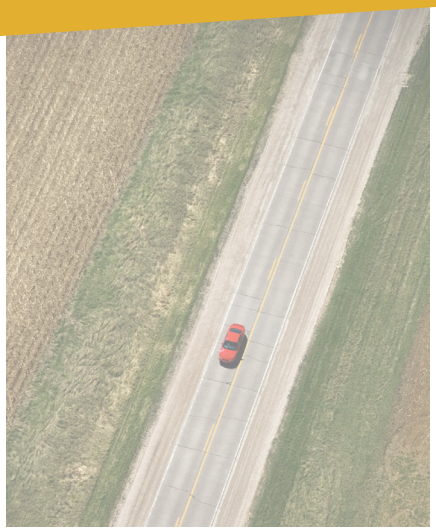
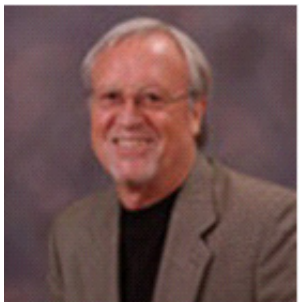
kansas state

University Transportation Center

Annual Report 2007-2008



The Sustainability and Safety of Rural Transportation Systems and Infrastructure



Dr. Robert W. Stokes

Director's Welcome

K-State's designation as a Tier II University Transportation Center (UTC) by the U.S. Department of Transportation (DOT) has brought a host of opportunities to advance transportation research, education, human resources, diversity, and outreach at Kansas State University. This past year saw the first annual Teen Driver Safety Fair, the funding of ten new research projects, and the equipping of a mobile research lab for transportation research.

I would like to extend my sincere appreciation to the K-State faculty, staff and students, the members of our UTC Advisory Committee, our partners at the Research and Innovative Technology Administration (RITA) of the U.S. Department of Transportation (USDOT) and the Kansas Department of Transportation (KDOT) for their contributions in advancing the Center's theme of "the sustainability and safety of rural transportation systems and infrastructure."

Finally, I would like to extend a special word of thanks to the Center's past Director, Dr. Brian Coon, for his outstanding leadership during the initial years of the K-State UTC. All of the work reported in this Annual Report was accomplished under Brian's leadership. All of us at the Center wish Brian much success in his future endeavors.

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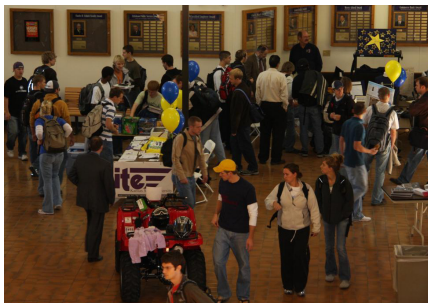
Teen Driver Safety Fair



As part of National Teen Driver Safety Week, the University Transportation Center hosted a young driver safety fair in Fiedler Hall on the Kansas State University campus. The fair was open to the public, and participants were able to try out state-of-the-art driving simulators, ride the Seatbelt Convincer, learn about ATV safety, visit booths with information about driver safety, and enjoy cookies, soda, and conversation with transportation professionals.

"Bringing in young voices into the discussion on transportation safety is critical in developing new transportation professionals," said Brian A. Coon, the director of K-State's University Transportation Center.

The fair was held in conjunction with Congress's recognition of a National Teen Driver Safety Week, noting that automobile crashes are the leading cause of death amongst our nation's youth.

"I was thrilled when I learned that Congress passed the resolution," said Renee Slick, Associate Director of the UTC and Director of the Simulation Training and Assessment Research (STAR) Lab research project. "We've been lobbying at all levels to reenergize a national research agenda for young driver safety," said Slick. "So the announcement of a National Focus on Teen Driver Safety was the perfect opportunity to bring that focus center stage right here at the UTC to showcase all we are doing in the young driver safety arena."

