GRANTS AWARDED
September, 2005

Principal Investigator: Ismail Fidan, Manufacturing and Industrial Technology
Co -PI(s):
Project Title: Integrating Rapid Prototyping Technology into a Manufacturing and Industrial Technology Curriculum
Activation Amount: $23,990.00
Agency: National Science Foundation
This project proposes to expand on the model(s) developed on prior NSF-ATE project supported curriculum development in Rapid Prototyping (RP). The expansion will include establishment of regional train-the-trainer workshops and the development of instructional support material. The project team is comprised of Saddleback College (California) in the lead, Central Maine Community College (Maine), Cuyahoga Community College (Ohio), Tennessee Tech University (Tennessee), San Diego State University (California), and Rochester Institute of Technology (New York).

Previously funded RP projects have identified additional barriers in the education and training of faculty and students in the area of Rapid Prototyping, and the need for recruiting students into design engineering. The project will be supported by the original equipment manufacturers of RP equipment (Zcorp, Stratasys, and 3D Systems). They will provide technology at the workshops, technical support for the project, and serve as active partners on the project's Advisory Board.

Principal Investigator: Sabine Leborne, Mathematics
Co -PI(s):
Project Title: Theory and Application of Hierarchical Matrices in Multiscale Problems
Activation Amount: $98,125.00
Agency: U. S. Department of Energy

Multiscale problems that appear in physical, biological, and chemical systems, and notably their numerical solutions, are notoriously hard to solve and the focus of much current research. On almost all fronts, from hardware to software simulation tools, significant advances have been achieved. A point of resistance remains, however, in the required numerical solution of very large systems of linear equations which typically consumes a significant portion of the overall computational time (70% up to 95%) when using current methods. This proposal details an aggressive and novel approach that can significantly reduce the cost for solving these large systems of equations.
The goals of this project is to construct the required efficient iterative methods in an international collaboration with the Max-Planck-institute for Mathematics in the Sciences in Leipzig, Germany, as well as Oak Ridge National Laboratory, by using so-called hierarchical (H-) matrix techniques. H-matrices are data-sparse and allow an approximate matrix arithmetic of almost linear complexity in the case of uniformly elliptic problems. In this project, H-matrices will be applied to singularly perturbed multi-scale problems. The objectives are to 1) adapt H-matrices to provide an efficient and robust solver for these non-symmetric, ill-conditioned problems, 2) analyze theoretical properties and implement the proposed algorithms, and 3) perform intensive

numerical tests in comparison with other state-of-the-art techniques.

This novel approach, if successful, would benefit a broad range of applications in numerous fields in science since it fills the need for a (nearly) optimal blackbox method for sparse as well as fully populated linear systems of equations. This will overcome the bottleneck that is holding progress back in many real-time simulations of complex systems.

Principal Investigator: Sharon Huo, Civil and Environmental Engineering
Co-PI(s):
Project Title: Structural Analysis of Structural Insultated Panels (SIPs)
Activation Amount: $15,000.00
Agency: SGI Ventures

Most residential buildings in the USA are made of wood-frames, constructed with lumbers and nailed together to form the skeleton of the buildings. Although these buildings are economical to build, they have caused concerns on their utilization of natural resources, energy cost, and certain undesirable durability performance. Use of newly developed structural insulated panels (SIPs) system could overcome the shortcomings of the wood-frames structures. The main advantages of these SIPs are: (1) having better energy-saving structural panels with high and uniform whole wall R-value across the panel; and (2) reducing the use of raw materials or need for virgin lumber. This research is a joint effort among Oak Ridge National Laboratory (ORNL), an industrial business (SGI Ventures, Inc.), and Tennessee Tech University to investigate the structural performance of the new SIPs.

