2009

Annual Report, 2008-2009

Mack-Blackwell National Rural Transportation Study Center (U.S.)

Mack Blackwell Rural Transportation Center

Annual Report 2008 - 2009

Improving the quality of rural life in America through transportation

University of Arkansas - Fayetteville

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Front and back cover photographs were taken by Mark Kuss, Master Scientific Research Technologist in Civil Engineering.

The “shaker truck” is used in geotechnical earthquake engineering and pavement studies and is also known as
“The Hawg.”

Message from the Director

With the transition to the Obama Administration and ongoing development of a new Transportation bill, this is an exciting time to be working in the transportation field. In addition to our contributions in transportation research, MBTC focused a great deal of effort this year on stimulating and educating our students on opportunities in transportation-related careers. Several of our students and faculty presented at national conferences which gave them opportunities to interact with other transportation professionals and witness the excitement firsthand.

MBTC researchers completed eleven projects during the past year as described later in this report. We are proud of their work and hope you will review the final reports (www.mackblackwell.org) when you see research topics that interest you. In addition to Civil Engineering and Industrial Engineering faculty, this year's projects include principal investigators from Anthropology, Geosciences and Environmental Dynamics and Mathematical Sciences. We had the pleasure of supporting our fellow transportation professionals at Auburn University, University of Arkansas at Little Rock, and Missouri University of Science and Technology.

In January 2009, we kicked our first set of projects for our Department of Homeland Security (DHS) National Transportation Security Center of Excellence (NTSCOE) program. Details of these projects begin on page 13. We have enjoyed this exciting opportunity to formally work with the other six members of the NTSCOE (Long Island University, Rutgers University, San Jose State University, Texas Southern University, Tougaloo College, and University of Connecticut). The commencement of our NTSCOE program benefited greatly from the support of Gia Harrigan, Jeanne Lin, and the rest of the University Programs and Science and Technology teams at DHS.

MBTC focused a good deal of effort this year on K-12 outreach opportunities. We recognize the importance of intriguing children about careers in transportation during their primary and secondary school years. Our Center for Training Transportation Professionals (CTTP) was a full participant in Arkansas' first Construction Career Days which provided hands-on experiences for high school students in the area. MBTC continues to be an annual sponsor of the local Summer Transportation Institute program and will welcome this year's class of participants to MBTC in the next few weeks. MBTC is also excited to be a part of next year's First Lego League competition which presents a "Smart Moves" challenge to middle school and junior high students.

Although we had to let Jack Buffington officially retire from his administrative role in MBTC, Jack graciously agreed to continue to support MBTC as a member of our Professional Advisory Board. I am very pleased to welcome Dr. Tish Pohl as the Assistant Director to our NTSCOE program. I am grateful to Dana, Kevin, and Sandy for all of their hard work during this year's transition, and greatly appreciate the efforts of our advisory board members, faculty, staff, and students. Thank you to Curt, Lydia, and the rest of the RITA team who provide tremendous support for our education and research programs.

Heather Nachtmann

Director,
Mack-Blackwell Transportation Center

Featured MBTC Researchers

Principal and co-principal investigators are the backbone of the Mack-Blackwell Rural Transportation Center. MBTC has sponsored more than 200 research projects at 14 universities in 9 states over the past 18 years. Our researchers include engineers, economists, political scientists, landscape architects, and logistics specialists. These are the profiles of just a few of the faculty who make MBTC's program a success!

Brady R. Cox, Ph.D.
University of Arkansas
Ph.D., The University of Texas at Austin
M.S., Utah State University
B.S., Utah State University

Dr. Cox's current project, "Accelerated Characterization of Full-Scale Reinforced Flexible Pavement Models Using a Vibroseis (MBTC DOT 3013)," uses the "shaker truck" (cover) as a testing machine that is very easy to move and can be transported to many different locations for many different tests. Geosynthetic basal reinforcement has been used in flexible pavements to limit the occurrence of rutting, fatigue, and environmental-related cracking, and to permit reduction in base course thickness in weak subgrade soils. However, the lack of an accelerated field test to evaluate the behavior of full-scale pavement test sections in an economical and representative manner has limited our understanding of variables that may affect the performance of basally-reinforced flexible pavement. Current accelerated tests involve either cyclic plate load tests on laboratory-scale pavement models, or heavy vehicle simulator tests on field-scale pavements. Cyclic plate load tests often have scale effects due to the small size of the test specimens, while heavy vehicle simulators require significant space, high construction cost, and relatively long durations of testing. These shortcomings have prevented parametric analyses of important variables such as pavement configuration, geosynthetic properties, and depth of geosynthetic placement, stress state, and dynamic load (magnitude and frequency). The research objective of this study is to develop and validate a new accelerated testing approach to characterize full-scale pavement models that has the capability of considering these variables in a timely manner. Specifically, this study involves construction of full-scale reinforced-pavement test sections which have been characterized in an accelerated manner using a truck-mounted servo-hydraulic shaker (Vibroseis). The Vibroseis can apply static loads, as well as dynamic normal and shear loads at selected frequencies to simulate traffic loading. Cycles of load with various magnitude and frequency can be applied until pavement failure is observed in a manner similar to traditional heavy vehicle simulator tests. However, the Vibroseis is a highly mobile, rapid testing machine that can easily be moved to various test locations. Accordingly, this type of accelerated test is expected to yield useful deflection information on a wide variety of pavement configurations. In the tests conducted thus far, dynamic loads have been applied at the surface and nonlinear stiffness-strain relationships for the pavement layers (base, geogrid, and subgrade) have been inferred using geophones and suction sensors embedded at different depths in the pavement section. Furthermore, surface deflection basins have been measured as a function of load magnitude and number of loading cycles. Future studies will apply this new test in parametric evaluation of design alternatives, permitting selection of the optimal pavement design before implementation in the field. Information from such tests can be used to develop design guidelines for reinforced pavements, perform cost-benefit design analyses, evaluate the impact of environmental variables in a controlled setting, and calibrate design codes for lifetime prediction of reinforced pavements.

Dr. Cox is enthusiastic about his work and stated, "This Vibroseis shaker truck is a unique piece of equipment that is an important part of my research in geotechnical earthquake engineering and pavement studies. We call it 'The Hawg' in honor of the Arkansas Razorbacks! The Hawg is literally one of only a handful of similar vehicles owned by universities across the country. As such, it provides opportunities for conducting a wide range of studies that cannot be performed elsewhere. In addition to the accelerated pavement characterization work mentioned in this article, we are currently using it to conduct research aimed at advancing the state of practice in non-intrusive surface wave testing for earthquake site characterization. We also enjoy taking The Hawg out to elementary, middle, and junior high schools to shake the ground and peak their interest in engineering. Invariably the kids end up lying down on the ground to feel the vibrations shake their whole body!"

Manuel D. Rossetti, Ph.D.
University of Arkansas
Ph.D., Industrial & Systems Engineering, The Ohio State University
M.S., Industrial & Systems Engineering, The Ohio State University
B.S., Industrial Engineering, University of Cincinnati

Dr. Rossetti's recent project investigates planning methods for rural emergency planning. Dr. Rossetti stated, "When designing our neighborhoods, communities, and shopping areas, it is important to consider the risks associated with how people will evacuate during an emergency. This Mack-Blackwell project is part of efforts to better understand the risks associated with evacuation. In particular, we improve methods to better identify those neighborhoods that are at risk because of the connecting road network. Emergency planners can then develop better evacuation strategies for existing communities and understand the risks associated with the design of future communities. With better engineered plans, our communities will be safer."

When a disaster strikes, emergency planners need to be prepared to handle many important duties, such as directing evacuations and distributing emergency supplies. Therefore, emergency planners rely on decision support systems (DSS), which help them to carry out these duties. To be most effective, a DSS should be integrated with a geographic information system (GIS), which provides analysis for the problems that arise and helps users of the DSS to visualize the situation. In addition, an effective DSS should include simulation models and optimization techniques, especially in the pre-event planning. For instance, a simulation model could be used to determine the fastest method of evacuation so that when a hurricane approaches an area, police can use this method to appropriately direct traffic. "Applications of GIS and Operations Research Logistics Planning Methods for Arkansas Rural Transportation Planning (MBTC DOT 2088)" explores the many issues involved in integrating a GIS into a DSS, creating simulation models, and applying optimization techniques so that emergency planners are well prepared should a disaster occur.

To better examine the use of optimization in emergency planning this report investigates the determination of hazard zones within a geographic area. A hazard zone is an area corresponding to a worst-case evacuation scenario and is a potential vulnerability that should be addressed by risk mitigation strategies. His research compares two heuristic approaches to determining hazard zones based on population and road connectivity within a spatial network. The genetic algorithm and the Cova heuristic both have strengths and weaknesses as discussed throughout his project report. The Cova heuristic performs better in sparsely connected networks with smaller hazard zones, while the genetic algorithm performs better in terms of time to obtain a solution and the quality of the solution when the network is dense and has larger hazard zones. Based on these results, the Cova heuristic is recommended for sparse rural networks.

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Kelvin C.P. Wang, Ph.D., P.E.
University of Arkansas
Ph.D., Civil Engineering, Arizona State University
M.S., Transportation Engineering, Northern Jiatong University, Beijing, China
B.S., Transportation Engineering, Southwest Jiatong University, ChengDu, China

Dr. Wang recently completed "Applicability of Microelectric and Mechanical Systems (MEMS) for Transportation Infrastructure Management (MBTC DOT 2056)" which looks at the application of Microelectronic and Mechanical Systems (MEMS). The information provided in the project will be advantageous to have on the state of health of infrastructure at all times in order to carry out effective on-demand maintenance. With the tremendous advancement in technology, it is possible to employ devices embedded in structural members for real-time monitoring of infrastructure health. Micro-electromechanical systems (MEMS) are miniature sensing or actuating devices which can interact with their environment to either obtain information or alter it. With remote query capability, it appears such devices can therefore be embedded in structures to monitor distresses such as cracking. Recently the potential for application of many of the developments in the nanotechnology field in the area of transportation engineering is growing. In this report a broad overview of the potential applications of various nanotechnology developments in civil and transportation engineering field is conducted. The focus is on the potential effects that the technology may have on aspects such as bridge, pavement, and traffic engineering. The most important challenges of the implementation of MEMS into transportation infrastructures are also addressed. Dr. Wang said, "Through funding from various state, Federal, and private industries for more than 10 years, the University of Arkansas research team is a world leader in automated pavement condition survey with related technologies used in nearly all continents of the world."