The event was attended by K-State and Manhattan High School students, with even a few elementary-aged students. "We need to make transportation safety part of everyday conversation. One of the ways to do that is by making people aware of the problem," said Manhattan High School driving instructor, Brad Wille.

The fair also presented guest speakers, including Wade Allen, president of System Technology, Inc., on driving simulation; Larry Emig, director of Local Projects of the Kansas Department of Transportation, on "Put the Brakes on Fatalities"; and Brian A. Coon, director of the University Transportation Center, on crash reconstruction and transportation safety.

Research Highlights

Factors Affecting Fatal Crash Involvement of Older Drivers

Dr. Sunanda Dissanayake

The percentage of elderly among the U.S. population is increasing and the majority of elderly are dependent on automobiles for their transportation needs either because of lack of public transportation or by choice. However, as a result of the natural aging process, older drivers experience decreased mental and physical capabilities as compared to younger drivers. This situation combined with imperfect highway infrastructure is making older drivers one of the most critical groups in terms of highway safety, particularly in terms of fatal crash involvement.

A project is currently under way at KSU-UTC to study the factors affecting this situation. A literature survey has been conducted and a number of studies and publications have been identified and are being reviewed. Two sources of crash data are to be analyzed in this project to achieve the objectives of this study. Those are Fatality Analysis Reporting System (FARS) data and fatal crash data from the Kansas Accident Reporting System (KARS) database. As the initial step both of these datasets have been acquired by the research team. The datasets are presently being screened and basic characteristics are studied to identify the characteristics of fatal crashes involving older drivers. Additionally, exposure seems to be one of the crucial factors that needs to be studied when the crash involvement of older drivers under various conditions are taken into consideration. With that consideration, data from the National Household Travel Survey has also been obtained to see whether the amount of actual driving with respect to various subcategories could be obtained. Data from the crash datasets are expected to be combined with exposure data to make a more meaningful risk analysis.

Asphalt core samples are drilled for testing

Thin Surface Treatment for Asphalt Pavements

Dr. Mustaque Hossain

This project was initiated in the summer of 2007 to examine the performance of seal coat and its design features in Kansas. The seal coat projects were created from the Pavement Management Information System (PMIS) of the Kansas Department of Transportation. There are approximately 1,500 seal coat projects in Kansas.

Project Selection

The projects were classified based on the year of treatment. Four projects from two different Districts were selected for extensive investigation. Cores were taken and tested in the Advanced Asphalt Laboratory.

Laboratory Tests:

To test these cores in the Hamburg Wheel Tracking Test, the core size should be 150 mm diameter and 622 mm according to Tex-242-F. The cores were cut to achieve the above dimensions by using a radial saw. The bulk and theoretical specific gravity tests were performed to evaluate the air voids of the cores.

Hamburg Wheel-Tracking Tests:

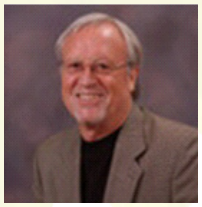
The cores were tested the next day in the Hamburg Wheel Tracking machine at 500C. The results (rut depth in mm and number of passes) are shown below. Most projects had the maximum allowable rut depth limit (20 mm) at about 9,000 passes.

Seal Coat History Data

Performance of seal coats depends on various factors like weather, environmental conditions of the region, traffic, materials, design method, and construction process. Thus, the distresses on the pavements were examined after application of the seal coat. The research shows there is significant change in the condition of the projects after application of the seal coat for a few years. However, the specific lifespan of the seal coat could not be determined. Seal coat performance is influenced by so many other factors like traffic growth, existing conditions of the pavement, weather, materials, etc. However, the seal coat slowed down the progression of roughness on all projects.

