A NATIONAL UNIVERSITY TRANSPORTATION CENTER
AT MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

# CENTER FOR TRANSPORTATION INFRASTRUCTURE AND SAFETY

## ADVANCED MATERIALS, TRANSITION-STATE FUELS AND NON-DESTRUCTIVE TESTING TECHNOLOGIES

**Sixth Year Annual Report**
July 1, 2011 – June 30, 2012

## PART A: CORPORATE STYLE ANNUAL REPORT

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Center Director

**AUGUST 31, 2012**

# Sixth Year Annual Report
# Part A: Corporate Style Annual Report

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# OVERVIEW: CENTER FOR TRANSPORTATION INFRASTRUCTURE AND SAFETY

## Introduction

Throughout five years of operation as a National University Transportation Center (NUTC), the Center for Transportation Infrastructure and Safety (CTIS) has become a Center of Excellence on the theme areas of advanced materials, transition-state fuel vehicle infrastructure and non-destructive testing technologies.

CTIS has provided the faculty, staff and students at Missouri University of Science and Technology (Missouri S&T) with the means for establishing key relationships with transportation-oriented state and federal agencies and industry partners. With NUTC leverage, the research and development (R&D) projects carried out at Missouri S&T have created the critical mass and the track record necessary to establish a Center of Excellence.

In addition to contributing to successful and relevant R&D projects, with the development of significant educational resources and by facilitating the transfer of advanced technology developed within the Center's theme areas, CTIS has impacted the quality of available education for engineers and transportation professionals, equipping engineers with interdisciplinary skills and experiences. As a result of CTIS activities, new academic programs for educating better-prepared engineers have been created at Missouri S&T and the University has become, and continues to be, the provider of the Local Technical Assistance Program (LTAP) for the state of Missouri.

Since its inception, CTIS has performed work in accordance with its strategic plan to accomplish projected goals in the areas of education, research and technology transfer. CTIS has put forth significant efforts to become highly visible and credible with the aim to recruit and retain quality students, faculty and professionals and to make significant contributions to transportation-related fields.

## Future

The future activities of CTIS will continue to draw on the capabilities and campus expertise in the Center's research theme areas. This synergism will be further fostered by the first annual Transportation Infrastructure Conference, which will be held on the Missouri S&T campus on September 27, 2012. The conference will showcase recent transportation-related projects dealing with advanced construction materials and structural systems, non-destructive testing and structural health monitoring of surface transportation infrastructure. This year's conference will feature five leading engineers from the US, Canada and Europe as keynote speakers who will discuss some of the cutting-edge technology related to the research themes of the CTIS. The CTIS hopes that this technology transfer event will grow in the future to foster further exchange between S&T researchers, industry and government agencies in the area of transportation infrastructure engineering.

Partnerships with industry professionals and organizations will be continuously sought out and developed. Currently, partnerships with the University of Miami and University of Illinois, Urbana-Champainge are being developed.

In particular, CTIS aims to become the point of reference and preferred partner of industry organizations that have not traditionally been involved with transportation-related applications and activities. The intention is to improve the quality and lifespan of existing transportation infrastructure using the broadest-based technology possible and to stimulate the economic viability of U.S. corporations.

## Mission and Theme

**Mission**: The mission of the Center for Transportation Infrastructure and Safety (CTIS) at Missouri S&T is to advance U.S. technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research and technology transfer at university-based centers of excellence.

**Theme:** To address national needs in the areas of transportation infrastructure and safety, focusing on the following topical areas:

- **Advanced materials** including constructed facilities security, which will involve several tasks:
    - The development, manufacture and application of modern construction materials
    - Installation processes and engineering design
    - Standardization and code approval of products and design protocols
- **Transition-state fuel vehicle infrastructure** leading to a hydrogen economy, which will require two critical tasks:
    - Development of safety codes, standards and regulations
    - Infrastructure development and deployment
- **Non-destructive evaluation (NDE) technologies and methods** including monitoring and evaluation of new and repaired structures and system components.

Advanced materials developed for use in transportation infrastructure offer superior mechanical properties, long-term durability and design flexibility. R&D in advanced materials address the growing needs for strengthening/rehabilitation of aging structures and for the design/construction of new structures to more stringent requirements and for extended service life. These materials apply to all modes of surface transportation.

Alternative fuel vehicles face the same implementation challenges as that of hydrogen vehicles. Research, development, demonstration and deployment activities of alternative fuel (including hydrogen) vehicles and supporting infrastructure across all modes of transportation address the growing need for a successful transition to a hydrogen economy.

Recent advances in sensor technologies and NDE techniques offer new methods of non-intrusive, in-situ monitoring of the health, geometric, environmental and structural characterization of civil structures and their supporting systems. NDE sensor technologies and methods enable more accurate, sensitive, cost-effective, rapid and straightforward evaluations. Integration of NDE technology to existing and future infrastructure systems will improve network evaluation and enhance the safety of the transportation infrastructure.

The choice of the Center theme comes from an analysis of state and national needs/opportunities, as well as the strengths/potential of Missouri S&T. We are walking the bridge that connects the transportation infrastructure of the second millennium to that of the third millennium. Existing infrastructure was conceived to support vehicular traffic powered by fossil fuel and has dramatic shortcomings in terms of durability and congestion. But the future will be an intelligent infrastructure incorporating advances in information technology and supporting a new generation of alternative fuels up to an ending point, which is conceivably hydrogen, with all the associated challenges in terms of safety, deployment and market acceptance.

Missouri S&T determined that it is of critical importance to its own mission and future, as well as the economical success of the state of Missouri, to focus on advanced materials in order to: a) help with the upgrade and maintenance (including security hardening) of existent infrastructure; and b) contribute to the development of new infrastructure. Similarly, NDE methods and techniques are a core area of expertise at Missouri S&T and their development and deployment continues to help with health monitoring of existing infrastructure and is becoming an integral part of new infrastructure to ensure both acceptance and safety. Finally, the Center takes a systematic approach to tackle the challenge of alternative fuels (including hydrogen) as the only viable methodology for the safe deployment of a new form of transportation.

# MANAGEMENT STRUCTURE

This section presents an overview of the Center's management structure and staff, those individuals who actively contribute to the functioning of Center activities, as well as information about the composition and purpose of the Research Advisory Board.

## Center Staff

In addition to the Director, the following individuals actively contribute to the management/operation of the Center: one associate director, four office staff persons and three laboratory staff persons. The Research Scholar position is currently open.

| Name | Title | Address/Phone/Fax/E-mail | Responsibilities |
|---|---|---|---|
| Khayat, K. | Director | 224 ERL, Rolla MO 65409<br>573-341-6223/6215 khayatk@mst.edu | Center management |
| Myers, J. J. | Associate Director | 325 Butler-Carlton Hall, Rolla MO 65409<br>573-341-6618/6215 jmyers@mst.edu | Research activities |
| Sheffield, J. | Associate Director | 331 Toomey Hall, Rolla MO 65409<br>573-341-6073/4607 sheffld@mst.edu | Research activities |
| Sherman, A. | Program Support Specialist | 222 ERL, Rolla MO 65409<br>573-341-7884/6215 abigayle@mst.edu | Proposal coordination/ newsletter/website |
| Spitzmiller, G. | Admin. Assistant | 221 ERL, Rolla MO 65409<br>573-341-7170/6215 spitz@mst.edu | Administration and accounting |
| Geisler, C. | Secretary | 223 ERL, Rolla MO 65409<br>573-341-4497/6215 geislerc@mst.edu | Clerical support |
| Open Position | Research Scholar | 218 ERL, Rolla MO 65409<br>573-341-6223/6215 | Research activities/mentoring |
| Cox, J. | Sr. Research Specialist | G-8 ERL, Rolla MO 65409<br>573-341-6742/6215 coxjn@mst.edu | Laboratory and field testing/coordination |
| Bullock, J. | Lab/Research Technician | G-8 ERL, Rolla MO 65409<br>573-341-7895/6215 bullockjr@mst.edu | Laboratory testing/ equip. maintenance |

# OVERVIEW OF EDUCATION, RESEARCH, AND TECHNOLOGY TRANSFER PROGRAMS

This section presents a summary and overview of all projects awarded during Year VI (2011-2012).

## Research Projects

### R310— Repair of Earthquake-damaged Bridge Columns with Fractured Bars [Sneed, L., PI – Missouri S&T, new in this reporting period]

Past effort in seismic design of concrete bridges has been on detailing of bridges to prevent collapse. Reinforced concreLeslesneedhte bridge columns are designed to undergo cracking, spalling, and yielding of steel and provide significant rotational capacity at plastic hinges so that the integrity of the overall structure is maintained. With proper design and construction this objective can be met. However, the serviceability of the bridge after the earthquake is in question. The level of damage to different columns of a bridge varies depending on the intensity of the ground shaking, type of earthquake, and the force/deformation demand on individual members. Based on the inspection of the damaged columns engineers have to determine whether the bridge is sufficiently safe to be kept open to traffic. They should also recommend repair methods for the columns. Any delay in opening of the bridge to traffic can have severe consequences on the passage of emergency vehicles, detour lengths, and traffic congestion in the area. Rapid and effective repair methods are needed to enable quick opening of the bridge to minimize impact on the community.

This project includes the repair of fractured bars in a series of interlocking spiral bridge column models that were tested to failure as part of a separate study funded by the National Science Foundation at Missouri S&T. This project is a new collaboration between the University of Nevada, Reno (UNR), Missouri S&T, and the University of Houston. Work performed by Missouri S&T and the University of Houston is being performed as a subcontract to UNR's contract with Caltrans. The work performed in this project is an extension of a project by UNR (Caltrans Contract No. 59A0543), which is aimed at developing guidelines for reliable and efficient reinforced concrete repair methods using fiber reinforced polymers (FRP). This project extends the work to the repair columns of with fractured bars.

### R309— Effects of Organic Additives on the High Volume Reuse of Fly Ash in Geotechnical Engineering

[Bate, B., PI – Missouri S&T, new in this reporting period]

As the coal remains the world's most abundant and accessible fossil fuel, the production of energy from coal will inevitably generate waste materials, i.e., the coal combustion products (CCPs). From 2002 to 2009, about 40% of CCPs was reused, while only 2.8% of the CCPs were used in pavement. This study intends to study the high volume reuse of fly ash, a major component of CCPs, in geotechnical engineering with organic additives, such as surfactant and polysaccharides. The microscopic properties, the unsaturated behaviors, and the unconfined compressive strength of fly ash and fly ash-soil mixture are studied. The microscopic imaging

technique will provide the size, shape, and structure of the mixture. Then the water content and matric suction relationship, or soil water characteristic curve (SWCC) were measured. The suction can be calculated by the size and shape information from microscopic study by Laplace equation, and SWCC can also be predicted from particle size distribution. On the other hand, SWCC can also be used to predict the strength of fly ash-soil mixture. Furthermore, the physicochemical properties of the influent and effluent will be monitored to detect any chemical reactions. The outcome will provide the guideline on organic type and quantity, optimum fly ash to soil ratio, and water content of mixture for optimum performance in terms of strength. By connecting the intrinsic relations between microscopic behavior and the macroscopic mechanical properties, the understanding of the mechanisms for strength variation are advanced.

**R308— Fiber Reinforced Cementitious Matrix (FRCM) Composites for Reinforced Concrete Strengthening**
[Sneed, L., PI – Missouri S&T, new in this reporting period]

Fiber-reinforced composite systems are widely used for strengthening, repairing, and rehabilitation of reinforced concrete structural members. A promising newly-developed type of composite, comprised of fibers and an inorganic cement-based matrix, provides several environmental, structural, and sustainability-related advantages over fiber reinforced polymer (FRP) composites traditionally used in structural applications, which potentially expands the strengthening applications beyond those currently utilized. Such advantages include: 1) high resistance to fire and high temperatures; 2) resistance to UV radiation; 3) ease of handling during the application because the inorganic binder is water-based; 4) easy cleanup and reuse of tools; 5) low odor and toxin emissions during application and curing; 6) permeability compatibility with the concrete substrate; and 7) unvarying workability time (between 40°F and 105°F). Stress-transfer mechanisms and interfacial fracture propagation of fiber-reinforced composites externally-bonded to a concrete substrate are complex phenomena that are highly dependent on the bond characteristics of the composite matrix material to the fibers. These phenomena have not yet been clearly defined and understood for FRCM composites. Experimental work will be carried out in this study to isolate the shear debonding phenomenon using single lap shear tests.

**R307— Effects of Road Construction Intensity and Operations on Rural Freeway Work Zone Capacity**
[Luna, R., PI – Missouri S&T, new in this reporting period]

Capacity has been defined and measured by many researchers. Capacity is dependent on many variables that can be broadly categorized as traffic, geometric and traffic control conditions. Capacity is also affected by construction type and its intensity on adjacent open traffic lanes. The effect on capacity is a function of vehicles moving in and out of the closed lanes of the work zone, and the presence of heavy construction vehicles. Construction activity and its intensity, however, are not commonly considered in estimating capacity of a highway lane.
The main purpose of this project is to quantify the effects of construction type and intensity (e.g. maintenance, rehabilitation, reconstruction, and milling) on work zone capacity. The intensity of construction activity can be defined as the frequency of work zone vehicles ingress/egress from the open traffic lane, the presence of heavy construction vehicles like milling machines, etc., number of workers present at the work site. The objective will be to quantify the effects of construction type and its intensity on work zone capacity and to develop guidelines for MoDOT

to estimate the specific operation type and intensity that will improve traffic flow and shorten the length of queues commonly associated with work zones.

**R306— Breaking Wire Detection and Strain Distribution of Seven-Wire Steel Cables with Acoustic Emission and Optical Fiber Sensors- Civil Engineering portion**
[Chen, G., PI – Missouri S&T, new in this reporting period]

Cable-stayed bridges have been increasingly used as river-crossing links in highway and railway transportation networks. In the event of an abnormal situation, they can not only impact the local and national economy but also threaten the safety of passengers. To assess the structural condition of cables, the strain distribution among multiple wires must be effectively determined as one or more wires are broken due to overstress and/or corrosion. This proposal is focused on a preliminary study of wire breakage detection and associated strain redistribution. The specific objectives are to develop and validate a new algorithm for the localization of broken wires with acoustic emission technology and a new model for the determination of strain redistribution with distributed optical fiber sensor measurements. Both laboratory tests and numerical simulations will be conducted to understand the mechanism of strain redistribution as a result of wire breakage. In particular, a seven-wire steel cable will be tested and analyzed to take into account both the initial stress due to wire twisting and the friction effect between wires. For sensitivity study, various section losses in percentage of sectional area will be considered to understand the effective length of a cable over which the strain condition prior to the loss of wire sections can be recovered.

**R305— Breaking Wire Detection and Strain Distribution of Seven-Wire Steel Cables with Acoustic Emission and Optical Fiber Sensors- Mining Engineering portion**
[Ge, M., PI – Missouri S&T, new in this reporting period]

Cable-stayed bridges have been increasingly used as river-crossing links in highway and railway transportation networks. In the event of an abnormal situation, they can not only impact the local and national economy but also threaten the safety of passengers. To assess the structural condition of cables, the strain distribution among multiple wires must be effectively determined as one or more wires are broken due to overstress and/or corrosion. This proposal is focused on a preliminary study of wire breakage detection and associated strain redistribution. The specific objectives are to develop and validate a new algorithm for the localization of broken wires with acoustic emission technology and a new model for the determination of strain redistribution with distributed optical fiber sensor measurements. Both laboratory tests and numerical simulations will be conducted to understand the mechanism of strain redistribution as a result of wire breakage. In particular, a seven-wire steel cable will be tested and analyzed to take into account both the initial stress due to wire twisting and the friction effect between wires. For sensitivity study, various section losses in percentage of sectional area will be considered to understand the effective length of a cable over which the strain condition prior to the loss of wire sections can be recovered.

