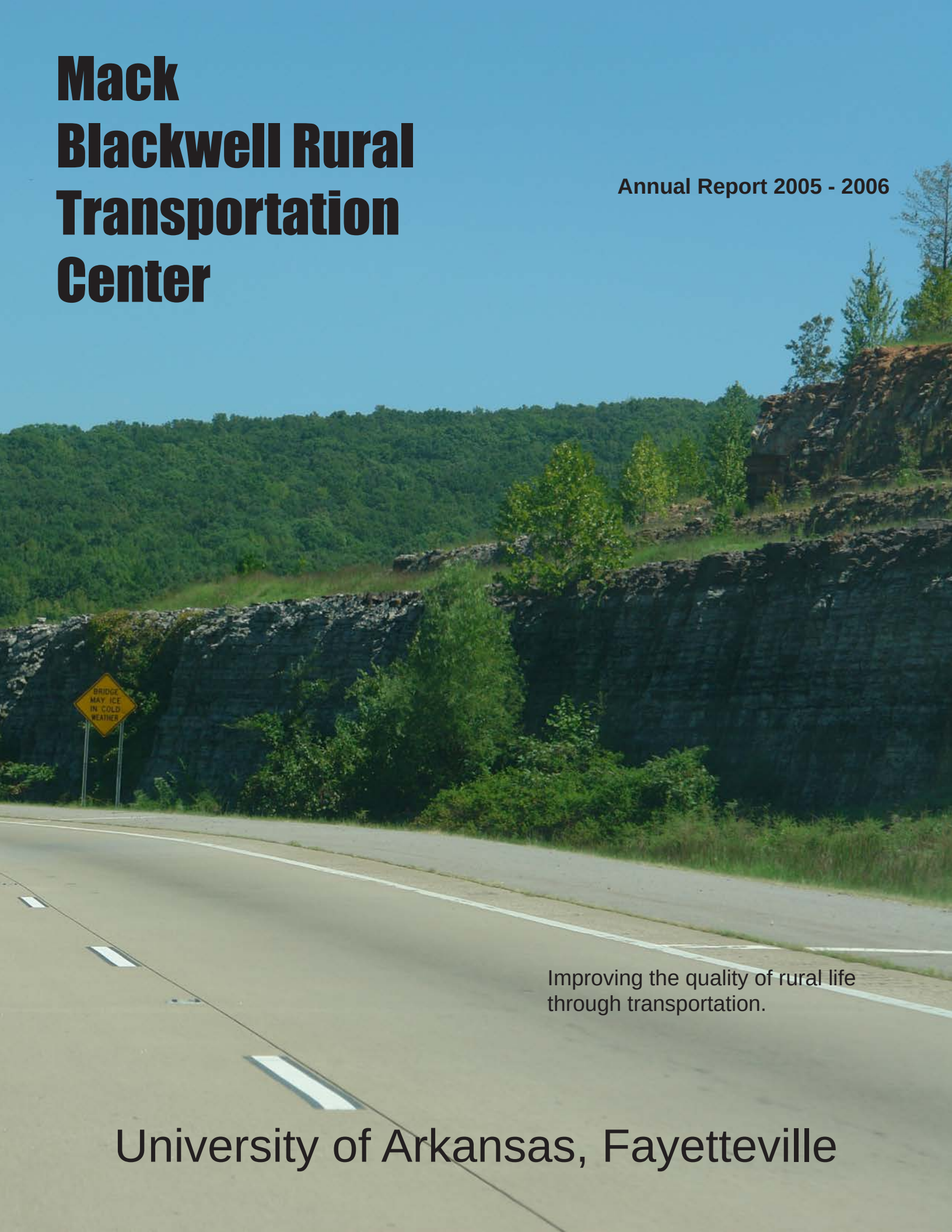
2006

Annual Report, 2005-2006

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

Mack Blackwell Rural Transportation Center

Annual Report 2005 - 2006



Improving the quality of rural life through transportation.

University of Arkansas, Fayetteville

Professional Advisory Board

Tom Dames, Ph.D, P.E., RADM (Ret.)
Senior Vice President (Ret.)
Transportation Business Group
CH2M Hill

Pat Drennon, PE, RADM (Ret.)
Senior Vice President
Parsons Brinckerhoff

Dan Flowers, P.E.
Director
Arkansas Highway and Transportation Department

Keith Garrison
Executive Director
Arkansas Waterways Commission

Wesley Kemp
Vice President
ABF Freight System Inc.

Lane Kidd
President
Arkansas Trucking Association

Steve Mitchell
Director of Fleet Operations
Tyson Transportation

Sandy Otto, P.E.
Division Administrator
US Department of Transportation Federal Highway Administration

Paul Revis, P.E.
Executive Director
Ouachita River Valley Association

Michael J. Right
Vice President - Public Affairs
American Automobile Association

Col. Wally Z. Walters, P.E.
District Engineer
Corps of Engineers

Mark Westmorland
State Program Manager
Federal Motor Carrier Safety Administration

Gary Whicker
Senior Vice President for Engineering Services
J.B. Hunt Transport

Academic Advisory Board

Doug Adams, Ph.D.
Associate Professor
Sociology and Criminal Justice

Mark Cochran, Ph.D.
Department Head
Agricultural Economics and Rural Sociology

Thomas O. Graff, Ph.D.
Associate Professor
Geosciences

Will Miller, Ph.D.
Professor
Political Science

Ronald Skeith, Ph.D., P.E.
Professor
Computer Science and Computer Engineering

Contents

Photo Credits

Dana L. Ledbetter - Cover & Back Pages, 5, 6, 9
Mark Kuss, J.L. Gattis, Hirak Patangia, Kelvin Wang, Stacy Williams - Page 2
Steve Johnson - Page 6
Robert Babcock - Page 7
Hirak Patangia - Page 7
Melanie Brakeville - Page 10 & 17
William Chesser - 13, 14, 15, 16, 19, 23, 24, 27

Staff

Jack E. Buffington, P.E., RADM (Ret.)
Interim Director
Research Professor

Heather Nachtmann, Ph.D.
Associate Director
Associate Professor
Industrial Engineering

Dana L. Ledbetter
Communications Director

Sandra (Sandy) Hancock, CPS/CAP
Accountant

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

Frances Griffith
EI Administrator, CTTP

Roselie Conley
Research Technologist, CTTP

Carrie Pennington
Secretary, CTTP

Executive Committee

John R. English, Ph.D., P.E.
Department Head
Industrial Engineering

Collis Geren, Ph.D.
Associate Vice Chancellor for Research
Dean of the Graduate School

Kevin D. Hall, Ph.D., P.E.
Department Head
Civil Engineering

John Ozment, Ph.D.
Professor and Oren Harris Chair of Transportation
Marketing and Logistics


ROAD
CLOSED

Message from the Director

MBTC has completed another successful year filled with lots of challenges. Our past director, Dr. Melissa Tooley, gave in to Texas A&M after two or three years of prodding to join their staff and will head up a new transit research center. Melissa did a tremendous job of moving MBTC to the forefront of transportation research centers, and has gained national attention and recognition by being elected President of the Council for University Transportation Centers for the past year. Her position will be difficult to fill, however we are combining the Director's position with a newly funded Chair in Transportation Planning which should attract a scholar of national prominence. During the period we are searching for a new Director, I am serving as the Interim Director. I previously served as Director for three years prior to Melissa and remained on as Associate Director. Joining me as Associate Director is Dr. Heather Nachtmann, Associate Professor of Industrial Engineering and one of our most prolific researchers. Heather is featured later in this report, but her being in this position will only strengthen the Center. We are most fortunate to have her accept this position.

Another newcomer to our staff is Ms. Dana Ledbetter as Communications Director. Dana has a tremendous background and owned her own company for several years. She is also featured later in this publication along with our longtime Accountant, Ms. Sandra Hancock. Another newcomer, who isn't new at all, is Dr. Kevin Hall, the new Department Head for Civil Engineering who also serves as one of our four Executive Committee members. The Director answers to the Executive Committee on all matters. Dr. Hall has also been our top researcher for several years.

This past year has been marked by the completion of several projects of importance and the award of others with a great deal of potential, such as Dr. Buddy Babcock's converting chicken fat to biodiesel. Our research projects have historically scored very high in the percentage that is adopted for use. Our thanks to our superb PI's for all their hard work. Our current and new projects are listed in the following pages along with short synopses.

Our Distinguished Lectures this year have included such industry leaders as Dr. Delon Hampton of Hampton Associates, Ltd. of Washington, DC. Dr. Hampton's A&E firm, which started out as a minority firm, is one of the top in the nation. He spoke on their role in expanding Reagan and Dulles Airports. We also had Rear Admiral Retired Mike Johnson, Associate Vice Chancellor for Facilities at the University of Arkansas, speak on the large expansion program underway for the University. Admiral Johnson was Chief of Engineers for the Navy, riding herd on all construction and public works worldwide as well as the Navy Seabees prior to joining the staff at Arkansas. Last fall included Dr. John Christian from Boston speaking on the very current problems with the Big Dig, and our annual "Evening with the Pro's" where we have a panel of successful and distinguished graduates host a forum with the students on how they built their companies and what opportunities are awaiting the students when they graduate.