Project KS-0671-01			
	Left	Right	Average
Run Depth (mm)	-20.6057	-20.3057	-16.6648
Number of Passes	9142	13530	9142
Project KS-0624-01			
	Left	Right	Left
Run Depth (mm)	-20.3295	-20.4057	-18.8531
Number of Passes	11850	13290	11850
Project KS-0641-01			
	Left	Right	Average
Run Depth (mm)	-19.8628	-20.0835	-13.8303
Number of Passes	19,850	4472	4450
Project KS-0634-01			
	Left	Right	Average
Run Depth (mm)	-20.4041	-20.0739	-16.918
Number of Passes	6268	8364	6250

Rural Transportation Safety Research Program



This project is headed by Robert W. Stokes (Civil Engineering) and his research team: Sunanda Dissanayake, Eugene R. Russell (Civil Engineering), Malgorzata J. Rys, Kendra L. Sullivan (Industrial and Manufacturing Systems Engineering).

The basic objective of the study was to develop a multi-disciplinary, comprehensive research agenda that can guide the Kansas State University Transportation Center's (KSU UTC) rural transportation safety research program into the 21st century. The products of the research include a description of recommended rural transportation safety research topic areas, a proposed organizational structure (in terms of research expertise) to implement the research agenda, and a suggested technology transfer program to disseminate information on the research program and its findings. The research team recommends the following rural transportation safety research topics as focus areas for the KSU UTC: 1) Sustaining Proficiency in Older Drivers and Providing Mobility Options for the Elderly in Rural Areas; 2) Improving the Traffic Safety Culture in Rural Areas; 3) Increasing Seatbelt Usage in Rural Areas; 4) Keeping Vehicles on Roadways in Rural Areas; 5) Making Rural Truck Travel Safer; 6) Enhancing Rural Emergency Medical Capabilities; 7) Designing Safer Rural Work Zones; 8) Improving Design and Operations of Rural Highway Intersections; 9) Creating More Effective Rural Safety Management Systems; 10) Making Non-Motorized Rural Travel Safer; 11) Economic Issues Associated with Rural Transportation Services and Facilities; and 12) Transportation Planning for Terrorism, Natural Disasters, Traffic Incidents, and Other Emergencies in Rural Areas.

The selection of the topic areas was based on the following criteria: 1) The research area must address one or more of the UTC's strategic research focus areas; 2) The research area must address a "rural" transportation safety issue and have the potential to significantly improve rural transportation safety; 3) The research area should offer substantial opportunities to involve students in the research effort; 4) The research area must have a moderate to high potential to attract regional and national funding; 5) The research area should have the potential for a multi-disciplinary research effort; and 6) The research area must address one of the areas identified in the Kansas DOT Strategic Highway Safety Plan (SHSP). It is the recommendation of this study that the KSU Advisory Committee adopt this research report as a policy guide in the selection of future UTC-funded research projects in the area of rural transportation safety. In ranking and selecting potential safety research projects in the future, it is recommended that the UTC Advisory Committee consider the six "Criteria for Selecting Research Areas" established by the research team in developing the 12 recommended Research Areas presented in this report. To implement the KSU UTC rural transportation safety research agenda presented in this report, it is recommended that the KSU UTC Advisory Committee consider establishing a rural transportation safety "institute" within the KSU UTC.

ITE Chapter Introduced at K-State

Kyle Warta, president, ITE Student Chapter

This fall, we were excited to introduce the Institute of Transportation Engineers (ITE) Student Chapter to Kansas State University. K-State will be one of 130 student chapters around the world. With the help of Brian Coon, associate professor in the department of civil engineering, this organization will provide student members with a strong connection to professional engineers throughout the Midwest.

A wide variety of speakers will provide students with a greater knowledge of transportation engineering, as well as present transportation product demonstrations. This relaxed hands-on atmosphere will allow students to develop knowledge about upcoming products used in everyday design. One of ITE's main goals is to provide members with the correct knowledge and tools required for life after college. Students will be provided with mock interviews as well as resume-building sessions to ensure the success of all members.