**R304— Use of Adsorption Mechanism to Decrease Heavy Metal Mobility in Soil**
[Wang, J., PI – Missouri S&T, new in this reporting period]

The U.S. Food and Drug Administration has been involved in the recent food safety and beverage discussion about elevated levels of arsenic and other heavy metals in foods such as

apple juice, honey and rice. Some forms of arsenic have been determined a human carcinogen by the U.S. EPA, making it imperative that food quality and the associated threat to human health be studied further. Some highway construction materials such coal fly ash could be a source of these toxic elements. The environmental engineering approach to this topic is not limited to, but focuses on heavy metal (i.e. arsenic, selenium) mobility and transport in the environment, exposure and corresponding human health impacts. Missouri S&T is part of a small number of engineering institutions that are currently researching these topics. If current research trends indicate impending roles of environmental engineering, one forthcoming role will be food quality assurance. The assurance methods explored in this research includes the modification of soil chemistry and competitive adsorption states. This chemistry is based on testing the ability adsorption material (i.e. iron oxide) to fixate arsenic and other heavy metals to effectively decrease mobility and transport into the environment. This application will be tested under varying adsorbent applications to optimize adsorbent added per decreased heavy metal mobility and improve the role of environmental engineering in food quality assurance.

This research is related to the NUTC Theme #1: Advanced materials. Fly ash and other recycled construction materials could be used as novel construction materials for highway, to reduce cost, improve structure stability, and reduce carbon emission. However, heavy metals could be leached from these materials. Ultimately these heavy metals will be accumulated by crops and impact human health. While this proposed research does not directly address the strength of the construction material, it does evaluate the resulted environmental and health impact related to the application of these materials, which is part of the NUTC theme #1.

**R303— A Pilot Study on Diagnostic Sensor Network for Structure Health Monitoring**
[Cheng, M., PI – Missouri S&T, new in this reporting period]

This project aims to address the tomography analysis problem in sensor networks. Wireless sensor networks can be placed inside of or on the surface of a structure to estimate the health state of the structure and to detect changes in the structure. For this purpose, the sampled data must be reliable and represent the true state of the structure. In reality, the measured data often come with uncertainty and thus cannot always be interpreted with a theoretical model. When disagreement occurs, the measured data may or may not represent an anomalous state of the structure. Anomaly in data could originate from the source of a structure due to unknown loads and material properties, the error introduced during measurement, and the signal contamination in the process of data communication. One must distinguish the structure anomaly from the sensor network anomaly. For anomaly detection and identification, we must understand the spatial and temporal correlation of the data collected at different sampling points of the structure, and fully understand the network behavior that could introduce anomaly in data. We will provide preliminary results on the asymptotic distribution of test statistics, develop effective means for estimator design and data gathering, and design an efficient algorithm for data processing based on dependence modeling. The ultimate goal is to be able to reconstruct the contour map of some critical parameters of the structure. The algorithm and sensor network will be validated with physical tests of civil engineering structures in laboratory.

**R302— Polyurethane Foam Infill for Fiber-Reinforced Polymer (FRP) Bridge Deck Panels [Volz, J., PI – Missouri S&T, new in this reporting period]**

Although still in their infancy, fiber reinforced polymer (FRP) bridges have shown great promise in eliminating corrosion concerns and meeting (or exceeding) FHWA's goal of 100-year life spans for bridges. While FRP bridges are cost-effective in terms of life cycle analyses, the combination of higher first costs and limited state DOT budgets has restricted their use. One area that has shown some headway is the use of FRP for bridge decks, focusing on the location where the majority of corrosion-related damage normally occurs. However, first costs still hamper widespread use of this approach.

FRP bridge deck panels offer superior corrosion resistance, at one-fifth the weight of reinforced concrete. However, current FRP bridge deck panels typically rely on an intricate geometric honeycomb system between the top and bottom layers of the sandwich panel. This labor-intensive honeycomb construction doubles the cost of FRP panels compared to reinforced concrete. Although cost-effective in terms of longevity of the bridge and overall reductions in weight, the lower first cost of reinforced concrete precludes the use of FRP bridge decks in the majority of situations.

Closed-cell, high-density polyurethane foams lower first cost, offering a cost-effective alternative to the complex honeycomb construction. Structural sandwich panels with a polyurethane foam infill are well established in other commercial applications, such as automobiles, aircraft, and prefabricated buildings. Several recent advances in polyurethane foam formulations have resulted in a material that can resist the localized compressive stresses and fatigue loading beneath a truck wheel, making this type of sandwich panel construction a viable alternative for bridge decks. Once these panels can compete against reinforced concrete on a first-cost basis, their significantly longer life expectancies will result in a more cost-effective transportation network.

**R301— Development and Testing of Synthetic Riprap Constructed from Coal Combustion Products**
[Volz, J., PI – Missouri S&T, new in this reporting period]

Even with an increase in the amount of CCPs used in concrete construction, soil stabilization, and other applications, the coal power industry must dispose of a significant amount of fly ash and bottom ash. One potential avenue for the material is to develop a riprap to armor bridge abutments, bridge pilings, streambeds, and shorelines against scour and ice damage. The proposed research plan is divided into three (3) phases, which consist of the following:
Phase I – Product & Criteria Development
Phase II – Prototype Development & Testing
Phase III – Production Plant Design
Phase I involves determining the most appropriate applications for the synthetic riprap. There are several ranges of potential products available depending on the specific applications, including bridge pier scour prevention, channel stabilization, lake boundary erosion control, and shoreline protection. Once the potential product areas have been determined, the next part of Phase I will be to determine the necessary design requirements and specifications for the riprap. Phase II involves prototype development and testing based on the results from Phase I. Phase III involves development of a production plan and facility layout.

**R300— MoDOT Pavement Preservation Research Program**
[Richardson, D., PI – Missouri S&T, new in this reporting period]

University of Missouri researchers will produce a set of guidance documents that will assist MoDOT in setting up a Pavement Preservation Selection system, which will include methods of data retrieval, pavement deterioration models, site assessment technologies, and a preservation treatment selection process.

**R298— Emergency Repair of Damaged Bridge Columns Using Mechanical Splices**
[Sneed, L., PI – Missouri S&T, new in this reporting period]

Past effort in seismic design of concrete bridges has been on detailing of bridges to prevent collapse. Reinforced concrete bridge columns are designed to undergo cracking, spalling, and yielding of steel and provide significant rotational capacity at plastic hinges so that the integrity of the overall structure is maintained. With proper design and construction this objective can be met. However, the serviceability of the bridge after the earthquake is in question. The level of damage to different columns of a bridge varies depending on the intensity of the ground shaking, type of earthquake, and the force/deformation demand on individual members. Based on the inspection of the damaged columns engineers have to determine whether the bridge is sufficiently safe to be kept open to traffic. They should also recommend repair methods for the columns. Any delay in opening of the bridge to traffic can have severe consequences on the passage of emergency vehicles, detour lengths, and traffic congestion in the area. Rapid and effective repair methods are needed to enable quick opening of the bridge to minimize impact on the community.

The proposed project includes the repair of fractured bars in a series of interlocking spiral bridge column models that are to be tested to failure as part of a study funded by the National Science Foundation at Missouri S&T. This proposal to the University of Nevada, Reno (UNR) is for work that would be performed as a subcontract of UNR's proposal to Caltrans. The proposed work by Missouri S&T and UNR is an extension of a current project by UNR (Caltrans Contract No. 59A0543), which is aimed at developing guidelines for reliable and efficient reinforced concrete repair methods using fiber reinforced polymers (FRPs). The objective of the current project is to develop rapid repair methods for reinforced concrete bridge columns damaged by earthquakes. Because the repair was intended to be done expeditiously, there was a consensus among the Caltrans bridge maintenance staff, the Caltrans research management, and the UNR researchers that columns with fractured bars would not be included in the current project. The current project has achieved its objective of successfully developing emergency repair techniques. However, these techniques do no cover columns with fractured bars. Thus the proposed project extends this work to the repair of fractured bars.

**R297— Testing and Assessment of Portable Seismic Property Analyzer**
[Anderson, N., PI – Missouri S&T, new in this reporting period]

Investigator will thoroughly test and assess the Portable Seismic Property Analyzer (PSPA), a hand-held device that focuses on pavement layer properties. The device can be utilized on both rigid and flexible pavements. When used on rigid pavements, the PSPA can provide information with respect to the quality and thickness of concrete, the existence and/or the location of voids or delamination within concrete, and the existence of voids or the loss of support underneath the slab. For flexible pavements, the PSPA provides information about the quality of the asphaltic-concrete layer.

**R296— Advanced Moisture Modeling of Polymer Composites**
[Chandrashekhara, K., PI – Missouri S&T, new in this reporting period]

With increasing usage of composite materials, study of the performance of composites exposed to different environments is of great interest. Over time, composite materials absorb moisture from the surrounding environment and this increase in moisture affects the structural integrity of the part. To ensure the structural integrity, determination of moisture concentration inside the composite structure as a function of time and position is important. Test methods have to simulate typical worst-case aircraft service water vapor environment: 80°F / 82% relative humidity (RH) for 10 years. Currently, accelerated diffusion procedures with 160°F / 95% RH environment are used to reduce the time period of the testing. Conducting the experiments in maintained test environments for elongated period of 10 years is a tedious process. Evaluation of moisture behavior of composites through simulation studies would be time and cost saving. Missouri S&T project with Bell Helicopter will have two tasks. In Task 1, commercial finite element codes will be used to simulate the 3-D model of a homogeneous (one type of material) composite and generate the hygroscopic effect (T/RH profile). In Task 2, hybrid material configurations are considered and interface resistivity is taken into account. In both the tasks, the moisture distribution through the thickness of the composite will be evaluated.

**R295— Polyurethane Foam Infill for Fiber-Reinforced Polymer (FRP) Bridge Deck Panels**
[Volz, J., PI – Missouri S&T, new in this reporting period]

Although still in their infancy, fiber reinforced polymer (FRP) bridges have shown great promise in eliminating corrosion concerns and meeting (or exceeding) FHWA's goal of 100-year life spans for bridges. While FRP bridges are cost-effective in terms of life cycle analyses, the combination of higher first costs and limited state DOT budgets has restricted their use. One area that has shown some headway is the use of FRP for bridge decks, focusing on the location where the majority of corrosion-related damage normally occurs. However, first costs still hamper widespread use of this approach.

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The first step in establishing FRP sandwich panels as a viable option will be to examine the potential of using them to replace the precast, stay-in-place forms currently used to construct reinforced concrete bridge decks. The sandwich panel will serve as formwork for the concrete placement and act compositely with the hardened concrete under subsequent dead and live loading. As part of the sandwich panel development, S&T will evaluate polyurethane foam formulations, panel configurations (overall shape, jointing, end bearing), panel fiber architecture, panel durability, and methods of developing composite action with the concrete.

**R293—Field Evaluation of Thermographic Bridge Concrete Inspection Techniques**
[Washer, G., PI – University of Missouri-Columbia, new in this reporting period]

Field testing and evaluation of thermal imaging to evaluate the reliability of the technology, validate previously developed guidelines for field use, and evaluate implementation barriers. Participating states will be provided training and hardware for testing within their existing bridge evaluation programs, to identify implementation challenges, evaluate the effectiveness of guidelines, and assess the utility of the technology for bridge condition assessment. The research team, in cooperation with the states, will conduct a series of focused field tests that include field verification of results. These field tests will seek to quantitatively evaluate the capabilities and reliability of the technology under field conditions to validate and improve the guidelines, and support practical implementations of the technology. The outcome of the research will be a new inspection technique for improving bridge safety and identifying repair and maintenance needs.

**R292—Determination of Optimum "Multi-Channel Surface Wave Method" Field Parameters**
[Anderson, N., PI – Missouri S&T, new in this reporting period]

Multi-channel surface wave methods (especially the multi-channel analyses of surface wave method; MASW) are routinely used to determine the shear-wave velocity of the subsurface to depths of 100 feet for site classification purposes. Users are aware that the output shear-wave velocity function at a specific site will vary if acquisition parameters (including array orientation, geophone spacing, shot-to-receiver offset) are varied. However, these variations have never been statistically analyzed (quantitatively or qualitatively). As part of this investigation, the researchers will acquire MASW data at multiple study areas in karst terrain with a view to statistically analyzing the extent to which variations in field parameters can affect data quality, data utility, the output shear-wave velocity function and the output site classification.

**R289— Rapid Repair of Severely Damaged Reinforced Concrete Columns**
[Sneed, L., PI – Missouri S&T, new in this reporting period]

Damage to bridge structures during an earthquake can have devastating social and economic consequences, particularly for bridges located along key routes critical for emergency response and other essential functions. According to ATC 18, damage to important bridges should be repairable within three days. Thus rapid and effective repair methods for varying levels of damage are needed to enable quick opening of these bridges and to minimize impact on the community. The subject of this study is the rapid repair of severely-damaged concrete bridge columns under combined loading effects. The term "rapid" in the context of this study refers to a 3-day time period as defined in the literature. Research in this field is currently limited to the

repair of columns with slight to moderate damage levels; thus this research will fill in a critical gap in the literature with respect to the severe damage level. In this study, one-half scale concrete bridge columns that have been tested to failure as part of a separate ongoing study are repaired using externally-bonded carbon fiber reinforced polymer (CFRP) wrap. The repaired columns are then tested under the same loading regime as the original columns, combined action of bending, shear, torsion, and axial effects, and the behavior is compared directly with the original response. Since the current literature contains little information with respect to repair of columns subjected to torsion, the inclusion of torsion in the combined loading is a significant contribution to the state of knowledge, and represents a more comprehensive and realistic loading condition than without. Results will serve as the basis for and add credibility to future proposals on rapid repair of bridge columns, with high potential for collaboration with leading researchers in this field.

**R288— Evaluation of Long Carbon Fiber Reinforced Concrete to Mitigate Earthquake Damage of Infrastructure Components**
[Volz, J., PI – Missouri S&T, new in this reporting period]

The proposed study involves investigating long carbon fiber reinforced concrete as a method of mitigating earthquake damage to bridges and other infrastructure components. Long carbon fiber reinforced concrete has demonstrated significant resistance to impact and blast loading. The carbon fibers will potentially reduce spalling and the degree of cracking during an earthquake event as well as increase the overall structural capacity. The scope of the research project includes testing of carbon fibers, development of a fiber-concrete composite material, and dynamic testing to evaluate the response of the material.

**R287— Ground Penetrating Radar (GRP) for Pavement Evaluation - Supplement to R261**
[Anderson, N., PI – Missouri S&T, new in this reporting period]

In the near future the Arkansas State Highway and Transportation Department Pavement Management System (PMS) will utilize a Falling Weight Deflectometer (FWD) to collect network level pavement structural data to aid in predicting performance of pavement sections. One of the drawbacks to running the FWD is that pavement thickness is required for the tested pavement section. The standard method for obtaining pavement thickness information is coring. Coring for a network level survey would be cost prohibitive. Coring costs can run between $3,000 and $3,600 per day with a typical collection distance of 20 miles per day. The Department manages over 16,000 centerline miles of highways. Previous research has shown Ground Penetrating Radar (GPR) is a proven and reliable technology that can be used as a feasible alternative to provide pavement thickness data. GPR data collection can be costly as well; contract services for pavement thickness can cost between $50 and $100 per mile from a reputable service provider. GPR equipment has become less cumbersome, more user-friendly and more affordable in the last few years. There are GPR technologies that employ multiple antennas to provide pavement layer thickness for network level surveys. These newer technologies could provide the pavement layer thicknesses required for network level FWD data collection in a timely and cost-effective manner.