Our special congratulations to Dr. Jim Gattis and the Arkansas Highway and Transportation Department for winning the annual 2005 Roadway Work Zone Safety Awareness Award, sponsored by the American Road & Transportation Builders Association and the National Safety Council. Dr. Gattis and AHTD have produced several videos on improving safety in highway construction zones. Also congratulations to Minh Le for being selected as MBTC's Student of the Year Award. Minh received his award at the CUTC Banquet at TRB annual meeting in DC.

We also want to thank our Professional Advisory Board and our Academic Advisory Board for their continued support. They, along with our Executive Committee, give us every reason to be more successful. MBTC grows stronger and becomes more of a contributor to improving the national rural transportation system each year, and we deeply appreciate the superb backing given us by the Department of Transportation and RITA in particular.

Jack Buffington

New Associate Director at Mack-Blackwell

Photo by Russell Cothren

Heather Nachtmann, Ph.D. has been appointed as Associate Director for the Mack-Blackwell Rural Transportation Center. Nachtmann is an Associate Professor in the Department of Industrial Engineering at the University of Arkansas. In 2000, she received her doctoral degree in Industrial Engineering from the University of Pittsburgh. Her current research interests include intermodal network optimization, economic analysis of inland waterways, and vulnerability assessment and emergency preparedness for rural transportation networks.

Nachtmann has managed more than $1 million of research funding as principal investigator and is the recipient of two best paper awards for her works published in The Engineering Economist and the Engineering Management Journal. She is a member of ASEE, ASEM, IIE, INFORMS, and SWE. Nachtmann is also the faculty advisor to the University of Arkansas' Alpha Pi Mu, the Industrial Engineering Student Honor Society since 2002, as well as the Women in Engineering and Society of Women in Engineering organizations. She is an area editor for the The Engineering Economist Journal. "Centers such as MBTC provide a catalyst to conduct research that focuses on regional interests such as the importance of rural transportation to the state of Arkansas," Nachtmann said. "The Mack-Blackwell Rural Transportation Center's research in areas such as homeland security and biofuels are vital to our region, and I am thankful for the opportunity to serve in this capacity."

Mack-Blackwell Staff Profiles

Sandra (Sandy) Hancock, CPS/CAP

Sandy Hancock, accountant, tracks all expenses and disbursement of funds. Her primary responsibilities include MBTC and CTTP accounting procedures and records, requisitions, travel, and hourly payroll, and project budgets, revisions, and extensions. Ms. Hancock has a B.S.B.A. in Accounting and a B.S.B.A. in Office Systems Management. Joining the UA staff in 1986, she has been the financial administrator of MBTC for 13 years. She is a member of the National Council of University Research Administrators and a leader in the International Association of Administrative Professionals. Our accountant, Ms. Sandy Hancock, has been with the Center since our inception in 1991 and willingly mentors these Centers who have requested assistance. She has enjoyed International Folk Dancing since the late 1980's.

Dana L. Ledbetter

Dana L. Ledbetter is the newest addition to Mack-Blackwell Rural Transportation Center as Communications Director. She is originally from Muskogee, Oklahoma and graduated from Northeastern State University in Tahlequah, Oklahoma with a Bachelor in Business Administration, Management Information Systems. She owned her own business for over 10 years and was a programmer for Wal-Mart before coming to the University of Arkansas. Dana says, "In the short time I have been here, I see what an important role a center such as MBTC provides to day to day activities on any form of transportation in Arkansas. It is nice to know we have such educated and dedicated faculty, staff and supporters to continue the important work necessary to keep up with such endeavors. I am honored to be apart of such an esteemed group of people." Dana will continue to update the website and would like any information you feel that would be important, sent to her email address (danal@uark.edu) for publication on the website or the annual/ semiannual report.

Mack-Blackwell Researchers

Principal and Co-Principal Investigators are the backbone of the Mack-Blackwell Rural Transportation Center. MBTC has sponsored more than 137 researchers in 12 states over the past 14 years. Our researchers are engineers, economists, political scientists, landscape architects, and logistics specialists among many others. These are profiles of just a few of the people who make MBTC's program a success!

John E. Delery, Ph.D., University of Arkansas

BS, Tulane University, Psychology
MS, Memphis State University, Psychology
Ph.D., Texas A&M University, Human Resource Management/ Organizational Behavior

Nina Gupta, Ph.D., Univerisity of Arkansas

BA, University of Allahabad, Psychology
MA, University of Allahabad, Psychology
Ph.D., University of Michigan, Psychology (organizational)

Drs. Delery and Gupta's research for MBTC concerns the recruitment and retention of good drivers. Their study was designed to determine the trends in driver management that affect recruitment and retention. Dr. Delery joined the faculty at the University of Arkansas in 1992 and is currently a Professor of Management. He teaches in the areas of human resource management and organizational staffing. Dr. Gupta (Raymond F. Orr Chair) is currently a Professor of Management and has been affiliated with the University of Arkansas since 1984. Dr. Gupta specializes in reward and compensation systems in both her research and teaching.

Steve L. Johnson, Ph.D., P.E., C.P.E., University of Arkansas

BA, Psychology, University of South Dakota
MS, Engineering Psychology, University of Illinois
Ph.D., Industrial Engineering, SUNY at Buffalo

Speed differentials between large trucks and automobiles are due to both state regulated speed limits and commercial trucking company policies that restrict maximum truck speeds. Speed data were collected for both heavy trucks and automobiles on rural interstate highways with four speed limit configurations: two with uniform speed limits (75 mph and 70 mph) and two with differential speed limits (70/65 and 65/55 mph). The information collected, analyzed and documented in this report is being used by both state regulatory agencies and trucking company decision makers when establishing policies related to maximum truck speed limits and speed differentials between heavy trucks and automobiles.

Dr. Johnson's teaching and research interests include ergonomics / human factors engineering, productivity improvement / lean manufacturing, quality engineering and management, statistics, and design of experiments. He is also a member of the Board of Directors for Board of Certification for Professional Ergonomists (BCPE) and advisor to Hyundai Motor Company.

Robert E. Babcock, Ph.D., University of Arkansas

BS, Petroleum Engineering, University of Arkansas
MS, Chemical Engineering, University of Oklahoma
Ph.D., Engineering, University of Oklahoma

In the future, fat shaved off chicken breasts and other parts may power automobiles that emit less pollution. Chemical engineering researchers associated with the MBTC at the U of A have developed an optimized method of converting chicken fat into biodiesel fuel. The novel project could lead to using chicken fat – a plentiful, accessible and low-cost feed stock – as an inexpensive supplement to petroleum-based diesel fuel.

Dr. Babcock's primary research interests are in the fossil fuel area related to the production and processing of petroleum and natural gas. Dr. Babcock has conducted research projects in tar sands recovery, crude oil de-waxing, fugitive emissions related to natural gas processing, and the production of biodiesel from grain oils, chicken fat, and beef tallow. Dr. Babcock has also conducted research in the area of pyrotechnics and coal gasification modeling.

Hirak Patangia, Ph.D., P.E., University of Arkansas at Little Rock

B.Tech., Engineering Electronics, Indian Institute of Technology, Karagapur, India
MS, Electrical Engineering, University of New Brunswick, Fredericton, Canada
Ph.D., Electrical Engineering, McGill University, Montreal

Think of yourself driving through a construction zone at night when it is rainy, misty, and foggy! You switch from familiar pavement markings to the unfamiliar and unforgiving concrete dividers with single narrow traffic lane. It could be a very stressful experience. The project seeks to develop a low cost solution to provide active lighting along the concrete dividers similar to driveway lighting at homes or runway lights at airports. These reflector size lamps will be visible from a distance even under rainy and foggy conditions, and help guide the motorist through the construction site or in situations where there are sharp bends on the exit road.

Since the devices will be used outdoor without provision for utility connection, dc battery with solar charging is the power source. The project investigated two approaches for formulating power efficient designs. The first approach uses Light Emitting Diodes assembled in a matrix form much like the type of lighting now being implemented for traffic lights and automobiles. The second approach employs EL (Electro-Luminescent) technology that has the potential for superior performance for its low power requirements. However, it requires a high voltage ac driver, and the research has been successful in developing highly efficient dc to ac inverter which can be powered by solar power. Both the systems were field-tested at a construction zone on HWY 270 in Hot Spring under actual environmental condition. The results are promising enough for MBTC/AHTD to extend the grant funding for Phase II to evaluate motorists' perception of the new lighting system.

Dr. Patangia's general focus is ITS (Intelligent Transportation System) with particular interest in harnessing solar power for early warning or traffic guidance system to enhance motorists' safety in highway travel. The system can also be adapted for other mode of transportation.

Work Zone Safety Video Awards

AHTD and Mack-Blackwell Center Win Work Zone Safety Awareness Award

The Arkansas State Highway and Transportation Department and the Mack-Blackwell Rural Transportation Center at the University of Arkansas are the recipients of the 2005 Roadway Work Zone Safety Awareness Award, sponsored by the American Road & Transportation Builders Association and the National Safety Council.

The award was presented to Farrell Wilson, special projects coordinator for the AHTD, and Melissa Tooley, former director for Mack-Blackwell Rural Transportation Center at the University of Arkansas, on September 29th during the 2005 Intertraffic North America Trade Show and Convention in Baltimore, Maryland.