This close-knit organization will allow licensed professional engineers in the Midwest, as well as student members at K-State, to create relationships within the civil engineering community. In addition to speakers, ITE will provide members with several service projects within the Manhattan area, field visits to local transportation engineering sites, and the opportunity to attend national transportation conferences. ITE is looking forward to a strong first year at K-State as well as in the community.

ite Kansas State University

Dr. Jacob Najjar

Development of Efficient Asset Management Practices For Transportation Infrastructure in Rural Communities

Principal Investigators: Drs. Yacoub Najjar, Asad Esmaeily, and Sunanda Dissanayake

Asset Management is a relatively new term in the transportation world. It involves a systematic approach to maintaining, upgrading and operating all transportation assets (including infrastructure) cost-effectively. With the Government Accounting Standards Board's Statement 34 (GASB 34) requiring all transportation entities to report all capital assets on their annual reports as well as the development of new software and technologies. Asset Management is becoming easier to implement and quickly becoming an important part of the transportation industry.

In Kansas, the Department of Transportation has developed and successfully utilized an Asset Management system for all assets including bridges, roadways, drainage structures, and signs. Kansas counties however, do not have the funds and personnel to implement and maintain an Asset Management system similar to that of the KDOT. Asset Management systems have only been developed by counties with large populations, but even they have not reached the full potential of the system.

This introductory study discusses the importance of creating and maintaining an effective Asset Management system. Kansas counties were surveyed and asked a series of questions about their asset management systems, or lack thereof, as well as the successes and failures of these systems. The counties were asked how they prioritize maintenance, what software they are using, and what assets they have inventoried.

The results of the questionnaire show that counties with large populations have shown interest in implementing Asset Management systems and many have worked to implement such a system. Conversely, counties with small populations that do not have the resources or personnel available have not implemented Asset Management systems. Recommendations for implementing Asset Management systems are made to counties in the three population ranges: Less than 5,000, between 5,000 and 50,000, and greater than 50,000. These include software recommendations and creating inventories of all county assets including culverts, signs, and pavements.

Knowledge Discovery in Transportation Databases (KDiTD)

Principal Investigators: Drs. Yacoub Najjar, Sunanda Dissanayake, and Dunja Peric

Over the years, DOT agencies along with university laboratories have produced a large number of transportation system databases that cover a wide spectrum ranging from crash-traffic historical databases to pavement-material performance databases. The main goal of the knowledge discovery process, via the use of statistically-based, artificial intelligence-based or hybrid techniques, is to extract the knowledge buried within these databases. Knowledge discovery via statistically-based techniques is widely used. However, these techniques have severe limitations and constraints in extracting the knowledge due to the complexity of these databases. On the other hand, artificial intelligence-based methods such as artificial neural networks, fuzzy logic, and other various forms of data mining procedures offer a more efficient methodology for knowledge discovery. For example, artificial intelligence-based (AIB) methods are not constrained by the required functional form that is typically needed to be defined in advance for statistically-based (SB) methods. Appropriately combining the best features of SB and AIB methodologies can yield a far more superior hybrid knowledge discovery (HKD) approach. Utilizing such hybrid approach can efficiently extract the important features (i.e., useful knowledge) hidden in the complex transportation system databases.