Center for Training Transportation Professionals (CTTP)

The Center for Training Transportation Professionals (CTTP) recently renewed their agreement with the Arkansas Highway and Transportation Department (AHTD), signing a three-year contract extension. CTTP will continue to offer regularly scheduled courses in Basic Aggregates, Portland Cement Concrete, Hot Mix Asphalt, Soils/Aggregates, and Concrete Strength Testing. Courses offered by request will include Roadway Construction Control, Concrete Patching, National Pollutant Discharge Elimination System (NPDES), and Bridge Scour.

Two new courses were introduced this year. A course in National Pollutant Discharge Elimination System (NPDES) was developed to provide training and certification in erosion and sediment control, primarily addressing highway construction issues. This course provides instruction on the basic principles of erosion and sedimentation, legal obligations relative to the recent Arkansas construction stormwater permit changes, best management practices for minimizing stormwater pollution, and inspection procedures. Stream Stability and Bridge Scour was the second course introduced this year. This course incorporated a number of critical topics relating to the concepts of bridge scour and inspection methods, as well as countermeasures for mitigating the devastating effects of bridge scour.

In addition to new courses, CTTP has completed a new website design. New features on the website include online registration, detailed course schedules with enhanced calendar features, and expanded course descriptions. In the coming months, CTTP will continue to upgrade the online features to better serve course participants.

The staff members of CTTP continue to be involved in training and certification issues at the national level, holding key positions in a number of organizations and committees, including the American Concrete Institute, the American Society for Testing and Materials, the Transportation Coordination Curriculum Council, the Southeastern Asphalt User Producer Group Training Task Group, the Arkansas Ready Mixed Concrete Association, and the Arkansas Asphalt Pavement Association. Active participation in these groups has allowed the CTTP staff to take a lead role in the development of an online course in Self-Consolidating Concrete for the National Highway Institute and a Concrete Transportation Construction Inspector training course for ACI. In addition, CTTP staff members have been invited to direct the development of a new ASTM specification for the gyratory compaction of Roller-Compacted Concrete.

For more information on CTTP and to see their listing of available courses, go to their updated website at www.cttp.org.

L to R - Roselie Conley, Mary Fleck, Carrie Pennington, CTTP Director Stacy Williams, Frances Griffith and MBTC Executive Director Kevin Hall.

Distinguished Lecture Series

The fall semester was kicked off with our annual civil engineering career orientation program, **"Evening with the Pros,"** presented in conjunction with the Arkansas Highway and Transportation Department (AHTD). The program was held on September 11, 2008 in the Combs Auditorium in the Bell Engineering Center.

Bob Walters and presenters Robert Seay, Natalie Becknell, Bill Staggs, and Mike Marlar take questions from students.

This year's emcee was Mike Marlar, P.E., President of Marlar Engineering of North Little Rock. The speakers for the evening were Sherman Smith, P.E., Director of Pulaski County Public Works; Robert Seay, P.E., City Engineer for the City of Hot Springs; Charles Clements, P.E., Division Head, Roadway Design, AHTD; Natalie Becknell, P.E., Project Engineer at Garver Engineers who received her MSCE in 2005 from the University of Arkansas; and Bill Staggs, P.E., Chief Engineer at North Little Rock Wastewater Utility.

The topics varied from an overview of engineering that went into the space race and landing on the moon to things you need to know other than math. Others discussed the many opportunities available for construction and transportation careers and what is to be expected in your first job.

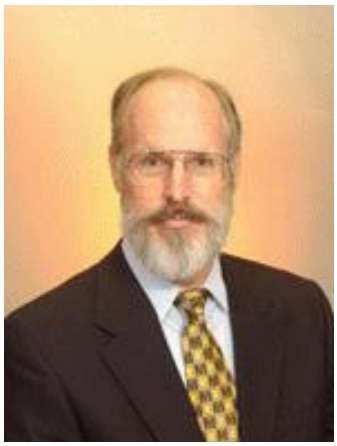
Wallace F. Forbes, CFA

The second lecture this fall was given by **Wallace F. Forbes, CFA**, President of the Forbes Investors Advisory Institute. This lecture was presented on October 23, 2008. Mr. Forbes discussed the many opportunities available to engineers in many areas. He gave himself as an example of having a bachelor degree from Princeton in civil engineering and later attending Harvard Business School and earning his MBA. He is both a successful civil engineer as well as a financial analyst.

Many of the students had questions as to what he thought about our nation's financial future. Mr. Forbes was able to encourage everyone that he felt this downward turn would not last for long and for everyone to keep a positive outlook and continue with their education.

Forbes with MBA students from the Walton College of Business

Kenneth H. Stokoe, II, Ph.D., P.E. was the featured guest speaker for the spring Distinguished Lecture Series. Dr. Stokoe is a professor in the Civil and Environmental Engineering Department from the University of Texas at Austin. Dr. Stokoe's lecture entitled, "The Increasing Role of Seismic Measurements in Geotechnical and Pavement Studies" was held on February 5, 2009 in the Combs Auditorium in the Bell Engineering Center.



Kenneth H. Stokoe, II, Ph.D., P.E.

Dr. Stokoe has been working in the areas of in situ seismic measurements, laboratory measurements of dynamic material properties, and dynamic soil-structure interaction for the past 38 years. Dr. Stokoe was instrumental in developing the cross hole seismic method for in situ shear wave velocity measurement. He and his colleagues have also developed the Spectral-Analysis-of-Surface-Waves (SASW) method for non-destructive testing of geotechnical, pavement, and structural systems. Many students and faculty as well as other interested parties attended his lecture.

Jack Buffington Retires

When someone mentions the name "Jack Buffington," you receive many positive responses but the common theme is that he is the most down-to-earth person you will ever meet. Jack is from Westville, Oklahoma, and has never sidetracked from those down-home values his parents taught him. His father was in the world champion rodeo at Madison Square Garden with Roy Rogers in 1943 and 1944. One of Jack's fondest memories as a small child was when he was given a saddle by Bob Wills. These are just a few of the events that formed Jack as a young boy.

In April 2009, Jack Buffington retired as research professor and associate director for MBTC. A surprise retirement party was held in Jack's honor on the 16th of April. Dan Flowers, Director of the Arkansas Highway and Transportation Department (AHTD), presented Jack with a proclamation to honor his contributions to the State of Arkansas. Many of Jack's former students, friends and family were in attendance.

Jack played an integral role in both the civil engineering department and MBTC. His work with the university involved teaching, research and service. "Jack is the definition of humility and class. For many of us, working with Jack will truly be a once-in-a-lifetime experience; we will not be so lucky to work with such a talented individual again," said Kevin Hall, Executive Director of MBTC and Department Head of the Civil Engineering Department.

Jack graduated from the University of Arkansas with a Bachelor of Science degree in Civil Engineering. He received his Master of Civil Engineering from Georgia Tech and graduated from the Armed Forces Staff College. Jack retired from the Navy Civil Engineer Corps with the rank of Rear Admiral. His career with the Navy spanned 34 years. During his military career, he served as the Chief of Engineers for the Navy, Commander of the Naval Facilities Engineering Command and Chief of the Civil Engineer Corps in charge of Navy contracting and public works worldwide with an annual workload of over $7 billion and more than 22,000 employees.

Jack was honored by the Society of American Military Engineers with the prestigious Golden Eagle Award at a ceremony in Arlington, Virginia, on March 27, 2009. Since 1996, the society has honored two outstanding Americans each year for contributions to the engineering profession and national security. The society is the premier professional engineering association in the United States for connecting architects, engineers and builders in the public sector and private industry, uniting them to improve individual and collective capabilities for national security. His impeccable reputation in teaching and his development of a high quality job search program for civil engineering students led to his recognition with the Outstanding Service to Students Award in 1999, 2002 and 2004.

Jack had been with the University of Arkansas for 13 years and he managed studies for federal, state and local agencies and private companies concerning highways, bridges, waterways, railroads and other issues affecting rural America. Jack served on the executive committee for the Council of University Transportation Centers (CUTC) with the Department of Transportation (USDOT). His work with these departments has been invaluable to MBTC and the transportation community.

Jack is a past president of the National Academy of Construction, a member of the National Academy of Engineering, past president of the Arkansas Academy of Civil Engineering, and a member of the National Society of Professional Engineers and American Society of Civil Engineers.

L to R - MBTC Director Heather Nachtmann, Don Medal (Hugh's father), and Hugh Medal, recipient of the 2009 Mack-Blackwell Rural Transportation Center Outstanding Student of the Year at the CUTC Awards Banquet.

MBTC Outstanding Student of the Year

Hugh R. Medal was selected as the 2009 Mack-Blackwell Rural Transportation Center (MBTC) Outstanding Student of the Year for his research and exceptional academic skills as well as his future goals as an educator. Hugh stated, "It was an honor for me to receive the student of the year award. I believe that it will have a positive impact on my planned career as a college professor."

Hugh also commented, "As research assistants, it is sometimes easy to see our efforts as insignificant. Receiving this honor made me feel that my work as a research assistant was appreciated."

Along with the monetary prize, Hugh was also given the opportunity to attend the CUTC Awards Banquet in Washington, D.C. and brought along his father as his guest to share in his experience. "The banquet was a good opportunity for me to network with other people in the transportation industry and opened my eyes to how many people in government, industry, and academia are interested in transportation," Hugh declared.

Hugh is a doctoral student in Industrial Engineering at the University of Arkansas. He graduated from North Dakota State University with a B.S. in Industrial Engineering and Management in 2006. Hugh's research interests are in modeling, simulation, optimization and its application to transportation and logistics problems. Hugh recently completed a master's thesis titled "Multi-Objective Simulation Optimization: A Comparison of Methods." Hugh examined the use of a variety of simulation optimization techniques on a multi-objective military transportation logistics problem. Hugh's research for MBTC focused on routing models for rural transportation networks with time-varying constraints. The models developed focus on the transportation of live chickens in a rural poultry network with an emphasis on being able to deal with disease outbreak in the poultry industry in order to find alternate routes to reach their destinations without exposing the transported chickens to the potential disease. Hugh's research was published and presented at the Industrial Engineering Research Conference in May 2008. Hugh is a model student with exceptional academic skills, a promising researcher, and an active student participant in a variety of student organizations. Hugh's goal is to continue as a researcher and educator upon graduation.