The competition recognizes outstanding efforts to help reduce roadway work zone construction accidents, injuries and fatalities. The awards are divided into four categories: private outreach campaigns, government outreach programs, safety training and innovations in technology. An independent panel of judges reviewed the entries and selected the winners. The joint submission by AHTD and the Mack-Blackwell Rural Transportation Center was the single winner in the safety training category.

"Work zone safety is a top priority of AHTD. Ensuring that every engineer, inspector and construction worker is fully trained in safe work zone designs protects motorists and all the men and women who are working to construct and maintain Arkansas' highways," said AHTD Director Dan Flowers. "We are honored that this partnership project with the Mack-Blackwell Rural Transportation Center has been recognized in this way by ARTBA and the National Safety Council."

Gattis produced the videos with funding from Mack-Blackwell Rural Transportation Center and AHTD, along with filming and editing by the university's media services department. He designed this instructional video tool to allow inspectors and workers to see work zone situations and potential hazards as they develop and change over time. The series offers five productions ranging in length from 15 to 30 minutes and uses a blend of narration, on-camera spokespeople, and round table discussion to explain construction scenes, graphics and illustrations of actual work zone areas. The series has been promoted and distributed to all AHTD field offices for inspection personnel to review as needed. The videos have also been distributed upon request to outside organizations.

Highway work zone safety is an important issue in the United States. According to the Federal Motor Carrier Safety Association, 768 people are killed and another 40,000 are injured in motor vehicle crashes each year in highway work zones. Sixteen percent of these fatalities involve non-motorists, and 24 percent involve large trucks.

"The videos contain the same information that can be found in the 'Manual on Uniform Traffic Control Devices,'" Gattis explained. "But the videos allow us to show terrain features and other visuals to make the information more understandable. A work zone is a dynamic situation and a written manual can't show that."

These are the five award-winning videos Gattis has produced on work zone safety:

- Drop-Offs instructs highway workers on the proper way to ensure worker and motorist safety in areas where there is a significant difference in the level of the pavement surface and the level of the road work surface.

- Diversions trains personnel on the proper procedures to use when diverting traffic around a work zone to ensure maximum safety.

- Signs of Work demonstrates the proper use and placement of signs indicating highway construction activity.

- Lane Closures shows how to properly and safely mark and close lanes of traffic in work zones.

- Pavement Markings includes instructions for workers that are helpful in making good decisions about the placement of highway pavement markings, which can often change during construction.

Gattis has also released a sixth video called Driving in Orange. It is intended to inform the general public on safe driving practices in work zones. "Our inspectors put safety first all of the time. Safe travel for the public is the biggest part of their job," said Flowers. "These videos serve as a review for new employees to make them aware of the standards we need to follow. Professor Gattis made the videos accurate and easy to understand."

Student Success

Minh Le Honored as Mack-Blackwell Outstanding Student of the Year

The 15th Annual Outstanding Student of the Year Awards ceremony took place in conjunction with the Transportation Research Board (TRB) 85th Annual Meeting in Washington, DC, in January 2006 as part of the Council of University Transportation Centers (CUTC) annual banquet.

For the past 14 years, the U.S. Department of Transportation (USDOT) has honored an outstanding student from each University Transportation Center (UTC) at a special ceremony held during the TRB Annual Meeting. Each student receives $1,000 plus the cost of attendance at TRB from his/her Center, along with a certificate from USDOT. In addition, the CUTC banquet features a key speaker from the transportation field and provides its own awards for university transportation research and education.

Minh Le was brought by his parents to the United States when he was four years old. He received his BSCE degree from the University of Minnesota in 1997. He then began working for Metroplan, the central Arkansas metropolitan planning organization. His responsibilities at Metroplan have included developing short- and long-range transportation plans, modeling travel demand, conducting travel-time surveys, developing roadway cross section standards, reviewing roadway design plans, and estimating project costs.

In 2005, Mr. Le took a leave of absence from Metroplan to pursue a Master of Science in Civil Engineering (MSCE) degree at the University of Arkansas, with an emphasis in Transportation. “In his time at Metroplan, Minh became well-known for his ability to build consensus within the community. He is a perfect example of how transportation education opportunities provided by the UTC program can benefit working professionals. I am very proud to honor Minh with our Student of the Year award,” said Melissa Tooley, former Director of the Mack-Blackwell Rural Transportation Center.

Mr. Le conducted research funded by the Arkansas Highway and Transportation Department and the Mack-Blackwell Rural Transportation Center to examine correlations between factors that, if not taken into account, may skew or distort the analysis of the safety effects of various multilane roadway cross section designs. The findings are expected to help in comparing the relative safety of four-lane, five-lane, and raised/depressed median arterial roadways. Minh graduated in May of 2006.

New Projects

MBTC 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.
Civil Engineering
University of Arkansas

Over ninety percent of pavements in Arkansas and the surrounding region are surfaced with hot-mix asphalt (HMA). Current HMA mix design procedures, particularly Superpave, produce HMA mixtures that have proven to resist rutting and cracking (fatigue). However, on occasion HMA is placed and experiences premature distress – rutting, fatigue cracking, stripping, raveling, etc. – early in the life of the pavement. HMA may also be placed that does not fully meet applicable quality control standards, i.e. binder content, air voids, density, etc. In addition, it may be desirable to assess the current condition, and potential future performance, of a pavement that has been in service for a number of years. In many of these situations, it is difficult to assess the quality of the asphalt layer in terms of its future expected performance. A set of forensic tools are needed to assess the "remaining life" of a hot-mix asphalt layer in-situ; such tools may provide highway agency personnel data necessary to determine immediate and/or future reconstruction/ rehabilitation measures to be taken. This research will focus on a number of non-destructive test (NDT) methods and procedures that hold promise as forensic tools for the assessment of hot-mix asphalt. The objectives of this study will be to:

- Evaluate non-destructive test (NDT) methods and procedures for characterizing hot-mix asphalt in-situ,
- Develop methodologies for using NDT results for estimating the remaining life of hot-mix asphalt,
- Identify any materials tests (destructive) necessary to estimate remaining life, and
- Develop a field inspection guide for hot-mix asphalt pavements regarding suspect HMA mixtures.

The direct application of the proposed research will be to highway agencies and municipalities charged with the construction, maintenance, and rehabilitation of HMA pavements. Project implementation products will include a field inspection guide for HMA pavements; testing procedures and specifications for conducting non-destructive and (potentially) destructive tests for HMA pavement evaluation; and assessment procedures for estimating the remaining life of in-service hot-mix asphalt concrete.

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

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

The use of prestressed concrete bridges in Arkansas is becoming more common. The increase in steel costs has contributed to the popularity of prestressed bridge girders. Prestressed girders are particularly common in areas that border neighboring states (and these areas are also typically rural).
Self Consolidating Concrete (SCC) is a recent advancement in the concrete industry. SCC is a type of concrete that can be placed without consolidation and is beginning to be widely accepted. Some states are allowing the use of SCC bridge girders. SCC is not much different from conventional concrete. The constituent materials are the same, but SCC typically contains more fine aggregate and cement, but less coarse aggregate. These differences may affect the creep behavior, shrinkage, and modulus of elasticity of SCC specimens when compared to conventional concrete specimens. These differences may also contribute to greater prestress losses than those predicted by AASHTO LRFD Bridge Design Specifications. The loss (or gain) in prestress force has little effect on the design strength of the girder. The main concern is the potential effect to service load behavior (camber, deflections, or cracking moment) which affects the quality of ride for the bridge. AASHTO LRFD Bridge Design Specifications allows for the use of other methods for calculating prestress losses, and one goal of the research program is providing information to AHTD and other designers on the accuracies of each method.

MBTC 2072 - Roundabout Feasibility Study for West Memphis, Arkansas, as a Prototype for Intersection Improvements Around Interstate Overpasses

John V. Crone, M.Regional Planning
Landscape Architecture
University of Arkansas

Otto Loewer, Ph.D., P.E.
Carolyne Garcia, Ph.D.
Economic Development Institute
University of Arkansas

Transportation agencies are often faced with questions from communities concerning the safety and aesthetics of off/on ramps and intersections located below aging and unsightly interstate overpasses in the many rural-to-rapidly-urbanizing areas in Arkansas. A key issue is the challenges encountered by the citizens in their attempts to implement economic development projects, a crucial concern for the Arkansas Delta. These challenges are mirrored by those facing the Arkansas Highway and Transportation Department in dealing with citizens who have substantive issues, but may not understand the technical and regulatory constraints.

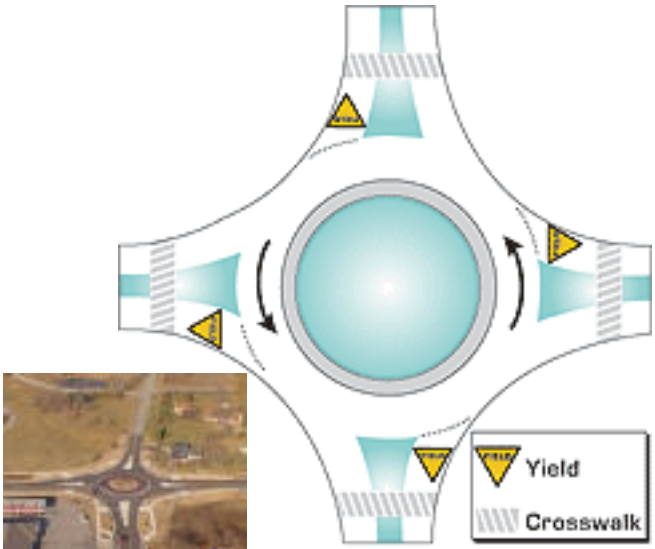
The proposed two-phase project will study the feasibility of interstate bridge and intersection design solutions - including roundabout designs - and develop a model for community-based transportation planning that will facilitate the interface between community stakeholders and the agencies implementing infrastructure modifications. Phase I includes analysis and presentation for community and agency approval of formal design options to advance transportation efficiency, public safety, and visual enhancement as a response to increasing population growth and economic development in West Memphis, Arkansas. Based on the results, Phase 2 will focus on development of a community-based expert-system planning model that could be used to address similar transportation issues throughout the Arkansas Delta and beyond.