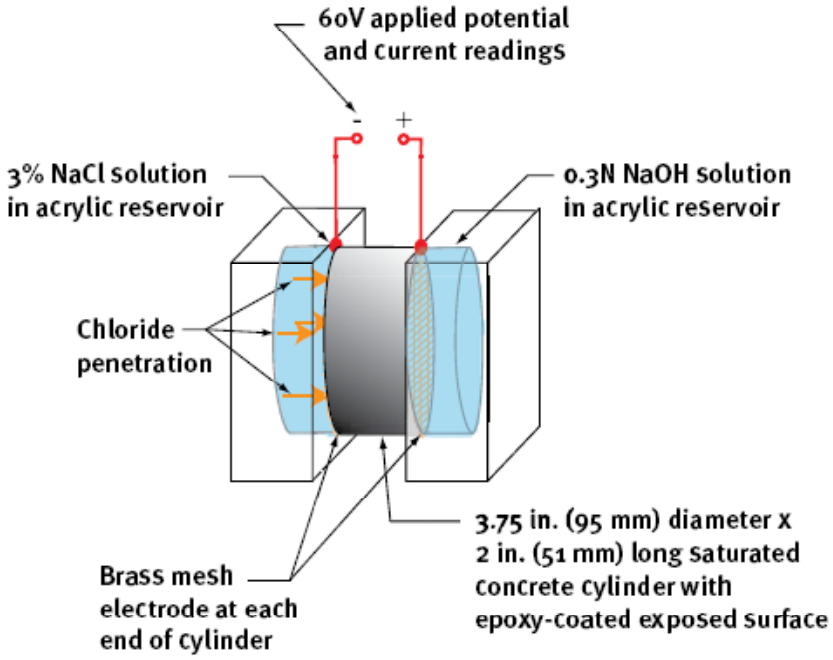
In this research study, we are proposing to appropriately combine the diverse expertise of the research team in order to develop an efficient HKD approach. The developed HKD approach will then be used to extract the hidden features within a wide spectrum of databases ranging from crash-traffic-driver related databases to pavement-material-performance related databases. It is expected that this research will help advance the proper utilization of the newly created information-based science (IBS) in transportation engineering.

Characterizing KDOT's Chloride Permeability Testing Protocol: Reducing the Duration of the Rapid Chloride Permeability Test

Principal Investigators: Dr. Yacoub Najjar

Reliable and economical design of PCC pavement structural systems relies on various factors among which is the proper characterization of the expected permeability response. Permeability is an extremely important factor that strongly relates the durability of PCC pavement systems to prevailing environmental conditions. For this reason, KDOT uses the Rapid Chloride Permeability testing protocol to determine the resistance of concrete to water, chlorides, and other chemical intrusion. Typically, the Rapid Chloride Permeability test measures the number of coulombs that pass through a concrete sample over a period of six hours at a concrete age of 56 days. Results of this test make it possible to obtain the desired time-dependant concrete permeability response. During the past years, KDOT has performed numerous numbers of full six-hour permeability response tests. Unfortunately, KDOT has not been able to capitalize on the richness of the available full-response permeability database in order to shorten the testing duration. Accordingly, it is proposed herein that we utilize the statistical/artificial neural network (SANN) approach for the development of appropriate SANN-based models that can effectively project the full six-hour response from a shorter-duration permeability response. The proposed research is in direct response to KDOT's need to reduce the testing time of the currently used KDOT rapid chloride permeability test.

These developed models will allow KDOT to reduce the duration of the Rapid Chloride Permeability test from 6 hours to 1 or 2 hours. Additionally, these models will allow KDOT to: 1) increase the number of tests that can be performed in one day, and 2) minimize/eliminate damage to the testing cells, particularly, when excessively permeable concrete is tested. The proposed research will provide an excellent research opportunity to produce innovative prediction models that will impact Chloride Permeability testing procedure for KDOT and other DOT agencies.



Schematic of rapid chloride permeability test setup

Custom Built Test Apparatus for Testing

Advanced Modeling of Interfaces between Asphalt Concrete Layers

Dr. Dunja Peric

Asphalt pavement layers cannot be constructed in one single lift if the layer thickness is larger than 2.5 to 3.0 inches because thicker lifts cannot be efficiently compacted with the existing equipment. Poor bonding between layers may cause distress in the form of a slippage failure, which usually occurs due to accelerating, decelerating, and turning of heavy vehicles. To achieve a good bond between the asphalt layers, a tack coat is sprayed on the bottom layer prior to the placement of the top layer if the later is placed more than two days after the former.

