

**Recommended Rural Transportation Safety Research Program for the 21<sup>st</sup>  
Century**

**by**

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## **ABSTRACT**

The basic objective of this 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 21<sup>st</sup> 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.

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## INTRODUCTION

### **Problem Statement**

Over 60 percent of the nation's highway fatalities occurred on rural two-lane highways [USGAO, 2004]. More than 40 percent of all fatal traffic crashes in 2003 involved vehicles running off the road. The statistics are even worse in rural areas, where two-thirds of fatalities result from vehicles first leaving the road and then overturning or hitting fixed objects such as trees or embankments [AASHTO, 2005]. Over 1000 people per year are killed in highway construction zone crashes [AASHTO, 2005]. Nearly one-third of these fatalities are construction zone workers. It has been estimated that 15-30 percent of highway crashes are "secondary" crashes (crashing into stalled, disabled or wrecked vehicles at an accident scene). Nearly 18 percent of highway crash fatalities are due to secondary crashes. Over 40 percent of law enforcement fatalities in this country are traffic-related [PB Farradyne, 2000]. It has been estimated that a pedestrian is killed or injured about every 6 minutes on our nation's streets and highways. Twenty-eight percent of pedestrian fatalities occur in rural areas; challenging the notion that pedestrian fatalities are an urban problem [Hall et al., 2004]. Vehicle-animal (e.g., deer) crashes, along with the associated habitat encroachment issues, are becoming a significant safety problem in many rural states. Crashes at highway/rail grade crossings are a continuing safety problem in rural states. Young and older drivers statistically appear to have a higher fatality rate per capita than other drivers. Motor vehicle crashes are the leading cause of death for people ages 16 to 20. Intoxicated drivers 21 to 34 years old accounted for 59 percent of fatal alcohol-related crashes in 2003. Furthermore, 74 percent of young drivers who had been drinking and killed in crashes were unrestrained. Overall, it has been estimated that over 50 percent of passenger car occupants who die in crashes are not belted [AASHTO, 2005].

While the litany of statistics cited above highlights the magnitude of the problem and suggests potentially productive areas of research, it must be born in mind that research efforts to date have been incremental and piecemeal at best; focusing in large part on

“standard” traffic engineering measures directed at reducing the number of crashes while ignoring the broader social, human and environmental aspects of the problem. For example, 45 to 75 percent of all highway crashes are the result of “driver/human error” (inattentiveness, speeding, failure to yield the right of way, drug and alcohol use, failure to use seat belts) [USDOT, 2002]. Therefore, transportation safety researchers should recognize that despite their best efforts in highway design and signing, crashes will continue to occur and that research efforts should focus on increasing driver safety awareness and improving the crashworthiness of vehicles and roadside obstructions, and/or employing automated vehicle guidance and vehicle crash-avoidance systems. Improved communications (via GPS/cell phone based “mayday” technologies, for example) with the driver and/or vehicle before and after crashes also should be given increased consideration in highway safety research. As a sidebar, and to illustrate the complex and confounding nature of the problem, some human factors researchers have suggested that people respond to safety improvements by taking additional risks (e.g., improvements that increase the safe speed on a highway curve may encourage some drivers to continue to attempt to negotiate the curve at a higher, unsafe speed).

If transportation safety is examined more broadly to include basic infrastructure and “environmental” factors, a wide range of other critical safety issues come into play. For example, the American Society of Civil Engineers has estimated that nearly 30 percent of the nation’s bridges are structurally deficient or functionally obsolete [ASCE, 2005]. This is as much a highway safety issue as it is a mobility issue. Environmental and natural or man-made disasters are becoming increasingly significant transportation safety factors. Many of these factors are applicable to both rural and urban transportation systems. Recent natural disasters and the continuing threats of terrorism (including bio-terrorism) have underscored the central role of our highway transportation infrastructure in protecting the safety of our citizens before, during and after such events. These disasters and threats have made us painfully aware of the weaknesses and vulnerability of our nation’s highways, tunnels, bridges and transit facilities. The more direct environmental safety impacts of air quality, roadway flooding and the impacts of roadway de-icing practices on water quality also should be addressed under the rubric of

transportation safety. Any comprehensive transportation safety program must address these environmental and emergency preparedness issues.

