and Environmental Engineering

Project Title: Improved Traffic Signal Efficiency in Rural Areas Through the Use of Variable Maximum Green Time

Activation Amount: $23,819.00

Agency: Mack-Blackwell Transportation Center

The purpose of this project is to investigate the potential for an existing but little-used traffic signal controller feature, namely Variable Maximum Green Time (VMGT), to provide improved operations at rural traffic signals. VMGT allows the maximum duration of a given phase to be increased in subsequent cycles if the current cycle demand is not fully served. The primary method of evaluation is comparative simulations, including both Hardware-in-the-Loop Simulation (HILS) and Controller Software In the Loop Simulation (CSILS), both of which involve direct connection between in-field traffic signal equipment or control applications with traffic simulation models. The goal of the research is to establish the ability of VMGT to replace or supplement regular timing updates, a costly and time-consuming effort which is frequently not possible in rural settings.

Principal Investigator: Xubin He, Electrical and Computer Engineering

Project Title: SGER: Distributed Symmetric Active/Active Metadata Management

Activation Amount: $50,000.00

Agency: National Science Foundation

This objective of this project is to explore high availability storage services through forefront research on distributed symmetric active-active metadata management. This project investigates and provides a proof of concept of three key problems: global state identification and consistency, group communication overhead, and metadata server membership management.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Jeffrey Boles/Mona Wells/John Harwood/Jisook Kim, Chemistry/Martha Wells, Water Center

Project Title: MRI/RUI: Acquisition of a Liquid-Chromatography-MS for Biological and Environmental Analysis

Activation Amount: $369,996.00

Agency: National Science Foundation

The objective of this proposal was to acquire a liquid chromatograph-tandem mass spectrometer for chemical, biochemical, and environmental analysis in research and research training. The five major users (Jeffrey Boles, Martha Wells, Mona Wells, John Harwood, and Jisook Kim) are engaged in identification and structural elucidation that involves the synthesis, analysis, and quantitation of molecules of biological and environmental importance. The acquired instrumentation allows for the analysis and characterization of both high and low molecular weight compounds due to the diverse research interests of the principal investigators.

The acquired instrumentation will: 1) strengthen the undergraduate and graduate research infrastructure in the chemistry department through advanced research and training; 2) allow additional opportunities to send underrepresented students and faculty alike to national meetings to disseminate novel research; and 3) provide the resources necessary to address local and national issues of biochemical and environmental importance. Collaborations with local, state, and federal agencies will result in an increased understanding of the identification and fate of important biochemical and environmental metabolites in our community and will broadly impact the world in general through an increased understanding of the impact of human endeavors. Most of the chemistry department graduates plan careers in chemistry, biotechnology, or environmental science and ultimately go on to attend graduate school or professional school. There are currently 16 full-time faculty in the Department of Chemistry, 22 students in our MS/PhD programs and over 50 students involved in undergraduate research. Of the 16 faculty, there are five major users and two minor users of the instrumentation, thus, many students will be directly impacted on an annual basis. Finally, women and minorities are underrepresented in many science and engineering programs at TTU, and funding of this proposal will help address this situation by enhancing the capacity of the three female principal investigators to serve as mentors and role models in STEM fields.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Jeffrey Boles/Ed Lisic, Chemistry/Martha Wells, Water Center

Project Title: Methamphetamine Research: Environmental Impact and Detection

Activation Amount: $355,402.00

Agency: Department of Justice-COPS

Concern over the growing use and manufacture of homemade methamphetamine in the United States necessitates the development of new and rapid detection/analysis techniques and advanced environmental impact studies in order to protect children and community from clandestine lab hazards. Not only is the drug a threat to the user and/or cook, experts now say that the production process is hazardous to children who may be living in homes nearby. With new methods available in the illegal drug industry, methamphetamine can be cooked in a home, apartment, or car trunk; and the process produces a cloud of harmful chemicals, including methamphetamine itself. Since the potential exists to characterize methamphetamine lot-by-lot, we wish to advance impurity-profiling methodologies of seized methamphetamine by GC/MS and LC/MS/MS in order to provide a detailed tool which can be used to link meth-related crimes to the original cook. LC/MS/MS in particular is an excellent technique for the detection/characterization of methamphetamine because it offers little chance of interference, a very high sensitivity, a great deal of precision and accuracy, can be used to scan for essentially any additional drug and is very rapid in analysis time. We will investigate the potential for using the acquired instrumentation to identify suspected clandestine labs by analysis of samples collected outside the suspect residence in order to hasten warrant issuance. In addition, the acquisition of ion-trap GC/MS is critical to the identification, characterization, and environmental impact imposed by many unknown compounds found or partically metabolized at clandestine laboratories. In addition, the applicability of procedures used for sampling and analysis of contaminants at traditional hazardous substance release sites relative to investigating residences contaminated by drug lab activity is not well understood at this time. Data on contaminants of concern are very limited and health-based cleanup standards do not currently exist. We propose to identify the best cleaning methods for home contamination sites for the different synthesis techniques used in these illegal labs and examine the environmental impact to the community. One principal area of interest is in the determination of "how clean is clean?" Lastly, we also wish to develop new chemical detection technologies in this endeavor. Developing the newer chemistries we envision at TTU will potentially provide for a relatively inexpensive new on-site detection system. The new system will potentially be used to provide plentiful and inexpensive "wipe" kits, which are needed by law enforcement officers.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Thomas Roberts/Kenneth Morgan, Biology