A group photo of all University Transportation Centers' 2009 Outstanding Students of the Year.

The 2009 winter meeting of the Transportation Research Board (TRB) marked the 18th Annual Outstanding Student of the Year Awards ceremony, sponsored by USDOT. This year, 53 students from USDOT-sponsored University Transportation Centers (UTC) were honored at the banquet.

The student awards are held in conjunction with the Council of University Transportation Centers (CUTC) awards banquet each year. Each year at the annual winter meeting of TRB, USDOT honors the most outstanding student from each participating UTC for his/her achievements and promise for future contributions to the transportation field. Students of the year are selected based on their accomplishments in such areas as technical merit and research, academic performance, professionalism, and leadership.

Construction Career Days

The Center for Training Transportation Professionals (CTTP) participated in the first Arkansas Construction Career Days located on the campus of Northwest Technical Institute (NTI). NTI and the Office of Human Concern partnered with the Arkansas State Highway and Transportation Department (AHTD) to host the event.

The program was held on a sunny September day with many high school students in attendance and was aimed to pique the interest of high school students to become involved in the construction field. There were many activities for the students (grades 10 to 12).

The Center for Training Transportation Professionals (CTTP) had a booth that allowed the students to mix their own concrete. To make it fun for the student, CTTP had pre-mixed portions of quick-setting concrete along with a hardening mixture. Once the student mixed the two components, they poured this into a small flat container (this allowed it to harden faster) and the students were provided many types of decorations such as beads to enhance the look. To also show the students the safety side of construction work, the CTTP staff had gloves and safety glasses that every student had to wear before performing the task.

Many of the students said that this was the best booth they had visited as they actually were able to see how concrete is mixed and how fast it will set up. Some of the students had worked summer jobs where they had helped in the mixing process but never actually were able to do it on their own.

Dr. Brady Cox, Assistant Professor in Civil Engineering, brought along his "shaker truck" to give the students a demonstration of what it feels like when the you shake the ground and how you can use equipment like this to do testing. (The "shaker truck" is featured on the front and back covers of this report.)

Jack Buffington, associate director (retired), was highly involved in making the event a success. He said that the workforce of the future is becoming smaller and smaller as the years go on, and we really need to start tapping into our youth now to make sure we have trained employees available in the future for this type of work. The need for new construction workers is great. The National Construction Career Days Center says:

- In 2008, there are 952,000 construction skilled trade jobs vacant. There will be a million plus new people needed to fill construction jobs each year thereafter.
- The average age of workers in the skilled trades nationwide is 48 years of age and these workers will start retiring in 2010-2015.

Construction Career Days (CCD) is about Youth, the Construction Industry, and Partnerships of Volunteers. Construction Career Day events are workforce development tools which introduce high school students to the transportation construction industry and support the pipeline that will provide the professionals of tomorrow. The CCD events have successfully promoted the transportation construction industry and the careers it offers. Since 1999, a total of 304,566 students have participated in CCD events.

New Projects

DOT University Transportation Center Projects

MBTC DOT 3008 - Emergency Response via Inland Waterways

Heather Nachtmann, Ph.D.
Edward A. Pohl, Ph.D.
Industrial Engineering
University of Arkansas

This project investigates the feasibility of constructing temporary medical facilities on barges to traverse inland waterways in response to natural or terroristic disasters. Limited resources are available for general hazard relief across much of the geographical U.S. Inland waterways can provide access for equipment and people when other means of transportation are unavailable due to capacity constraints or destruction. For example, there are over 1,000 miles of navigable waterways in the state of Arkansas that could assist in a catastrophic event such as a New Madrid earthquake in the northeast corner of the state. Particular research questions include (1) what medical services should/could be provided?, (2) what is a reasonable response time for such facilities? is this response time feasible?, (3) what is the optimal barge design?, (4) is this economically/practically feasible?, and (4) how does weather factor in?. Research will be accomplished through literature review, feasibility analysis and what-if analysis.

MBTC DOT 3009 - Economics of a Two-Step Biodiesel Process Involving Supercritical Methanol Esterification

Robert E. Babcock, Ph.D., P.E.
Edgar C. Clausen, Ph.D.
Chemical Engineering
University of Arkansas

Michael P. Popp, Ph.D.
Agricultural Economics and Agribusiness
University of Arkansas

Biodiesel is non-petroleum based alternative diesel fuel that consists of alkyl esters derived from renewable feedstocks such as plant oils or animal fats. These feedstocks commonly contain both triglycerides and free fatty acids, which can undergo transesterification or esterification reactions (respectively) to produce the alkyl esters that make up biodiesel. Currently, most of the global biodiesel is produced from refined vegetable oils that contain primarily triglycerides with limited free fatty acids. These refined oils, such as soybean and rapeseed oil, are becoming increasingly expensive, and generally account for as much as 80% of the total operating cost in biodiesel production. In general, without government subsidies, biodiesel production is not currently cost-competitive with petro-diesel. The investigators of this research in previous MBTC projects have studied less refined and less expensive feedstocks for use in biodiesel production in hopes of improving the economic competiveness of biodiesel.

Biodiesel holds many advantages over conventional petroleum diesel. Biodiesel is renewable, biodegradable, and locally produced while offering a low toxicity, high cetane index, and is a carbon-neutral fuel source. Some other advantages include superior lubricant and solvent properties, lower emissions of harmful chemicals, and the ease of storage, transportation, and adaptation into current equipment and infrastructure. Not only does this support a more sustainable energy infrastructure, it also lessens the need for foreign imports of oil while creating labor and market opportunities for domestic crops. A wide range of feedstocks can be used in the production of biodiesel including, but not limited to virgin or refined tree and vegetable oils, waste fryer oil, animal fats, pond algae, and importantly a combination of these feedstocks. It is imperative to adapt any proposed production process to locally available raw materials on an intermittent basis if biodiesel is to become an attractive alternative to petroleum diesel.

The transition from conventional diesel to biodiesel can be almost seamless. The diesel engine can operate on pure biodiesel. Older engine models that use rubber gaskets and seals can experience some deterioration due to the solvent properties of biodiesel. However, these seals can be replaced with more resistant materials. The logistics for distribution of diesel fuels currently in place can easily accommodate biodiesel as a fuel. Such is not the case proposed compressed gas fuels such as natural gas and hydrogen. Many biodiesel fuel facilities currently exist in the U.S. dispensing biodiesel-blended fuel.

The major disadvantage to widespread use of biodiesel is the production cost being driven higher on a daily basis by feedstock prices and availability. The development of an economic model for making comparative analysis of various feedstocks and feedstock blends is a useful tool, and is the subject of this effort. The supercritical methanol process was chosen for this study because of its ability to utilize variable quality feedstocks with little to no alteration in process operating conditions.

MBTC DOT 3010 - A Cost-Drive Policy Approach for Development of On-Street and Off-Street Bicycle, Multi-Use and Single-Use Paths and Related Facilities

John V. Crone
Landscape Architecture
University of Arkansas

This study examines policy issues related to multi-purpose and single use-trail cost based on an explicit process and empirical analysis of several case studies. Research continues to identify criteria for the design of appropriate bicycle facilities and pedestrian systems, but the selection of these modes of transportation depends on many factors, including vehicular and bicycle traffic characteristics, adjacent

land use and expected growth patterns, terrain, path size and materials, and even the impact of tourism and physical health measures of a community. These factors affect the cost and design requirements of path facilities and thus need to be reflected in cost saving strategies that are then made available to policy makers.

MBTC DOT 3011 - Improving Forced Transfer and Special Needs Busing in Rural Public Schools

Scott J. Mason, Ph.D.
Edward A. Pohl, Ph.D.
Industrial Engineering
University of Arkansas

The goal of this project is to assist rural school systems in developing effective strategies for dealing with transportation-related school overcrowding issues and special needs busing. Specifically, we develop a spreadsheet-based tool that enables school system transportation personnel to explore options for moving students from an overcrowded school to one with available capacity. The objective is to minimize loss of classroom time due to movement from the overcrowded school to the appropriate school with capacity while minimizing the cost associated with the resources required to move students within the system. In addition, we investigate increasing the efficiency of special needs student buses through investigating alternate transportation network design strategies such that the point-to-point busing of these students may potentially be improved via smarter vehicle routing. Our methodology includes mathematical and heuristic optimization solution approaches as we are focused on developing practical solution methodologies that can scale appropriately to address the practical-sized busing problems of interest.

MBTC DOT 3012 - Examining the Effects of Mixer Type and Temperature on the Properties of Ultra-High Performance Concrete

W. Micah Hale, Ph.D., P.E.
Kirk A. Grimmelsman, Ph.D.
Civil Engineering
University of Arkansas

Ultra-High Performance Concrete (UHPC) is a new type of concrete that holds much promise in the areas of homeland security (specifically blast resistance structures) and transportation structures (specifically bridges). When mixed and cured properly, UHPC can achieve compressive strengths in excess of 30,000 psi compared to traditional concrete that has strengths that range from approximately 4000 psi to 17,000 psi. The high compressive strength of UHPC is not its only advantage, UHPC also has superior tensile strength, ductility, and durability. However, a special type of concrete mixer (high shear mixer) is required for batching UHPC so that it can obtain these superior properties. Researchers at the University of Arkansas have been the first and only University to batch UHPC in a standard rotating drum mixer, however there has been no research conducted on the effect of mixer type on UHPC's properties. The objective of this research project is to examine the effect of mixer type on the performance of UHPC. UHPC mixtures will be batched using a standard rotating drum mixer, a high shear mixer, and a concrete ready mix truck. The fresh and hardened properties of the UHPC will be measured for all mixtures. Additionally, the UHPC will be batched at temperatures ranging from 10 C to 30 C to assess the effect of mixing temperature on UHPC performance. Results from the research program will be used to develop mixing guidelines when UHPC is mixed using a standard rotating drum mixer and at a range of temperatures. The research program will also determine if the performance of UHPC is diminished when mixed in a standard mixer. If the results show that there is little effect or no effect on concrete performance, the opportunities for UHPC (especially in field casting) will increase which will result in longer lasting and safer structures.