There is a need for a comprehensive transportation safety research program that addresses the driver, the vehicle and the roadway, and that considers the broader issues of human factors and socio-environmental issues as key components in transportation safety. The objective of this research effort was to define a multi-disciplinary, comprehensive rural transportation safety research program for the Kansas State University Transportation Center (KSU UTC) for the 21<sup>st</sup> century. The implementation of the proposed research program will require the expertise of a wide range of engineering disciplines and social sciences.

### **Objectives**

The basic objective of the proposed study is to define a multi-disciplinary, comprehensive research agenda that can guide the KSU UTC rural transportation safety research program into the 21<sup>st</sup> century. The products of the proposed 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.

### **Study Method**

The project work plan consisted of the following basic tasks.

Task 1: Conduct literature reviews to identify current and emerging issues in the area of rural transportation safety, as broadly defined in the research problem statement. The literature review will be supplemented with the knowledge of the research team and personal contacts.

Task 2: Develop criteria for selecting research topics to be included in the research program.

Task 3: Prepare interim report. The interim report will provide a summary of potential research areas, a preliminary prioritization of research areas in terms of implementation potential and expected benefits and a preliminary identification of the disciplines/areas of expertise best suited to address the individual problem areas. The interim report will also outline the organizational and administrative structure needed to implement the recommended research program.

Task 4: Solicit input from KSU faculty and others whose areas of expertise could be brought to bear on the problems identified in the interim report. The interim report will be posted on the UTC website with a request for comments, suggestions and recommendations concerning the basic content and scope of the interim report. The purpose of this solicitation will be to further refine the recommended research program and to link the research needs identified in the interim report with the appropriate KSU faculty. Faculty desiring to participate in the research program will be asked to prepare and submit a research problem statement in a format to be defined by the UTC Advisory Committee.

Task 5: Prepare final report. The final report will provide a general description of the proposed research agenda in the form of a preliminary prioritization of research areas, preliminary research problem statements, a proposed organizational and administrative structure (e.g., establishment of a “Safety Institute” within the KSU UTC) to implement the research agenda, identification of the areas of expertise needed to implement the recommended research program, estimated short and long term benefits associated with the various research agenda items and a proposed technology transfer program to disseminate information on the research program and its findings. The final report will be presented to the UTC Advisory Committee with the recommendation that the report be adopted by the advisory committee as a policy guide in the selection of future UTC-funded research projects in the area of rural transportation safety.

## **IDENTIFICATION OF RESEARCH NEEDS**

The identification of potential research areas was based on a review of the 2005 American Association of State Highway and Transportation Officials (AASHTO) *AASHTO Strategic Highway Safety Plan* [AASHTO, 2005], a review of state DOT strategic safety plans, a review of the research focus areas identified in the KSU UTC Strategic Plan and the personal knowledge and research interests of the project research team. An overview of the potential rural transportation safety research areas identified through this process is provided below.

### **AASHTO Strategic Highway Safety Plan**

In 2005 the American Association of State Highway and Transportation Officials (AASHTO) published the *AASHTO Strategic Highway Safety Plan* [AASHTO, 2005]. The Strategic Highway Safety Plan (SHSP) was developed in response to the US Department of Transportation's initial goal of reducing the nation's highway fatality rate by 2008 to not more than one fatality per 100 million vehicle miles traveled. The AASHTO Standing Committee on Highway Safety has modified this initial goal to "reducing fatalities by 1,000 per year over the next two decades" [AASHTO, 2007].

The SHSP was developed using input from a range of stakeholders representing the private and public sectors. The SHSP identifies 22 specific highway safety challenges or goals under six general "emphasis areas". Exhibit 1 summarizes AASHTO's six emphasis areas and its 22 goals to mitigate major problems and advance effective safety practices. The AASHTO SHSP served as a key resource in identifying transportation safety research needs for the KSU UTC research program.

### **State DOT Strategic Highway Safety Plans**

One of the requirements of SAFETEA-LU, 23 USC 148 is the development of State Department of Transportation (DOT) Strategic Highway Safety Plans (SHSP). This requirement is a major part of the core Highway Safety Improvement Program (HSIP).