MBTC 2073 - Effects of Freeway Frontage Road Conversions

James L. Gattis, II, Ph.D., P.E.
Civil Engineering
University of Arkansas

Some freeway frontage roads were originally constructed and operated as two-way roadways. Over time, changes in land development patterns, increased traffic volumes, and an increase in the number and/or severity of crashes may dictate converting the frontage roads to one-way operation. It is not uncommon for these changes to accompany the spread of urban development into previously rural areas.

Although one-way operation may eliminate certain vehicle conflict patterns and result in a safer corridor, the perceived increased travel time and the indirection required to reach tracts along the frontage roads can produce protests from abutting property owners. Documenting the tradeoffs that occur as a result of conversion would help the decision makers and guide future frontage road conversions. This study will continue parts of a previous September 2002 through June 2004 AHTD study that examined changes in certain measures associated with frontage road conversion.



MBTC 2074 - Evaluation of Pavement Thickness and Modulus Using Spectral Analysis of Surface Waves

Norman D. Dennis, Jr., Ph.D., P.E.
Civil Engineering
University of Arkansas

Currently the Arkansas State Highway and Transportation Department has no non-destructive testing (NDT) device to measure the thickness of various components of pavement systems. When pavement thicknesses are needed in Falling Weight Deflectometer (FWD) analyses and similar pavement life studies they must be determined by physical drilling or coring of the pavement structure. This is a very costly alternative which provides only spot measurements at the locations selected for coring. It could also lead to premature pavement deterioration in the vicinity of the coring if the patching of the pavement is not performed correctly. Ideally, pavement thickness would be determined at each location where FWD measurements are made in a non-destructive manner. While several alternative NDT techniques could be used to determine pavement thickness, only one is currently available that can measure pavement thicknesses and simultaneously provide an estimate of dynamic moduli in a cost effective manner. Two NDT tehniques that are most commonly used to make thickness measurements are Spectral Analysis of Surface Waves (SASW) and Ground Penetrating Radar (GPR). GPR has been used with great success in areas where there is no ground water table present and concentrations of plastic fines are very low. While the GPR device can make rapid measurements, the presence of either of these complicating conditions severely affects the accuracy of the GPR device in determining pavement thicknesses. Additionally the GPR device only measures changes in material conductivity to determine interfaces and does not do a good job in predicting the absolute value of that conductivity which could be correlated to the modulus or density of the material in the sampled cross-section. The use of SASW to determine thickness and modulus of pavement sections has been widely reported for over 15 years. Its use has been limited by highway departments, however, because the existing SASW hardware is cumbersome and time consuming to set up in the field and the technique requires highly trained technicians to interpret the results. The goal of this research is to create a truly portable and self contained device with associated software that would make the process of determining pavement thicknesses quick, easy and accurate for moderately trained highway personnel. Such a device would have the potential for replacing the FWD device altogether.

MBTC 2075 - Non-Nuclear Methods for Density Measurements

Stacy G. Williams, Ph.D., P.E.
Civil Engineering
University of Arkansas

In-place density is a key property when constructing asphalt pavements. Non-nuclear technology is now available for testing this property, having the advantage of taking many measurements quickly and easily, while not requiring special training or licensing for purchase, use, or transport. Early studies discouraged the use of such devices due to poor correlations with traditional test methods. However, recent technological advancements indicate improved capabilities. In light of these advancements, this type of device should be evaluated to determine its applicability to QC/QA testing in Arkansas. Specifically, the testing variability of this device should be measured, and factors affecting the measurements should be analyzed. Potential factors include nominal maximum aggregate size, pavement density, gradation, pavement thickness, mat temperature, joint smoothness, and moisture content.

MBTC 2076 - Physical and Chemical Characteristics of Superpave Binders Containing Air Blown Asphalt From Two Different Feedstocks
John R. Hardee, Ph.D.
Chemistry
Henderson State University

In project MBTC 2049 a series of asphalt blends containing air blown asphalt were characterized using chemical and physical methods of analysis. Some of the conclusions of this project are:

1. Air blowing asphalt increases the amount of asphaltenes and decreases the levels of saturates, aromatics, and resins. The weight percent asphaltenes ranges from 7.8% in a blend containing no air blown material to 32.8% for pure air blown asphalt. The asphaltene level increases linearly with the percent air blown asphalt in the blend.

2. An infrared study on blends aged at 88 degrees Celsius and 1 atmosphere showed a PG64-22 blend prepared from 39% air blown asphalt and 61% flux aged 5.5 times faster than a PG64-22 with no air blown asphalt.

3. Inverse Gas Liquid Chromatography using phenol as a test compound showed that air blown blends had higher phenol interaction coefficient values than those measured for non air blown blends implying inferior road performance for blend containing air blown asphalt. IGLC results confirm higher rates of oxidation for blends containing air blown asphalt.

4. Gel permeation chromatography (GPC) showed air blowing increases the molecular weight of asphaltene molecules. The subsequent increase in intermolecular forces due to this increase in molecular weight explains the increase in stiffness that results from air blowing.

These results were for a particular feedstock obtained in southern Arkansas. In this project, these same physical and chemical methods will be used on air blown blends from two additional feedstocks to broaden the knowledge base of air blown blends and to determine if any of these conclusions are feedstock dependent. One asphalt will come from a company that advertises air blown asphalt and the other will come from a company that uses air and heat during the refining process, but does not claim to air blow asphalt.

MBTC 2078 - Evaluation of Economic Impacts of NAFTA on the Transportation System / Sector of Selected Southern States
Gregory Hamilton, Ph.D.
Institute for Economic Advancement
University of Arkansas at Little Rock

There is a close interaction between transportation activities and international trade, economic growth, economic development efforts, various public policies, and geographic endowments. The NAFTA has profoundly impacted transportation services both directly and indirectly. The development of trade corridors often furnishes the formation of transportation corridors, which are an integrated transportation system including highway, rail, and airlines. Each transportation mode is related to private cargo and passenger services, public investment on infrastructure, and the related manufacturing and construction activities. A study is needed to assess both the short-term and long-term effects of NAFTA on current trade patterns, commodity flows, and future transportation needs along major trade corridors. The analysis will focus on highway capacity issues, industrial trends, and economic development planning as related to rural areas and regional development patterns.

MBTC 2079 - A Safety Analysis of Driver Reaction to Alternative Traffic Control Devices at Rail-Highway Grade Crossings

Eugene R. Russell, Ph.D.
Civil Engineering
Margaret J. Rys, Ph.D.
Industrial & Manufacturing Systems Engineering
Kansas State University

The majority of highway-rail grade crossings on rural roads in the Midwestern states do not warrant automatic signals and gates, however, the potential for catastrophic crashes is always present. For example, on any given day several hundreds of school buses cross these grade crossings. Catastrophic crashes in other states have led to renewed national emphasis on alternative approaches and policies that states need to consider. There is growing national pressure to use a STOP or YIELD sign at all grade crossings. Many believe this is not the answer. A safety study analyzing driver reaction to these options is needed to determine the safest signing system. Where railroad tracks parallel state highways, there are many with limited space and a potential risk to school buses, large/long vehicles and farm equipment that need special consideration.

A team of Kansas State University (KSU) researchers and a team of Kansas Department of Transportation (KDOT) employees will jointly conduct the research necessary to collect and analyze the necessary data that will lead to conclusion and guidelines to mitigate these risks.

On passive signage, there is an initiative to sign all passive crossings with an additional “STOP” or “YIELD” sign. This is a valid initiative, but there needs to be research to set guidelines for the distinction on the use of these two signs. This research will provide an analyzes of drivers’ reaction leading to guidelines to help states make the decision of “STOP” versus “YIELD” and, through literature searches and personal contact, associated other details such as; signs mounted on X-buck post or separate post, need for advance “STOP AHEAD” or “YIELD AHEAD” signs, who installs, who pays, who maintains, etc.

In Kansas and throughout the Midwest there are many transportation corridors that are shared by Railroads and Highways. In a few instances there isn’t adequate storage space between the crossing and the intersection to safely store a legal length vehicle. Where there are signalized crossings and intersections it is possible to interconnect the systems to provide clear out times for the vehicles in this area between the crossing and the intersection. In situations where both are signed passive and the storage space is less than 100 feet, Kansas signs the crossing with a “STOP” sign and the intersection with a “YIELD” sign. There are also a few instances where Kansas has “STOP” signs on crossings with flashing lights and gates (a “shall not do” in the MUTCD) and a “YIELD” at the passive signed intersection. This research will study the effectiveness of these techniques and develop general guidelines for the most effective ones for all states that have these conditions, i.e., most Midwestern states.