**R286— Beneficial Reuse of Fly Ashes in Geotechnical Engineering with Physicochemical and Electron Microscopic Methods**
[Bate, B., PI – Missouri S&T, new in this reporting period]

As the coal remains the world's most abundant and accessible fossil fuel, the production of energy from coal will inevitably generate waste materials, i.e., the coal combustion products (CCPs). From 2002 to 2009, about 40% of CCPs was reused, while only 2.8% of the CCPs were used in pavement. This study intends to study the high volume reuse of fly ash, a major component of CCPs, in geotechnical engineering. The physicochemical properties and the microscopic imaging techniques are proposed as the tools to advance the knowledge of fly ash and fly ash-soil mixture. The outcome will provide the guideline for the beneficial reuse of the fly ash. The theories of the fine-grained materials behavior will be advanced, so that the chemical forces are comparable to that of physical ones.

**R285— Effect of Trona on the Leaching of Trace Elements from Coal Fly Ash**
[Wang, J., PI – Missouri S&T, new in this reporting period]

Trona has been tested or used to control SO2 and SO3 emissions from coal fired power plants. Due to its alkaline nature, trona is also effective to remove other acid gases such as hydrochloric acid (HCl), and hydrofluoric acid (HF) from flue gas emissions. EPA has proposed to have tighter control on emissions of both SOx and HCl, and trona injection method could be an option to meet these new EPA requirements. However, trona injection could result in some issues with the fly ash. Recent study indicated that trona injection for SO2 control significantly increased the leaching of anionic trace elements such as As and Se. Fly ash, in some cases, has been used as a construction material for highway, so that this otherwise wasted material can be beneficially used. While this practice improves the quality of the construction and offers environmental benefit by reducing the cement use therefore reduce greenhouse gas production, the use of trona ash could also pollute groundwater if the metal leaching is high. The objectives of this research are to perform standard laboratory leaching tests on fly ash samples collected at different trona and hydrated lime injection rates, and to develop fundamental understanding regarding the leaching behavior of As and Se from trona ashes. In addition, one fly ash will be used to develop a pozzolanic cement sample with portland cement. This sample will be taken out to measure the mechanical properties to ensure the structural stability of the cement. The metal leaching performance of the pozzolanic cement will also be tested. This research is important when determining what type of ash should be used or should not be used for highway construction, to prevent environment pollution.

**R284— Bottom Ash as Aggregate Replacement in Concrete**
[Volz, J., PI – Missouri S&T, new in this reporting period]

Although relatively unreactive compared to fly ash, bottom ash does have the potential to replace either all or a portion of the natural aggregates used in concrete. This study will evaluate the fresh and hardened properties of concrete containing bottom ash as a partial or total replacement of the fine and coarse aggregate. The properties that will be studied include workability, finishability, air content, air-void system, strength gain, and durability. The investigation will begin with mortar mixes and then, based on the results, progress to concrete mixes and evaluation of the properties mentioned.

In particular, the study will focus on durability of the final material, as the porous surface structure of most bottom ashes has the potential to negatively impact freeze-thaw resistance of

the concrete. The study will also include a complete physical, chemical, and mineralogical characterization of the different bottom ash sources to aid in the investigation.

Sustainable alternatives to traditional concrete construction are necessary to address the current state of our nation's crumbling infrastructure. The use of bottom ash as aggregate replacement in concrete will reduce the need for virgin materials and remove a material from the solid-waste stream, increasing the sustainability of concrete construction. Consequently, the concretes developed in this study will be compared to traditional concretes used in infrastructure-related applications, such as bridges, roadways, culverts, and retaining walls. These comparisons will determine whether concrete containing bottom ash offers a viable, sustainable alternative to help rebuild our nation's infrastructure.

## Education and Technology Transfer Projects

**ETT294—Women In Science & Engineering Scholarships and Summer Camp Outreach Programs, Year 6**
[Elmore, C., PI - Missouri S&T, new in this reporting period]

This project will make scholarships available to minority and women students interested in engineering and science and will increase significantly the number of minority and female students that Missouri S&T can recruit to its science and engineering programs. Recipients of scholarships will also be exposed to career opportunities in transportation.

Women in Science and Engineering (WISE) scholarships are awarded to support female Missouri S&T students studying science and engineering. Missouri S&T's WISE program provides a campus focal point for increasing the number of women in science, engineering, math, and technology fields through outreach, recruitment, and retention efforts from middle school age through undergraduate levels. WISE provides support programs such as mentoring, advising, professional/technical workshops, and social activities, with the goal of providing a rich academic and social experience for young women at Missouri S&T.

Since the inception of this scholarship program in 2004-2005, women's enrollment has increased in the following transportation- related fields of study: architectural engineering-80%, chemical and biological engineering-57%, civil engineering-56%, computer science-37%, engineering management and systems engineering-35%, information science & technology-69%, materials science and engineering-27%, and mechanical engineering-58%. Also, the female students who have enrolled in undeclared engineering as freshman has increased by 65%, so those students have the potential to major in a transportation-related field.

**ETT291—2011 Missouri Local Technical Assistance Program (LTAP) at Missouri S&T**
[Pickerill, H., PI - Missouri S&T, new in this reporting period]

The objective of this project is to manage the Missouri LTAP program for the Missouri Department of Transportation (MoDOT). The LTAP program was established by the Federal Highway Administration (FHWA) in 1982 and operates in each state to provide community leadership through advocacy and implementation of education and training.

The Missouri LTAP program will provide a resource center and technology transfer activities for local officials, counties, parishes, townships, cities and towns throughout the state of Missouri in the form of: workforce development services; resources to enhance safety and security; solutions to environmental concerns, congestion, capacity and other issues; technical publications; and training materials and videos.

**ETT290— Minority Engineering Scholarships Renewal**
[Perkins, W., PI - Missouri S&T, new in this reporting period]

This project will make scholarships available to minority students interested in engineering and science and will increase significantly the number of minority students that Missouri S&T can recruit to its science and engineering programs. Recipients of scholarships will also be exposed to career opportunities in transportation.

Minority Engineering and Science Program (MEP) scholarships provide critical financial support for under-represented students majoring in engineering and science programs at Missouri S&T. MEP scholarship students receive professional and academic support through the close-knit MEP network of friends, mentors, and Missouri S&T staff. MEP has a rich 30 year tradition of sponsoring events, activities and organizations that ensure its students are prepared for personal and professional success.

# DOT PRODUCTS

Because the Center's theme areas focus around safety in transportation infrastructure as well as new technologies in fuel and infrastructure monitoring, many of the awarded research projects are tied to the U.S. and state Departments of Transportation, particularly Missouri Department of Transportation (MoDOT).

Below are brief explanations of a few research projects meant to serve as examples of how work and research at CTIS serves the transportation and infrastructure needs of our state and nation.

**2011 Missouri Local Technical Assistance Program (LTAP) at Missouri S&T – ETT291**

The objective of this project is to manage the Missouri LTAP program for the Missouri Department of Transportation (MoDOT). The LTAP program was established by the Federal Highway Administration (FHWA) in 1982 and operates in each state to provide community leadership through advocacy and implementation of education and training.

The Missouri LTAP program will provide a resource center and technology transfer activities for local officials, counties, parishes, townships, cities and towns throughout the state of Missouri in the form of: workforce development services; resources to enhance safety and security; solutions to environmental concerns, congestion, capacity and other issues; technical publications; and training materials and videos.

**MoDOT Pavement Preservation Research Program – R300**

The Pavement Preservation Research Program will lead to substantial cost savings by providing produce a set of guidance documents that will assist Missouri Department of Transportation (MoDOT) in setting up a Pavement Preservation Selection system, which will include methods of data retrieval, pavement deterioration models, site assessment technologies, and a preservation treatment selection process.The execution and completion of this program will address many of MoDOT's most pressing research needs while making notable improvements to the state of the art and practice of pavement engineering at a national and international level. The objective, as a whole, is to achieve significant and recurring cost savings for (MoDOT) by a developing pavement maintenance selection process.

# SUCCESS STORIES

This section lists a sampling of "success stories" for Year VI, including notable Center events; NUTC News articles of interest; faculty and student awards; and media articles about the Center, faculty or campus. Articles, awards and events with corresponding clips are available in the Appendix.

## Featured Articles in the NUTC News

- "Taking the Reigns: Kamal H. Khayat." Volume 6, Issue 4.
- "Making Highway Rock Cuts Safer." Volume 6, Issue 4.
- "Hybrid Composite Beam Research." Volume 6, Issue 4.
- "Vitreous Enamel for Chemical Bond between Steel and Concrete." Volume 7, Issue 2.
- "Bottom Fly Ash as Aggregate Replacement in Concrete." Volume 7, Issue 2.

## Awards

- Nathan Muncy, a civil, architectural and environmental engineering M.S. student, was named Missouri S&T's 2011 UTC Outstanding Student of the Year.
- Dr. John Sheffield, Associate Director of CTIS, received the Missouri *impact!* Award from Missouri Enterprise for his work to help reduce energy usage by manufacturers across the state.
- Dr. Bruce McMillon, a Professor in Computer Science, received the Outstanding Contribution Award for his 20 years of outstanding service to the IEEE Computer Society.
- Dr. Theresa Swift, assistant teaching professor of electrical and computer engineering, recently received the Outstanding Educator Award from the St. Louis section of the Institute of Electrical and Electronics Engineers (IEEE).
- Beth Cudney, assistant professor of engineering management and systems engineering, was awarded the 2012 Lean Teaching Award by the Institute of Industrial Engineers (IIE).
- Roche Health Center, which serves 25,000 villagers in rural Tanzania, was recognized by the Association of Collegiate Schools of Architecture with the 2011-2012 Global Collaborative Practices Award. Dr. Daniel B. Oerther, the John A. and Susan Mathes Chair of Environmental Engineering at S&T, formerly mentored the student architectural team at the University of Cincinnati.

- Thirteen electrical engineering seniors and recent graduates each received a $5,000 Grainger Power Engineering Award

- S&T wins human-powered vehicle competition

- Two computer science students at Missouri University of Science and Technology received National Science Foundation funding to support their research to create a future "smart" electric power grid.

- S&T students place fourth in international hydrogen design competition

## Missouri S&T in the News

### External Media Sources

- "S&T welcomes new Vernon and Maralee Jones Professor of Civil Engineering." Rolla Daily News. September 16, 2011.

- "Building the 'bridge to the future'." Structural Engineering and Design. March 13, 2012.

- "Missouri S&T Graduates Helping Bridge the Technological Workforce Gap." Newswise.com April 19, 2012.

- "Ancient structural elements leads to new ideas in bridge building." Physorg.com. June 5, 2012.

- "Scientists, designers work on bridge." Rolla Daily News. June 6, 2012.

- "S&T engineer wins research award." Rolla Daily News. July 3, 2012.

- "S&T grad student win international competition." Rolla Daily News. July 26, 2012.

- "Missouri S&T to compete in worldwide solar house competition." KMOV.com. August 9, 2012.

### Internal Media Sources

- "S&T students recognized at national AIChE conference." Missouri S&T Public Relations. October 26, 2011.

- "S&T to help establish new university in China." Missouri S&T Public Relations. September 22, 2011.

- “Missouri S&T offers sustainability minor.” Missouri S&T Public Relations. November 30, 2011.

- “S&T researchers help cemetery with ground-penetrating radar technology.” Missouri S&T Public Relations. May 14, 2012.

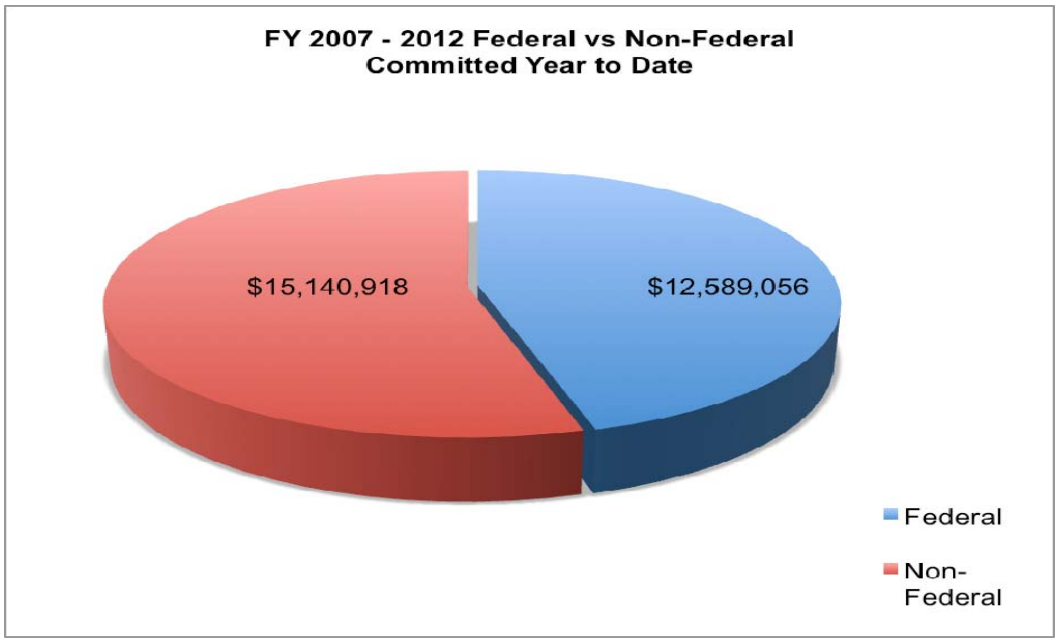
- “S&T tops Newsweek ranking of public schools for out-of-state students.” Missouri S&T Public Relations. August 6, 2012.

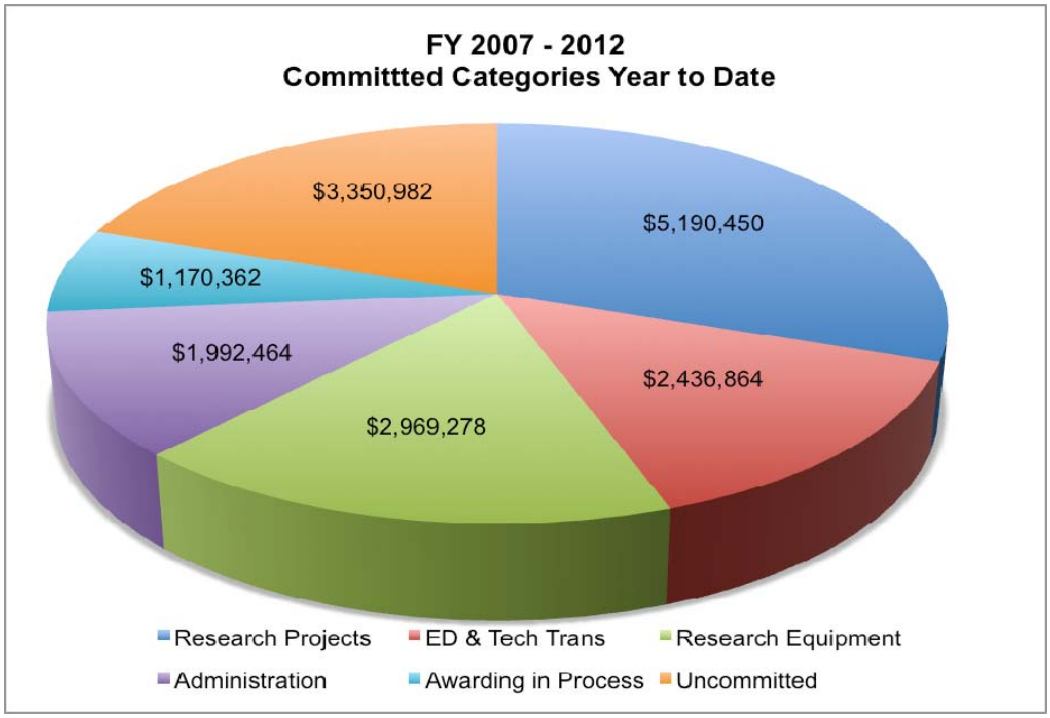
- “Enrollment at S&T continues to climb.” Missouri S&T Public Relations. August 21, 2012.