MBTC DOT 3013 - Accelerated Characterization of Full-Scale Reinforced Flexible Pavement Models Using a Vibroseis

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Geosynthetic basal reinforcement has been used in flexible pavements to limit the occurrence of rutting, fatigue, and environmental-related cracking, and to permit reduction in base course thickness. However, the lack of an accelerated test to evaluate the behavior of full-scale pavement test sections in an economical and representative manner has limited our understanding of the role of variables that may affect the performance of basally-reinforced flexible pavement. Current accelerated tests involve either cyclic plate load tests or heavy vehicle simulators. Cyclic plate load tests often have scale effects, while heavy vehicle simulators require significant space, high construction cost, and long durations. These shortcomings have prevented parametric analyses of important variables such as pavement geometry, geosynthetic properties, depth of geosynthetic placement, stress state, and load (magnitude and frequency). The research objective of this study is to develop and validate a new accelerated testing approach to characterize full-scale pavement models with the capability of considering these variables in a timely manner. Specifically, this study involves construction of full-scale pavement test sections which will be characterized using a vibroseis (shaker truck). The vibroseis can apply static wheel loads as well as dynamic normal and shear loads at selected frequencies. In the tests, dynamic loads will be applied to the pavement surface, and nonlinear stiffness-strain relationships for the pavement layers (base, geogrid, and subgrade) will be inferred using geophones and suction sensors embedded at different depths in the pavement section. This information will be useful to perform long-term dynamic modeling of pavements. Cycles of ESALs will then be applied until pavement failure is observed, similar to traditional heavy vehicle simulator tests. Accordingly, this test is expected to be faster and yield more useful information than existing tests, while still maintaining representative loading conditions. An important component of this study is the selection of the geometry of the test sections and the characteristics of the applied loads to ensure test conditions representative of actual pavements. This study involves the development and validation of this testing approach. However, future projects will apply this new test in parametric evaluation of design alternatives, permitting selection of the optimal pavement design

before implementation in the field. Information from such tests can be used to develop design guidelines for reinforced pavements, perform cost-benefit design analyses, evaluate the impact of environmental variables in a controlled setting, and calibrate design codes for lifetime prediction of reinforced pavements (MEPDG).

MBTC DOT 3014 - A Prototype Remote Structural Health and Security Monitoring System for Bridges

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The project investigates the development of a prototype bridge monitoring system that will permit quantitative assessments of structural condition and safety both remotely and in real-time. The research also attempts to identify and integrate real-time video surveillance methods and other related sensing technologies with the health monitoring system to enable the system to be used for assessing bridge security. The prototype system will be designed and deployed on a small-scale physical model of a bridge in the laboratory, and the capabilities and performance characteristics of the system will be evaluated for various controlled deterioration and damage scenarios that are consistent with the effects of common hazards affecting bridge condition and safety. The evaluation of the prototype monitoring system under known and controlled conditions will enable recommendations to be made regarding the design of similar systems for full-scale implementations of structural health and security monitoring systems for in-service bridge structures.

DHS National Transportation Security Center of Excellence Projects

MBTC DHS 1101 - Designing Resilient and Sustainable Supply Chain Networks

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This new project seeks to develop a fundamental understanding of the inter-dependence within and between critical supply chain infrastructure systems. We will quantify the impact of this inter-dependence on both the resiliency and sustainability of supply chain systems, both individually and collectively. In this research, we will examine the trade-offs between resource allocation and the efficacy of various types of resources to mitigate supply chain vulnerability. We will develop a theoretical foundation upon which analytical methods will be constructed and utilized to effectively model, analyze, and improve the resiliency and sustainability of critical supply chain systems. Our approach will study both resiliency and sustainability at a variety of hierarchical levels/supply chain echelons, as well as under different time horizons (i.e., strategic, tactical, and operational). This approach will afford us the flexibility to analyze both supply chain performance and supply chain impacts/disruptions at disparate levels across the various supply chain infrastructure systems.

This research seeks to fill this need by developing new supply chain network strategies that incorporate the risks associated with disruption. Our models will be useful both to emergency response teams and to military and civilian logistics planners during the planning and pre-planning phases of contingency assessment. In addition, our resulting solution techniques will be suitable for deployment in decision support network tools for contingency planning.

MBTC DHS 1102 - Simulating Transportation Models in Large-Scale Evacuation Scenarios

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Large-scale evacuation involves the movement of people and resources both into and out of a geographic area under threat of disaster/attack or directly after the incident. The literature discusses the use of simulation during evacuations. Micro-simulation tracks the movement of individual entities such as people or vehicles to plan emergency evacuations. Also of use are macro-simulations, which approximate large-scale population flows as fluids, and meso-simulations, which track groups of individuals. Recent advances in simulation modeling and visualization techniques using agents have enabled better dynamic modeling of evacuation scenarios. In agent modeling, a large number of autonomous agents are programmed with rules and simulated within a physical environment to discover emergent behavior patterns.

For example, researchers use a simulation model to compare the evacuation times of simultaneous evacuations to the total evacuation times of staged evacuations where different zones are evacuated in a sequence at set time intervals. Basically, two types of evacuation strategies were investigated. One is a simultaneous evacuation strategy: all residents in the affected area are informed at the same time and then evacuate simultaneously. The other strategy is a staged evacuation: the affected area is divided into several different zones and residents in different zones are organized to evacuate in a specific order. The overall evacuation time of one evacuation event is calculated from the time of first agent starting to evacuate to the time of last agent leaving the affected area. This time typically represents the effectiveness of an evacuation event. The simulation used agent-based methods via the Paramics software platform, i.e. micro-simulation, meaning it tracked individual vehicles. By using Paramics, the researchers were able to access micro-level agent communication characterized by the interaction behavior of individual vehicles, and study the joint behaviors of the whole affected community.

Paramics primarily focus on vehicle modeling. It is "well known that the behavior of individual vehicles plays a crucial role in an emergency evacuation". However, a full understanding of evacuation dynamics should integrate multiple modes of transportation (e.g. vehicles (cars, busses, trains, etc), pedestrians, trucking etc.) and better simulate human behavior in such systems. It is also critical to develop human behavior models that can mimic the strain on transportation resources due to the simultaneous use of the network by first responders and other support personnel.

The purpose of this exploratory research project is to identify the current state of the art in simulation-based evacuation modeling and to begin to develop an understanding of the effect of better human behavior modeling in the multi-modal transportation context.

MBTC DHS 1103 - Automated Real-Time Object Detection and Recognition on Transportation Facilities

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University of Arkansas

Rapid inspection of critical transportation infrastructure elements is essential to the efficient operation of the nation's transportation systems. This is particularly crucial in the period immediately following a catastrophic event, i.e. earthquake, terrorist attack, etc. Rapid response and inspection of transportation infrastructure elements is vital to ensure routes into and out of affected areas are safe for emergency traffic and/or evacuation of persons outside danger zones. The primary objective of the proposed research is to develop a fully automated, real-time, high definition digital video inspection system suitable for implementation on a vehicle-based platform operating at near-highway speeds. Such a system would allow security personnel to rapidly inspect and assess critical infrastructure elements such as bridges, tunnels, rail, and highway surfaces with respect to safety and suitability for use post-catastrophic-event.

This project explores available hardware and software technology solutions capable of supporting the subsequent development of automated real-time inspection and computer-driven image recognition and assessment algorithms for transportation facilities.

MBTC DHS 1104 - Structural Health Monitoring and Assessment of Critical Intermodal Transportation Infrastructure Elements

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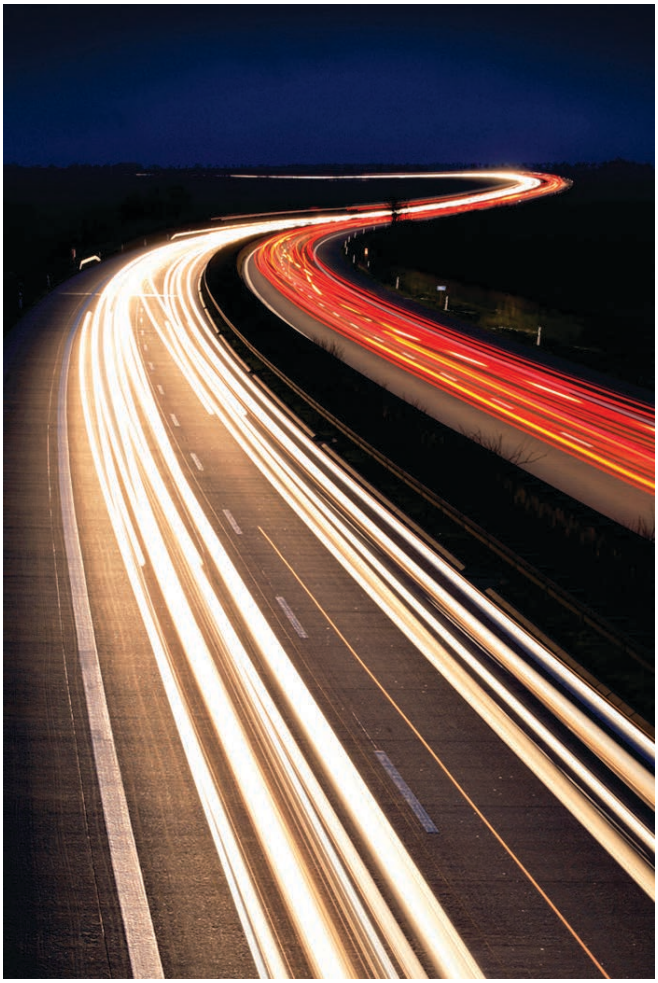
The primary objective of this study is to investigate and/or develop a prototype system for remote structural health monitoring of transportation infrastructure elements that can be used for both routine condition assessment and for rapid, post-incident safety evaluation. Structural health monitoring is a concept that may have great merit for assuring the safe operation, rapid assessment, and efficient repair of transportation infrastructure elements, particularly following catastrophic events. It may be possible to develop metrics for these systems based on dynamic measurements that will characterize the global condition and integrity of these elements, and that can be remotely measured and tracked to



ensure their serviceability. By its very nature, a structural health monitoring system represents a "system of systems" incorporating experimental technologies (sensing, data acquisition, communications, and others), analytical technologies (numerical and analytical computer models, data analyses and evaluation algorithms, and others), and information technologies (real-time data management, presentation and archival engines, decision algorithms, and others) – and the optimal integration of these technologies.