The primary objective of this study was to evaluate the shear behavior of three asphalt-to-asphalt mix interfaces subjected to static and dynamic loading. To accomplish this objective, a special attachment and loading mechanism was designed and built. The mechanism enabled the measurement of dynamic shear moduli and shear strength of the asphalt-to-asphalt interfaces exposed to simultaneous action of shear and normal forces. Dynamic and static shear tests were conducted on 4-inch diameter cylindrical samples cored from an asphalt concrete pad. Three different interface types including coarse on coarse, coarse on fine, and fine on fine asphalt mixes were constructed. Each interface type was constructed with four different amounts of tack coat including the option of no tack coat. The experiments suggest that the dynamic shear modulus are affected by both the interface type and the amount of tack coat.

UTC Advisory Committee Members

The following individuals have volunteered their time and expertise to help guide the University Transportation Center in its efforts to further transportation research. The center, its director, and the UTC faculty wish to offer their thanks to the following individuals:

J. Michael Bowen, *Federal Highway Administration*
Keith Browning, *Douglas County Public Works*
E. Dean Carlson, *Carlson Associates*
Lt. Gregory Harkrader, *Kansas Highway Patrol*
Leon Hobson, *Riley County Public Works*
James Jones, *Kansas Asphalt Pavers Association*
W. Michael Lackey, *Kansas Dept. of Transportation (Ret.)*
Paul Malir, *TranSystems Corporation*
Richard McReynolds, *Kansas Dept. of Transportation*
Edward J. Mulcahy, *TranSystems Corporation*
Robert Thorn, *Finney & Turnipseed, L.L.P.*
Joanie Roeseler, *Federal Transit Administration*
Matt Ross, *American Concrete Pavement Association*

2007-2008 UTC Research Projects

The following projects were selected for funding by the UTC Advisory Committee. Individuals with interest in these projects are welcome to contact the investigators or the Center director to contribute their experience, expertise, or knowledge to the projects.

Project reports, theses, dissertations, and other information can be found on the Center's website,
www.transport.k-state.edu

Primary Investigator	Research Topic
Peterman	Establishing a Mobile Laboratory for Transportation Research and Education
Rys & Russell	Promoting Center Line Rumble Strips to Increase Rural, Two-lane Highway Safety
Dissanayake	Factors Affecting Fatal Crash Involvement of Older Drivers
Hossain & Testa	Kansas Pavement Preservation Initiative
Russell	Increased Pedestrian Safety and Decreased Motorist Delay with a HAWK Pedestrian Signal
Rys & Russell	Effectiveness of Larger Traffic Signs, High-Performance Sheeting, and Clearview Font on Accident Reduc-
Dissanayake & Stokes	tion
Najjar, Dissanayake & Romanoshi	Improving the Usage of Demand Response Transit Services in Rural Kansas
Najjar	Knowledge Discovery in Transportation Databases (KDiTD) Characterizing KDOT's Chloride Permeability Testing Protocol: Reducing the Duration of the Rapid
Dissanayake	Chloride Permeability Test

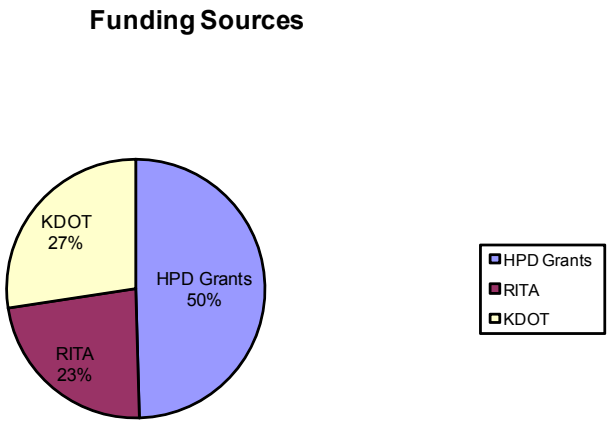
Establishing a Mobile Laboratory for Transportation Research and Education