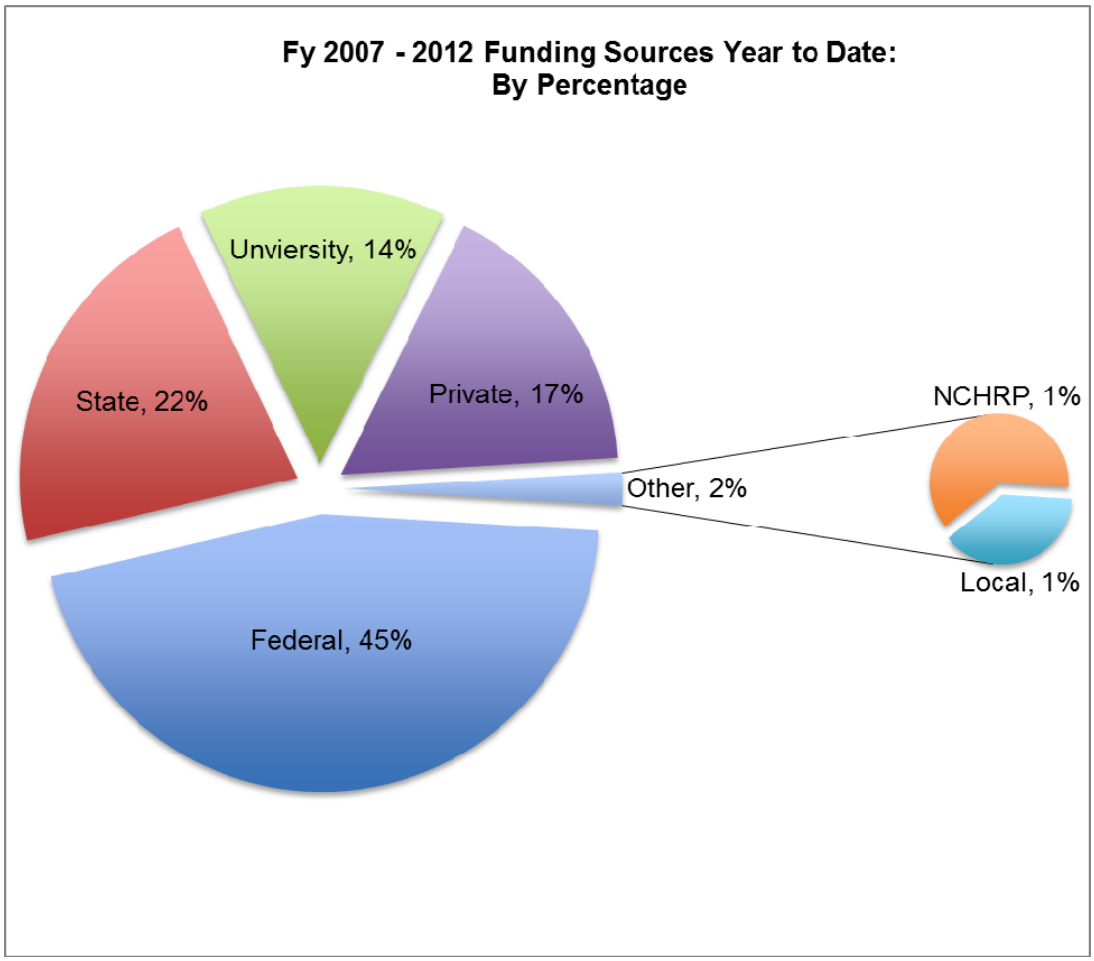
- “25 faculty to receive awards at S&T.” Missouri S&T Public Relations. December 16, 2012.

# FUNDING SOURCES AND EXPENDITURES

This section provides information on Funding Sources and Expenditures for Years I-VI of the NUTC grant. The following funding charts and tables show committed revenues; expenditure categories; match funding sources; pending project allocations; and funding sources and expenditures for both awarded and pending projects.




Fy 2007 - 2012 Funding Sources Year to Date:
By Percentage
Unviersity, 14%
State, 22%
Private, 17%
NCHRP, 1%
Other, 2%
Local, 1%
Federal, 45%

## Funding Sources and Expenditures

### Amounts and Sources of Funding: July 1, 2006–June 30, 2011

| Seq. No. | Non-Federal * Source | Amount | UTC | Total |
|---|---|---|---|---|
| R195 | NCHRP-NYSDOT-MS&T CE | $ 157,873 | $ 78,936 | $ 236,809 |
| ETT196 | Industry | $ 394,450 | $ 187,500 | $ 581,950 |
| R197 | NCHRP-MS&T CE | $ 120,000 | $ 60,000 | $ 180,000 |
| R198 | MoDOT-UMC CE | $ 283,162 | $ 100,087 | $ 383,249 |
| ETT199 | MoDOT | $ 200,054 | $ 99,537 | $ 299,591 |
| R200 | General Motors | $ 26,902 | $ 13,776 | $ 40,678 |
| R201 | EPRI | $ 68,980 | $ 42,985 | $ 111,965 |
| R202 | MS&T GS&E | $ 58,087 | $ 115,000 | $ 173,087 |
| R203 | MS&T Depts. | $ 500,000 | $ 250,000 | $ 750,000 |
| R204 | GTI | $ 600,000 | $ 250,000 | $ 850,000 |
| ETT205 | MS&T DCE | $ 19,366 | $ 10,000 | $ 29,366 |
| RE206 | LGA | $ 133,880 | $ 66,939 | $ 200,819 |
| R207 | CDOT | $ 21,960 | $ 9,286 | $ 31,246 |
| R208 | Roesch, Inc | $ 10,000 | $ 5,000 | $ 15,000 |
| R209 | Coreslab Structures | $ 7,746 | $ 3,873 | $ 11,619 |
| R210 | Transystems, Inc. | $ 21,200 | $ 10,599 | $ 31,799 |
| R211 | USB | $ 50,000 | $ 24,944 | $ 74,944 |
| ETT212 | Industry | $ 23,400 | $ 7,525 | $ 30,925 |
| R213 | Ameren | $ 25,000 | $ 12,500 | $ 37,500 |
| R214 | EPRI | $ 68,658 | $ 29,330 | $ 97,988 |
| ETT215 | MS&T VPR | $ 19,115 | $ 19,115 | $ 38,230 |
| ETT216 | Industry | $ 415,750 | $ 187,500 | $ 603,250 |
| ETT217 | Retired | $ - | $ - | $ - |
| R218 | MoDOT | $ 44,813 | $ 23,877 | $ 68,690 |
| R219 | MoDOT | $ 59,997 | $ 34,161 | $ 94,158 |
| ETT220 | MoDOT | $ 211,885 | $ 211,885 | $ 423,770 |
| R221 | SCI Engineering | $ 23,431 | $ 11,715 | $ 35,146 |
| R222 | HNTB Corp. | $ 10,387 | $ 5,116 | $ 15,503 |
| R223 | Lake Sherwood Estates | $ 3,239 | $ 2,250 | $ 5,489 |
| ETT224 | MS&T-VPR | $ 26,102 | $ 26,102 | $ 52,204 |
| R225 | MS&T Departments | $ 928,600 | $ 900,000 | $ 1,828,600 |
| ETT226 | Industry | $ 77,125 | $ 20,769 | $ 97,894 |
| R227 | Egyptian Concrete | $ 28,172 | $ 14,087 | $ 42,259 |

| | | | | |
|---|---|---|---|---|
| R228 | Ameren | $ 25,000 | $ 12,500 | $ 37,500 |
| ETT229 | MoDOT | $ 35,358 | $ 17,679 | $ 53,037 |
| R230 | NYSERDA | $ 50,000 | $ 50,000 | $ 100,000 |
| R231 | MS&T Departments | $ 500,000 | $ 250,000 | $ 750,000 |
| R232 | ASNT | $ 15,000 | $ 7,475 | $ 22,475 |
| R233 | MoDOT MS&T-CE | $ 121,555 | $ 75,972 | $ 197,527 |
| R234 | MoDOT MS&T-CE | $ 194,612 | $ 121,633 | $ 316,245 |
| R235 | MoDOT MS&T-CE | $ 78,192 | $ 48,870 | $ 127,062 |
| R236 | MoDOT Missouri S&T-CE | $ 363,590 | $ 152,981 | $ 516,571 |
| R237 | MoDOT Missouri S&T-CE | $ 60,217 | $ 48,077 | $ 108,294 |
| R238 | MoDOT UMC-CE | $ 80,033 | $ 37,750 | $ 117,783 |
| R239 | MoDOT UMC-CE | $ 109,309 | $ 50,178 | $ 159,487 |
| R240 | MoDOT UMC-CE | $ 102,444 | $ 53,928 | $ 156,372 |
| R241 | MoDOT UMKC-CE | $ 133,165 | $ 35,612 | $ 168,777 |
| R242 | MoDOT / UMC CE | $ 151,296 | $ 35,965 | $ 187,261 |
| R243 | MoDOT / Missouri S$T CE | $ 141,116 | $ 97,406 | $ 238,522 |
| R244 | MoDOT / Missouri S$T CE | $ 64,473 | $ 55,927 | $ 120,400 |
| R245 | MoDOT / UMC CE | $ 89,047 | $ 50,863 | $ 139,910 |
| R246 | MoDOT / Missouri S&T CE | $ 132,890 | $ 91,620 | $ 224,510 |
| R247 | MoDOT / UMC CE | $ 915,596 | $ 43,218 | $ 958,814 |
| ETT248 | MoDOT | $ 343,261 | $ 218,261 | $ 561,522 |
| ETT249 | MoDOT | $ 30,506 | $ 11,438 | $ 41,944 |
| R250 | City of Rolla | $ 169,733 | $ 165,000 | $ 334,733 |
| ETT251 | Industry | $ 367,250 | $ 187,500 | $ 554,750 |
| RE252 | Spirit Aerosystems | $ 25,000 | $ 12,500 | $ 37,500 |
| R253 | NCHRP/MAPA/MS&T CE | $ 144,996 | $ 95,449 | $ 240,445 |
| R254 | Industry | $ 1,208,409 | $ 604,205 | $ 1,812,614 |
| R255 | USB | $ 50,000 | $ 25,000 | $ 75,000 |
| R256 | KH | $ 2,469 | $ 3,500 | $ 5,969 |
| R257 | CRSI | $ 30,000 | $ 15,000 | $ 45,000 |
| ETT258 | Industry | $ 376,250 | $ 187,500 | $ 563,750 |
| ETT259 | MoDOT | $ 218,289 | $ 218,289 | $ 436,578 |
| R260 | MoDOT | $ 99,978 | $ 49,966 | $ 149,944 |
| R261 | University of Arkansas | $ 40,011 | $ 20,005 | $ 60,016 |
| R262 | GEI | $ 3,500 | $ 2,400 | $ 5,900 |
| R263 | USB | $ 50,000 | $ 25,000 | $ 75,000 |
| R264 | MS&T-MRC | $ 15,000 | $ 7,500 | $ 22,500 |
| R265 | MoDOT | $ 120,000 | $ 60,000 | $ 180,000 |
| R266 | EPRI | $ 15,000 | $ 7,500 | $ 22,500 |
| ETT267 | MoDOT | $ 218,289 | $ 218,290 | $ 436,579 |
| R268 | MoDOT | $ 100,000 | $ 50,000 | $ 150,000 |
| R269 | MoDOT | $ 74,924 | $ 37,195 | $ 112,119 |

| | | | | |
|---|---|---|---|---|
| R270 | MoDOT | $ 60,000 | $ 30,000 | $ 90,000 |
| R271 | MoDOT UMC-CE | $ 76,615 | $ 20,000 | $ 96,615 |
| R272 | MoDOT | $ 48,173 | $ 23,057 | $ 71,230 |
| R273 | MoDOT | $ 80,000 | $ 40,000 | $ 120,000 |
| R274 | UM-RB | $ 25,800 | $ 12,899 | $ 38,699 |
| R275 | MoDOT/WCM | $ 225,000 | $ 112,500 | $ 337,500 |
| R276 | PCI | $ 20,000 | $ 10,000 | $ 30,000 |
| R277 | PCI | $ 20,000 | $ 10,000 | $ 30,000 |
| R278 | GEI | $ 10,115 | $ 5,000 | $ 15,115 |
| ETT279 | Industry | $ 207,335 | $ 93,085 | $ 300,420 |
| ETT280 | Industry | $ 239,000 | $ 99,501 | $ 338,501 |
| R281 | MoDOT | $ 59,425 | $ 39,500 | $ 98,925 |
| R282 | MoDOT | $ 46,995 | $ 31,238 | $ 78,233 |
| R283 | GEI | $ 3,333 | $ 1,667 | $ 5,000 |
| R284 | Ameren | $ 20,000 | $ 10,000 | $ 30,000 |
| R285 | EPRI | $ 125,001 | $ 79,206 | $ 204,207 |
| R286 | MS&T-MRC | $ 15,000 | $ 7,500 | $ 22,500 |
| R287 | AHDT | $ 5,000 | $ 2,171 | $ 7,171 |
| R288 | MS&T-CE | $ 8,353 | $ 8,353 | $ 16,706 |
| R289 | MS&T-CE | $ 8,353 | $ 8,353 | $ 16,706 |
| ETT290 | MS&T/Industry | $ 199,000 | $ 99,500 | $ 298,500 |
| ETT291 | MoDOT | $ 218,288 | $ 218,288 | $ 436,576 |
| R292 | MS&T-GS&E | $ 8,353 | $ 8,353 | $ 16,706 |
| R293 | MoDot | $ 120,000 | $ 60,000 | $ 180,000 |
| ETT294 | MS&T/Industry | $ 197,564 | $ 97,600 | $ 295,164 |
| R295 | MoDOT | $ 120,000 | $ 60,000 | $ 180,000 |
| R296 | Bell Helicopter | $ 50,000 | $ 25,000 | $ 75,000 |
| R297 | MS&T-Geo | $ 27,708 | $ 13,921 | $ 41,629 |
| R298 | CalTrans | $ 65,854 | $ 32,927 | $ 98,781 |
| RE299 | MS&T-CIES | $ 15,050 | $ 2,285,634 | $ 2,300,684 |
| R300 | MoDOT/MS&T-CE/UMC | $ 927,904 | $ 500,000 | $ 1,427,904 |
| R301 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R302 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R303 | MS&T-CompSci/RB | $ 26,562 | $ 26,562 | $ 53,124 |
| R304 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R305 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R306 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R307 | ISU | $ 49,966 | $ 24,983 | $ 74,949 |
| R308 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |

| | | | | |
|---|---|---|---|---|
| R309 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| R310 | MS&T-CE | $ 13,281 | $ 13,281 | $ 26,562 |
| **Facilities & Admin. Indirect Costs** | | | $ 1,992,464 | $ 1,992,464 |
| **TOTAL** | | **$ 15,140,917** | **$ 12,589,056** | **$ 27,729,973** |

**Legend:**

**AHDT**=Arkansas State Highway and Transportation Department
**CDOT**=California Department of Transporation
**CRSI**= Concrete Reinforcing Steel Institute
**EPRI**=Electrical Power Research Institute
**FMSME**=Fuller, Mossberger, Scott & May Engineering
**GEI**=GeoEngineers Inc.
**GTI**=Gas Technology Institute
**ISU**=Iowa State University
**KH**=Knight Hawk
**LGA**=Leica Geosystems Advantage
**MODOT** = Missouri Department of Transporation
**MODOT/WCM** = Missouri Department of Transporation & Washington County Missouri
**MS&T DCE** = Missouri Uniersity of Science & Technology-Distance & Cont. Education
**MS&T GS&E** = Missouri Uniersity of Science & Technology-Geological Science & Engineering
**MS&T-CE**= Missouri University of Science and Technology-Civil Engineering
**MS&T ME** = Missouri Uniersity of Science & Technology-Mining Engineering
**MS&T MRC** = Missouri Uniersity of Science & Technology-Materials Reserach Center
**MS&T-VPR**= Missouri University of Science and Technology-Vice Provost of Research
**NCHRP**=National Cooperative Highway Research Program
**NYSDOT**=New York State Depart. of Transporation
**NYSERDA**= New York State Energy Research and Development Authority
**PCI**=Precast Concrete Institute
**UAF-CE** =University of Arkansas, Fayette-Civil Engineering
**UM-RB** =University of Missouri-Reserach Board
**UMC-CE** =University of Missouri-Columbia Civil Engineering
**UMKC-CE**=University of Missouri Kansas City-Civil Engineering
**UNR**=University of Nevada-Reno
**USB**=United Soybean Board

# APPENDIX: SUCCESS STORIES CLIPS

## Featured Articles in the NUTC News

# Taking *the reigns*

## Kamal H. Khayat

Dr. Kamal Henri Khayat joined Missouri S&T in August of 2011 as the Vernon and Maralee Jones Professor of Civil Engineering and Director of the Center for Infrastructure Engineering Studies and the Center for Transportation Infrastructure and Safety (CTIS).