Characterizing and evaluating the condition and safety of a constructed system, particularly in the immediate aftermath of a man-made or natural hazard event represents a significant additional challenge to that described previously. In addition to the constructed system-related factors discussed, a quantitative record of the inputs and responses of the structure before, during, and after the occurrence of the hazard event is rarely available for use in the evaluation process. Presently, subjective evaluations of structural condition and safety after a hazard event are made by personnel with varying degrees of knowledge and/or experience based on physically demanding on-site observations and heuristics. Conducting such assessments in the extreme and often chaotic (and/or dangerous) conditions that exist after a hazardous event occurs is time consuming, labor intensive, and not likely to provide very timely and reliable results. At best, this might delay emergency response and recovery following the hazard event (e.g. earthquakes, hurricanes, etc.) – and at worst, it could lead to additional loss of life (e.g. the World Trade Center collapse).

MBTC DHS 1105 - Information Enhancement Among Aviation Security Partners

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The Top Ten Challenges Facing The Next Secretary of Homeland Security includes the following: "Continue to improve intelligence and information sharing (Homeland Security Advisory Council, September 11, 2008)." However, while the University Affiliate Centers to the Institute for Discrete Sciences (IDS) were established by DHS for advanced methods research in information analysis, IDS activities focus on common author identification, influenza surveillance and text analysis. The activities of this exploratory project will adopt and/or develop tools to derive knowledge specific to potential attacks against general aviation (GA).

Commercial examples include Incident Reports and Surveillance Detection Reports filed by Federal Air Marshals (FAM), and analyzed by law enforcement organizations in a Tactical Information Sharing System (TISS). FAM also place in TISS incident reports by airline employees, and Screening Passengers by Observation Techniques identifies activities by utilizing behavioral analysis.

In the GA domain TSA and the Aircraft Owners and Pilots Association have implemented an Airport Watch Program using pilots for reporting suspicious activity. Also TSA and the National Response Center (U.S. Coast Guard) have implemented the GA Hotline for airport operators, technicians and pilots to report suspicious activity. However there are not more formal information reporting and sharing systems available to GA. In order to design such effective systems, and make GA a more equal partner in homeland security, it is important to: 1) consider what is relevant about commercial examples to GA, and make recommendations for improved intelligence and information sharing which originates at GA landing facilities, 2) reference the Airport Characteristics Measurement Tool (TSA Security Guidelines for GA Airports, Information Publication A-001, May 2004) to develop reporting standards, and analyze information that would come from reports, and 3) estimate and/or identify models of usual GA activity that could be used to detect potential attacks.

Ongoing Projects

DOT University Transportation Center Projects

MBTC DOT 2006 -Investigation of the Long Term Stability of Highway Slopes, Phase III
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2007 - Estimating Subgrade Resilient Modulus for Pavement Design
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2026 - Using Multi-Spectral Satellite Imagery to Enhance Slope Failure Prediction
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2037 - Route and Site Characterization Using Multi-Spectral Satellite Imagery
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2055 - Roadway Median Treatments
James L. Gattis, II, Ph.D., P.E.

MBTC DOT 2067 - Roadway Median Treatments
James L. Gattis, II, Ph.D., P.E.

MBTC DOT 2070 - Development of Methods for Estimating Remaining Life of Hot-Mix Asphalt Field Mixes
Kevin D. Hall, Ph.D., P.E.
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2074 - Evaluation of Pavement Thickness and Modulus Using Spectral Analysis of Surface Waters
Norman D. Dennis, Jr., Ph.D., P.E.

MBTC DOT 2090/3002 - Performance Prediction of the Strong Company's Soft Ground Arrestor System Using a Numerical Analysis
Ernie Heymsfield, Ph.D., P.E.
W. Micah Hale, Ph.D., P.E.

MBTC DOT 2091 - Rural Transportation Emergency Preparedness Plans
Heather Nachtmann, Ph.D.
Edward A. Pohl, Ph.D.
C. Richard Cassady, Ph.D.

MBTC DOT 2095/3004 - Potential Application of Nanotechnology on Cement Based Materials
R. Panneer Selvam, Ph.D., P.E.
Kevin D. Hall, Ph.D., P.E.

Completed Projects

MBTC DOT 2056 - Applicability of Microelectronic and Mechanical Systems (MEMS) for Transportation Infrastructure Management

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It will be advantageous to have information on the state of health of infrastructure at all times in order to carry out effective on-demand maintenance. With the tremendous advancement in technology, it is possible to employ devices embedded in structural members for real-time monitoring of infrastructure health. Micro-electromechanical systems (MEMS) are miniature sensing or actuating devices which can interact with their environment to either obtain information or alter it. With remote query capability, it appears such devices can therefore be embedded in structures to monitor distresses such as cracking. Recently the potential for application of many of the developments in the nanotechnology field in the area of transportation engineering is growing. In this report a broad overview of the potential applications of various nanotechnology developments in civil and transportation engineering field is conducted. The focus is on the potential effects that the technology may have on aspects such as bridge, pavement, and traffic engineering. The most important challenges of the implementation of MEMS into transportation infrastructures are also addressed.

MBTC DOT 2071 - Prestress Losses in Prestressed Bridge Girders Cast with Self-Consolidating Concrete

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University of Arkansas

The primary objective of this research study was to compare the prestress loss of beams cast with self-consolidating concrete (SCC) to beams cast with conventional concrete of the same compressive strength. Additionally, the transfer length and development lengths were measured for both types of beams and compared to one another and to AASHTO/ACI prediction equations. Twenty beams, 18 ft. long with a cross section of 12 inches deep and 6.5 inches wide, were constructed: 14 from SCC and 6 from conventional concrete. Transfer and development lengths and prestress losses of the beams were measured and compared to predicted values obtained by using current recommended equations. For the beams (and compressive strengths) examined in this study, the test results indicate that the SCC and conventional concrete beams have approximately the same transfer and development lengths. Measured transfer and development length values for all beams were found to be less than those predicted using current ACI and AASHTO equations. Measured prestress losses for SCC beams were also similar to that of the conventional concrete beams. For all beams, the measured prestress losses were less than the predicted values using the AASHTO Detailed Method.

MBTC DOT 2083 - Human Factors Study of Driver Assistance Systems to Reduce lane Departures and Side Collision Accidents

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University of Arkansas

This study investigated the human factors issues related to the implementation of lane departure warning systems (LDWS) to reduce side collision and run-off-road crashes for heavy trucks. Lane departures can be either intentional (e.g., to pass another vehicle or avoid an object in the roadway) or unintentional (due to drowsiness, inattention or distraction). The report discusses the recent research and applications literature that evaluates the problem of lane departure accidents and the potential for LDWS to reduce the frequency and/or severity of those accidents. The report also discusses the issues related to the use of LDWS data that are recorded to improve the fleet and individual driver safety performance. The value of systems that range from simply warning the driver, with no even recorded, to the transmission of an event with the possibility of real-time intervention if driver performance is perceived to be degraded (e.g., due to fatigue or drowsiness). The study addresses the resources necessary to effectively integrate the information from these systems into the driver management system toward the goal of facilitating safe driving behaviors and reducing costly accidents. Truck accident data were analyzed to further evaluate the potential for safety benefits from LDWS. The Large Truck Crash Causation Study (LTCCS) data were analyzed with respect to the types of crashes that could be affected by LDWS (e.g., departed roadway, inattention, etc.). The analysis focused on rural highways and interstates with posted speed limits of above 50 mph. In addition, safety data for eight large commercial trucking fleets were analyzed to determine the relative frequency of accidents for which LDWS would reduce the occurrence or severity of lane or roadway departure accidents. The results indicated that, although the frequency of lane departure and run-off-road accidents was found to be relatively low, the consequences of these crashes can be very high. In addition, the relative frequency of lane departure accidents varied greatly from fleet to fleet. This indicates that the decision to implement LDWS or what type of LDWS to implement must depend upon a fleet's own experience, rather than aggregate data.

MBTC DOT 2086 - Routing Models for Rural Networks with Time-Varying Constraints

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University of Arkansas

The motivation for this work comes from the poultry industry, but can be broadened to other application areas. One problem of concern in the poultry industry is when an infected flock of birds has to be transported to another facility, but in doing so, the infected flock cannot come within a certain radius (e.g., five miles) of a breeding (or some other type of) facility. Alternately, a feed truck may not be allowed to come within a certain radius of an infected site/area. The poultry industry often has trouble solving these types of problems. In fact, they tend to solve the most restricted form of this problem, assuming a static radius value over time, rather than the real problem where the radius might vary over time, depending on site-specific conditions. Furthermore, conditions are clearly variable, as the disease may be one that spreads in the air and the spreading mechanism is dependent on the passage of time, wind speed, and other stochastic factors. The network that connects poultry facilities is primarily rural.

To address this problem, we took a systems perspective and developed a method that integrates the Geo-Spatial information available on rural transportation routes with logistics decision support knowledge tools to efficiently route the movement of infected flocks while minimizing the risk of exposure to other poultry farms. In this report we present a mathematical model for executing pickups and deliveries in a rural network with a fleet of capacitated vehicles under time constraints. We demonstrate the use of this model in transporting live chickens in a rural poultry network in Northwest Arkansas. The data for this network was obtained through a Geographical Information Systems (GIS) database. This research also applies to the transportation of toxic waste, network routing where rush hour traffic is a concern and other important transportation applications where the network changes over time in a stochastic manner.