Because no skeleton frames present in the building and the panels are the only load-bearing structural members in the SIPs system, the structural capability of the SIPs is the key element for the successful application of this building system. The objective of this project is to conduct structural analysis of the stresses, strains, load capacities, and deformations of individual SIP components under various load cases. The research team will use ANSYS 8.0 to perform the proposed analysis. Using ANSYS, the research team will perform computer modeling of structural members; apply appropriate loads; and study structural responses of SIP elements. Through this research, engineers will have a better understanding of the actual performance of the panels and system.

Principal Investigator: Daniel Badoe, Civil and Environmental Engineering **Co-PI(s):**
Project Title: Development of Tennessee Travel Demand Model Users' Group
Activation Amount: $7,000.00
Agency: University of Tennessee-Knoxville via TDOT

One of the most important transportation decision-making tools used at both the metropolitan level and the state level is a travel demand forecasting model. Travel demand forecasting models are used widely not only in the Unites States, but also in other countries. Their purpose is to assist decision-makers in making critical decisions about transportation investments. Currently there are nine MPO's in the State of Tennessee (soon to be 11), which do or will utilize a travel

demand forecasting model as part of their transportation planning process. Many of these areas have invested hundreds of thousands of dollars in operating, maintaining, and updating various components of their models. Some MPOs have recently completed household travel surveys so that they can update their model equations to reflect changing social and economic conditions as well as other trip making characteristics. To date, approaches to collecting this information and how data are coded has not been standardized. Unfortunately, the lack of standardization in the state has limited the transferability and comparability of the data. Given the cost associated with collecting these data it may be prudent to encourage some standardization within the state which could eventually allow the data collected by one MPO to be utilized by another MPO. TDOT has been assisting these areas as they move forward with their travel demand models. TDOT purchased a TransCAD license for each of the nine existing MPOs and paid to have the old models and networks translated into a TransCAD format. However, there is no coordinated approach to developing improvements to the models, model protocols, or other standard operating procedures, which could help reduce costs and improve the models currently in place. Additionally, this segmented approach makes it nearly impossible for TDOT to have a statewide model with the MPO models being a subset given the vast differences in equations and other model standards. Many state DOTs have begun to see the advantage of having a statewide travel demand users group as a means of improving the quality, consistency, and retention of modeling expertise in their respective state. As part of the recent Planning Assessment, it was observed that all five of the peer state DOTs evaluated have a travel demand model user groups in their state and in most cases the state DOT plays a major role in its existence. Further, one of the Planning Assessment recommendations is for TDOT to create and support a statewide travel demand model users group. The objective of this project is to establish a statewide travel demand modeling users' group to assist TDOT and other transportation stakeholders in the state to focus efforts to develop and maintain a key transportation planning tool--a travel demand forecast model-- both at a statewide level and regional level. This group will establish a set of goals to improve travel demand modeling within the state. The group would be a cooperative effort with other agencies and interested parties, such as the MPOs and Universities. The modeling group would promote standard statewide guidelines and validation standards, coordinate systematic data collection and processing, and help to organize and promote staff training and on-going research.

Principal Investigator: Kenneth Morgan, Biology
Co -PI(s): Thomas Roberts, Biology
Project Title: Development of a Geo-Referenced Database to Identify and Inventory Wetlands at Guilford Courthouse National Military Park
Activation Amount: $29,958.00
Agency: National Park Service

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 #77-1: Wetland Protection is needed as part of the natural resource inventory for Kings Mountain National Military Park. An assessment of wetland functions and values is also needed in order to facilitate the evaluation of future potential project impacts on wetlands and to determine appropriate compensation for unavoidable wetland

impacts as may be required by the Corps of Engineers for Section 404 permits and/or by the NPS for compliance with Director's Order #77-1.

Principal Investigator: Kevin Liska, Decision Science and Management
Co -PI(s):
Project Title: RODP Marketing Campaign
Activation Amount: $200,000.00
Agency: Tennessee Board of Regents

No abstract available at this time.