Dr. Khayat received his Ph.D. in civil engineering with an emphasis in civil materials from the University of California at Berkeley. He served as Director of the Center of Excellence on Concrete Infrastructure Engineering and Head of the Integrated Research Laboratory on Materials Valorization and Innovative and Durable Structures at the Université de Sherbrooke in Canada. He led a team of 10 researchers to secure the University's largest grant (C$16M ) to construct a state-of-the-art research laboratory which was inaugurated in 2009.

He was named the National Science and Engineering Research Council (NSERC) Chair on High-Performance Flowable Concrete with Adapted Rheology in 2008, a consortium re-grouping 17 industrial partners from Canada and the US to develop a new generation of construction materials.

Dr. Khayat has authored and co-authored over 200 technical publications and received several awards for his research and services. He is an active member of ACI, RILEM, and CSA technical committees and chairs ACI 237 (SCC) and RILEM 228 (Mechanical Properties of SCC). He has been involved in organizing and chairing major international conferences in Canada, China, France, Poland, and the United Arab Emirates.

Since his arrival at Missouri S&T, Dr. Khayat has coordinated a major effort involving two partner universities, the University of Illinois at Urbana-Champaign and University of Miami, and a multi-disciplinary research team of 27 faculty members with expertise in eight engineering disciplines. The $3.5M proposal aimed to build upon the past success of CTIS by creating a collaborative vehicle for addressing the complex and growing needs facing the transportation industry, with the ultimate goal of ensuring a sustainable, reliable, and safe national transportation infrastructure.

Dr. Khayat's main goal over the coming years is to foster an atmosphere of inter-disciplinary collaborative research efforts in the field of transportation that will further Missouri S&Ts position as a national leader.

Dr. Khayat would like to recognize the leadership and achievement of Dr. John Myers as the former Interim Director of CTIS. Dr. Myers' knowledge of the CTIS will continue to be a valuable resource to the Center via his new role as Associate Director. Dr. Khayat would also like to acknowledge Dr. John Sheffield, who has agreed to continue his role as Associate Director of CTIS. Dr. Khayat looks forward to working with Drs. Myers and Sheffield to build upon and ensure the continued sucess of this well-established research Center.

# PROJECT:

## Making highway rock cuts safer

- Norbert Maerz, Associate Professor of Geological Engineering, Missouri S&T

Figure 1:
LIDAR scanner measuring rock cut

Rock falls constitute a significant geological hazard along highways in hilly terrains, causing financial loss, damage to vehicles and infrastructure and even injury and occasional loss of life. By most accounts raveling type rock falls (time dependent regressive displacement failures) constitute better than half of all failures. Yet there is no way to model them or predict their progress or severity. Even the mechanisms are poorly understood.

A new technology called LIDAR (LIght Detection And Ranging) can make very precise measurements of rock slopes and cuts, detecting minute topographical differences over time, that will provide the data needed for developing a model for raveling (Figure 1). As a distance measuring device, LIDAR replaces traditional methods of laser surveying, which take individual measurements, and require reflective targets to measure distances and angles. LIDAR is analogous to radar, in that the scanning laser can make of 50,000 point measurements per second, returning a point cloud, which can be used by sophisticated software to create a very detailed surface map. At Missouri S&T, we have a Leica ScanStation II, and a Leica HDS6000, both terrestrial LIDAR models that are being used for this project. These have a range of over one hundred meters, a sampling resolution of less than 1 mm, and a modeled precision of 2 mm.

Multiple scans over time can reveal the timing, sequence, number of blocks and volumes of material falling off the face and accumulating on the ground below, up to and including the fall of very small individual blocks (Figure 2). Rock fall events can be precisely correlated with external stimuli, such as rainfall, temperature cycling, and seismic activity (Figure 3). In time measurements such as these will allow us to understand the causes and triggers of raveling failures and to learn how to predict and prevent raveling rock falls using new modeling methods.

Figure 2:
LIDAR and resulting areas of rock loss painted in red on the image

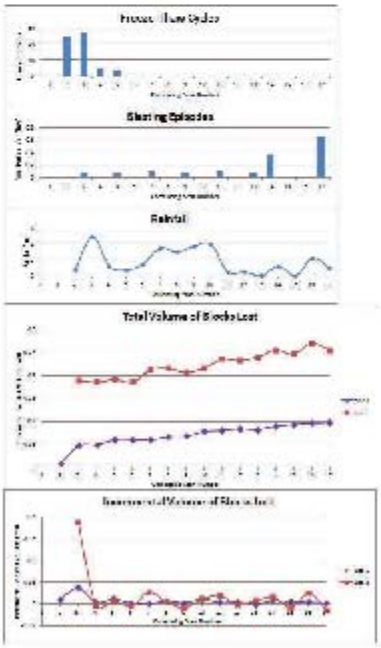


Figure 3:
Results of the pilot study

# PROJECT:

## Hybrid composite beam research

- John Myers, Associate Professor of Civil, Architectural and Environmental Engineering, Missouri S&T
- Glenn Washer, Associate Professor of Civil Engineering, University of Missouri-Columbia

In July of 2011, researchers from Missouri S&T and the University of Missouri-Columbia initiated a research study with the Missouri Department of Transportation (MoDOT) and CTIS, studying the field behavior of three new innovative bridges to be constructed in Missouri. This new bridge support system involves the use of an innovative Hybrid-Composite Beam (HCB), shown conceptually in Figure 1. These HCB's are comprised of three main sub-components that include a shell, compression reinforcement in the shape of an arch, and tension reinforcement that serves as a tension tie. The outer shell consists of a fiberglass composite which is non-corrosive. Tensile reinforcement includes the use of galvanized high strength steel. Self-consolidated concrete (SCC) is used to form the concrete compression arch. An arch was selected to reduce the overall dead load of the member and only use the concrete where it is most desirable, in the compression and end bearing regions. By minimizing the dead load, more members can be transported to the job-site together and lower rated capacity cranes can be used for field erection compared to traditional concrete girders.

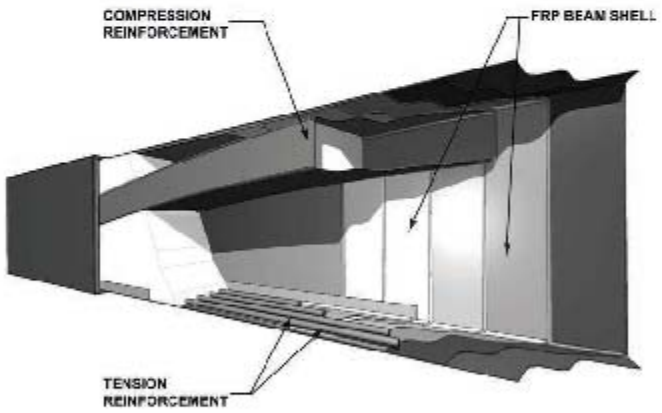



Figure 1: Fragmentary Perspective of Hybrid-Composite Beam

Dr. John J. Myers heads the Missouri S&T research team which is evaluating the in-situ structural behavior of the bridges including behavior during fabrication, transportation and service, displacements under controlled loads, component strains, and thermal behavior as well as examining performance within the bearing-strand anchorage regions. The research team will also be studying the long-term durability of the system as a whole in addition to accelerated durability evaluation of the fiberglass shell component that serves to help protect the internal structural system. The target service life is for this innovative bridge system to have a minimum service life of 100 years. To date, beams for the first HCB Bridge have been successfully fabricated and erected (see Figure 2) on the first bridge in southern Missouri followed by the construction of the bridge deck.

(continued on next page)

Figure 2: Erection of Hybrid-Composite Beams in Douglas County, Missouri

Dr. Glenn Washer leads the Mizzou research team. The objective of the MU research portion is to develop tools for quality control and in-service inspection of the HCB's. The primary nondestructive evaluation (NDE) technology being investigated in the research is infrared thermography, to evaluate the integrity the embedded concrete arch. The cast-in-place concrete arch is a critical load-carrying element of this innovative beam design. However, it is entirely embedded within the composite box section of the beam, and as such is inaccessible for visual inspection. Thermography is being utilized to measure the surface temperatures along the web of the HCB during early concrete hydration, to assess if the thermal signature of the concrete arch, indicates embedded defects. The SCC placed in the arch may be susceptible to voids caused by air entrapped in the narrow arch during the placement process or unanticipated obstructions in the arch void. These voids could reduce the load-bearing capacity of the beam. Voids may also affect the thermal signature of the arch imaged at the beam surface, resulting in anomalies in the thermal image.

Figure 3 shows a thermal image of the end section of a HCB following recent fabrication. The thermal image was taken 24 hours after concrete placement, when the heat of hydration from the concrete creates a thermal signature at the surface of the HCB. The image shows the concrete end block and initial portion of the arch. Safety caps placed on the end of rebar extending out from the beam appear as dark squares on the end block. As shown in the figure, the thermal signature of the embedded arch can be clearly seen.

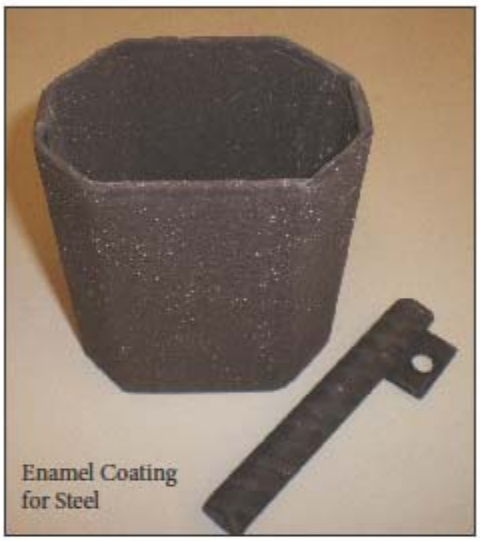

Figure 3: Thermal Image of HCB Showing Concrete Arch and End Block

Tap testing and visual inspection will also be utilized as tools for assessing the condition and performance of the composite shell. Tap testing and infrared thermography are both being utilized to detect delaminations in the composite shell. Visual inspections will be utilized to assess the HCB in service and following planned load testing.
For questions related to this article, please contact the authors, Drs. John Myers and Glenn Washer, at JMyers@mst.edu and Washerg@misouri.edu, respectfully.

# FEATURED PROJECT:

## Vitreous Enamel for Chemical Bond Between Steel and Concrete

- Genda Chen, Professor, Department of Civil, Architectural and Environmental Engineering, Missouri S&T



Enamel Coating for Steel

In 2007, Missouri S&T initiated a series of studies on the potential use of **chemically reactive, vitreous enamel as a coating of steel rebar** (application shown at left) in order to better bond steel rebar to concrete and protect the steel from corrosion. The following is a brief report on the progress of these studies. For more information, please contact Dr. Genda Chen by email at gchen@mst.edu.

Approximately $10B per year has been spent to remediate corrosion problems with our nation's bridges, and indirect costs push that annual expenditure up by a factor of 10. Thus far, epoxy-coating has been the most widely used method to protect steel rebar from corrosion. Once breached, however, the epoxy coating can actually accelerate the steel corrosion since its physical bond with the steel is too weak to prevent a moisture attack. Furthermore, use of the epoxy coating reduces the concrete-steel bond strength and thus requires longer development lengths for epoxy-coated rebar, which results in not only the use of more materials but also the non-assurance of construction quality in congested rebar areas such as beam-column joints. Similarly, other types of rebar, such as zbar, stainless steel, stainless steel clad, and fiberglass do not form chemical bonds with the surrounding concrete matrix, and so offer no opportunity to enhance the overall strength of reinforced concrete (RC) structures. Once in production, enamel coating is expected to cost comparable to the widely used epoxy coating in civil engineering construction.

**Porcelain enamel** is a vitreous or glassy inorganic material that can be bound to a substrate metal by fusing glass frits at 750 °C to 850 °C. It has been extensively used in domestic and industrial applications that require chemical, high temperature, corrosion and mechanical protection. The properties of enamel coating are flexible and can be controlled by altering the chemical composition, microstructure, and by pre-treating the metal substrate. Therefore, the enamel coating can be designed and used to improve corrosion resistance in an alkaline environment with an enhanced chemical bond to the steel substrate.

Porcelain enamel was first introduced as a steel rebar coating by the Army Corp of Engineers in 2006. Since then, in close collaboration with Pro-Perma Engineered Coatings managed by Mr. Michael Koenigstein, Dr. Genda Chen, Professor of Civil Engineering, and his colleagues, Dr. Richard Brow in Material Science and Engineering, and Dr. Jeffery Volz in Civil Engineering, have systematically characterized the microstructures, mechanical properties, and chemical reactions with concrete of both conventional and innovative cement-modified enamels. Up to date, three types of enamel coating have been investigated: pure (conventional) enamel, mixed enamel, and double enamel. Mixed enamel is a mixture of the pure enamel and calcium silicate directly taken from Porcelain cement. Double enamel consists of an inner pure enamel layer for corrosion protection and an outer mixed enamel layer for rebar bond performance in concrete.