MBTC DOT 2087/3001 - A Model to Design a National High-Speed Network for Freight Distribution

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Kevin R. Gue, Ph.D.
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The United States has a significant problem with highway congestion, with an estimated cost of $7.8B in lost productivity annually. To alleviate congestion issues, it is often recommended that the United States should build and encourage more high-speed passenger rail. However, since passenger traffic shares our highways with freight traffic, an alternative to alleviate congestion issues is to remove freight traffic from our highways through the development of a national high-speed network for freight distribution. In addition to reducing congestion on our highways, a high-speed freight network utilizing, say, Maglev technology, would also afford benefits in terms of fuel-efficiency and lower emissions, both of which are highly important given the unprecedented cost of fuel and the importance placed on environmental and "green" initiatives.

The objective of our research is to explore the maximum impact of instituting a high-speed rail network for freight distribution. In our research we utilize the results of technology feasibility tests indicating that freight in such a system will move approximately two to three times faster than freight distributed via the nation's highways. However, we do not consider the cost of using either mode of transportation, leaving the economics of developing a network for future consideration. Instead, we address designing a high-speed rail network for freight distribution and analyze its maximum impact on the current highway system, assuming the freight that benefits the most from the network will use the network. Thus, our goal is to determine the high-speed freight network with the maximum benefit in terms of improved freight transit times and decreasing the number of highway miles driven to move the freight. We formulate our problem as a multi-modal network design problem and present an uncapacitated network design problem with a post-processing step for the capacity constraint to construct such a network.

As a case study application of our model, we evaluate the impact of a high-speed freight network on our nation's highways with data from the Federal Government's Commodity Flow Survey as well as a major truckload carrier. For the technology parameters, we utilize current and expected values from the primary producer of Maglev technology. We create a traffic load model that examines how various amounts of investments in high-speed rail leads to a reduction in freight transit times, which then leads to a reduction in the amount of truck traffic on the highways. Since the technology is evolving, an important result of our work is that the network developed with our models is shown to be relatively robust to changes in the speed of the technology. We use our models to create a potential implementation plan of a high-speed network in the United States, one that evolves with increasing technology investment.

The results of our work show that, with sufficient capacity and associated investment, a high-speed network for freight distribution will have a significant impact on freight transit times and highway congestion, with the potential to address many of the challenges facing transportation today. For example, a 20,000-mile network (approximately half of the U.S. interstate highway system) that utilizes current Maglev technology parameters and proposed 6-minute headways would make it advantageous for a majority of the freight traffic to utilize the high-speed network. And although such a network would require a significant investment of $760B - $2.8T (using current cost estimates of $38M - $140M per mile), this investment would lead to an estimated 38% reduction in overall freight transit times. And perhaps more importantly to the public, would precipitate a net 78% decrease in the annual total truck highway miles driven.

MBTC DOT 2088 - Applications of GIS and Operations Research Logistics Planning Methods for Arkansas Rural Transportation Emergency Planning

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When a disaster strikes, emergency planners need to be prepared to handle many important duties, such as directing evacuations and distributing emergency supplies. Therefore, emergency planners rely on decision support systems (DSS), which help them to carry out these duties. To be most effective, a DSS should be integrated with a geographic information system (GIS), which provides analysis for the problems that arise and helps users of the DSS to visualize the situation. In addition, an effective DSS should include simulation models and optimization techniques, especially in the prevent planning. For instance, a simulation model could be used to determine the fastest method of evacuation so that when a hurricane approaches an area, police can use this method to appropriately direct traffic. This report explores the many issues involved in integrating a GIS into a DSS, creating simulation models, and applying optimization techniques so that emergency planners are well prepared should a disaster occur.

To better examine the use of optimization in emergency planning this report investigates the determination of hazard zones within a geographic area. A hazard zone is an area corresponding to a worst-case evacuation scenario and is a potential vulnerability that should be addressed by risk mitigation strategies. The research compares two heuristic approaches to determining hazard zones based on population and road connectivity within a spatial network. The genetic algorithm and the Cova heuristic both have strengths and weaknesses as discussed throughout this report. The Cova heuristic performs better in sparsely connected networks with smaller hazard zones, while the genetic algorithm performs better in terms of time to obtain a solution and the quality of the solution when the network is dense and has larger hazard zones. Based on these results, the Cova heuristic is recommended for sparse rural networks.

MBTC DOT 2089 - Development of a Soft Ground Arrestor System

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Ernest P. Heymsfield, Ph.D., P.E.
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Increase in the demand for air travel safety has promoted the development of Ground Arrestor Systems (GAS). Currently, GAS has been deployed in many of the airports throughout America and is called as Engineered Material Arrestor System (EMAS). The present EMAS is designed to decelerate the speed of the aircraft in order to bring it to complete rest without any causalities and not causing much damage to the aircraft. But the present GAS that's in use is considered expensive as well as labor intensive. Efforts are being made to develop a mixture that can be used as a replacement for the present material that is being used in GAS construction. The research program described in this thesis examined the behavior of ultra-lightweight concrete with variation of chemical admixtures. Different concrete mixtures were batched and tested for fresh and hardened properties to develop the ultra-lightweight concrete that can meet the requirements provided by FAA in advisory circular AC 150/5220-22A.

MBTC DOT 2094/3003 - Acceleration Lane Design for Higher Truck Volumes

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University of Arkansas

The research project examines attributes associated with tractor-trailer trucks accelerating on freeway entry ramps and entering the main traffic lanes. Data for this project were collected at five commercial vehicle weigh stations in Arkansas and Missouri, which allowed the researchers to examine the effects of vehicle weight as the trucks accelerated. Other attributes examined included truck speeds at various distances from the scales, freeway volumes, and freeway grades. From the analysis, the report offers recommendations about the lengths of acceleration lanes needed for heavy vehicles to accelerate to speeds closer to the speeds on the main lanes, and be less disruptive to freeway traffic flow as the heavy vehicles merge into the main lanes.

MBTC DOT 2096/3007 - Solar Powered Lighting for Overhead Highway Signs

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The purpose of the research is to design and develop a low cost solar powered lighting system for overhead highway signs with a view to improving night visibility especially under poor driving conditions, and enhance highway safety. Two lighting systems have been researched, developed and tested: one system employs LED technology and the other uses CFL technology. The commercial CFL lights are ac powered and for dc operation with photo-voltaic energy, a new inverter design has been implemented. The inverter efficiency is better than 95% and the total harmonic distortion (THD) is less than 15%. The design incorporates SLA (Sealed Lead Acid) batteries for energy storage. The inverter is essential when hybrid operation (solar as well as ac line) is desired. For stand-alone solar application, it has been shown that the CFL lights can be directly operated from dc source and thus is less than 15%. The design incorporates SLA (Sealed Lead Acid) batteries for energy storage. The inverter is essential when hybrid operation (solar as well as ac line) is desired. For stand-alone solar application, it has been shown that the CFL lights can be directly operated from dc source and

thus eliminate the inverter to minimize power losses. Further, a new dc operated ballast configuration was also investigated for CFL lighting to increase its luminous efficacy. The LED system employs pulse-width modulation technique controlled by a micro-controller for its operation. Both the systems incorporate a power management controller to adjust the lighting effect to compensate for weather conditions for days with inadequate solar charging. The two lighting systems have been deployed to illuminate two signs (Memphis and Remington Exit) on Interstate 40 East at the Remington exit. The CFL technology was used for the Remington Exit sign with a lighting area of 50-60 sq. ft. This report presents the design and development of the two systems, their outdoor deployment results, and recommendations for future research.

MBTC DOT 2098/3005 - A Model-Based Risk Map for Roadway Traffic Crashes

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Visualization of traffic safety data that transforms spatial data into a visual form can help highway engineers and traffic safety officials to effectively analyze the data and make decisions on which roadways and road side features to improve by providing the spatial distribution of the data. However, research efforts in the visualization of traffic safety data, which are usually stored in a large and complex database, are quite limited because of methodological constraints. For example, there are only a few model-based maps that can account for the high variance of traffic crash estimates in low population areas, and at the same time clarify overall geographic trends and patterns. In addition, designers of roadways historically did not take into account the full range of driver characteristics, such as driver perception-response time, age differences, etc. One of the most important components of the roadway transportation is the human driver whose error is a factor in about 90% of traffic crashes. Therefore, it is very important for highway engineers and traffic safety officials to identify and understand the basics of human factors as relevant to driving and traffic safety.

MBTC DOT 2099/3006 - Identification and Analysis of High Crash Segments on Interstate, US, and State Highway Systems of Arkansas

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This project report identifies the high crash locations on the Interstate, US, and State highway systems in the state of Arkansas. High crash locations can be defined as any highway location which has a higher frequency of crashes compared to other roadway locations due to local factors including factors such as driver behavior, traffic, geometric and control conditions, etc. There are eight Interstate, nineteen US, and two hundred and thirty nine State highways in Arkansas and all were considered in identifying the high crash locations.

Literature review was conducted on the different methods and based on the literature review three methods were selected for the identification and ranking of high crash locations. Three year crash data, 2004 to 2006 was analyzed and the Empirical Bayes', Crash Rate, and Equivalent Property Damage Only methods were selected to identify the high crash locations. These methods were found to be apt as they involved parameters like the Annual Average Daily Traffic, crash frequency and severity. The Empirical Bayes' method was found to be advantageous as it takes into consideration the effects of random variation in events. The Equivalent Property Damage Only method was useful as it weighted the different characteristics of a crash. The highway segments were ranked using the modified sum-of-the-rank method. Results revealed that the chosen methods yielded good results. The modified sum-of-the-ranks method was found better in approach than the sum-of-the-ranks method as the time taken for the process of analyzing was short and yielded the desired results.

This report identifies the highway segments with high frequency and severity of crashes. It was observed that most of the crashes were on undivided sections of the highways on US and State highway networks. The frequency of crashes was higher when highways pass through the vicinity of major cities pointing to heavy vehicular movement as one of the reasons for higher frequency of crashes. The high crash locations have higher AADT's but it is not always necessary that higher AADT's would lead to higher frequency of crashes. On I-40, mile segments 161 and 162 have similar AADT's compared to some of the mile segments from 126 to 155 and 272 to 284, but higher frequency of crashes were not observed in segments 161 and 162. Similarly, other routes also have certain mile segments whose AADT is similar/higher than the AADT of the identified high crash segments. Hence, it is can be stated that AADT is not the only factor which can be related to high crash locations. A future report will identify the causes of crashes and propose remedial measures to minimize the number of fatalities and severity of crashes as well as propose measures to reduce the frequency of crashes.

