KENTUCKY TRANSPORTATION CENTER

ANNUAL REPORT 2010

- Research
- Technology Transfer
- Education

www.ktc.uky.edu

Vision for 2015

Here is a condensed version of KTC's Vision for the year 2015. The Vision is written in the present tense, to express what we <u>want</u> to be true in 2015. The full version of the Vision can be found on our website at http://www.ktc.uky.edu/vision.html.

Customer Satisfaction and Customer Relationships

The Center has implemented tools for measuring our customers' perceptions regarding the quality and value of our products and services. Feedback provided is scrutinized on a regular basis to identify improvements that can be made. Feedback from all customers is consistently positive. Whenever shortcomings are noted, solutions are immediately developed and implemented. The Center maintains an extremely positive relationship with all clients, highlighted by a close, strong, and unique relationship with the Kentucky Transportation Cabinet. The Cabinet regards the Center as its research and training arm, a valued resource, and a source of visionary and progressive thought.

Research Excellence / National Prominence

The Center enjoys a strong national reputation in selected, high-priority areas of research and technology transfer. Researchers are widely known for their subject matter expertise, group facilitation skills, effective communications, and project management skills. The Center's technology transfer professionals are nationally recognized for excellence in information delivery and workforce development. The Center is frequently sought out as a partner by other universities and by both public-sector and private-sector organizations.

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Size of Program and Diversity of Funding Sources

The size of the Center's research and technology transfer program has grown substantially over the past five years, primarily due to the identification and cultivation of new funding sources (federal, state, local, and private-sector). The Center has strategically targeted areas of research and technology transfer that are important to Kentucky and to the nation. The Commonwealth receives substantial benefits from having direct access to the Center's research results and technology transfer resources. The state planning and research (SPR) program remains strong and vital.

Work Environment / Employee Satisfaction

The Center is a rewarding and enjoyable place to work. Employee retention is high, as is employee morale. The Center provides opportunities and support for all employees to continue learning and to grow professionally throughout their careers. Exceptional employee performance is recognized and rewarded. Employees receive constructive feedback, coaching, and follow-up as needed. The workforce includes a strong and increasing presence of minorities and women.

Implementation and Value of Research

Tools and processes have been put in place to promote, facilitate, and track the implementation of research results. Implementation is a priority for KTC and is accomplished through a team effort, involving practitioners, researchers, and technology transfer professionals. The benefits resulting from the implementation of research findings are well-documented and well-disseminated both within Kentucky and nationally.

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The publishing of this report was aided by David Cain, Carla Crossfield, Brittany Hedges, and Neil Tollner.

Director's Message

On March 1 of 2010, I became Director of the Kentucky Transportation Center. I am the seventh Director of this organization (dating back to 1941, when we were formed as the Research Division of Kentucky's Highway Department), and I am honored to follow in the footsteps of such illustrious predecessors. These gentlemen, along with the many staff, faculty, and students who have served this organization over the past 70 years, have built an outstanding legacy of research excellence, world-class technology transfer, and exemplary customer service.

My intent as KTC's Director is to grow and enhance our legacy. We will celebrate the accomplishments of the past, but we will not rest on them. I firmly believe that our best days are yet to come, and I am excited about the many opportunities that are waiting to be seized.

To guide our efforts in moving forward, we have developed a collective Vision for where we want to be in the year 2015. Using that Vision as a target, we have developed our Strategic Plan for 2010-2015. We are currently establishing specific targets and defining the metrics we will use in tracking our progress toward the vision.

It is indeed a privilege to serve the citizens of Kentucky, the Kentucky Transportation Cabinet, the University of Kentucky, and our many other partners and clients as Director of the Kentucky Transportation Center. If we can be of service to you, please don't hesitate to contact me or any of our staff. I look forward to working with all of you as we strive to improve the safety, efficiency and sustainability of Kentucky's transportation system.