MBTC 2080 - Effects of Not Wearing Safety Belts on Injury Severity

Sunanda Dissanayke, Ph.D., P.E.
Civil Engineering
Kansas State University

While almost all Americans are using the transportation system on a daily basis, safety remains one of the most important issues. Motor vehicle crashes are the leading cause of death for ages 2 to 33 years. Total number of fatalities stands around 42,000 and number of injuries is in millions making the total estimated economic losses to be more than $230 billion. While there are many contributing causes to this situation, seat belt usage or lack there of has a very significant impact on the outcome of the crash.

Severities of crashes seem to have a direct relationship with the safety belt usage as indicated by statistics. Based on 2002 data for the State of Kansas for example, only 27.4 percent of fatally injured occupants wore seat belts, and the usage rates for injured and unharmed occupants were 71.5% and 84.3% respectively. It is important to evaluate the effect of not wearing seat belts on the outcome of the crash, i.e. injury severity. This would then be converted to an equivalent monetary amount for the ease in comprehension by the general public, which would be helpful in developing new or improved public policy decisions related to safety belts.

Most importantly, the type of seat belt law (Primary vs Secondary) has a significant effect on the safety belt usage rates. As of 2003, there were 30 states with secondary seat belt law, where the safety belt usage rates varied from 52% (Maine) to 86% (Arizona) and the average was 73.3%. For other 20 states including District of Columbia which had the primary seat belt law, the usage rate varied from 74% (Louisiana) to 95% (Washington) and the average rate stood at 84.45%. In average states with primary enforcement have seat belt usage rates that are 10-15% higher than states with secondary enforcement. Additionally, usage rates in rural areas have found to be lower than average level, even though majority of fatalities occur in such areas, making this an issue that is worth investigating.

MBTC 2082 - Ancillary Benefits of the Ouachita River Navigation System

Heather Nachtmann, Ph.D.
Industrial Engineering
University of Arkansas

The Ouachita River, one of five designated commercially navigable waterways in the state, is economically and socially beneficial to the region's communities and industries. The river provides barge service via two public ports in addition to privately owned terminals and riverfront industrial sites. The Ouachita has been classified as a "low-use river" and is at high risk of losing its federal funding for maintenance and operation. This study investigates the ancillary benefits of the Ouachita River Waterway to the State of Arkansas including but not limited to recreation, tourism, commercial shipping, water supply and electrical generation. A concise reporting of these benefits will be provided with the goal of providing information that may be useful in seeking ongoing funding of the river.

MBTC 7015 - Assessment of Multimodal Transport of Baled Poultry Litter and Dewatered Biosolids from Northwest Arkansas

H.L. Goodwin, Jr., Ph.D.
K.B. Young, Ph.D.
Agricultural Economics and Agribusiness
University of Arkansas

Stakeholders in the Ozarks region have expressed concern over the degradation of surface water, with the poultry industry and municipal wastewater plants cited as possible contributors. Exporting poultry litter and municipal biosolids is a possible approach for ameliorating the excess nutrient situation and to improving water quality in the Northwest Arkansas (NWA) region.

Handling and truck-transporting raw poultry litter and dewatered biosolids out of the region is costly. Processing approaches such as pelleting and granulating reduce volume by roughly 10% but are expensive. A less expensive processing and transport combination must be found if poultry litter and biosolids are to be marketed as a crop nutrient source.

Mammoth Corporation (Spokane, WA) and the U of AR Division of Agriculture collaborated to develop technology for plastic-wrapping baled litter and biosolids and to evaluate their quality (USDA-SBIR 2004). We expect the results of this project to be useful in addressing excess nutrient issues in the NWA region and to serve as groundwork for solutions to similar problems elsewhere.

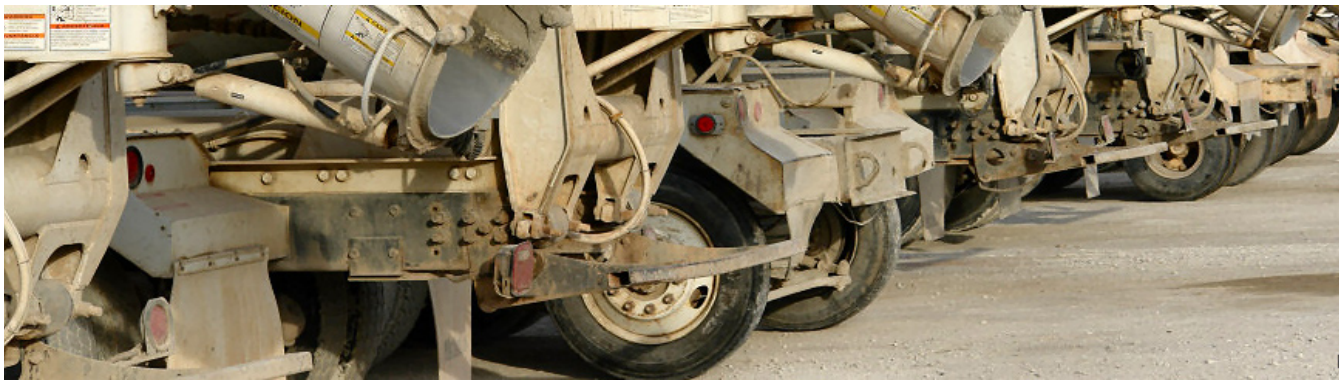
In Washington State, poultry litter produced from varying moisture contents (approx. 25%, 40%, and 55%) was plastic-wrapped with a modified municipal solid waste baler and stored outside for a period of three months.

The bales were transported from Spokane to Prairie County, AR on a flatbed truck; the baled litter was land-applied under typical field conditions. Field handling and spreading posed no major difficulties, especially at moisture levels around 40%. Preliminary pathogen tests revealed no salmonella or E. coli in the baled litter. Nutrient tests indicated that inorganic nitrogen was present in a form not susceptible to volatilize as ammonia, demonstrating that baled poultry litter can be land-applied without requiring soil incorporation.

Co-processing poultry litter and biosolids has never been done, but we expect it to be a cost-efficient and cutting-edge means of deriving the benefit of these products while eliminating potential biosecurity and sanitary threats. Processing both products into bales is expected to eliminate pathogens that are usually present in litter and biosolids, take advantage of the nutrients in both products, and reduce potential nitrogen losses.

Unlike other litter and biosolids materials, plastic wrapped bales can be transported in a variety of truck trailers; thus truckers can take advantages of more backhaul opportunities. The UV plastic wrapped bales can be stored outside at their destination, reducing the need for storage and double handling costs at the market end.

Two types of transport methods will be investigated: truck and a combination of truck and barge. Young et al. compared these options in the shipment of poultry litter in raw and baled forms from Northwest to Eastern Arkansas and found that while truck transport of bales is cost effective to supply nearer nutrient markets, a truck and barge combination is more cost effective.



MBTC 2083 - Human Factors Study of Driver Assistance Systems to Reduce Lane Departure and Side Collision Accidents

Steve L. Johnson, Ph.D., P.E., C.P.E.
Industrial Engineering
University of Arkansas

The objective of the effort is to address the human factors issues related to driver assistance devices that are designed to reduce the frequency and severity of lane departure and side collisions accidents. Due to the low frequency of accidents that are associated with the scenarios addressed by these systems, it is very difficult for any one fleet to conduct a valid study of the device effectiveness. By combining the experience from a number of fleets the effective "sample size" will be sufficient to provide reliable, valid and generalizable results and conclusions. The study will provide valuable information as to the operational effectiveness of the various systems. An important component of system effectiveness is acceptance and proper use by the drivers. An important objective of the study is to establish the best methods for fleet managers to use the information provided by the various systems toward the goals of modifying driver behavior, improving safety and reducing costs.

The effort will address four specific issues related to driver assistance devices designed to reduce the frequency and severity of lane departure and side collisions accidents.

1. Does the use of these devices actually reduce the incidence and severity of crashes or near crashes.
2. Does the use of these devices modify driver behavior either positively (i.e., by increasing attention) or negatively (i.e., as a "crutch" that results in reduced attention).
3. Does the effectiveness of these devices differ depending upon the characteristics of the drivers (i.e., new or experienced) or the driving scenario (long-haul vs. short-haul, flatbed, tanker, etc.).
4. From the management standpoint, how can the data from these systems most effectively be used to positively modify driver behavior and provide user/driver acceptance of the systems.

MBTC 2084 - Development of an Intermodal Container Load Status and Security Monitoring System

Roy McCann, Ph.D., P.E.
Electrical Engineering
University of Arkansas

This research will develop an intermodal container security monitoring system that incorporates recent advances in signal processing, microsensors (MEMS), and wireless remote monitoring of commercial vehicles and assets. In addition, one of the focus areas for Homeland Security Initiatives is to improve the security and monitoring capability of intermodal shipping containers. These containers transport goods throughout the world by sea, rail, and truck using a standardized configuration that allows easy transfer between modes. The hazard is that this transport method is susceptible to illegal use by hostile and malicious groups. In addition, during transit and loading between modes, the container contents may shift and result in a safety hazard for human operators during unloading and subsequent transport.