Project Title: Black Swamp Hydrogeomorphic Bottomland Hardwood Functional Assessment

Activation Amount: $10,000.00

Agency: Tennessee Wildlife Resource Agency

The hydrogeomorphic (HGM) approach is a method designed to develop and use functional indices to assess the capacity of a wetland to perform various functions relative to similar wetlands in the same region. The overall goal of the HGM approach is to develop wetland assessment methods that are rapid, scientifically acceptable, and repeatable. Though initially the HGM approach was designed for use with the U. S. Army Corps of Engineers (USACE) wetlands regulatory program, other applications have been identified and include: assessing impacts to wetlands resulting from development, adequacy of compensatory mitigation efforts, determining suitability of different management options, and assessing wetland performance throughout a watershed. The HGM approach identifies groups of wetlands that function similarly using three criteria that fundamentally influence how wetlands function: geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landform and position of the wetland in the landscape. Water source refers to the primary water source in wetland such as precipitation, overbank flooding, or groundwater. Hydrodynamics refers to the level of energy and the direction that water moves in the wetland. Based on these three classification criteria, any number of "functional" wetland groups can be identified at different spatial or temporal scales. This HGM slope wetland assessment is the third such assessment for wetland types in Tennessee. Objectives of this assessment include: (1) characterize slope wetlands in middle Tennessee, (2) determine the functions performed by slope wetlands in middle Tennessee, (3) determine the most important variables and metrics to be used in the assessment, and (4) develop and calibrate assessment models.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Bradford Cook, Biology

Project Title: Habitat Characterization of the Nashville Crayfish (Orconectes Shoupi) in Mill Creek Watershed, TN

Activation Amount: $35,000.00

Agency: U. S. Fish and Wildlife Service

The Nashville crayfish (Orconectes shoupi), the only federally listed endangered crayfish in Tennessee, is endemic to the Mill Creek watershed in Davidson and Williamson counties, Tennessee. Due to increasing anthropogenic activity in the Mill Creek watershed, this crayfish was federally listed as endangered on September 26, 1986, with no designation of critical habitat. The Mill Creek watershed drains approximately 280 km2 within the Nashville Basin, originating in Williamson County and flowing north into Davidson County before reaching the Cumberland River. Nashville crayfish are known to inhabit runs with gravel and cobble, pools with up to 10 cm of settled sediment and intermittent flows, and seek shelter under slabrocks and other forms of cover. They have been found to select large stones for cover and tend to inhabit non-flowing rather than flowing water. Although these habitat descriptions have been documented, a habitat utilization model has not been developed for this species. Objectives for this project will be to: (1) identify seasonal macro-habitat variables that influence the distribution of Nashville crayfish; (2) identify seasonal micro-habitat variables influencing habitat utilization by Nashville crayfish; and (3) develop a predictive habitat model for Nashville crayfish.

Sample sites will be identified such that a representative number of locations will be sampled within the known distribution of the Nashville crayfish. Sites will include, not only the mainstem of Mill Creek, but also major tributaries. A random sample of sites in secondary tributaries to the five major Mill Creek tributaries will also be sampled to determine when Nashville crayfish use these waters and to describe the habitat used. GPS coordinates will be obtained for each sample reach. Physical macro-habitat features of each site will be delineated and field water quality parameters will be measured during each sampling event. Nashville crayfish will be sampled using D-frame aquatic nets and small aquarium nets when necessary. All sites will be sampled seasonally to document seasonal use of habitats. Each time a Nashville crayfish is collected, a weighted marker will be dropped at the location. After each reach is systematically sampled, investigators will return to each marker and obtain micro-habitat data. The same micro-habitat data will be recorded for a statistically valid number of locations which do not harbor Nashville crayfish. Data analysis will involve logistic regression techinques. Habitat variables will be evaluated to determine which variables explain seasonal habitat use by this species.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Donald Visco, Chemical Engineering

Project Title: Developing Novel Scaffolds for Biological Molecules by Solving the I-QSAR Problem Using the Signature Molecular Descriptor

Activation Amount: $50,000.00

Agency: Sandia National Laboratories

The signature molecular descriptor is a very powerful and robust way to encode the local environment of a particular atom in a molecule. Work in this area by this research team have demonstrated this feature in several refereed journal articles, conference presentations, and invited speaking engagements. Much of this project's recent work has been on exploring the use of the signature molecular descriptor to solve the inverse design problem. As this technique matures, certain algorithmic bottlenecks have become apparent as we fine-tune this methodology against a variety of different problems. Current work focuses on fleshing out these issues and addressing them via several concurrent studies. Additionally, we also plan to generate some of these solutions in the lab and test them in order to feedback "real" information to evaluate the effectiveness of the methodology.