Joe Crabtree, Ph.D., P.E.
December, 2010

Research: Construction Management

Dr. Paul Goodrum

CHANGE ORDERS AND LESSONS LEARNED [KTC-10-18/SPR384-09-1F]

What are the most common change orders on Kentucky transportation projects? Which change orders have the greatest impact? If a change order occurs on a project, what is the best way to develop a competitive price? These issues and more were examined and the team investigated the leading causes of change orders on Kentucky transportation projects among three years of archived change order data. The project also examined the relationship between project characteristics and the frequency and size of change orders. Potential characteristics investigated included contract type, project type (e.g. new versus expansion), and construction type. Quantifying the risk in change orders may help the Cabinet avoid or better anticipate the likelihood of occurrence on certain types of projects. Results of the analyses have been summarized in quick reference cards to identify the potential change order risk a project may face.

The project also interviewed several Kentucky engineers on the different methods and procedures used to price change orders and examined pricing procedures used in other state transportation agencies. The comparison revealed some similarities between the different methods and a standardized pricing flowchart was developed for use by Cabinet field engineers. The flowchart was designed to be a one-page quick reference to be used for preparing an estimated price for comparison to the contractor's submission. The flowchart allows for the engineer to use professional judgment, but gives enough pricing options to take away some of the uncertainty

Quick Guide: Risk of IMPACT by Reason Code and Construction Type

Reason Code	Description	Earthwork	Road Surface	Structures
1	Asphalt Lot Pay Adjustment	◍	◍	○
3	Fuel & Asphalt Adjustment	◍	●	◍
4	Contract Omission	◍	◍	●
5	Utility Issue	◍	○	○
6	Contract Item Overrun	●	◍	●
7	Geotechnical Issues	◍	○	○
8	Owner Induced Enhancement	◍	●	◍
9	Environmental Issues	◍	○	○

○ Low Risk of impact
◍ Risk of impact
● Extreme Risk of impact

Earthwork: Grade & Drain, Flood/Slide Repair
Road Surface: Asphalt Surfacing, Asphalt Resurfacing, Jointed Plain Concrete
Structure: Bridge Work, Culvert Replacement, Guardrail, Pipe Replacement

Other research projects underway:

- *KY--Contract Time Determination System Update*
- *Next Generation Technician Training requirements*

Research: ITS (Intelligent Transportation Systems)

Jennifer Walton

Wireless Roadside Inspection Testing and Evaluation

The Wireless Roadside Inspection (WRI) safety research program for commercial motor vehicles (CMVs) is being conducted by the Federal Motor Carrier Safety Administration (FMCSA) to determine whether conducting safety inspections of the driver, vehicle, and carrier while the truck or bus is moving will reduce at-risk behavior among commercial drivers and carriers and improve driver safety performance. Kentucky has been selected by FMCSA as one of three pilot states for the WRI program.

The Center will work in close cooperation with FMCSA and the WRI project team to deploy, test and support the evaluation of a prototype WRI system. The Center will implement an end-to-end system prototype to test the technical and operational feasibility of conducting wireless roadside inspections using license plate readers, U.S. Department of Transportation (USDOT) number readers, and dedicated short-range communication (DSRC) devices to identify commercial vehicles and facilitate the exchange of driver, vehicle and carrier data. The Kentucky field operational test will allow the WRI team to test and evaluate the technical and operational feasibility of conducting wireless roadside inspections using OCR (Optical Character Recognition) and DSRC technologies.

Automatic License Plate Reading System

Other Research Projects Underway:

- Demonstrate and Evaluate the Use of DSRC Technology for Travel Time Monitoring and Incident Detection
- Develop Strategies to Address "Freddie the Free-Roader"
- Pilot Project Evaluation: Emergency Traffic Control for Responders
- SAFE Patrol Assessment

Research: Pavements, Materials and Geotechnology

Clark Graves

Evaluation of Warm Mix Asphalt

Asphalt is used in over 94% of all paved roadways in the United States. The ability to reduce costs and emissions while improving pavement performance could potentially change the direction the asphalt industry moves in the future. One definition of warm mix asphalt is asphalt that has been modified in such a way as to be placed at a lower temperature. It may provide many benefits over conventional hot-mix asphalt. Warm mix producers claim some of these benefits are a decrease in mixing and placement temperatures, a decrease in fuel consumption, reduced emissions, a safer work environment, and higher densities with lower compactive effort. Through extensive field testing and monitoring, this research study has evaluated these claims. By placing traditional hot mix adjacent to different types of warm mix, we will be able to continually monitor the performance of both sections, and therefore come to conclusions regarding long-term warm mix performance and value.