(continued next page)

Figure A Figure B

Two RC Columns under Cyclic Loading
Figure A: Uncoated Reinforcement
Figure B: Enamel-Coated Reinforcement

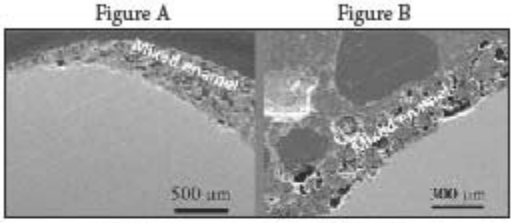



Figure C Figure D

Microstructure and Coating-Steel Inferface
Figure C: Deformed rebar
Figure D: Smooth rebar

From extensive experiments and simulations, the following **MAIN CONCLUSIONS** can be drawn:

- The firing process of enamel-coated steel rebar does not change the ductile behavior of the steel rebar. During tensile tests, the enamel coating of steel rebar will not crack unless the rebar experiences approximately 1.5 times the yield strain.
- Steel-mortar cylinders fail in different modes from ductile steel pulling-out to brittle concrete splitting, and their bond strengths increase as the calcium silicate contained in mixed enamel coating increases.
- The mixed enamel coating can increase the 28-day bond strength of smooth steel rods in mortar by 7 or 8 times due to the increased adhesive (over 2 times) and surface roughness (over 3 times). For deformed steel rebar in concrete, the increase in bond strength by enamel coating is reduced to approximately 15% since the concrete bearing on rebar ribs exceeds the adhesive and fictional effects between the rebar and concrete.
- The coating effect on the bond strength of enamel-coated rebar in concrete can be well represented by a coating factor 0.85 in the ACI 318-08 development length equation.
- The corrosion performance of enamel coatings largely depended upon the coating thickness and the concentration of calcium silicate within the coating. In general, the double and pure enamel coatings outperform the mixed enamel coating that has many interconnected pores formed during the firing process. However, thin sections of coating around the ribs of deformed rebar due to low enamel slurry viscosity and gravity effects can significantly reduce the corrosion resistance of enamel coatings.
- Unlike epoxy coating, a damaged enamel coating remains bound to its steel substrate and thus causes no thin film corrosion underneath the coating. During ponding tests, 28% and 4% decrease in corrosion resistance were observed due to damage in epoxy and enamel coatings, respectively.
- It is recommended that pure, mixed, and double enamel coatings be respectively used for a moderate protection of steel rebar in corrosive environments, an enhancement of rebar-concrete bond strengths, and a design concern of both corrosion resistance and bond strength.

# FEATURED PROJECT:

## Bottom Ash as Aggregate Replacement In Concrete

- Jeffery Volz, Assistant Professor of Civil, Architectural and Environmental Engineering, Missouri S&T

**Bottom ash** (shown at left) is a waste product from the burning of coal in thermal power plants. Most modern plants pulverize the coal before it is injected into the boiler. The non-combustible material remaining after burning becomes either fly ash or bottom ash. Bottom ash results when the non-combustible material agglomerates in cooler sections of the boiler and eventually falls to the bottom, as opposed to fly ash, which travels upward with the combustion gases. Bottom ash is primarily comprised of fused coarser ash particles. Frequently, these particles are very porous and resemble volcanic lava. Although relatively unreactive compared to fly ash, bottom ash does have the potential to replace either all or a portion of the natural aggregates used in concrete. In particular, bottom ash holds considerable potential for use as internal curing of high-performance concretes (HPCs).

HPCs offer the potential for smaller element cross-sections and increased durability, reducing both first and life-cycle costs. However, to extend the benefits of HPCs, internal curing is required to reduce the potential for early-age cracking and develop the full strength potential of the material. Why the need for internal curing over traditional external curing methods such as fogging, misting, and wet burlap? Basically, the capillary porosity of higher performing concretes becomes disconnected during the first few days of hydration, such that external water may only penetrate less than one-tenth of an inch. In addition, with extremely low water-cement ratios, moisture can become trapped during early hydration due to cement particles reacting at different rates. Without internal sources of well distributed water, the concrete can self-desiccate, which results in significant internal stresses and unhydrated (wasted) cement. The purpose of internal curing is to provide water as needed throughout the interior of the concrete element, resulting in complete cement hydration and the elimination of autogenous stresses that can lead to early-age cracking. Furthermore, HPCs that use relatively high amounts of supplementary cementitious materials (SCMs) – fly ash, silica fume, slag – benefit even more from internal curing due to their longer hydration periods.

**Preliminary results appear very promising.** Measurements of fine bottom ash particles from several thermal power plants in Missouri indicate absorptions ranging from 9% to 12% compared with lightweight fine aggregate which ranges from 5% to 8%. Higher absorption allows a greater amount of water to be stored and thus available for internal curing. Preliminary results of the research indicate that mortar mixtures containing prewetted bottom ash (fine gradation) experienced early-age shrinkage comparable to the identical mixtures without prewetted bottom ash. However, long-term shrinkage was significantly reduced for the mixtures containing bottom ash, on the order of 50%. In addition, restrained shrinkage tests indicated reduced restraint stresses for the mortars containing prewetted bottom ash as well as a significant delay in the onset of shrinkage cracking.

**Awards**

## 2011 CTIS Student of the Year
### *Nathan P. Muncy*

Hometown and State: Kansas City, MO

Nathan Muncy, 2011 CTIS Student of the Year

Student Bio: Mr. Muncy obtained a B.S. degree in Civil Engineering with Cum Laude honors from the Missouri University of Science and Technology (Missouri S&T) in December 2010 and is expenced to complete his M.S. in Civil Engineering in December 2012.

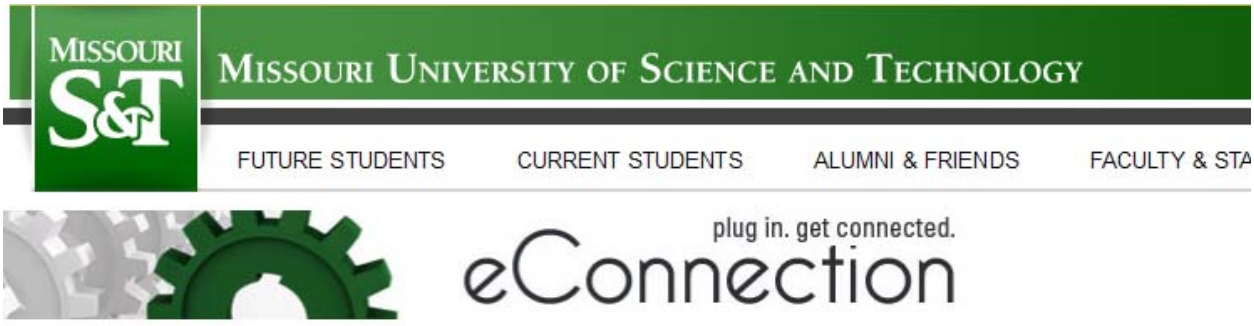
During his undergraduate career, Mr. Muncy was a member of the Missouri S&T chapters of the American Society of Civil Engineers (ASCE) and the American Concrete Institute (ACI). He was also highly involved in the Missouri S&T Steel Bridge Team as a leader and coordinator of bridge fabrication.

Nathan was also a member of the Concrete Canoe Mix Design Team where he served two years as the lead mix designer. As an undergraduate student, Nathan completed a National Science Foundation (NSF) supported OURE studying the long-term in-situ bond behavior of externally bonded carbon fiber reinforced polymer (CFRP) laminates subject to eight years of field conditioning. This work has added important field data to a very limited database on in-situ FRP strengthened bridges.

As a graduate student, Nathan studied the field performance of three bridge approach slab designs including a new most cost effective innovative prestressed-precast approach slab design. The research evaluated the field performance of bridge approach slabs including the deflection and rotation based on static and dynamic load testing. This work has been sponsored by the Missouri Department of Transportation (MoDOT) and the NUTC at Missouri S&T. He has also continued to document the field behavior of FRP strengthened bridges throughout Missouri creating a database of CFRP bond behavior under varied environmental and mechanical conditioning. During his graduate and undergraduate scholarly activities, Nathan was advised by Dr. John J. Myers.

Nathan was recognized at the TRB Conference in January 2012 along with the other UTC Outstanding Students' of the Year from UTC member institutions.

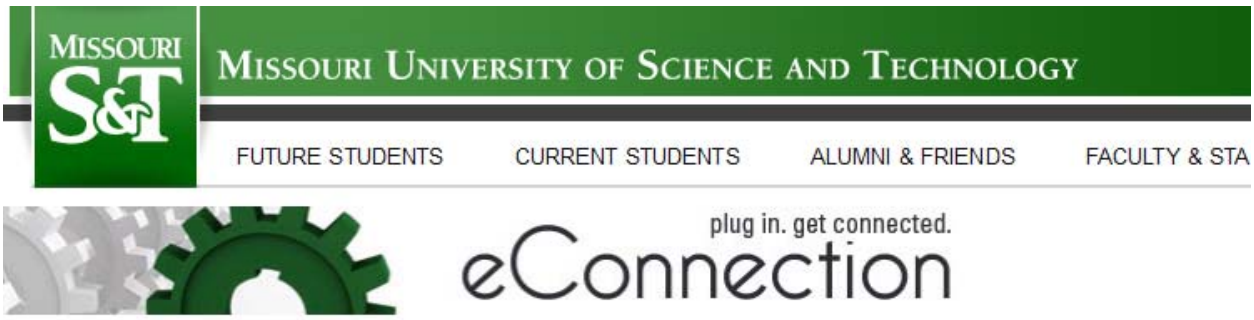
Selection Criteria: Mr. Muncy was selected as the Outstanding Missouri S&T UTC Student of the Year for his outstanding academic performance, the technical merit and national importance of his research, as well as his service to the Missouri S&T campus and surrounding community.




## Sheffield receives Missouri *impact!* Award

December 24, 2011 8:18 AM | Permalink

Dr. John Sheffield, professor of mechanical and aerospace engineering, recently received the Missouri *impact!* Award from Missouri Enterprise for his work to help reduce energy usage by manufacturers across the state.




## Professors win IEEE awards

August 2, 2010 5:15 PM | Permalink

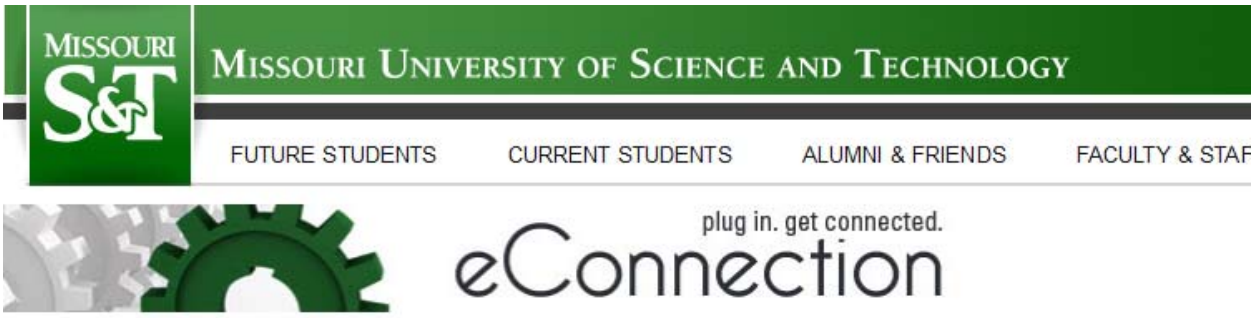
Dr. Bruce McMillin, professor of computer science at S&T, recently received the Outstanding Contribution Award for his 20 years of outstanding service to the IEEE Computer Society. The award was presented on July 20 at the annual IEEE Computer Society Signature Conference on Computers, Software and Applications in Seoul, Korea.

Dr. Donald Wunsch, professor of electrical and computer engineering at S&T, Dr. Rui Xu, post doctoral fellow in electrical and computer engineering at S&T and Dr. Jie Xu of United Airlines won the Best Overall Paper Award for 2010 at the IEEE Conference on Evolutionary Computation in the World Congress on Computational Intelligence held in Barcelona, Spain. The award was presented on July 21.


## Swift receives educator award

November 24, 2011 9:20 AM | Permalink

Dr. Theresa Swift, assistant teaching professor of electrical and computer engineering, recently received the Outstanding Educator Award from the St. Louis section of the Institute of Electrical and Electronics Engineers (IEEE). The St. Louis section includes eastern Missouri and southern Illinois and incorporates Missouri S&T, the University of Missouri-Columbia, St. Louis University, Washington University, Southern Illinois University at Carbondale and Southern Illinois University at Edwardsville.




## Cudney receives Lean Teaching Award

March 12, 2012 8:28 AM | Permalink

Beth Cudney, assistant professor of engineering management and systems engineering, was awarded the 2012 Lean Teaching Award by the Institute of Industrial Engineers (IIE). This award is given annually to recognize the contribution of individuals in advancing the knowledge and practice of lean concepts. The award is based on the contributions in the areas of leadership, design and content quality, applied learning, innovation and student satisfaction. Cudney will receive the award at the IIE Annual Conference in Orlando, Fla., in May. The IIE is the world's largest professional society dedicated to supporting the industrial engineers profession.



## Tanzanian health center wins award

March 8, 2012 8:57 AM | Permalink

The Roche Health Center, which serves 25,000 villagers in rural Tanzania, was recognized by the Association of Collegiate Schools of Architecture with the 2011-2012 Global Collaborative Practices Award. Dr. Daniel B. Oerther, the John A. and Susan Mathes Chair of Environmental Engineering at S&T, formerly mentored the student architectural team at the University of Cincinnati. A video of Oerther's most recent visit to the center in August 2011 is available on YouTube.

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## Missouri S&T students receive Grainger Power Engineering Awards

June 2, 2012 8:36 AM | Permalink | Comments (2) | SHARE

Thirteen electrical engineering seniors and recent graduates each received a $5,000 Grainger Power Engineering Award from the electrical engineering department at Missouri University of Science and Technology this spring. The awards are presented as a reward for academic excellence.

The Power Engineering Awards are funded by a $1.3 million endowment from The Grainger Foundation of Chicago. Missouri S&T is recognized by Grainger for its ability to attract top students and educate quality engineers and is one of only six universities in the nation chosen to receive such funding.

Each spring, the Grainger Power Engineering Award is typically presented to up to 13 electrical engineering graduate and undergraduate students who plan to pursue careers in

power engineering. Selection of recipients is based on academic performance, exhibited interest in power engineering and extra-curricular activities.

To be eligible for this year's award, students must have graduated with degrees in electrical engineering in August or December of 2011 or May 2012 and have emphasized their course work in power engineering. All of the recipients had significant power engineering experience, either through company internships, research projects or design projects.

2012 recipients of the Power Engineering Awards are:

**Tyler Allen** of O'Fallon, Ill., a 2012 electrical engineering graduate
**Kenneth Bassler III** of Belleville, Ill., a Dec. 2011 electrical engineering graduate
**Jason Buchanan** from Rolla, Mo., a 2012 electrical engineering 2012 graduate
**Zachary Johnson** of Lee's Summit, Mo., a 2012 master's degree recipient in electrical engineering
**Hao Liu** of Festus, Mo., a December 2011 electrical engineering graduate
**Nickolas McFowland** of Ferguson, Mo., a 2012 master's degree recipient in electrical engineering
**David Macke Jr.** of Glendale, Mo., a 2012 electrical engineering graduate
**Andrew Meintz** of Troy, Mich., a 2011 Ph.D. recipient in electrical engineering
**Stephen Moerer** of Parkville, Mo., a 2012 electrical engineering graduate
**Katlyn Peterson** of Granby, Mo., a 2012 electrical engineering graduate
**Adam Reab** of Blue Grass, Iowa, a 2012 electrical engineering graduate
**Amir Saad** of Schenectady, N.Y., a 2012 master's degree recipient in electrical engineering
**Daniel Sierra** of Kansas City, Mo., a 2012 electrical engineering graduate

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## S&T wins human-powered vehicle competition

May 13, 2012 8:22 AM | Permalink | Comments (1) | SHARE

Wearing her lucky Elmo socks, Nikia Chapman helped Missouri University of Science and Technology win another championship in human-powered vehicle racing.