Publications Available @ www.mackblackwell.org

Research and Innovative Technology Administration (RITA) Communities of Interest

Transportation Planning and Policy Research

2008

MBTC DOT 2034 - Community Impact of Regional Transportation Infrastructure: Revisited After Completion of Airport and Major Highway
Miller, Will

MBTC DOT 2078 - Evaluation of Economic Impacts of NAFTA on the Transportation System/Sector of Selected Southern States
Hamilton, Gregory L.

2007

MBTC DOT 2081 - A Study of Rural Transit Operations in the Arkansas Delta
Tooley, Melissa S.

MBTC DOT 2082 - Ancillary Benefits of the Ouachita River Navigation System
Nachtmann, Heather

2005

MBTC DOT 2038 - Physical, Economic, and Political Feasibility for Trade of U.S. Grain for Russian Oil
Asfahl, C. Ray

MBTC DOT 2068 - Northwest Arkansas Regional ITS Architecture
Tooley, Melissa S.

2004

MBTC DOT 2018 - Environmental Technology Verification Report of the Low-Cost Stormwater BMP Study
Edwards, Findlay G.

MBTC DOT 9206 - Update and Modification of the Kansas Low-Volume Roads Handbook and the Handbook of Traffic Engineering Practices for Small Cities
Russell, Eugene R.

2003

MBTC DOT 2002 - Ingredients in Planning Successful Rural Transportation Services for Welfare Reform
Wedel, Kenneth R. and Richard S. Marshment

MBTC DOT 2009 - Regional Mobility Plan: Development of Technical Scope of Services
Tooley, Melissa S.

MBTC DOT 2012 - Modeling and Analysis of Transportation Flows Created by E-Commerce Transactions
Kutanoglu, Erhan, Michael H. Cole and Michael Bartolacci

MBTC DOT 2022 - Development of a Strategic Plan for Statewide Deployment of Intelligent Transportation Systems in Arkansas
Tooley, Melissa S.

2002

MBTC DOT 9208 - Economic Evaluation of the Impact of Waterways on the State of Arkansas – Phase II
Nachtmann, Heather

2001

MBTC DOT 2001 - Quick Response Community Planning
Russell, Eugene R., E. Dean Landman and Avijit Mukherjee

Systems Performance Research

2004

MBTC DOT 9210 - Training and Course Materials of Stormwater Pollution Prevention
Edwards, Findlay G. and Steven J. Burian

2003

MBTC DOT 2015 - Online Benchmarking Database for Transportation Providers
Rossetti, Manuel D. and Terry Collins

Human Factors Research and Applications

2009

MBTC DOT 2083 - Human Factors Study of Driver Assistance Systems to Reduce Lane Departures and Side Collision Accidents
Johnson, Steven L.

2008

MBTC DOT 2100 - Evaluation of the Role of Driver's Knowledge of Who Has the Right-Of-Way Contributes to Interstate On-Ramp Crashes
Eustace, Deogratias

2007.

MBTC DOT 2040 - Supplemental Signing for Stop Signs - Phase 2
Gattis, James L

MBTC DOT 9202 - Supplemental Materials for Use with Educational Videotapes
Griffith, Frances

MBTC DOT 9204 - Development of a Construction Surveying Certification Course
Williams, Rodney D. and Kevin D. Hall

2004
MBTC DOT 2043 - A Model for Predicting Tractor-Trailer Truck Drivers' Job Performance Related to Highway Safety
Nafukho, Fredrick M. and Barbara E. Hinton

Transport, Logistics and Infrastructure Research

2009
MBTC DOT 2056 - Applicability of Microelectronic and Mechanical Systems (MEMS) for Transportation Infrastructure Management
Wang, Kelvin, C.P.

MBTC DOT 2086 - Routing Models for Rural Networks with Time-Varying Constraints
Mason, Scott. J., Russell D. Meller and Edward A. Pohl

MBTC DOT 2087/3001 - A Model to Design a National High-Speed Network for Freight Distribution
Meller, Russell D. and Kevin R. Gue

MBTC DOT 2094/3003 - Acceleration Lane Design for Higher Truck Volumes
Gattis, James L.

2008
MBTC DOT 2072 - Roundabout Feasibility Study for West Memphis
Crone, John V., Otto Loewer and Carolyne Garcia

MBTC DOT 2073 - Effects of Frontage Road Conversion
Gattis, James L.

MBTC DOT 7015 - Assessment of Multimodal Transport of Baled Poultry Litter and Dewatered Biosolids from Northwest Arkansas
Goodwin, Harold and Kenneth B. Young

2005
MBTC DOT 2035 - WebShipCost – Quantifying Risk in Intermodal Transportation
Nachtmann, Heather and Manuel D. Rossetti

2004
MBTC DOT 2024 - WebShipCost – Intermodal Transportation Linkage Cost Assessment Via the WWW
Rossetti, Manuel D. and Heather Nachtmann

MBTC DOT 2041 - Integrated Analysis of Transportation and Inventory In Intermodal Distribution Networks
Mason, Scott J and Erhan Kutanoglu

2003
MBTC DOT 2003 - Empty Container Management for Container-on-Barge (COB) Transportation: Planning Horizon Effects on Empty Container Management in a Multi-Modal Transportation Network
Cole, Michael H. and Erhan Kutanoglu

MBTC DOT 2016 - Further Study of Roundabouts
Russell, Eugene R. and Margaret J. Rys

MBTC DOT 2019 - Designing Horizontal Curves for Low-Speed Environments
Gattis, James L.

2002
MBTC DOT 2013 - Efficient Timing of Pickup and Delivery Assignment Decisions Through Simulation and Optimization
Kutanoglu, Erhan and G. Don Taylor

2001
MBTC DOT 2004 - Efficient Dispatching in a Terminal City Network
Kutanoglu, Erhan and G. Don Taylor

Materials Research

2009
MBTC DOT 2071 - Prestress Losses in Prestressed Bridge Girders Cast with Self-Consolidating Concrete
Hale, W. Micah

MBTC DOT 2089 - Development of a Soft Ground Arrestor System
Hale, W. Micah and Ernest P. Heymsfield

2008
MBTC DOT 2066 - Surface Friction Measurements of Fine-Graded Asphalt Mixtures
Williams, Stacy

MBTC DOT 2075 - Non-Nuclear Methods for Density Measurements
Williams, Stacy

MBTC DOT 2092 - Yield Characteristics of Biodiesel Produced from Chicken Fat-Tall Oil Blended Feedstocks
Babcock, Robert E., Edgar C. Clausen and Michael Popp

2007
MBTC DOT 2027 - Investigation of the affect of Fines on Base Course Performance
Dennis, Norman, Richard M. Welcher and John H. Lawrence

MBTC DOT 2030 - Development of 4.75 MM Superpave Mixes
Williams, Stacy and Kevin D. Hall

MBTC DOT 2053 - Development of an In Situ Permeability for Concrete Structures
Hale, W. Micah and Mark L. Kuss

MBTC DOT 2054 - A Comprehensive Study of Field Permeability Using the Vacuum Permeator
Williams, Stacy and Mark L. Kuss

MBTC DOT 2058 - Biodiesel Production from Varying Grades of Beef Tallow and Chicken Fat
Babcock, R.E., Edgar C. Clausen and Michael P. Popp

MBTC DOT 2076 - Physical and Chemical Characteristics of Superpave Binders Containing Air Blown Asphalt from Two Different Feedstocks
Hardee, John

2006
MBTC DOT 2032 - Development of Testing Protocol and Correlations for Resilient Modulus of Subgrade Soils
Dennis, Norman D.

2005
MBTC DOT 2039 - Life Cycle Economic Comparison of Common Sign Post Materials and Types
Rys, Margaret J. and Eugene R. Russell

MBTC DOT 2049 - A Study of Physical and Chemical Characteristics of Superpave Binders Containing Air Blown Asphalt
Hardee, John R.

2004
MBTC DOT 2033 - Repair of Damaged Concrete Structures Using Prepreg Composites
Li, Guoqiang

MBTC DOT 2052 - Comparative Esterification of Agricultural Oils for Biodiesel Blending
Babcock, Robert

MBTC DOT 9201 - Development of Superpave Training Materials for Local Agencies
Hall, Kevin D.

2003
MBTC DOT 2014 - Development of a Simplified Asphalt Concrete Stiffness/Fatigue Device
Tran, Nam and Kevin D. Hall

Vehicles Systems Research

2007
MBTC DOT 2008 - Automation of Pavement Surface Distress Survey Through Parallel Processing
Wang, Kelvin C.P.

MBTC DOT 2042 - Automated Survey and Visual Database Development for Airport and Local Highway Pavements
Wang, Kelvin C.P.

2004
MBTC DOT 9205 - Application and Advancement of the Next Generation Highway Data Vehicle
Wang, Kelvin C.P.

2002
MBTC DOT 2017 - Determining Optimal Trailer Duty as a Function of Use and Age
Nutter, Darin W. and C. Richard Cassady

2001
MBTC DOT 2005 - Quantifying the Impact of Refrigerated Unit Failures
Nutter, Darin W., C. Richard Cassady, John R. English, Don Taylor and Chet Tuck Wong

CNS/Traffic Management/Command and Control

2009
MBTC DOT 2088 - Applications of GIS and Operations Research Logistics Planning Methods for Arkansas Rural Transportation Emergency Planning
Rossetti, Manuel D., Edward A. Pohl and Fred Limp

2008
MBTC DOT 2047 - WebShipCostGIS in Inter-modal Transportation
Rossetti, Manuel D. and Heather Nachtmann

MBTC DOT 2077 - Networked Sensor System for Automated Data Collection and Analysis
Wang, Kelvin C.P.

MBTC DOT 2084 - Development of an Intermodal Container Load Status and Security Monitoring System
McCann, Roy

MBTC DOT 2097 - Automated Inventory and Analysis of Highway Assets: Phase II
Wang, Kelvin C.P.

2007
MBTC DOT 2065 - Automated Inventory and Analysis of Highway Assets
Wang, Kelvin C.P.

2006
MBTC DOT 2044 - Cost Efficient Management Tools for Assessing Cultural Resources
Sabo, George and Lela Donat

MBTC DOT 9209 - Training and Course Materials for Transportation Applications of GIS
Rossetti, Manuel D.