<u>Other Research Projects Underway</u>:

- Use of Ground Penetrating Radar for Rapid Inspection of Bridge Decks
- Evaluation of Intelligent Compaction in Kentucky
- Evaluation of Internal Drainage Layer Effectiveness
- Evaluation/Monitoring of New KY Pipe Policy
- Improved Longitudinal Joint Construction
- Chip Seal on Low-Volume Roads
- Calibration and Plan for Implementing AASHTO Mechanistic Pavement Design Guide

Research: Policy and Systems Analysis

Dr. Ted Grossardt

Structured Public Involvement for the Milton-Madison Replacement Bridge

In the past year, the Policy and Systems Analysis division of the Kentucky Transportation Center provided the Structured Public Involvement protocol for the design of the Milton-Madison replacement bridge over the Ohio River. Working with Wilbur Smith Associates and Michael Baker Jr. Inc., they met with residents of the two communities in the high school gymnasium. Nearly 200 citizens attended the meetings, and used an Audience Response System to register their aesthetic preferences regarding a palette of 18 different possible bridge designs, rating them for suitability on a scale of 1 to 9.

The PSA team then used this data to create a preference knowledge base that mapped community preference for a full range of potential designs. Ultimately, the selected design reflected the community's interest in preserving its historic identity, and is in a style patterned after the original 1929 structure. Currently, the bridge is under contract for construction.

Other Research Projects Underway:

- Archaeological GIS Predictive Model
- Historic Truss Bridge Assessment

Research: Structures

Dr. Issam Harik

Using Ultra High Modulus Carbon Fiber Reinforced Polymer (CFRP) Laminates to Strengthen a Steel Girder Bridge

The bridge over Lytles Creek, on state route 32, located in Scott County, Ky. is a single span steel girder bridge. The reinforced concrete bridge deck is supported on five W14x30 steel girders and was cast non-composite with the girders. The bridge had a 14 ton load posting and was in need of strengthening to remove the load posting.

To remedy the problem ultra high modulus carbon fiber reinforced polymer (CFRP) laminates/plates were selected to retrofit the bridge due to their high strength, high modulus of elasticity, and ease of application. Prior to the application of the laminates, the concrete deck was made partially composite with the steel girders by post installing shear studs. This type of initial strengthening was carried out to take maximum advantage of the CFRP laminate properties. The CFRP laminates were then applied to the top and bottom faces of the bottom flange of each steel girder. The retrofit was completed in April of 2010.

Several load tests were carried out after each stage of strengthening to evaluate the effectiveness of the retrofit. The strengthening depicted a decrease in maximum deflection of more than 30% compared to the original bridge. The field tests also indicated that the bridge was well within AASHTO serviceability limits resulting in the removal of the load posting from the bridge.

Other Research Projects Underway:

- Monitoring of Piers for Barge Impact
- Effect of Thermal Loads on Substructures
- Bridge Load Testing vs. Load Rating

Research: Coatings

Ted Hopwood

Fluorescing Coatings for Improved Inspection during Bridge Maintenance Painting

The KYTC maintenance painting program for bridges is a multimillion dollar program annually. One of the most difficult aspects of providing a fiscally responsible program is field inspection of maintenance painting projects. KTC is working with KYTC and the coatings industry to provide cutting edge technology and tools for inspectors in the field. Also recently there has been more emphasis on contractors to paint bridges in the night to minimize disruptions to the travelling public. In this study an optically assisted pigment (OAP / fluorescing) is added to coatings to allow field inspectors to more reliably assess coating application. In addition to better coating performance, inspections may be completed more rapidly thus addressing another important issue, delays to the traveling public.

Below is a photograph of the mock up beams painted with OAP coatings being inspected for defects by a coatings manufacturer and KYTC personnel.