A perennial powerhouse, Missouri S&T's team finished ahead of the 18 other university teams in the competition, which was held during the past week in Utah.

Chapman, a freshman engineering student from Columbia, Mo., and Jonathan Sanders, a junior in mechanical engineering from Webb City, Mo., each finished first in men's and women's individual speed events. The Missouri S&T team also won the endurance part of the competition.

According to Sanders, S&T has one of the most aerodynamic bikes this year. Each year, students on the teams design and build human-powered vehicles, which typically have aerodynamic shells but come in many shapes and styles.

"You learn what works, what doesn't, what can actually be built and what can't," Sanders told a reporter who covered the Utah competition. "Anyone can design a part. Not everyone can design a part that can actually be built."

# NEWS & EVENTS

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## S&T students win awards for 'smart' grid research

February 20, 2012 1:18 PM | Permalink | Comments (0) | SHARE

Two computer science students at Missouri University of Science and Technology have received National Science Foundation funding to support their research to create a future "smart" electric power grid.

Tom Roth of St. Louis, a Ph.D. student in computer science, received the NSF's FREEDM Systems Energy Research Consortium Graduate Fellowship for the 2012-2013 academic year. The fellowship provides $5,000 in funding for Roth's studies.

Michael Catanzaro of St. Louis, a junior in computer science, received a $4,000 award from the FREEDM Undergraduate Research Scholars Program to support his research.

FREEDM stands for Future Renewable Electric Energy Delivery and Management. The FREEDM center, established in 2008, involves seven U.S. and European universities working together to transform the nation's power grid into a distributed system - an Internet for energy - that will speed renewable electric-energy technologies into homes and businesses across the U.S. Missouri S&T is part of the effort, which is led by the FREEDM Systems Center at North Carolina State University.

Both Roth and Catanzaro are involved in developing methods that would allow homes connected to the future smart grid to schedule energy usage to conserve power or run appliances during off-peak hours. For example, a home connected to the smart grid could

decide that the refrigerator compressor turns on only after the washer has completed its spin cycle, says Dr. Bruce McMillin, a professor of computer science at Missouri S&T.

Under McMillin's direction, Roth and Catanzaro are developing the sophisticated scheduling algorithms that would make the smart grid work. Roth is also focusing on security issues associated with the system, and Catanzaro is looking at "plug-and-play" implementation that would allow the grid to recognize appliances plugged in to the network the same way a computer recognizes a USB device when it is plugged in.

The FREEDM Systems ERC Graduate Fellowship is designed to help increase the number of outstanding and underrepresented Ph.D. students in the FREEDM Systems ERC. The Undergraduate Research Scholars Program is designed to immerse undergraduate student researchers in the culture and programs of the center.

As part of the FREEDM Systems ERC, Missouri S&T's computer science department plays a major role in the development of distributed grid intelligence.

Missouri S&T's participation in the FREEDM effort is led by Dr. Mariesa Crow, the Fred W. Finley Distinguished Professor of Electrical and Computer Engineering at Missouri S&T and director of the university's Energy Research and Development Center.

# S&T students place fourth in international hydrogen design competition

**http://news.mst.edu/2012/06/st_students_place_fourth_in_in.html**

June 4, 2012 7:58 AM |

A team of six Missouri University of Science and Technology students placed fourth in the 2012 Hydrogen Student Design Contest.

The winners of the competition were announced Sunday, June 3, by the U.S. Department of Energy at the Young Scientist Symposium of the World Hydrogen Energy Conference in Toronto. A record 20 universities from around the world entered the competition, and the University of Maryland won the event.

For this year's competition, students created a plan and design for a system that produces electricity, heat and hydrogen for their university campus.

Members of this year's team are:

Abdulhakin Agll of Rolla, Mo., a Ph.D. student in mechanical engineering.

Sushrut G. Bapat of Mumbai, India, a Ph.D. student in mechanical engineering.

Tarek A. Hamad or Rolla, Mo., a Ph.D. student in mechanical engineering.

Yousif M. Hamad of Dearborn, Mich., a Ph.D. student in mechanical engineering.

Morgan Hoover of Pontiac, Ill., a sophomore in architectural engineering.

Mathew Thomas of Kottayam, India, a Ph.D. student in engineering management.

Faculty advisors for the team are Dr. John W. Sheffield, professor of mechanical and aerospace engineering; Dr. Kevin B. Martin, assistant research professor of mechanical and aerospace engineering; Dr. Stuart W. Baur, associate professor of architectural engineering; and Heath

Pickerill, an adjunct professor in civil, architectural and environmental engineering.

The team members are part of a larger group known as H2 Design Solutions, which is one of the design teams affiliated with Missouri S&T's Student Design and Experiential Learning Center.

Missouri S&T teams have fared well in previous hydrogen competitions, winning the event in 2008 and 2010.

## Missouri S&T in the News

### External Media Sources


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# S&T welcomes new Vernon and Maralee Jones Professor of Civil Engineering

Dr. Kamal H. Khayat is the new Vernon and Maralee Jones Professor of Civil Engineering at Missouri University of Science and Technology.



**Staff reports**
Posted September 16. 2011 12:01AM

Dr. Kamal H. Khayat is the new Vernon and Maralee Jones Professor of Civil Engineering at Missouri University of Science and Technology.

has also been named the director of the Center for Infrastructure Engineering Studies and the Center for Transportation Infrastructure and Safety at Missouri S&T.

Khayat specializes in the development of high-performance cement-based materials for structural applications and rehabilitation projects. He focuses on self-consolidating concrete and high performance concrete behavior.

During his career thus far, Khayat has authored or co-authored more than 200 articles in technical publications. He has also won numerous awards for his research and service, including the American Concrete Institute/Canada Centre for Mineral and Energy Technology Award for Outstanding Contribution in Concrete Technology.

Among the international universities he has visited as a guest professor are the Universite de Cergy-Pontoise in France and the Reykjavik University in Iceland.

Structural Engineering &DESIGN

# Building the 'bridge to the future'

ROLLA, MO. -- WITH 17 PERCENT OF MISSOURI'S BRIDGES DEFICIENT AND NOT ENOUGH RESOURCES AVAILABLE TO REPAIR AND REBUILD THEM, RESEARCHERS AT MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY ARE MORE DETERMINED THAN EVER TO DEVELOP INNOVATIVE AND INEXPENSIVE MATERIALS THAT CAN REPLACE THESE RELIC STRUCTURES.

ROLLA, Mo. -- With 17 percent of Missouri's bridges deficient and not enough resources available to repair and rebuild them, researchers at Missouri University of Science and Technology are more determined than ever to develop innovative and inexpensive materials that can replace these relic structures.

"A common saying for civil engineers is that we could build bridges that last forever, but we can't afford it," says Dr. Jeffery Volz, assistant professor of civil, architectural and environmental engineering at Missouri S&T.

The majority of the nation's 600,000 bridges were built nearly 50 years ago using traditional materials, like steel, concrete and rebar. The structural integrity of these bridges, nearing the end of their lifespan, has been greatly reduced due to weathering, combined with wear from vehicle traffic and de-icing chemicals and reduced maintenance.

Over the last 15 years, newer designs have called for replacing the concrete and rebar with fiber reinforced polymers (FRP). Built with intricate honeycomb structures, glass carbon fiber bridge decks are strong, lightweight and corrosion resistant. Despite offering a longer life and lower maintenance costs, fiber reinforced bridges come with a higher price tag up front – nearly twice the cost of traditional structures – because the honeycomb structure is extremely expensive to construct.

That's where Volz sees an opportunity. Using a $120,000 grant from the Missouri Department of Transportation matched with a $60,000 grant from the U.S. Department of Transportation, S&T researchers are exploring how high-density polyurethane foam could eliminate the need for the honeycomb structures. Sandwiched between FRP facings, polyurethane foam is often used in cars, planes and prefabricated buildings.

"We're using a formulation of polyurethane foam that can withstand compression beneath a truck wheel," he says. "By adding glass fibers to the polyurethane foam, we can get up to 1,000 psi."

Working on the project with Volz and his students are Dr. K. Chandrashekhara, Curators Professor of mechanical and aerospace engineering, and Dr. Victor Birman, professor of mechanical engineering and director of S&T's Engineering Education Center in St. Louis.

Built together in a factory, the sandwich deck panels could be shipped to site on trailers and are light enough that two workers could carry each panel. The team is completing their design and plans to test a prototype panel in the university's high-bay laboratory this summer. The lab can accommodate testing of full-size bridge components.

"The foam and FRP panels offer the same cost as concrete but could live forever," he says. "It should last until we have flying cars and don't need bridges anymore."

newswise

# Missouri S&T Graduates Helping Bridge the Technological Workforce Gap

**Released:** 4/19/2012 9:00 AM EDT
**Source:** Missouri University of Science and Technology

Newswise — As the U.S. economic recovery continues its struggle to gain traction, companies across the nation are eager to hire new college graduates who can replenish their aging talent pool in specific areas. With a record graduating class next month, Missouri University of Science and Technology is helping fill the growing demand for technologically savvy individuals in areas that are most poised for growth: business, computer science, and electrical, computer and mechanical engineering.

Missouri S&T will award more than one-third of its approximately 730 bachelor's degrees next month in these areas. More than half of the employers participating in a survey by the National Association of Colleges and Employers (NACE) identified these five fields as their main hiring focus.

**Channels:**

Technology

**Keywords:**

Graduation, Commencement, Jobs, Hiring, Engineer, Business

**Contact Information**

*Available for logged-in reporters only*

**Description**

As the U.S. economic recovery continues its struggle to gain traction, companies across the nation are eager to hire new college graduates who can replenish their aging talent pool in specific areas. With a record graduating class next month, Missouri University of Science and Technology is helping fill the growing demand for technologically savvy individuals in areas that are most poised for growth: business, computer science, and electrical, computer and mechanical engineering.

Brian Phagan of New Baden, Ill., is one of the more than 40 Missouri S&T students expected to earn a bachelor's degree in computer engineering. Phagan has accepted a software development engineer position with Microsoft Corp., where he'll be part of a team responsible for the Windows Phone Marketplace.

"The education at Missouri S&T is unrivaled in the Midwest," Phagan says. "The combination of excellent academics and an abundance of available scholarships made it an easy decision for me to begin my education here four years ago."

Like many Missouri S&T students, Phagan credits his internship experience with helping him stand out to potential employers.

"I obtained both of my internships through the Missouri S&T Career Fair, which is held each semester," he says. "Without the experiences I gained from these internships, I would not have been hired at Microsoft." Missouri S&T's career opportunities and employer relations department hosts two career fairs annually on campus.

More than 700 employers recruit at Missouri S&T each year, according to Dr. Edna Grover-Bisker, director of the career opportunities and employer relations department.

"Employers tell us that co-op provides an opportunity for them to complete significant projects that might otherwise go unfinished efficiently, while giving both the employers and students the benefits of an extended interview to gauge professional fit," Grover-Bisker says. "Additionally, Missouri S&T co-op students also are one-and-a-half times more likely to obtain a position in their field at graduation and enjoy 7 percent higher starting salaries over their less experienced peers." That 7 percent translates into about $5,000 a year, Grover-Bisker adds.

As one of the nation's top technological universities, Missouri S&T is committed to preparing its students to tackle the local challenges and global opportunities they'll face in their careers, says Dr. Cheryl B. Schrader, Missouri S&T chancellor.

"We recognize that a workforce of technologically savvy and innovative leaders is key for our nation's economic recovery," Schrader says. "It's our commitment as a land-grant institution to ensure we are producing highly qualified graduates to fill the technological talent gap facing industries across the United States and around the world."

# Ancient structural element leads to new ideas in bridge building

June 5th, 2012 in Technology / Engineering

Enlarge

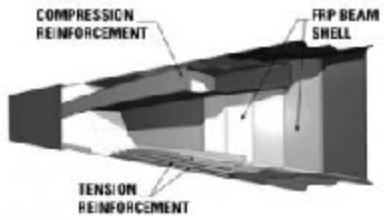
The Douglas County bridge, which opened to traffic in December 2011, carries Highway 76 over Beaver Creek just outside Jackson Mill.

**(Phys.org) -- Led by Dr. John J. Myers, S&T researchers are working with designers at HC Bridge Co. to combine an ancient concrete arch form - dating back to the Roman empire - with a composite shell to create bridge beams that are designed to last 100 years. Tucked inside durable, fiberglass composite shells, the lightweight beams are supported by a concrete arch and anchored by seven wire tendons, which serve as the system's tension tie.**

"The composite shell protects the system from the elements, extending its service life and reducing the maintenance expenses that might normally be needed in a traditional bridge girder," says Myers, associate professor of civil, architectural and environmental engineering at Missouri S&T. "It also serves as a formwork for the construction of the concrete arch system."

The system uses a high-performance concrete, known as self-consolidating concrete, which can flow easily into tight and constricted spaces without needing vibration to remove trapped air or allowing the coarse aggregate to separate from the cement paste.

Using advanced concrete materials and composites for bridges and other infrastructure applications has been a key focus for Myers, who was recently appointed to serve a three-year term on the Federal Highway Administration's Long-Term Bridge Performance Program Expert Task Group Advisory Committee.




Enlarge

Tucked inside durable, fiberglass composite shells, the lightweight beams are supported by a concrete arch and anchored by seven wire tendons, which serve as the system's tension tie.

At the end of the project, the three new bridges will be located in Douglas, Dade and Reynolds counties.

## Scientists, designers work on bridges

Posted June 06. 2012 12:01AM

Researchers at Missouri University of Science and Technology are bridging a gap between an ancient structural element and modern technology.

Led by Dr. John J. Myers, an associate professor of civil, architectural and environmental engineering at the university, researchers are working with designers at HC Bridge Co. to combine an ancient concrete arch form — dating back to the Roman empire — with a composite shell to create bridge beams that are designed to last 100 years.

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The bridges will be funded in part by the Missouri Department of Transportation's Safe and Sound bridge program, which is currently replacing or rehabilitating more than 800 of the state's poorest bridges.

Habor Technologies in Maine was commissioned to manufacture the composite shell and housing for the beams.

Myers said the technology is flexible enough to allow for the arch's self-consolidating concrete to be poured either at a precast facility or at the job site directly.

"Quality control is often better at a precast facility since the concrete is batched in a very close proximity to the beam," Myers said. "It's also often more cost-effective to pour at that type of facility because these bridges are in a rural part of the state."

The first two bridge beams were cast at a ready-mix plant in Mountain Grove, Mo., and a precast plant in Virginia, respectively. The final bridge will involve placing concrete at the job site after the beams are erected into place.

"In all cases, lower capacity cranes can set them in place because it's a lighter weight, more efficient structural system," Myers said.

Myers and two Missouri S&T graduate students are working on the project with Dr. Glenn Washer, an associate professor of civil and environmental engineering at the University of Missouri-Columbia

TheRollaDailyNews.com

**S&T engineer wins research award**

Posted July 03. 2012 12:01AM

Dr. Xiaodong Yang, assistant professor of mechanical and aerospace engineering at Missouri University of Science and Technology, has won a competitive research grant through the Oak Ridge Associated Universities (ORAU) Ralph E. Powe Junior Faculty Enhancement Awards program.

He is one of 30 junior faculty members in the nation to receive the honor. Yang and his fellow recipients, who must be in the first two years of a tenure-track position, will each receive $5,000 in seed money for the 2012-2013 academic year to enhance their research during the early stage of their career.

Each recipient's institution matches the ORAU award with an additional $5,000, making the total prize worth $10,000 for each winner.