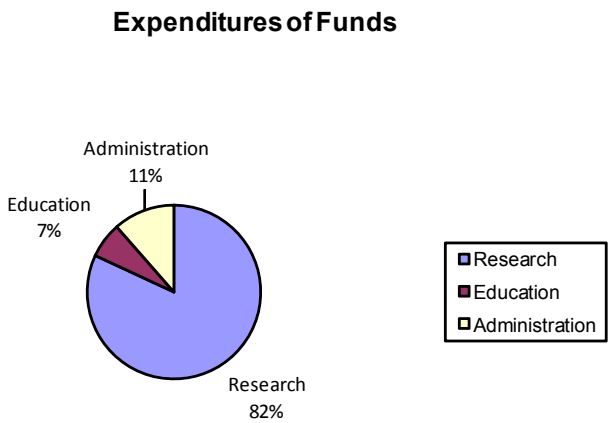

Dr. Robert Peterman

The need to replace or upgrade transportation infrastructure is typically based on the interpretation of data collected in the field. Often, the types of data that are available to decision makers are limited by the severe environment of the site (temperature, dust, and moisture). Thus, although engineers and technicians currently have many sophisticated tools and devices that can give detailed information about the performance of the infrastructure, these are often not employed to their full extent due to the difficulty of dealing with site conditions and also because of the increased effort required to set up and take down test systems (data acquisition, etc).

The focus of this project is to develop a mobile laboratory for use in transportation research at Kansas State University. To do this, Dr. Peterman was able to acquire a decommissioned mobile laboratory from the Federal Highway Administration. The laboratory consists of a 1997 International Navistar Truck with only about 50,000 miles of prior use. The box portion is complete with a hydraulic liftgate, heating and air conditioning, counter space, and an onboard generator.

As part of this project, the UTC Mobile Laboratory will be customized to include a window and access panel installed in the box portion of the truck, and then custom painted to proudly display the name and new logo of Kansas State University and the University Transportation Center. In addition, the lab will be outfitted with a data acquisition system.





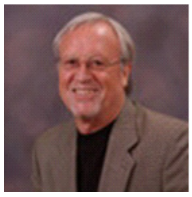
K-State UTC Sponsors National Roundabout Conference, Kansas City, MO. May 18-21, 2008

The Kansas State University Transportation Center was a major sponsor of the National Roundabout Conference held at the Westin Crown Center in Kansas City, Missouri on May 18-21, 2008. Other major sponsors were the Transportation Research Board (TRB), Missouri Department of Transportation (MoDOT), Kansas Department of Transportation (KDOT), Federal Highway Administration (FHWA), and the City of Overland Park, KS. The conference was conducted under the auspices of the Transportation Research Board (TRB) Roundabout Task Force (ANB75T), chaired by K-State Professor Emeritus Gene Russell. The program consisted of over 80 presentations in 10 podium sessions and two poster sessions. This major international conference attracted 417 registrants from 43 different U.S. states and 16 countries, including Canada, the United Kingdom, Australia, New Zealand, Netherlands, Italy, France, Japan, Denmark, Poland, Belgium, Jamaica, Lithuania, and Germany. All conference sessions were recorded and are available on-line at http://teachamerica.com/RAB08/index.html.

K-State Professor Emeritus Gene Russell (right) with TRB Safety Engineer Rick Pain at the 2008 National Roundabout Conference in Kansas City, MO.

University Transportation Center Faculty Members

Because transportation encompasses many disciplines, the K-State UTC faculty consists of a diverse group of engineers, planners, economists, and social scientists who bring their expertise to bear on the transportation problems facing rural America.



Robert W. Stokes, Director
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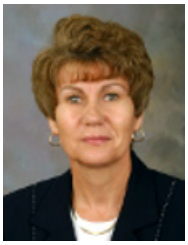

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University Transportation Center

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