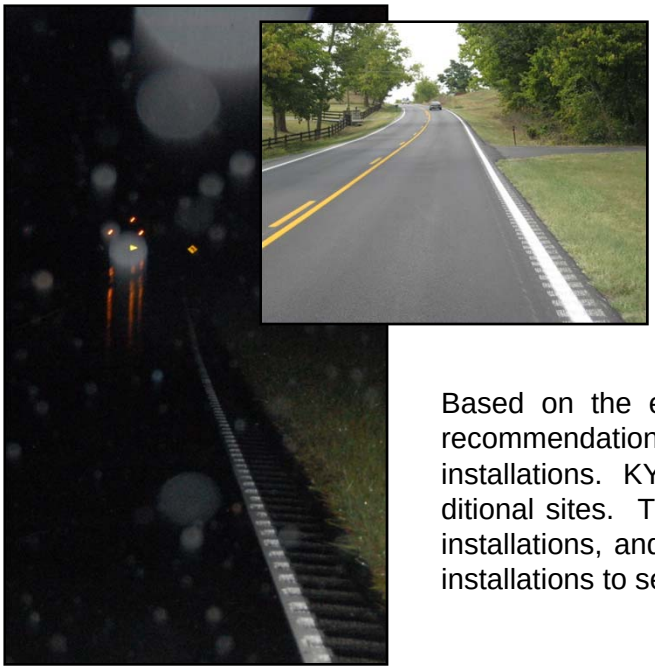
Other Research Projects Underway:

- Automated Chemical Stabilizing of Leaded Paint Residue
- Sealants, Treatments and Deicing Salt Practices to Limit Deck Corrosion
- Improved Bridge Expansion Joints
- Evaluation of the Use of Painted and Unpainted Weathering Steel
- New Coatings for Bridges (Over-Coat Systems)

EVALUATION OF RUMBLE STRIPES [KTC-10-1/SPR330-07-4I]

Lane departures have been shown to be a major cause of serious traffic crashes. Installing a rumble strip on the shoulders of two-lane roads provides drivers with an audible warning that they are leaving their lane of travel. When the edge line is painted on the rumble strip (this is called a rumble stripe), there is potentially an additional benefit of improved delineation in wet, nighttime conditions. The objectives of this study were to monitor the initial installations of rumble stripes at selected locations, to evaluate those installations, and to develop recommendations regarding future installations.

Based on a review of crash records, ten rural, two-lane road locations across the state were selected by the Kentucky Transportation Cabinet (KYTC) for the initial installations. These sections represented a total of 67.7 miles of roadway. The installations were completed in the summer of 2009. The installed rumble strips had a width of 12 inches (across the roadway) and a length of 7 to 7.5 inches (along the roadway). The spacing from the beginning of one rumble strip to the beginning of the next was 12 inches. The milled depth varied from 1/2 inch to 5/8 inch. The white edge line was four inches wide and was placed along the leftmost edge of the rumble strip, adjacent to the travel lane. For the selected locations, the total pavement width (including the width of the paved shoulder) varied from a minimum of 22 feet to a maximum of 27 feet.



For the selected locations, an analysis of crash data prior to the installations showed that single-vehicle crashes were the most common type of crash. This is the type of crash that shoulder rumble stripes are designed to reduce. Preliminary assessments of wet nighttime visibility showed that rumble stripes appear to provide improved visibility.

Based on the evaluation of the ten initial installations, recommendations were developed to improve future installations. KYTC is proceeding with installations at additional sites. This study will monitor and evaluate those installations, and it will also examine crash data after the installations to see if crashes have been reduced.

TECHNOLOGY TRANSFER

Patsy Anderson

The Technology Transfer Program shares transportation knowledge and puts research and new technologies into practice. This is accomplished through a safety circuit rider program, a transportation library, a wide variety of technical publications and guides, Roads Scholar and Road Master Programs, and special interest training designed to solve specific problems.

Classroom training continues to be the primary method for information transfer. During the past year, 195 workshops were conducted, reaching 5,669 participants. Technology Transfer Program publications, library resources, and a newly developed website are invaluable resources, especially for roadway workers in remote rural areas. By producing publications based upon the latest research and technology, we are able to inform agencies of technological advancements and provide critical guidance.