The objective of this research is to develop a low cost method of continuously monitoring the status of intermodal containers. The proposed technology is based on acoustic signature analysis using real-time wavelet transforms. This method has been introduced in automotive applications for diagnostic monitoring of internal combustion engines and passenger compartment noise cancellation. The principle is that a structure such as an intermodal container can be excited with a broadband acoustical impulse, and the time-varying frequency content of the echo is indicative of the load status (door open/shut, empty, partially loaded, full, container breach from hole cutting, etc). This method has been shown to reject ambient noise conditions such as wind noise and road vibration. In addition, the system can be configured to self-diagnose for failures and tampering.

Existing methods for monitoring intermodal containers have attempted to use conventional security and surveillance technologies such as video camera and infrared or ultrasonic proximity detectors in a line-of-sight configuration. These

systems have had limited success due to high cost, high failure rates in the severe temperature and vibration environment of intermodal containers, and poor accuracy in detecting cargo conditions due to the highly variable materials/configurations encountered in real-world freight transport. In addition, intermodal containers are often untethered and stored in a freight yard for long periods of time, resulting in battery drain of the monitoring system. This research will develop an alternative approach by extending the recent advances in digital signal processing techniques. In particular, low cost digital signal processors that operate at low voltage conditions with sleep/hibernate modes for low power consumption are now commercially available. In addition, research since the early 1990's has developed methods to discern frequencies of interest from background noise that would be encountered during rail or truck movement.

The principle steps in conducting this research are:

- Survey currently deployed technologies and report on strengths and deficiencies in performance.
- Create an understanding of the acoustical characteristics of intermodal containers by measuring representative samples from existing fleet equipment.
- Design, build and test acoustic transducer and receiver equipment.
- Research and develop signal processing algorithms suitable for determining container status.
- Validate and verify results in representative fleet equipment.

MBTC 2085 - Homeland Security for Rural Transportation Networks

Heather Nachtmann, Ph.D.
Edward H. Pohl, Ph.D.
C. Richard Cassady, Ph.D., P.E.
Industrial Engineering
University of Arkansas

Multiple agencies have conducted comprehensive vulnerability assessments of rail and transit networks in high-density urban areas. This project addresses vulnerability assessment of rural transportation networks. There are clear differences between rural transportation networks and those in urban areas including higher costs due to widely dispersed population and industry. Exploration of rural transportation security issues is important because these networks are essential for enabling commercial shipping and linking rural residents with distant services. This research investigates whether or not the results of urban assessment studies can be applied to rural transportation networks and seeks to identify appropriate scalability and adaption procedures and/or guidelines for conducting rural transportation vulnerability assessments. Multiple modes of rural transportation including highways, inland waterways, and rail will be considered.

Ongoing Projects

MBTC 2006 -Investigation of the Long Term Stability of Highway Slops, Phase III

Norman D. Dennis, Jr., Ph.D., P.E.

MBTC 2007 - Estimating Subgrade Resilient Modulus for Pavement Design

Norman D. Dennis, Jr., Ph.D., P.E.

MBTC 2008 - Automation of Pavement Surface Distress Survey through Parallel Processing

Kelvin C.P. Wang, Ph.D., P.E.

MBTC 2026 - Using Multi-Spectral Satellite Imagery to Enhance Slope Failure Prediction

Norman D. Dennis, Jr., Ph.D., P.E.

MBTC 2027 - Investigation of the Affect of Fines on Base Course Performance

Norman D. Dennis, Jr., Ph.D., P.E.

MBTC 2030 - Development of 4.75 mm Superpave Mixes

Stacy G. Williams, Ph.D., P.E.

MBTC 2034 - Community Impact of Regional Transportation Insfrastructure; Revisited After Completion of Airport and Major Highway

Will Miller, Ph.D.

MBTC 2037 - Route and Site Characterization Using Multi-Spectral Satellite Imagery

Norman D. Dennis, Jr., Ph.D., P.E.

MBTC 2040 - Supplemental Signing for Stop Signs – Phase 2

James L. Gattis, II, Ph.D., P.E.

MBTC 2042 - Automated Survey and Visual Database Development for Airport and Local Highway Pavements

Kelvin C.P. Wang, Ph.D., P.E.

MBTC 2047 - WebShipCost – A Geographical Information System for Waterway Utilization

Manuel D. Rossetti, Ph.D., P.E.

MBTC 2053 - Development of an In Situ Permeability Device for Concrete Strutures

W. Micah Hale, Ph.D., P.E.

Mr. Mark L. Kuss

MBTC 2054 - A Comprehensive Study of Field Permeability Using the Vacuum Permeameter

Stacy G. Williams, Ph.D., P.E.

Mr. Mark L. Kuss

MBTC 2055 - Roadway Median Treatments

James L. Gattis, II, Ph.D., P.E.

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

Kelvin C.P. Wang, Ph.D., P.E.

MBTC 2057 - Independent Graduate Assistantship – Comparison of the Evaluator of Rutting and Stripping of Asphalt with the Rotary Asphalt Wheel Tester (Bret Taylor)

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

MBTC 2058 - Biodiesel Production from Varying Grades of Beef Tallow and Chicken Fat

Robert E. Babcock, Ph.D., P.E.

Edgar C. Clausen, Ph.D., P.E.

Michael P. Popp, Ph.D.

MBTC 2061 - Modeling, Assessing and Managing Risk in Transportation Systems

Edward H. Pohl, Ph.D.

MBTC 2062 - Total System Cost/Benefit Assessment of Heavy Truck-Automobile Speed Differentials on Rural Highways

Steven L. Johnson, Ph.D., P.E., C.P.E.

MBTC 2063 - Highway Collison Warning Technology: Determination of Criteria for Detecting and Logging Hazardous Events in Tractor-Trailer Safety and Training Programs

Roy McCann, Ph.D., P.E.

Steven L. Johnson, Ph.D., P.E., C.P.E.

MBTC 2064 - Assisted Night Vision for Motorists in Highway Construction Zones: Phase II (Field Testing & Assessment)

Hirak C. Patangia, Ph.D

John M. Faucett, Ph.D.

MBTC 2065 - Automated Inventory and Analysis of Highway Assets

Kelvin C.P. Wang, Ph.D., P.E.

MBTC 2066 - Surface Friction Measurements of Fine-Graded Asphalt Mixtures

Stacy G. Williams, Ph.D., P.E.

MBTC 2067 - Roadway Median Treatments

James L. Gattis, II, Ph.D., P.E.

MBTC 2068 - Freeway Management Deployment Plan and Regional Architectural Development

Melissa S. Tooley, Ph.D., P.E.

MBTC 9202 - Supplemental Materials for use with Educational Videotapes

John J. Schemmel, Ph.D.

Completed Projects

Development of Testing Protocol and Correlations for Resilient Modulus of Subgrade Soils
MBTC 2032
Norman D. Dennis, Jr., Ph.D., P.E.
Civil Engineering
University of Arkansas

This study provides both a description of the theoretical aspects of Spectral Analysis of Surface Waves (SASW) method for determining the thickness and resilient moduli of pavement systems, and presents the results of testing performed using an SASW system assembled as part of this research. The SASW method is based on the dispersive behavior of surface waves in a layered medium. Dispersion is the term used to describe the fact that the rate at which seismic surface waves (Rayleigh waves) travel through a medium depends upon the frequency of the waves, and this dependency can be used to determine mechanical properties of the medium through which the waves travel. Plotting Rayleigh wave velocity versus frequency (or wavelength) produces a graph called a dispersion curve. This dispersion curve can be used to develop a modulus versus depth profile through the use of a backcalculation procedure. Once the modulus versus depth profile is known, the resilient modulus and thickness of individual layers can be directly obtained.

The results obtained from SASW testing at ten flexible pavement sites throughout the state of Arkansas are presented as part of this report. The thickness and resilient modulus of each layer of each pavement section are estimated from the SASW data using two methods of analysis; simple inversion, and software provided by the University of Texas at El Paso. The thickness results obtained from SASW analyses are compared to known thicknesses measured from cores taken at each of the test sites. The resilient moduli predicted by SASW analysis are compared to the resilient moduli predicted by laboratory resilient modulus testing, the resilient moduli predicted by FWD analysis, and to Standard Penetration test N-values. The simple inversion procedure provided the most consistent results for SASW testing. SASW methods proved to be very accurate in predicting the thickness of various layers in a pavement system and correlated well with the results from laboratory resilient modulus testing.

Physical, Economic, and Political Feasibility for Trade of U.S. Grain for Russian Oil
MBTC 2038
C. Ray Asfahl, Ph.D., P.E.
Industrial Engineering
University of Arkansas

This project explores the feasibility of an agreement to trade U.S. grain for Russian oil. Circumstances in the market prices of U.S. grain and world oil prices have set the stage for new initiatives in exploring economic benefits to both countries to be gained from such a trade agreement. Physical issues such as containerization and the feasibility of shipping these two dissimilar commodities via the same ocean-going ship will be examined, thereby avoiding deadheading. Economic issues to be considered include the histories of grain and oil prices and the feasibility of striking ratios between them. Freight costs and the logistics of the intermodal transportation of these commodities from production to port, port to port, and port to point of use are additional economic considerations. Political issues to be explored are the effect of recently imposed tariffs and embargoes on other commodities, private and public authority to negotiate trade agreements between parties located in the respective countries, and comparative safety, environmental, and other regulations that could pose barriers to a U.S./ Russia trade agreement. The project will set the stage for the negotiation of a trade agreement or will point out why such an agreement is either impossible or infeasible at this point in history. The principal potential advantage will be to the rural economies of grain producing states, with an additional benefit from supplying a new source of oil to the United States.