2005
MBTC DOT 2031 - GIS-Based BMP Planning Tool for Stormwater Quality Management
Edwards, Findlay G. and Steven J. Burian

2003
MBTC DOT 2023 - Impact of Wireless Data Systems on the Transportation Systems of the Future
Mason, Scott J. and Erhan Kutanoglu

MBTC DOT 2025 - Evaluation of Automated Work Zone Information Systems
Tooley, Melissa S. and James L. Gattis

2002
MBTC DOT 2020 - Design of a Mobility Information Management System (MIMS)
Anderson, Michael

Safety Analysis and Risk Management

2009
MBTC DOT 2098/3005 - A Model-Based Risk Map for Roadway Traffic Crashes
Nam, Chang S. and Joon J. Song

MBTC DOT 2099/3006 - Identification and Analysis of High Crash Segments on Interstate, US, and State Highway Systems of Arkansas
Bham, Ghulam H.

MBTC DOT 2096/3007 - Solar Powered Lighting for Overhead Highway Signs
Patangia, Hirak C.

2008
MBTC DOT 2061 - Risk Modeling, Assessment and Management
Pohl, Edward A.

MBTC DOT 2063 - Highway Collision Warning Technology: Determination of Criteria for Detecting and Logging Hazardous Events in Tractor-Trailer Safety and Training Programs
McCann, Roy and Stephen Johnson

MBTC DOT 2064 - Assisted Night Vision for Motorists in Highway Construction Zones: Phase II
Patangia, Hirak C. and John M. Faucett

MBTC DOT 2079 - Study Drivers' Behavior at Passive Railroad-Highway Grade Crossings
Russell, Eugene R. and Margaret Rys

MBTC DOT 2080 - Effectiveness of Seat Belts in Reducing Injuries
Dissanayake, Sunanda

MBTC DOT 2093 - Improved Traffic Signal Efficiency in Rural Areas Through the Use of Variable Maximum Green Time
Click, Steven M.

2007
MBTC DOT 2062 - Development of a Human Performance Simulation Model to Evaluate In-Vehicle Information and Control Systems in Commercial Trucking Operations
Johnson, Steven L. and Chang Soo Nam

MBTC DOT 2085 - Homeland Security for Rural Transportation Networks
Nachtmann, Heather, Edward A. Pohl and C. Richard Cassady

2005
MBTC DOT 2048 - Total System Cost/Benefit Assessment of Heavy Truck-Automobile Speed Differentials on Rural Highways
Johnson, Steven L.

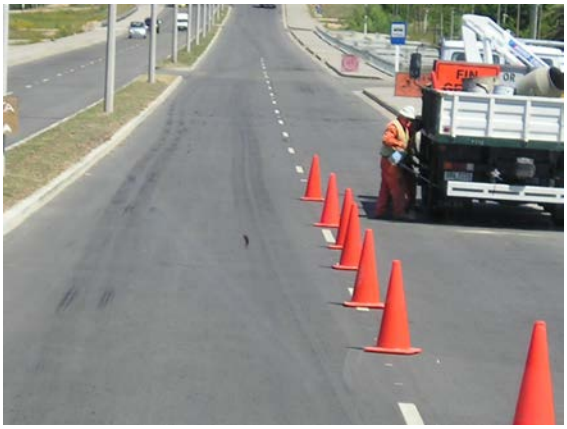
MBTC DOT 2050 - Assisted Night Vision for Motorists in Highway Construction Zones: Phase I
Patangia, Hirak C.

MBTC DOT 2051 - Identification of Countermeasures to Reduce Severity of Rural Highway Crashes
Dissanaykke, Sunanda

2004
MBTC DOT 9211 - Video Tapes/DVD's: "Driving in Orange"
Gattis, James L.

2001
MBTC DOT 9203-A - Video Tapes/DVD's: "Lane Closures"
Gattis, James L.

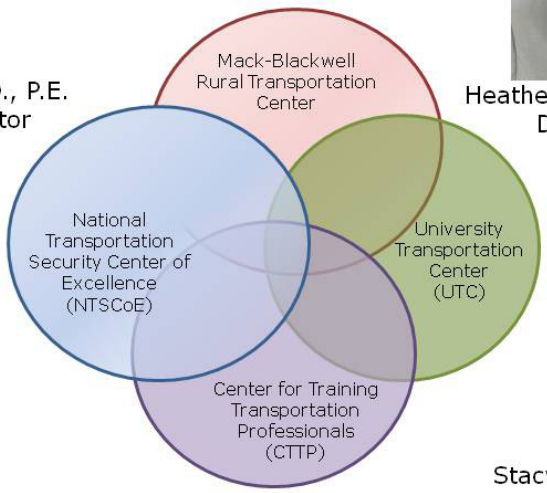
MBTC DOT 9203-B - Video Tapes/DVD's: "Pavement Markings"
Gattis, James L.



MBTC Administrative Personnel

Kevin D. Hall, Ph.D., P.E.
Executive Director

Heather Nachtmann, Ph.D.
Director, MBTC



Letitia Pohl, Ph.D.
Assistant Director

Stacy Williams, Ph.D., P.E.
Director, CTTP

MBTC Administrative Staff

Dana Ledbetter
Communications Director

Sandra Hancock
Accountant

CTTP Administrative Staff

Frances Griffith
Administrator for Technician Training

Roselie Conley
Research Technologist

Mary Fleck
Instructor

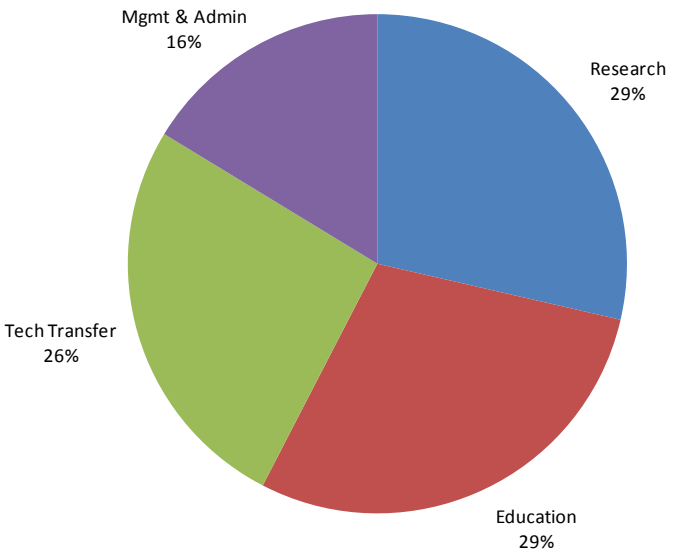
Carrie Pennington
Administrative Assistant I

Financial Report

Grant Year: July 1, 2008 - June 30, 2009

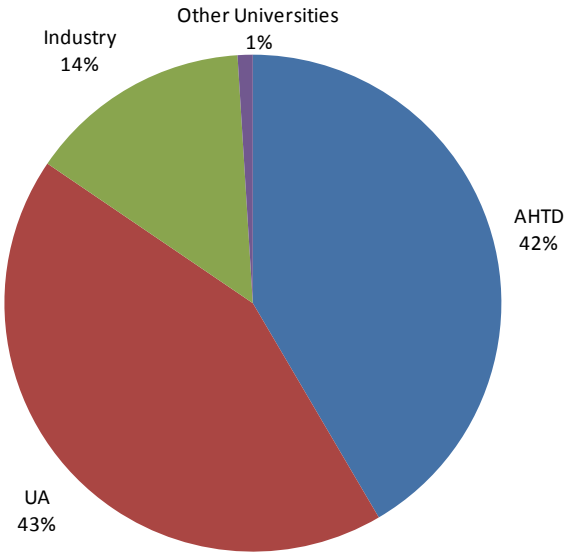
Federal Share - $368,130.67
Matching Share - $1,001,490.14
Total - $1,369,620.81

MBTC Expenditure Distribution
July 2008 - June 2009



*40.6% of Management and Administrative Expenditures come from Match Sources

MBTC Match Source Expenditure
July 2008 - June 2009



MBTC Upcoming Events for 2009-2010

Summer Transportation Institute
July 28, 2009

MBTC will be hosting a day of fun with 20 students from North Little Rock's Summer Transportation Institute which is sponsored by Arkansas Highway and Transportation Department (AHTD). The students will spend several weeks learning about materials, bridge design, html programming and personal development. They will be touring the CTTP facility and given a challenge to build a specific "transportation" object with materials provided.

First LEGO League

MBTC is looking forward to its first year participating in First LEGO League (FLL) with the challenge this year "Smart Moves." FLL brings theory and practice together in a revolutionary program. FLL empowers kids to combine what they've learned in the classroom with the latest technologies to solve the yearly challenge. The key to the challenge is accessing people, places, goods and services in the safest, most efficient way possible. In this journey, teams will consider many modes of transportation beyond their daily routine and streamline their options by making smart moves!

Advisory Board Meeting
October 19-20, 2009

MBTC will have its annual Advisory Board dinner and meeting on October 19 and 20, 2009. We have changed to MONDAY and TUESDAY this year so be sure to make a note in your calendar. MBTC looks forward to showcasing our accomplishments and what we will be working on in the next year!

Tish Pohl Joins MBTC Staff

Dr. Tish Pohl has joined the Mack-Blackwell Transportation Center as the Assistant Director of its National Transportation Security Center of Excellence program. Dr. Pohl completed her Ph.D. in Industrial Engineering from the University of Arkansas in 2009. She has a M.S. in Systems Engineering from the Air Force Institute of Technology and a B.S. in Mechanical Engineering from Tulane University. Dr. Pohl served as an officer in the U.S. Air Force for eight years.

Tish stated, "I am delighted to be a part of Mack-Blackwell, and am looking forward to applying my research skills to the area of transportation. Transportation security, in particular, is critical to our overall national security, and I am happy to have an opportunity to contribute." She will work closely with the Center's director in project administration, external proposal writing and research execution related to the mission of the program.

Welcome to MBTC and we are all looking forward to working with you!

Professional Advisory Board

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Fayetteville, Arkansas 72701
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Fax: 479-575-7168

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