In addition to the use of the signature molecular descriptor in the solution of the inverse design problem, we plan to explore signature as a tool in similarity searching of large chemical databases. Gleaning activity and functionality relationships through alignment of amino acids in a protein sequence against certain known alignments is a workhorse tool of those in the wide field of bioinformatics. The chemical landscape is very ripe for a similar procedure owning to the recent generation of very large chemical databases, including PubChem. In this portion of the work, we plan to explore the use of signature as the encoding device for any chemicals in order to facilitate the similarity searching of large chemical databases. The ultimate goal would be to find substances which score high on alignment relative to known (re: database) substances in a particular areas (re: therapeutics) in order to widen the candidate pool of substances in this area.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Mona Wells, Chemistry

Project Title: A Whole-Cell Biosensor Panel for Agricultural Endocrine Distruptors

Activation Amount: $50,000.00

Agency: BARD Liaison Office via USDA

Chemical agents, such as pesticides applied at inappropriate levels, may compromise water quality or contaminate soils and hence threaten human populations. Global demographics assure that threats to agriculture will continue to grow. An emerging threat is posed by endocrine disrupting compounds (EDCs), a class of compounds compromising both human and ecosystems' reproductive health; many pesticides have been implicated as EDCs. EDCs pose a threat in proportion to their bioavailability, since that which is biounavailable or can be rendered so is a priori not a threat; bioavailability, in turn, is mediated by complex matrices such as soils. Genetically engineered biosensor bacteria hold great promise for sensing bioavailability because the sensor is a live soil- and water-compatible organism with biological response dymnamics, and because its response can be generally "tailored" to report on general toxicity, on bioavailability, and on the presence of specific classes of toxicants. We propose the development of a sensor panel incorporating multiple strains of genetically engineered biosensors for the purpose of detecting different types of biological effects in tandem. Some of the biosensors used will have specific or "lights on" response--i.e., wherein response results from formation of a luminescent reporter molecule in direct proportion to the amount of exposure the biosensor has to its target analytes (e.g. pesticides or EDCs). Others will be "lights off" type biosensors wherein the organisms are engineered to be luminescent in the absence of exposure, this luminescence decreasing as a function of group-effect exposure (our panel will target endocrine disruption capacity as well as overall toxicity). The panel will consist of a matrix of spots, each spot containing a different strain of bacterial biosensor that will yield individual response information for evaluation of the biological effects of the target analytes. Additionally, algorithms suitable for small sensor arrays will be borrowed from the area of electronic nose sensing to discriminate biological effects from the cumulative panel response, constituting a type of biological multiplexing. The ultimate goal of the project is to demonstrate applicability of the sensor panel with real samples such as soil solutions, runoff, material leaching into aquifers, sewage from secondary treatment, etc., and the project will culminate in a field trial. This work relates directly to issues of water quality and soil health, but is extensible to risk-based assessment and homeland security issues as well.

Grants Awarded

From 9/1/06 To 9/30/06

Principal Investigator: Thomas Roberts/Kenneth Morgan, Biology

Project Title: Development of Geo-Referenced Database to Identify and Inventory Wetlands at Little River Canyon National Preservation

Activation Amount: $61,305.00

Agency: National Park Service

As part of a natural resource inventory at Little River Canyon National Preserve, the delineation and mapping of all wetlands and all other "waters of the United States" subject to jurisdiction under Section 404 of the Clean Water Act, and all wetlands subject to NPS procedures for implementing Director's Order #77 was requested from Tennessee Technological University. As part of the delineation and mapping, a geo-referenced database will be developed that consists of information about each wetland, including an assessment of the wetland's biotic and abiotic functions and values, and management recommendations for the resource. Maps, including U. S. Geological Survey (USGS) topographic mpas, National Wetland Inventory (NWI) mpas, soil survey maps, aerial photographs, and other existing data sets will be reviewed to locate potential wetlands within the park. Onsite investigations of all potential wetland sites will be conducted to examine and document soil, hydrology, vegetation, land use, and related characteristics using the above data sources in accordance with methods approved by the USCOE and NPS for wetland delineations. All wetlands will be delineated and classified using the Corps of Engineers Wetlands Delineation Manual (USCOE 1987), the

Cowardian Classification System (Cowardian et al. 1979), and the Hydrogeomorphic Approach to wetland classification (Brinson 1993). An assessment of the potential functions and values provided by each wetland utilizing methods outlined in HGM guidebooks. Deliverables to be included in the final product for this project include: (1) an electronic database of all wetlands delineated at the park, (2) a GIS point coverage (ArcView format) of the delineated wetlands at the park, (3) information that characterizes the biotic and abiotic components at each site, and (4) a final preliminary project report, that will include a narrative discussion based on information in the electronic database for each delineated wetland located during Phase I. The report also will include an assessment of any current or potential impacts and recommendations for future management of the wetland resources.