Cost Efficient Management Tools for Assessing Cultural Resources
MBTC 2044
George Sabo III, Ph.D.
Lela Donat, Ph.D.
Arkansas Archeological Survey
University of Arkansas

Several key components were completed for the Arkansas Archeological Survey's (Survey) database system, called AMASDA (Automated Management of Archeological Site Data in Arkansas). AMASDA contains information on over 40,000 Native American and historic sites and more than 5100 archeological projects in Arkansas. The AMASDA system consists of two Oracle databases (Site Files and Projects), linked to a statewide Geographic Information System (GIS) that provides environmental context for archeological sites and project areas. Two databases were updated: Radiocarbon Assays (information on radiometric dates) and Citations (bibliographic references to archeological publications and reports). Three new databases were created: 1) photographic images of archeological sites; 2) photographic images of representative artifacts from sites; and 3) illustrated text descriptions of over 200 archeological cultural phases/study units in Arkansas. These databases will significantly improve the process of identification and management of cultural resources as mandated for agencies such as the Arkansas Highway and Transportation Department (AHTD) under Section 106 of the National Historic Preservation Act of 1966 and related legislation. This project has moved the Survey much closer to our ultimate goal, which is to deliver the complete AMASDA system to AHTD and other state and federal agencies via the World Wide Web.

Total System Cost/Benefit Assessment of Heavy Truck-Automobile Speed Differentials on Rural Highways
MBTC 2048
Steven L. Johnson, Ph.D., P.E., C.P.E.
Industrial Engineering
University of Arkansas

Speed differentials between large trucks and automobiles on rural interstate highways are due to both state regulated speed limits and commercial trucking company policies that restrict maximum truck speeds. The initial portion of this effort involved a review of the research and applications literature pertaining to absolute and differential truck speeds on traffic flow, highway safety, and operational costs. Speed data were collected for both heavy trucks and automobiles on rural interstate highways with four speed limit configurations: two with uniform speed limits (75 mph and 70 mph) and two with differential speed limits (70/65 and 65/55). These highways were selected to represent the range of speed limits and posted speed differentials. Stakeholders were surveyed to obtain their opinions as to speed differentials and, more importantly, the basis of those opinions. Surveys were conducted of three stakeholder groups: commercial truck drivers, trucking company safety and operations personnel, and original equipment manufacturers. Using the information from the literature review, the empirical data collected, and stakeholder surveys, a cost-benefit analysis was conducted to addresses the financial issues related to maximum truck speeds. The information collected, analyzed, and documented in this report will assist both state regulatory agencies and trucking company decision makers when establishing policies related to maximum truck speed limits and speed differentials between heavy trucks and automobiles.

A Study of Physical and Chemical Characteristics of Superpave Binders Containing Air Blown Asphalt
MBTC 2049
John R. Hardee, Ph.D.
Chemistry
Henderson State University

Blends graded PG58-22 and PG64-22 were prepared from flux and hard asphalt. Blends graded PG64-22, PG70-22, and PG76-22 were prepared from flux and air blown asphalt obtained from air blowing flux for 6.5 hours in a 1.59 gallon container at a temperature range of 490 to 500oF and an air flow rate of 1.1 ft3/min.. One additional PG70-22 was included in the study that was prepared from air blown phosphoric acid modified asphalt and flux.

Complete Superpave testing was performed by the AHTD Materials Lab. Iatroscan analysis provided weight percent asphaltenes, resins, saturates and aromatics in each blend. An infrared aging study using the area under the carbonyl peak was performed at 88 degrees Celsius and 1 atmosphere on two different PG64-22 blends to look for differences in aging due to the presence of air blown asphalt. Nuclear magnetic resonance (n.m.r.), inverse gas liquid chromatography (IGLC), and gel permeation chromatography (GPC) were used to study each blend.

Assisted Night Vision for Motorists in Highway Construction Zones
MBTC 2050
Hirak C. Patangia, Ph.D
Engineering Technology
University of Arkansas at Little Rock

The goal of the project is to develop a low cost solution to provide a light emanating active reflector along the length of jersey barriers in construction zones. The project investigates two different technologies: Electroluminescent (EL) and Light Emitting Diode (LED) technologies. The EL technology is well known for its energy efficiency; however it requires a high voltage ac driver. The LED technology can be operated from a low voltage dc, but their power requirement is higher. For driving EL lamps, an efficient dc-ac inverter was researched and developed for the application. For the LED driver, Pulse Width Modulation (PWM) technique was employed to minimize power consumption. The systems were assembled at a construction zone in Hot Spring for field-testing. Fifteen lamps of each kind were installed on the barriers and powered from a 12V battery. The batteries were charged in the daytime through two solar panels (15” x 19”), one for each system. Electrical data were gathered for a period of more than three months. Both technologies performed well electrically, produced the desired effects, and solar power requirements were met. However the enclosures for the lamps needed further refinement to withstand the harsh conditions of UV, rain, and humidity.

Training and Course Materials for Transportation Applications of GIS
MBTC 9209
Manuel D. Rossetti, Ph.D., P.E.
Michael Cole, Ph.D., P.E.
Industrial Engineering
University of Arkansas

Due to the rapid growth of Geographical Information Systems (GIS) and Intelligent Transportation Systems (ITS), transportation engineers are required to be knowledgeable in the applications of these two techniques. The purpose of this project is to develop course and laboratory materials for a transportation logistics course (INEG 4633). The course covers various topics in transportations logistics, such as routing and location analysis, fleet sizing, and logistics facilities design that are of interest to engineers (especially Industrial and Civil engineers) and Transportation Logistics students from the Business Administration Department. The course also introduces the applications of GIS, Global Positioning System (GPS), and ITS technologies to transportation systems modeling and analysis. The course is available as an engineering technical elective primarily for civil and industrial engineering majors. In addition, the materials have been formulated into a short course format and made available via videotape and DVD. Course materials were also developed for use within a WebCT course offering. This document discusses the resulting course structure and materials developed for the course including a review of the GPS, GIS, and ArcLogistic Route learning modules developed for the course. Each of which can be utilized as stand-alone learning modules.

Publications Available

Characterization and Modeling

2004
Hardee, John R.
A Study of Physical and Chemical Characteristics of Superpave Binders Containing Air Blown Asphalt
MBTC 2049

2003
Kutanoglu, Erhan and Michael Cole
Modeling and Analysis of Transportation Flows Created by E-Commerce Transactions
MBTC 2012

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

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

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

2002
Kutanoglu, Erhan
Efficient Timing of Pickup and Delivery Assignment Decisions Through Simulation and Optimization
MBTC 2013

Physical Infrastructure Maintenance and Operations

2005
Patangia, Hirak C.
Assisted Night Vision for Motorists in Highway Construction Zones
MBTC 2050

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

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

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

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

2002
Wang, Kelvin C.P.
Automation of Pavement Surface Distress Survey Through Parallel Processing
MBTC 2008

Fleet Operational Management

2004
Mason, Scott J.
Integrated Analysis of Transportation and Inventory In Intermodal Distribution Networks
MBTC 2041

2002
Nutter, Darin W.
Determining Optimal Trailer Duty as a function of use and Age
MBTC 2017

2001
Kutanoglu, Erhan; G. Don Taylor, and Darsono Tjokroamid-jojo
Efficient Dispatching in a Terminal City Network
MBTC 2004

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

Transportation Planning, Economics, and Institutional Issues

2005
Asfahl, C. Ray
Physical, Economic, and Political Feasibility for Trade of U.S. Grain for Russian Oil
MBTC 2038

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

2004
Nachtmann, Heather
Economic Evaluation of the Impact of Waterways on the State of Arkansas – Phase I and II
MBTC 9207 and MBTC 9208

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

2003
Tooley, Melissa S.
Development of a Strategic Plan for Statewide Deployment of Intelligent Transportation Systems in Arkansas
2003 MBTC 2022

Tooley, Melissa S.
Regional Mobility Plan: Development of Technical Scope of Services
2003 MBTC 2009

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

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

Behavioral Sciences and Human Performance

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

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

2004
Johnson, Steven L.
Total System Cost/Benefit Assessment of Heavy Truck-Automobile Speed Differentials on Rural Highways
MBTC 2048

Transportation Education and Technology Transfer

2006
Rossetti, Manuel D. and Michael Cole
Training and Course Materials for Transportation Applications of GIS
MBTC 9209

2005
Dissanaykke, Sunanda
Identification of Countermeasures to Reduce Severity of Rural Highway Crashes
MBTC 2051

2004
Edwards, Findlay G. and Steven J. Burian
Training and Course Materials of Stormwater Pollution Prevention
MBTC 9210

Gattis, James L.
Work Zone Driving Public Service Instructional Video
MBTC 9211

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

2001
Gattis, James L.
Video Tapes/DVD's: Instruction in roadway work zone traffic control practices]
"Lane Closures"
MBTC 9203-A

Gattis, James L.
Video Tapes/DVD's: Instruction in roadway work zone traffic control practices]
"Pavement Markings"
MBTC 9203-B