The high standards and topical relevance of our publications have enabled them to serve as models for publication in other states, and they have even been translated into other languages for use abroad. A new website introduced this year has enabled the Technology Transfer Program to offer a professional, cutting-edge platform for sharing digital resources, important news, and information on programs and upcoming courses. We are now producing more publications and reaching more people than ever before. **Since the introduction of the new website, the number of visits has been increasing by an average of 46%, each month, reaching users across the U.S. and nine countries.**

The Transportation Library, the only such library in Kentucky, maintains and disseminates a broad collection of publications and resources, and has access to worldwide databases through the Internet and the University of Kentucky Libraries. The library staff provides expertise for quickly and accurately identifying topical resources across multiple media formats. A new Online Video Lending Library was implemented this year, enabling customers to more easily find and request videos for in-house training. **In 2010, use of the Transportation Library's materials increased 47% over the previous year.**

Training

Chainsaw Safety

With recent snow and ice events causing massive tree damage and cleanup efforts, Kentucky's local government agencies have sought chainsaw safety training for their employees. To meet this demand, the Technology Transfer Program now offers Chainsaw Safety Training statewide, through a Demonstration Course and a Hands-On Safety Course. This training has been added to the Technology Transfer Program's annual training schedule to reinforce skills. "I learned so much so quickly it was unbelievable," said Tim Antrobus, Road Supervisor for the Pendleton County Road Department.

The Demonstration Course covers personal protective equipment, the intricate details of saw safety features, making adjustments, and sharpening. It addresses the importance of planning, the complexity of reactive forces, and the intricacies of directional felling, limbing and topping.

The Hands-On Course replicates what participants viewed the day before during demonstrations, and recreates the variety of chainsaw tasks they are likely to encounter on the job. All hands-on activities are performed under the watchful eye of the instructor. Each activity allows the instructor and participants to evaluate good practice, as well as potential safety errors.

Participation included:

- Over 100 government employees
- Local governments: 13 cities and 11 counties
- Kentucky Department of Highways

TSM

Transportation Systems Management Program

Description of Courses (CE 699) in 2009-10

In the 2009-2010 academic year, the UK Transportation Center's Transportation Systems Management Program supported six Master's students (Arnold Lynch, Jon Lawler, Shinwoo, Mark Ramler, Joseph Klare, and Michael Slagle) and one Ph.D. student (Timothy Brock). These students represented five different Colleges: Engineering, Arts and Sciences (Geography), Public Administration, Design (Historic Preservation), and Agriculture (Landscape Architecture). Because transportation planning and design typically involves multiple disciplines, our program attempts to reflect that in its outreach to a broad range of disciplines and colleges across campus. The TSM students attended the Annual Meeting of the Transportation Research Board (TRB) in January and toured a high-speed train with a presentation on the California plan to build a high speed rail system.

In all, 12 students were enrolled in the class each semester. The Fall semester course covers concepts and theories for transportation and land use planning, while the Spring semester has a more applied focus on current issues and applications in transportation planning, including environmental laws, techniques for public participation, and context-sensitive solutions. During the Fall semester, each student prepared a research proposal, and during the Spring semester, each conducted original research and prepared a report. Research topics included the impact of urban design on walking and biking, light rail's association with transit-oriented development, programs for increasing rail transport of freight, and the feasibility of high-speed rail in the midwest and Kentucky.

Graduate Discipline	Students
Civil Engineering	68
Geography	30
Public Administration	19
Business Administration	21
Landscape Architecture	8
Historic Preservation	12
Total	**158**

In addition to the individual project each semester, students participate in group projects on transportation planning, in which they gather data on local counties and development projects and interview officials involved in transportation planning.

Special Initiatives

In 2002, the Center received notification of a Congressionally-mandated award to establish an academy focused on community transportation innovations. The Academy includes an education and research component, which is managed by the Center in cooperation with the University of Louisville (U of L) and carried out in partnership with the Kentucky Transportation Cabinet. The education and research mission is to educate students and professionals and to carry out research on new and innovative approaches that ensures the compatibility, sustainability, efficiency and safety of transportation for our communities. While the laboratory and classroom are Kentucky-based, the solutions and outreach extends to the region and beyond, thus serving as a national resource.