Winners may use the grants to purchase equipment, continue research or travel to professional meetings and conferences.

Yang joined the Missouri S&T faculty in 2011. His interdisciplinary research is focused on the mechanism and application of nanophotonics, plasmonics and optical metamaterials based on engineered optical nanostructures, which have sizes of only several hundred nanometers and are made from dielectrics (with silicon and glass) or noble metals (with gold and silver).

These optical nanostructures can be carefully designed in order to exhibit extraordinary optical properties, which will lead to many promising applications to advance the optical nanotechnology, such as solar energy harvesting, optical nanoelectromechanical systems (NEMS) and optical communication.

"Back to 400 years ago, mathematician and astrologer Johannes Kepler observed that comet tails always point away from the sun due to the optomechanical effects from solar radiation," Yang said. "Nowadays, optical forces have been widely used in optical tweezers to precisely manipulate or measure the position of microparticles, such as cells and DNAs."

Yang earned a Ph.D. from Columbia University in 2009. With the funds from his Powe Award, he plans to work on the enhanced opto-mechanical coupling between different types of metallic nanostructures and reveal the mechanism of both attractive and repulsive optical forces between these nanostructures.

"Such switchable optical forces at nanoscale will greatly enhance our capability to realize lots of interdisciplinary applications such as tunable optical NEMS devices and reconfigurable sensors and actuators," Yang said.

The Powe Awards, now in their 22nd year, are named for Ralph E. Powe, who served as the ORAU councilor from Mississippi State University of 16 years. Powe participated in numerous

committees and special projects during his tenure and was elected chair of ORAU's Council of Sponsoring Institutions prior to his death in 1996.
Since the program's inception, ORAU has awarded nearly 500 grants totaling more than $2.3 million.

More information on ORAU fellowships, grants and awards is available at www.orau.org/consortium/programs.

TheRollaDailyNews.com

Posted July 26. 2012 4:00PM

Two graduate students at Missouri University of Science and Technology submitted the winning student division poster that was selected for sponsorship to the 22nd International Council on Systems Engineering (INCOSE) International Symposium, held July 9-12, in Rome.

Bhanuchander Poreddy and Amanda Gealy won for "A Framework for Complexity Management: Virtual Forward Operating Base Camps."

Poreddy earned a master's degree in computer engineering from Missouri S&T and is a Ph.D. student in systems engineering.

Gealy earned a bachelor's degree in engineering management from Missouri S&T and is working on her master's degree in the same field.

Additional team members are Steven Corns, assistant professor of engineering management and systems engineering (EMSE) at Missouri S&T, principal investigator on the project, and Poreddy's adviser; Elizabeth Cudney, assistant professor of EMSE at Missouri S&T, and co-principal investigator; and Suzanna Long, assistant professor of EMSE at Missouri S&T, co-principal investigator and Gealy's advisor.

Technical advisers are Ahmet Soylemezoglu and Col. H. Garth Anderson of the U.S. Army Corps of Engineers. The work was supported by a grant from the Corps of Engineers.

Poreddy also won third place at the Society for Engineering and Management Systems (SEMS) competition at the Industrial and Systems Engineering Research Conference held in Orlando, Fla., in May.

He was recently offered a full scholarship through the Oak Ridge Institute for Science and Education, supported by the U.S. Department of Energy.

# Missouri S&T to compete in worldwide solar house competition

Missouri S&T to compete in worldwide solar house competition

by Justine Ward /KMOV.com

KMOV.com

Posted on August 9, 2012 at 2:11 PM

Updated Friday, Aug 10 at 8:35 AM

ROLLA, Mo. (KMOV) -- Missouri University of Science and Technology in Rolla will break ground Friday for their entry in the global collegiate competition to build the best solar house in the 2013 U.S. Department of Energy's Solar Decathalon project.

The 60-member team from **Missouri S&T** assembling the house will be competing against 20 other schools worldwide. The complete house will eventually be shipped to Irvine, California, from Rolla, and reassembled for the decathlon.

The students will also be hosting a "solar social" at the groundbreaking ceremony Friday, which will include tours of the university's four-house Solar Village.

The team is sponsored by the St. Louis Electrical Connection, a partnership of the International Brotherhood of Electrical Workers (IBEW) Local One and the St. Louis Chapter, National Electrical Contractors Association (NECA).

For more information about the solar decathalon, **click here**.

**Internal Media Sources**

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## S&T students recognized at national AIChE conference

October 26, 2011 1:39 PM | Permalink | Comments (0) | SHARE

Students from Missouri University of Science and Technology were recognized at the American Institute of Chemical Engineering's Annual Meeting held Oct. 16-21 in Minneapolis, Minn.

*Pictured, from left to right: Justin Cobb, Ronetta Morris, Steve Hancock, Chen Chen, Todd Jaco, Timothy Doonan, Julie Sullivan, Kristen Mills, Andrew Naida, Precious Forrest, Arch Creasy, Dr. Daniel Forciniti, Rachel Downen, Jason Sabo, Emily Kendall, Marsha Wisely and Sterling Wheelis.*

Missouri S&T's student chapter of AIChE was one of 16 chapters to receive the Outstanding Chapter Award, which recognizes exceptional program quality, professionalism and involvement in the university and community. This year's chapter

# NEWS & EVENTS



## S&T to help establish new university in China

September 22, 2011 2:23 PM | Permalink | Comments (4) | SHARE

Education officials from Chengdu, the capital of China's Sichuan Province, are seeking the assistance of Missouri University of Science and Technology and the University of Missouri-St. Louis to establish a new English-language university in China.

Dr. Warren K. Wray, interim chancellor of Missouri S&T, and Dr. Tom George, UMSL chancellor, have been working with officials from China's Tianfu College to develop the new university, pending approval from Chinese education officials. The university would be known as Sichuan Missouri University, or SMU.

"The quality of a Missouri S&T education is recognized worldwide," Wray says. "This is why we were contacted to help develop this new university. The engineering curriculum for SMU will mirror that of Missouri S&T, ensuring that SMU's programs align with our high academic standards."

The proposal calls for S&T and UMSL to design degree programs in eight target areas that meet University of Missouri System degree requirements. Four of the programs would be in mining engineering, metallurgical engineering, ceramic engineering and engineering management, and all would be identical to Missouri S&T's curriculum in those disciplines. The other degree programs will be in business, nursing, graphic design, and social work and gerontology, and would mirror UMSL's curriculum.

The University of Missouri Board of Curators recently approved plans to move forward with this project. Classes could begin by the fall 2013 semester.

The Chinese partners will cover the full cost of establishing SMU, including all construction and equipment purchases, and all faculty and staff salaries and benefit costs. Missouri S&T's investment will be limited to intellectual capital, Wray says.

Both UMSL and Missouri S&T will receive 10 percent of tuition fees per student per year.

Chengdu, the capital of Sichuan Province, has more than 14 million residents.

# NEWS & EVENTS



## Missouri S&T offers sustainability minor

November 30, 2011 4:13 PM | Permalink | Comments (0) | SHARE

Missouri University of Science and Technology now offers a multi-disciplinary minor in sustainability for S&T undergraduates. The program was approved for the 2011-2012 academic year by the Missouri S&T Faculty Senate.

Dr. Joel Burken, chair of the sustainability minor advisory board and professor of civil and environmental engineering, describes sustainability as "the long-term vision of a society operating to meet the needs of individuals in the responsible use of materials, energy and natural resources without compromising the needs of future generations."

Sustainability covers many fields of study, including social and natural sciences, engineering, and business, says Dr. Dev K. Niyogi, associate professor of biological sciences and a member of the sustainability minor advisory board. "Students who graduate with this minor will be equipped to evaluate efficient energy and materials usage while considering the impact of water use, the health impacts of pollutants, greenhouse gas emissions and economic viability in a global society," Niyogi says.

Developing environmentally sustainability economies will become increasing important in a global society, say Burken and Niyogi.

"As the planet has reached a population of 7 billion people, the need for efficient use of fossil fuels is greater than ever, and the drive to develop new renewable energy systems

has yet to be fulfilled," Burken says. "To maintain and improve a viable living environment globally, current strategies must be improved to feed, house, educate and care for the increasing population. The challenges also grow more difficult with an increasing global need and competition for a finite, shrinking pool of available natural resources. "

Sustainability applies to corporations, businesses and society as new technologies and practices are necessary to meet future needs, Burken says. "Our country needs to be a leader in sustainable approaches, while it leads the world to a greater future."

Joining Burken and Niyogi on the sustainability minor advisory board are Missouri S&T faculty members Dr. Bonnie Bachman, professor of business and information technology; Dr. Michael Davis, associate professor of economics; Dr. Irina Ivliyeva, assistant professor of Russian; Dr. Daniel Oerther, the John and Susan Mathes Chair of Environmental Engineering; Dr. Thomas Schuman, associate professor of chemistry; and Dr. Jeff Schramm, associate professor of history and political science.

The sustainability minor is available to any Missouri S&T student, regardless of major. For more information, visit sustainability.mst.edu.

# NEWS & EVENTS



## S&T researchers help cemetery with ground-penetrating radar technology

May 14, 2012 9:02 AM | Permalink | Comments (0) | SHARE

Researchers from Missouri University of Science and Technology recently helped a Phelps County cemetery locate old grave sites dating back to before the Civil War.

The project was initiated last year when the Corn Creek Cemetery Association Board began discussing ways of determining which areas were already occupied and which areas would be available for future grave sites.

"Corn Creek Cemetery has graves dating back to the 1830s, and many graves are marked by only a simple natural stone, if that," says Dr. Neil Anderson, professor of geological sciences and engineering at Missouri S&T.

Using ground-penetrating radar technology, the researchers found six locations where there are likely grave sites with no identifying grave stones.

Evgeniy Torgashov, a graduate student in geological sciences and engineering, worked on the project. He used the technology to differentiate potential grave sites from things like buried rocks, roots, and other ground disturbances.

The cemetery association plans to mark the six locations found with natural stones out of respect for the buried remains and to help ensure that the final resting places remain undisturbed.

# NEWS & EVENTS



## S&T tops Newsweek ranking of public schools for out-of-state students

August 6, 2012 4:41 PM | Permalink | Comments (1) | SHARE

Out-of-state students attending Missouri University of Science and Technology are receiving an education at the most affordable public university in the nation, according to a new report from *Newsweek* magazine.

Missouri S&T is included twice in *Newsweek*'s ranking of the nation's 25 "Most Affordable Schools." S&T ranks 24th in the nation in terms of affordability for out-of-state students and eighth in affordability for in-state students. When considering public universities only, Missouri S&T tops the list for out-of-state students. S&T is ranked third among public universities in terms of affordability for in-state students.

The affordability ranking is part of *Newsweek*'s "College Rankings 2012" listings. The collection of rankings was released online Monday (Aug. 6, 2012).

To compile the list, *Newsweek* considered four factors: debt, total cost, financial aid and future earnings. The magazine also "considered affordability on a college-by-college basis as a metric of long-term affordability," *Newsweek* explains on the website.

S&T and the other schools on the list are those considered by *Newsweek* to provide the most return on investment "when measured through a lens of the potential earnings with a degree from each institution as well as the average debt level of graduates." They are places "where students are most able to shoulder the cost of their degree - and where the education has a proven record of being a valuable investment relative to other schools."

Missouri S&T has been recognized previously for providing a good return on investment. In 2010, *Bloomberg BusinessWeek* ranked Missouri S&T 13th in the nation for a 30-year return on investment equal to $1,181,000, or an annualized net ROI of 12.4 percent.

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## Enrollment at S&T continues to climb

August 21, 2012 10:22 AM | Permalink | Comments (0) | SHARE

The first day of classes at Missouri University of Science and Technology began Monday, Aug. 20. Total enrollment on the first day was 7,406, an increase of nearly 2 percent from fall 2011 first-day enrollment of 7,271.

The class includes 1,127 first-time freshmen, another increase from last year.

Missouri S&T's solid enrollment figures might be attributed in part to the high starting salaries of its graduates. The average starting salary for a grad is almost $60,000, making an S&T education one of the best investments in the country, according to *Newsweek*.

Official enrollment figures are released after the fourth week of classes.

# News & Events

## 25 faculty to receive awards at S&T

December 16, 2011 11:15 AM | Permalink | Comments (0) | SHARE

Twenty-five Missouri University of Science and Technology faculty members will receive the Faculty Achievement, Research, Service or Teaching Award for 2011. Each award winner receives a $1,000 stipend funded by industry and alumni contributions. An awards ceremony will be held on Tuesday, Feb. 7.

Receiving the 2011 2011 Achievement Award are:

- Dr. Petra DeWitt, assistant teaching professor, history and political science
- Kellie Grasman, lecturer, engineering management and systems engineering
- Dr. Ryan Hutcheson, assistant teaching professor, mechanical and aerospace engineering
- Dr. Rachadaporn Seemamahannop, assistant research professor, Center of Environmental Science and Technology
- Dr. Jeff Thomas, assistant teaching professor, civil, architectural and environmental engineering.

Receiving the 2011 Research Award are:

- Dr. Martin Bohner, professor, mathematics and statistics
- Dr. Genda Chen, professor, civil, architectural and environmental engineering
- Dr. Jun Fan, assistant professor, electrical and computer engineering
- Dr. Robert Landers, associate professor, mechanical and aerospace engineering
- Dr. Sanjay Madria, associate professor, computer science
- Dr. Susan Murray, professor, engineering management and systems engineering
- Dr. Matthew O'Keefe, professor, materials science and engineering
- Dr. Hai-Lung Tsai, professor, mechanical and aerospace engineering.

Receiving the 2011 Service Award are:

- Dr. Susan Murray, professor, engineering management and systems engineering
- Dr. J. Keith Nisbett, associate professor, mechanical and aerospace engineering
- Dr. Henry Pernicka, associate professor, mechanical and aerospace engineering
- Dr. David Westenberg, associate professor, biological sciences.

Receiving the 2011 Teaching Award are:

- Dr. Diana Ahmad, associate professor, history and political science
- Dr. Michael Bruening, assistant professor, history and political science
- Dr. Ronald Frank, associate professor, biological sciences
- Dr. Irina Ivliyeva, assistant professor, arts, languages and philosophy
- Dr. Henry Pernicka, associate professor, mechanical and aerospace engineering
- Dr. David Richardson, associate professor, civil, architectural and environmental engineering
- Dr. David Riggins, professor, mechanical and aerospace engineering
- Dr. Jeffrey Schramm, associate professor, history and political science.

presidents were Matt Gill of St. Charles, Mo., who earned his bachelor's degree in chemical engineering last spring, and Andrew Naida Travis, a senior in chemical engineering from Harrisonville, Mo. This is the second consecutive year S&T's chapter has won.

S&T students also participated in the Chem-E Car competition, where their student-designed chemical reaction-powered car finished third out of 32 teams. This is the first time the chapter has placed in the national competition. S&T's Chem-E Car Team president is Brian Latal, a senior in chemical engineering from Fenton, Mo.

"This is an exceptional accomplishment," says chapter and team advisor, Dr. Daniel Forciniti, professor of chemical and biological engineering at S&T. "It demonstrates the maturity and professionalism of our students."

Participating in the event were the following Missouri S&T students, all of them chemical engineering majors and all members of AIChE:

Lisa Barrett
Chen Chen
Jonathan Colaric
Arch Creasy
Brian Hahn
Michael Hansing
Joe Hoing
Brian Latal
Luke Meyer
Josh Moyers
Levi Palmer
Charlene Ruwwe
Derek Schloemann
Jen Snyder
Julie Sullivan
Aleeya Watson