Yaz, Edwin
Developing a course Entitled "Enabling Technologies in ITS"
MBTC 9015

1998
Gattis, James L.
Video Tapes/DVD's: Instruction in roadway work zone traffic control practices]
"Signs of Work" (15 min.)
MBTC 9014

Schemmel, John J. and Kevin D. Hall
[For primary and secondary students; transportation and civil engineering as a profession. Three age-appropriate segments on one videotape; each segment 6-8 minutes] "Check It Out" (gr. K-3) "Make It Happen" (gr. 4-8) "Back to the Future, Please" (gr. 9-12)
MBTC 9009

1997
Gattis, James L.
Video Tapes/DVD's: Instruction in roadway work zone traffic control practices]
"Drop-Offs" (15 min.)
MBTC 9003-A

Gattis, James L.
Video Tapes/DVD's: Instruction in roadway work zone traffic control practices]
"Diversions" (15 min.)
MBTC 9003-B

Construction, Design, Processes, Structures, Materials

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

2005
Edwards, Findlay G.
Environmental Technology Verification Report of the Low-Cost Stormwater BMP Study
MBTC 2018

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

Hardee, John R.
Physical and Chemical Characteristics of SuperpaveTM Binders Containing Air Blown Asphalt
MBTC 2049

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

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

2004
Babcock, Robert
Comparative Esterification of Agricultural Oils for Biodiesel Blending
MBTC 2052

Edwards, Findlay G.
Stormwater Pollution Prevention Best management Practices for Transportation Facilities
MBTC 2018

2003
Gattis, James L.
Designing Horizontal Curves for Low-Speed Environments
MBTC 2019

Hall, Kevin D.
Development of Simplified Asphalt Concrete Stiffness/Fatigue Testing Device
MBTC 2014

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

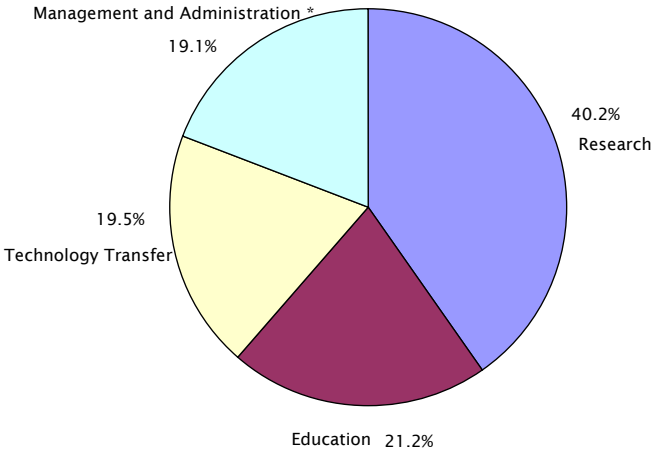
1998
Gattis, James L. and Sonny T. Low
Gap Acceptance at Non-Standard Stop-Controlled Intersections
MBTC 1059

Financial Status

Grant Year: July 1, 2005 – July 30, 2006

Federal Share – $639.309.16
Matching Share – $1,394,710.74
Total – $2,034,019.90

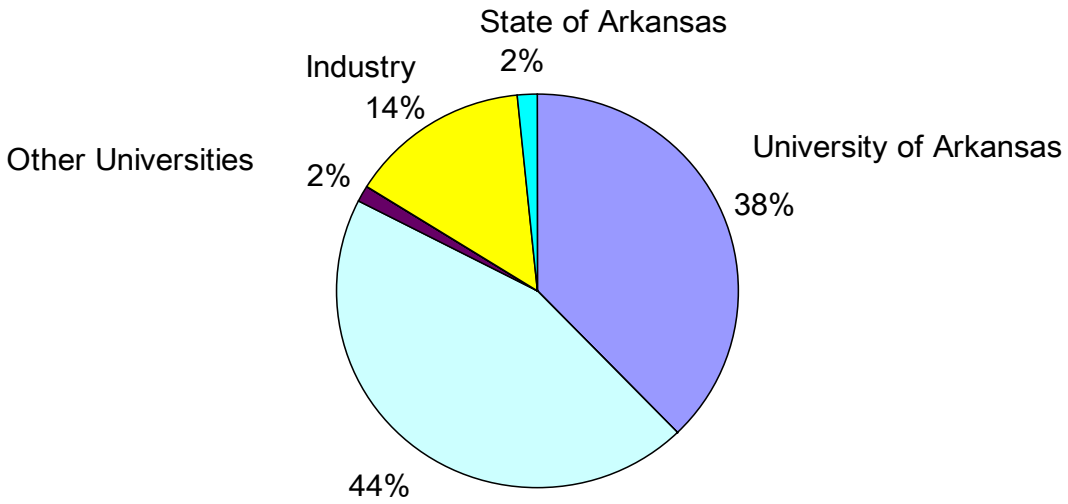
MBTC Expenditure Distribution
July 2005- June 2006



* 35.6% of Management and Administrative Expenditures come from match sources

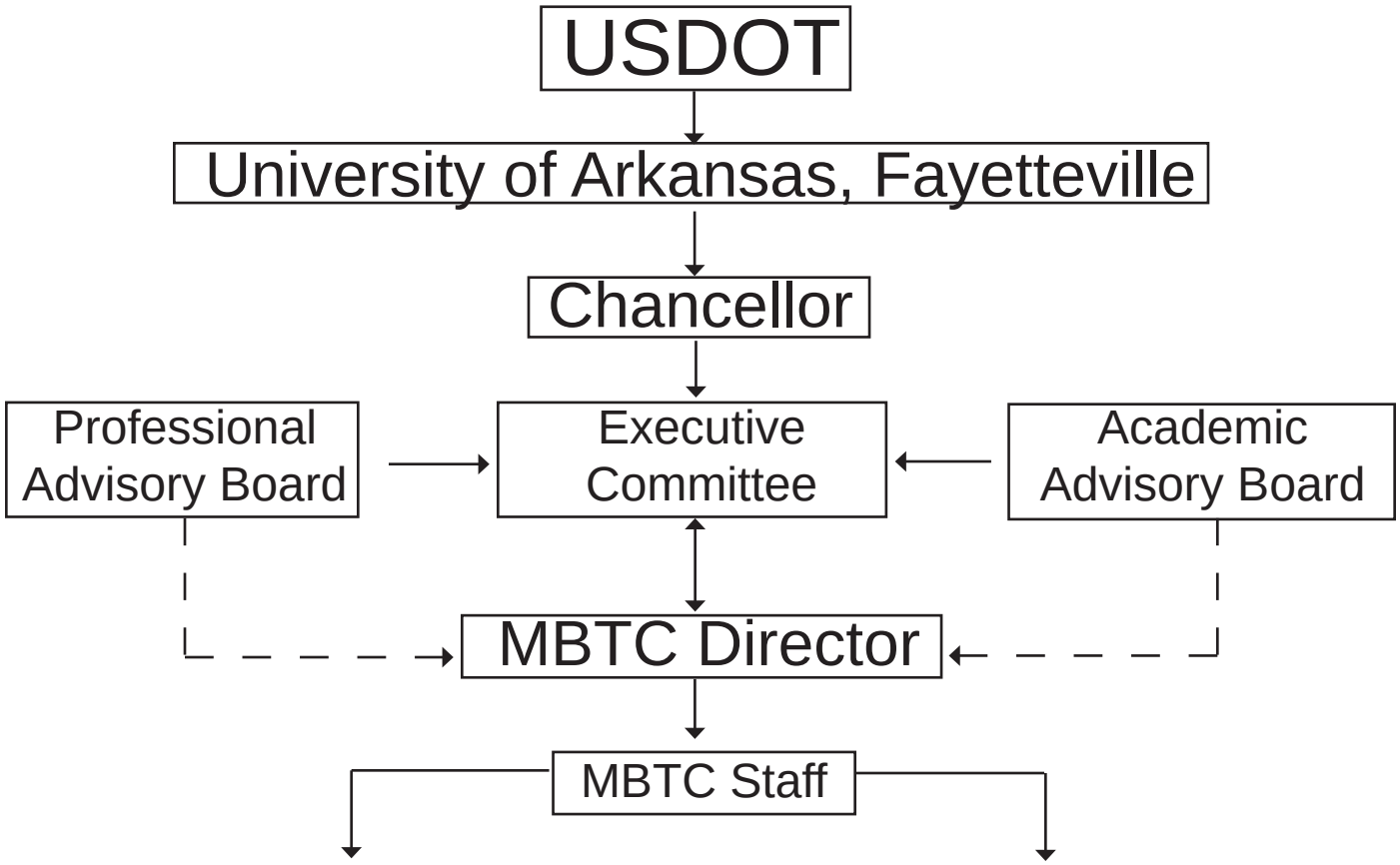
MBTC Match Source Expenditures

July 2005 – June 2006



Arkansas Highway & Transportation Department

Organizational Chart



Participating Universities

Henderson State University

Kansas State University

Louisiana State University

University of Alabama Huntsville

University of Arkansas Little Rock

University of Oklahoma Norman

University of West Virginia

Participating University of Arkansas Fayetteville Colleges

College of Education and Health Professions

College of Engineering

Dale Bumper College of Agriculture, Food, and Life Sciences

J. William Fulbright College of Arts and Sciences

The School of Architecture


www.mackblackwell.org