The Midwest Bridge Working Group (MBWG) (www.midwestbridge.org) is a successful forum for the discussion of issues in the field of bridge maintenance and inspection. The forum attracts bridge professionals from numerous state highway agencies, consulting firms, vendors, and universities for one and a half days of discussion of best practices, along with technical, political, and financial issues. Since 1996, the MBWG has been coordinated through a joint effort between the Kentucky Transportation Center and the Infrastructure Technology Institute at Northwestern University.

Special Initiatives

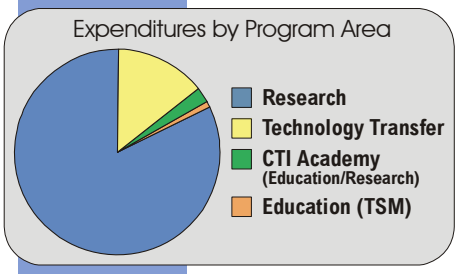
Fedtrak is a real-time tracking and risk management system for shipments of Tier 1 Highway Security Sensitive Materials -- the riskiest traveling the nation's highways. The UK-led project team has released core operating components of the Fedtrak system for field testing in 2010-11. Fedtrack's research and development program is supported by the U.S. Department of Homeland Security and the Transportation Security Administration.

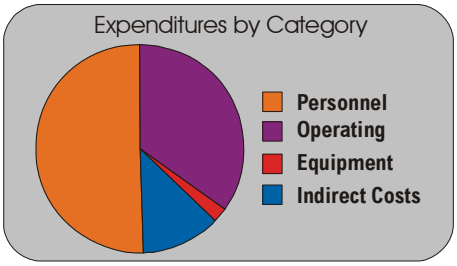
The C.A.T.S. (Center for Advanced Traffic Solutions) laboratory being developed at the University of Kentucky is a state-of-the-art laboratory dedicated to training, research and education for traffic signal operations. CATS was established to develop and evaluate advanced transportation technologies and implementation strategies with the aim of increasing the safety and efficiency of Kentucky's roadways.

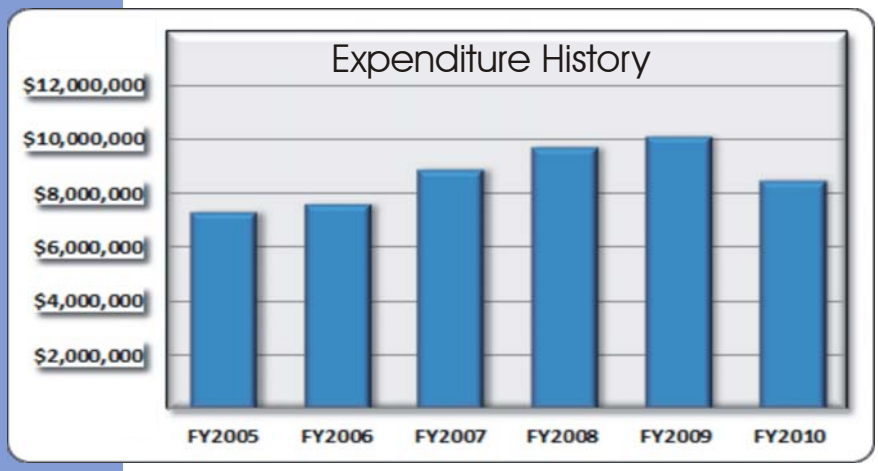
The signals lab houses two complete controller racks and tester boards -- one with a model 170 controller and the other with a model 2070 controller. The cabinets are intended primarily for training of signal technicians and traffic engineers, and are also available for use by UK's Department of Civil Engineering for their transportation systems classes. Additionally, the lab will be used to develop and simulate advanced and experimental traffic system operations.