Principal Investigator: Bradford Cook, Biology
Co -PI(s):
Project Title:
Quantification of Injury to Aquatic Resources Resulting from the Pryor Oil Spill and Fire, Obed Wild and Scenic River
Activation Amount: $10,308.00
Agency: Proprietary

On July 19, 2002, an oil well in Morgan County, Tennessee, started to spill oil. Clear Creek, White Creek, and portions of the Obed Wild and Scenic River system within the Emory River Watershed were affected during this spill event. The purpose of this study is to assist in the interpretation of benthic macroinvertebrate data collected during the investigation of this oil spill. Macroinvertebrate data will be critically reviewed and benthic index scores will be determined for all benthic macroinvertebrate samples. Life histories of various species will be evaluated to estimate the time necessary for recovery once exposure to oil has ceased.

Principal Investigator: Joseph Biernacki, Chemical Engineering
Co -PI(s):
Project Title: RUI: Micro and Meso-Scale Strain Measurements in Cement-Based Materials
Activation Amount: $66,002.00
Agency: National Science Foundation

Concrete is the most used man-made construction material on the planet. With trillions of dollars in existing infrastructure and trillions being invested in new construction, concrete has a global economic impact on infrastructure development and sustainability. Concrete is made from water, aggregate (stones) and Portland cement. Upon mixing, the cement fraction undergoes a chemical reaction which transforms anhydrous calcium silicates and calcium aluminates into hydrous phases that glue the aggregate together producing strength. Yet, many aspects of the durability of this important material are not well understood. Stressors caused by mechanical, chemical and other physical loads, i.e., freezing and thawing, strain (deform) the concrete and eventually cause it to yield due to fatigue or excessive one-time loading. When materials deform, the very atoms and molecules of which they are comprised must also be displaced, one relative to another. For some materials, crystalline ones, this atomic-level displacement can be directly measured using

one of several diffraction-based techniques including x-ray and neutron diffraction. Direct visualization using electron microscopy may also be possible as well as vibrational light-based spectroscopy methods. While diffraction-based peak shifts represent the average deformation in a sizable sample volume, on the order of mm3 (millimeters cubed), electron microscopy and light spectroscopy have a spatial resolution on the order of um2 (micrometers squared). If successful, this suite of techniques may make it possible to study stress and strain distributions on the meso- (millimeter) and micro- (micrometer) length scales and hopefully provide the experimental basis for multi-scale modeling of concrete mechano-chemical behavior to improve our knowledge of this complex and important material.

Principal Investigator: Glen Johnson
Co-PI(s):
Project Title: Tennessee Space Grant Consortium Award
Activation Amount: $16,300.00
Agency: Vanderbilt University via NASA

This outreach program is to introduce middle school girls to career opportunities in science, math, engineering, and technology. With support from the Space Grant, we will emphasize space exploration and space related industry.

Principal Investigator: Ahmed Elsawy, Manufacturing and Industrial Technology
Co-PI(s):
Project Title: INTERNATIONAL: Innovative Technology for Improving Wear Resistance and Fracture Toughness of Austempered Ductile Iron Used for Automotive Industry by Either Thermomechanical or Two-Step Austempering
Activation Amount: $11,369.00
Agency: National Science Foundation

The automotive industry is continuously investigating means for producing long lasting and cheaper parts to stay competitive in the market place. Austempered Ductile Iron (ADI) is an engineering material used for manufacturing crankshafts, camshafts and gears. Because if its high strength, good ductility, good wear resistance and fracture toughness, it is considered an attractive substitute for wrought or forged steel parts. This proposed work is aimed to further improve the mechanical properties of the conventional ADI by applying either thermomechanical process for producing ausformed-austempered ductile iron (AADI) or using a novel two-step austempering process. This work will investigate both unalloyed as well as alloyed ADI with different amounts of Ni, Mo and Cu. The relationship between fracture toughness, reduction ratio in height during the thermomechanical processing and the microstructural variables such as amount of retained austenite, austenite carbon content, type of formed bainitic structure and matrix hardness will be determined. At the same time, the prediction equations of fracture toughness and wear resistance of those ADI's will be also determined using the finite element method (FEM).