## **Exhibit 1: Elements of the AASHTO Strategic Safety Plan.**

**Drivers.** The subject area Drivers encompasses everything from graduated licensing for young drivers to curbing aggressive driving, from reducing impaired driving and keeping drivers alert to methods of increasing driver safety awareness and seat belt usage.

- Goal 1: Instituting Graduated Licensing for Young Drivers
- Goal 2: Ensuring Drivers are Fully Licensed and Competent
- Goal 3: Sustaining Proficiency in Older Drivers
- Goal 4: Curbing Aggressive Driving
- Goal 5: Reducing Impaired Driving
- Goal 6: Keeping Drivers Alert
- Goal 7: Increasing Driver Safety Awareness
- Goal 8: Increasing Seatbelt Usage and Improving Airbag Awareness

**Special Users/Nonmotorized.** Special Users use non-motorized modes of transportation on highways. Pedestrians and bicyclists are two examples.

- Goal 9: Making Walking and Street Crossing Safer
- Goal 10: Ensuring Safer Bicycle Travel

**Vehicles.** Vehicles addresses motorcycle and commercial truck safety and vehicle safety enhancements such as antilock brake systems (ABS).

- Goal 11: Improving Motorcycle Safety and Increasing Motorcycle Awareness
- Goal 12: Making Truck Travel Safer
- Goal 13: Increasing Safety Enhancements in Vehicles

**Highways.** Vehicle-train crashes, highway intersection design and operation, head-on and across-median crashes and work zones are some of the problem areas discussed in Highways.

- Goal 14: Reducing Vehicle-Train Crashes
- Goal 15: Keeping Vehicles on the Roadway
- Goal 16: Minimizing the Consequences of Leaving the Road
- Goal 17: Improving the Design and Operation of Highway Intersections
- Goal 18: Reducing Head-on and Across-median Crashes
- Goal 19: Designing Safer Work Zones

**Emergency Medical Services.** EMS capabilities can be enhanced to increase survivability of crash victims.

- Goal 20: Enhancing Emergency Medical Capabilities to Increase Survivability

**Management.** The Management area deals with problems in gathering and analyzing crash data.

- Goal 21: Improving Information and Decision Support Systems
- Goal 22: Creating More Effective Processes and Safety Management Systems

Source: [AASHTO, 2005].

The purpose of an SHSP is to identify the State's key safety needs and guide investment decisions to achieve significant reductions in highway fatalities and serious injuries on all public roads. The SHSP allows all highway safety programs in the State to work together in an effort to align and leverage its resources and positions the State and its safety partners to collectively address the State's safety challenges on all public roads.

An SHSP is a statewide-coordinated safety plan that provides a comprehensive framework, and specific goals and objectives, for reducing highway fatalities and serious injuries on all public roads. This statewide document, developed by the State DOT in a cooperative process, includes input from public and private safety stakeholders. The SHSP is a data-driven, four to five year comprehensive plan that integrates the four E's - engineering, education, enforcement and emergency medical services (EMS). The SHSP establishes statewide goals, objectives, and key emphasis areas developed in consultation with Federal, State, local, and private sector safety stakeholders [USDOT, 2007].

Table 1 and Figure 1 provide summaries of the major components of the 50 State DOT Strategic Highway Safety Plans, as extracted from information provided by the National Highway Traffic Safety Administration [NHTSA, 2007]. A summary of the AASHTO goals addressed by the individual state DOTs can be found in Table A-1 in Appendix A.

The twenty-two AASHTO goals are broken into six categories: drivers, special users, vehicles, highways, emergency medical services, and management. Most states addressed problems from a combination of these categories. A few states expressed goals that are not contained within the AASHTO goals, such as school bus safety.

Several of the problems that are related to drivers (AASHTO goals 1-8) received a great deal of attention from states in their safety plans. The problems of seat belt usage and impaired driving were addressed by 49 of the 50 states, with Virginia being the sole state not to address these issues in their safety plan. Other driver related problems, such as increasing driver safety awareness and curbing aggressive driving were also of great

interest, with 72 percent and 64 percent of states addressing these issues, respectively. The other goals pertaining to drivers were mentioned by less than 25 percent of the states.