Financial Snapshot (FY 2010 Expenditures*)

Program Area / Category	Research**	Technology Transfer	Education (TSM)	CTI Academy (Education/Research)	Total
Personnel	3,549,824	533,121	67,542	116,163	$4,266,650
Operating	2,240,500	653,013	2,744	46,154	$2,942,411
Equipment	194,737	1,001	0	0	$195,738
Indirect Costs	973,797	16,538	6,445	42,652	$1,039,432
Total	$6,958,858	$1,203,673	$76,731	$204,969	$8,444,231







*Expenditure detail by subcategory of expense is available on request (1-800-432-0719)

**The research/study program for FY10 consisted of over 100 projects conducted for the following agencies: the Kentucky Transportation Cabinet, Kentucky State Police, USDOT/FHWA, USDOT/FMCSA, NSF, TRB/NCHRP, NORPASS, and various other public jurisdictions. Some work was done in cooperation with other universities including: Northwestern University, University of Louisville, University of Tennessee, and Calspan-University of Buffalo Research Center and also in partnership with firms and organizations such as Michael Baker Inc., HMB Professional Engineers, Wilbur Smith and Associates, Coldstream Digital, General Dynamics, Visual Risk, and the Asphalt Institute.

Note: The Education (TSM) funding is from SECUTC (Southeastern Council of University Transportation Centers) of which the University of Kentucky is a member. The funding received is for operating a Transportation Systems Management Graduate Certificate Program. The CTI (Community Transportation Innovation) Academy is both an education and research program that has been funded periodically by the USDOT/FHWA as a result of directed Congressional appropriations to the University of Kentucky (and the University of Louisville).

Projects Completed

KTC-09-15/KSP1-09-1F	*"2009 Safety Belt Usage Survey in Kentucky"*
KTC-09-16/KSP2-09-1F	*"Analysis of Traffic Crash Data in Kentucky (2005-2008)"*
KTC-09-17/SPR358-08-1F	*"Guardrail Location Rating System User's Manual"*
KTC-10-01/SPR330-07-4I	*"Evaluation of Rumble Stripes"*
KTC-10-02/KSP1-10-1F	*"Evaluation Plan for the Ticketing Aggressive Cars and Truck (TACT) Program in Kentucky"*
KTC-10-03/KH58-07-1F	*"Cumberland Gap Tunnel Inspection"*
KTC-10-04/SPR298-05-1F	*"Durability Issues of Asphalt Pavements (Polymer Modifiers)"*
KTC-10-05/RSF14-05-1F	*"Factors Affecting Asphalt Density and the Effect on Long-Term Pavement Performance"*
KTC-10-06/SPR56-10-1F	*"Distracted Driving – Preliminary Analysis and Survey"*
KTC-10-07/SPR399-10-1F	*"Roadway Related Tort Liability and Risk Management"*
KTC-10-08/PL18-09-1F	*"Travel Time Based Congestion Measures for Freeway Corridors"*
KTC-10-09/SPR380-09-1F	*"Improving Intersection Design Practices"*
KTC-10-10/SPR366-08-1F	*"Effects of Chloride Contamination on Coatings Performance"*
KTC-10-11/KH60-07-1F	*"Nondestructive Testing of Defective ASTM A-514 Steel on the I-275 Combs-Hehl Twin Bridges over the Ohio River in Campbell County, Kentucky"*
KTC-10-12/KSP-10-1F	*"2010 Safety Belt Usage Survey in Kentucky"*
KTC-10-13/SPR390-10-1F	*"Review of State Laws and Practices for Disposition of Re-Aligned or Bypassed Segments and Associated ROW"*
KTC-10-14/KSP2-10-1F	*"Analysis of Traffic Crash Data in Kentucky (2005-2009)"*
KTC-10-15/KSP4-10-1F	*"2010 Driver Attitudes and Awareness Survey"*
KTC-10-15/KSP3-10-1F	*"Evaluation of the Locations of Kentucky's Traffic Crash Data"*
KTC-10-17/FR181-10-1F	*"Kennedy Interchange Crash Study"*
KTC-10-18/SPR384-09-1F	*"Change Orders and Lessons Learned"*
KTC-10-19/FR142-01-1F	*"Final Warranty Evaluation I-275 Boone/Kenton Counties MP 1.05-7.15"*

All research project reports completed since 2000 can be found on the Center's Web site:

http://www.ktc.uky.edu

Technology transfer short course and workshop listings can be found at:

http://www.kyt2.com

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