AASHTO goals nine and ten relate to special users and received attention from a majority of the states. 78 percent of the states addressed the AASHTO goal of “Making Walking and Street Crossing Safer”. The safety of bicycle travel was addressed by 72 percent of the states.

Of the vehicle goals (goals 11-13), Motorcycle Safety and Awareness was the only one that was addressed by a large portion of the states, with 86 percent of the states addressing these goals. Only 18 percent of the states showed an interest in improving the safety of truck travel, and no states expressed the need to increase safety enhancements in vehicles.

AASHTO goals 14-19 involve improving the highways themselves. The states showed little support for these goals. Goal 19, “Designing Safer Work Zones”, is being addressed by 22 percent of states. Interest in the other highway goals ranges from 10-20 percent.

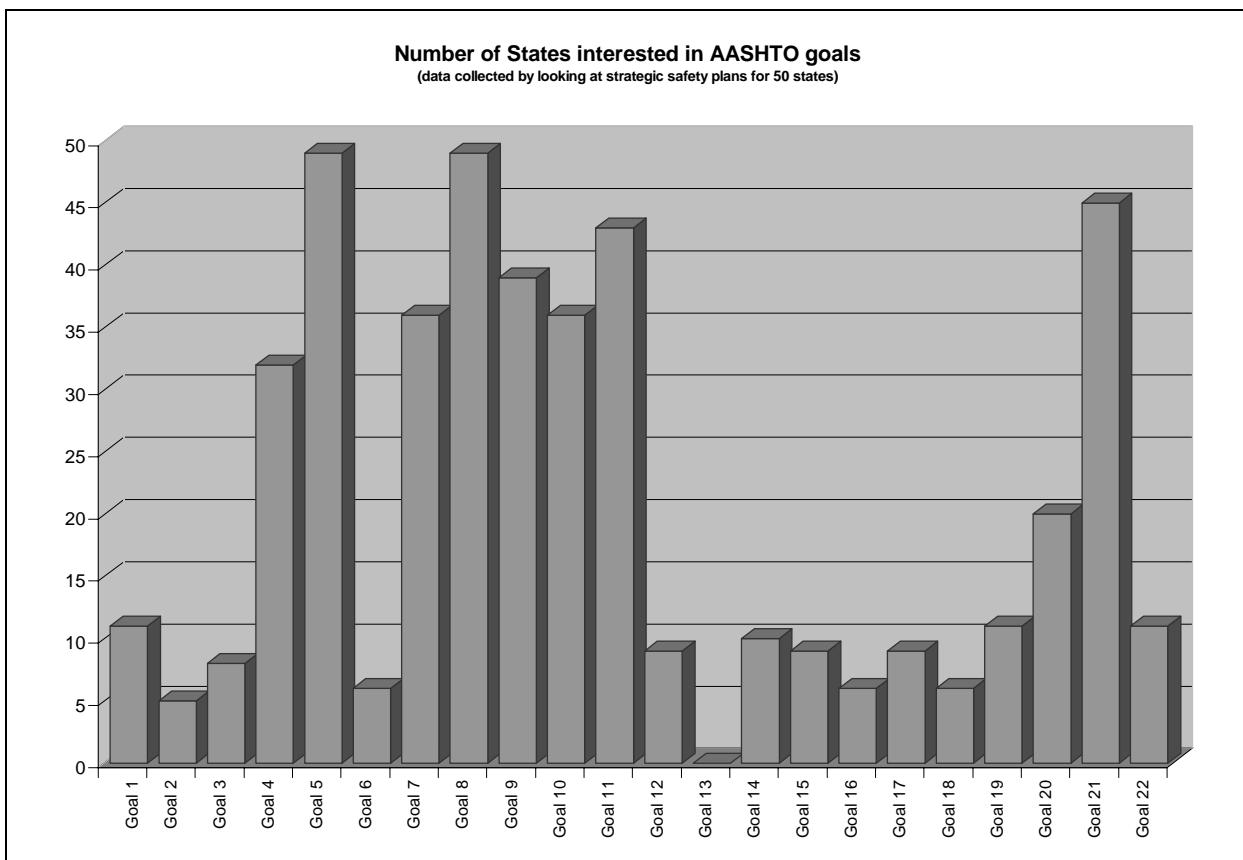
Goal 20 pertaining to Emergency Medical Services was addressed by 40 percent of the states. “Improving Information and Decision Support Systems” was a very popular goal that was being addressed by 90 percent of the states.

Overall, the states appear to be most interested in goals dealing with drivers, special users, and management.

**Table 1. AASHTO Goals Addressed in State DOT Strategic Plans**

AASHTO Goal	# of States	% of States
Goal 1: Instituting Graduated Licensing for Young Drivers	11	22%
Goal 2: Ensuring Drivers are Fully Licensed and Competent	5	10%
Goal 3: Sustaining Proficiency in Older Drivers	8	16%
Goal 4: Curbing Aggressive Driving	32	64%
Goal 5: Reducing Impaired Driving	49	98%
Goal 6: Keeping Drivers Alert	6	12%
Goal 7: Increasing Driver Safety Awareness	36	72%
Goal 8: Increasing Seat Belt Use and Improving Airbag Effectiveness	49	98%
Goal 9: Making Walking and Street Crossing Safer	39	78%
Goal 10: Ensuring Safer Bicycle Travel	36	72%
Goal 11: Improving Motorcycle Safety and Increasing Motorcycle Awareness	43	86%
Goal 12: Making Truck Travel Safer	9	18%
Goal 13: Increasing Safety Enhancements in Vehicles	0	0%
Goal 14: Reducing Vehicle-Train Crashes	10	20%
Goal 15: Keeping Vehicles on the Roadway	9	18%
Goal 16: Minimizing the Consequences of Leaving the Road	6	12%
Goal 17: Improving the Design and Operation of Highway Intersections	9	18%
Goal 18: Reducing Head-On and Across-Median Crashes	6	12%
Goal 19: Designing Safer Work Zones	11	22%
Goal 20: Enhancing Emergency Medical Capabilities to Increase Survivability	20	40%
Goal 21: Improving Information and Decision Support Systems	45	90%
Goal 22: Creating More Effective Processes and Safety Management Systems	11	22%

Source: [NHTSA, 2007]



**Figure 1. AASHTO Goals Addressed in State DOT Strategic Plans**

Source: [NHTSA, 2007]

## **Other Sources**

### **KSU UTC Strategic Plan Research Focus Areas**

The KSU UTC Strategic Plan identifies the following focus areas for its safety research program.

1. The effects of an aging Kansas population on transportation services and facilities.
2. Economic issues associated with rural transportation services and facilities.
3. Rural emergency medical services.
4. Terrorism and food safety issues associated with rural transportation services and facilities.
5. Provision of rural public transportation services and facilities.

### **Research Team Personal Knowledge**

The personal knowledge and research interests of the study team were also reviewed to identify potential rural transportation safety research needs. That review identified the following potential rural highway safety research areas.

1. Safety and operations of rural roundabouts.
2. Rural transportation safety education courses and programs.
3. Rural work zone safety programs (e.g., KDOT's "Give 'em a Brake" program).
4. Rural highway incident management programs (e.g., implementation of the 2003 MUTCD's Section 6I).

## **RECOMMENDED SAFETY RESEARCH PROGRAM**

### **Criteria for Selecting Research Areas**

The research team established the following criteria to select those research areas that best fit the stated objectives of the study and the UTC's research focus areas.

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.
6. The research area must address one of the areas identified in the Kansas DOT SHSP.

### **Recommended Research Areas**

Based on the process outlined above, the research team recommends the following rural transportation safety research topics as focus areas for the KSU UTC. While the following represents the research team's prioritized of the research topics, it is recognized that it may be necessary to modify the priorities based on available funding opportunities and the Advisory Council's priorities. Guidance concerning the general nature of the basic research needed within each of the recommended research areas is provided in the draft Research Problem Statements presented in Appendix B of this report.

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.
12. Transportation Planning for Terrorism, Natural Disasters, Traffic Incidents and Other Emergencies in Rural Areas.

### **Recommended Organizational Structure for the Research Program**

The proposed organizational structure for implementing the research agenda calls for the creation of a rural transportation safety “institute” within the KSU UTC. The “divisions” and potential disciplines for the proposed institute could include the following: traffic/highway engineering and planning division (civil engineers, planners); structures division (civil, mechanical and architectural engineers); environmental division (civil and chemical engineers); advanced technology/intelligent transportation systems division (civil, electrical and computer engineers); human factors division (industrial and civil engineers, sociologists, psychologists), policy division (engineers, economists, political scientists); and outreach/technology transfer division.

To more formally identify faculty members whose expertise could be brought to bear on specific research problem areas, the Advisory Council should consider the establishment of a “UTC Faculty” designation. This designation could require interested faculty to

submit a brief statement identifying their specific areas of research interest and their qualifications to pursue research in those areas.

In addition, it is recommended that the Traffic Assistance Services for Kansas (TASK) program, the Kansas Transportation Engineering Conference and possibly other on-going KSU transportation safety-related outreach and extension programs be administered through the proposed KSU UTC Safety Institute.

Clearly a diverse group of faculty and students will be needed to identify and implement specific areas of research within each division. By providing the framework for innovative (even futuristic), multidisciplinary research, this systematic and comprehensive approach to rural transportation safety can serve as a guide in the selection of safety research projects. Implementation of the recommended research program could significantly improve rural transportation safety and establish the KSU UTC as an innovator and world leader in the field.

## **IMPLEMENTING THE RECOMMENDED PROGRAM**

### **Program Implementation**

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 area of rural transportation safety. In ranking and selecting potential safety research projects, 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.

### **Technology Transfer**

The College of Engineering has a long history of extension, outreach and educational programs that will serve as models for the education and technology transfer activities for the proposed research program. For example, the Traffic Assistance Services for Kansas (TASK) program has been providing highway safety training programs since 1980. The continuing success of the Kansas Transportation Engineering Conference, the Annual Bridge Workshop, and the SuperPave training program demonstrate the capabilities of the engineering faculty to develop and deliver quality training and extension services. Other information and technology transfer technologies that will be explored as part of the proposed research include Internet clearinghouse(s) for transportation safety and best practices, and use of virtual design and visualization technology to demonstrate/disseminate research findings and concepts.

Finally, the Technology Transfer program should have a strong classroom education component to insure that research findings are made available in the appropriate undergraduate and graduate level courses at KSU.

## **INTERIM RECOMMENDATIONS**

### **Interim Recommendations**

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 area of rural transportation safety.

In ranking and selecting potential safety research projects, 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. The “divisions” and potential disciplines for the proposed institute could include the following: traffic/highway engineering and planning division (civil engineers, planners); structures division (civil, mechanical and architectural engineers); environmental division (civil and chemical engineers); advanced technology/intelligent transportation systems division (civil, electrical and computer engineers); human factors division (industrial and civil engineers, sociologists, psychologists), policy division (engineers, economists, political scientists); and education/outreach/technology transfer division.

To more formally identify faculty members whose expertise could be brought to bear on specific research problem areas, the Advisory Council should consider the establishment of a “UTC Faculty” designation. This designation could require interested faculty to submit a brief statement identifying their specific areas of research interest and their qualifications to pursue research in those areas.

In addition, it is recommended that the Traffic Assistance Services for Kansas (TASK) program, the Kansas Transportation Engineering Conference and possibly other on-going KSU transportation safety-related outreach and extension programs be administered through the proposed KSU UTC Safety Institute.

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## APPENDIX A: SUMMARY OF SURVEY OF STATE DOT SAFETY PLANS

**Table A-1. Goals by State**

	Goal 1: Graduated Licensing	Goal 2: Drivers are Licensed & Competent	Goal 3: Proficiency in Older Drivers	Goal 4: Aggressive Driving	Goal 5: Impaired Driving	Goal 6: Keeping Drivers Alert
Alabama				1	1	
Arizona					1	
Arkansas					1	
California		1	1	1	1	
Colorado	1			1	1	1
Connecticut				1	1	
Delaware				1	1	
District of Columbia				1	1	
Florida				1	1	
Georgia	1			1	1	
Hawaii				1	1	
Idaho			1	1	1	
Illinois					1	
Indiana				1	1	
Iowa					1	
Kansas					1	
Kentucky					1	
Louisiana				1	1	
Maine				1	1	
Maryland				1	1	1
Massachusetts			1	1	1	
Michigan	1		1		1	
Minnesota				1	1	
Mississippi	1				1	
Missouri	1		1	1	1	
Montana				1	1	
Nebraska	1				1	
Nevada					1	
New Hampshire					1	
New Jersey				1	1	
New Mexico					1	
New York				1	1	
North Carolina	1		1	1	1	
North Dakota				1	1	
Ohio			1		1	
Oklahoma					1	
Oregon		1		1	1	
Pennsylvania	1	1	1	1	1	1
Rhode Island	1			1	1	
South Carolina				1	1	
South Dakota	1			1	1	1
Tennessee		1		1	1	
Texas		1		1	1	
Utah					1	1
Vermont	1			1	1	1
Virginia						
Washington					1	
West Virginia					1	
Wisconsin				1	1	
Wyoming				1	1	
<b>Totals:</b>	<b>11</b>	<b>5</b>	<b>8</b>	<b>32</b>	<b>49</b>	<b>6</b>
<b>Percentages:</b>	22.00%	10.00%	16.00%	64.00%	98.00%	12.00%

**Table A-1 (Continued). Goals by State**

	Goal 7: Driver Safety Awareness	Goal 8: Seatbelt Usage and Airbag Awareness	Goal 9: Walking and Street Crossing	Goal 10: Bicycle Travel	Goal 11: Motorcycle safety and awareness	Goal 12: Truck Travel
Alabama	1	1				
Arizona		1	1	1	1	
Arkansas		1				
California	1	1	1	1		1
Colorado	1	1	1	1	1	1
Connecticut	1	1			1	
Delaware	1	1	1			
District of Columbia		1	1	1	1	
Florida	1	1	1	1	1	
Georgia	1	1	1	1	1	
Hawaii		1	1	1	1	
Idaho	1	1	1	1	1	1
Illinois		1	1	1	1	
Indiana	1	1	1	1	1	
Iowa	1	1	1	1		
Kansas	1	1	1	1	1	
Kentucky	1	1	1	1	1	
Louisiana	1	1	1	1	1	
Maine	1	1	1	1	1	
Maryland	1	1	1	1	1	
Massachusetts		1	1	1	1	
Michigan	1	1	1	1	1	1
Minnesota	1	1			1	
Mississippi	1	1				
Missouri	1	1	1	1	1	1
Montana		1			1	
Nebraska	1	1			1	
Nevada	1	1	1	1	1	
New Hampshire	1	1	1	1	1	
New Jersey	1	1	1	1	1	
New Mexico	1	1	1	1	1	
New York	1	1	1	1	1	
North Carolina		1	1	1	1	
North Dakota	1	1			1	
Ohio	1	1			1	
Oklahoma		1	1	1	1	
Oregon		1	1	1	1	
Pennsylvania	1	1	1	1	1	1
Rhode Island	1	1	1	1	1	
South Carolina	1	1	1		1	
South Dakota	1	1			1	1
Tennessee	1	1	1	1	1	1
Texas	1	1	1	1	1	
Utah	1	1	1	1	1	
Vermont	1	1	1	1	1	
Virginia			1	1		
Washington		1	1		1	
West Virginia		1			1	
Wisconsin		1	1	1	1	1
Wyoming	1	1	1	1	1	
<b>Totals:</b>	<b>36</b>	<b>49</b>	<b>39</b>	<b>36</b>	<b>43</b>	<b>9</b>
<b>Percentages:</b>	72.00%	98.00%	78.00%	72.00%	86.00%	18.00%

**Table A-1 (Continued). Goals by State**

	Goal 13: Safety Enhance- ments in Vehicles	Goal 14: Vehicle- Train Crashes	Goal 15: Keeping Vehicles on the Roadway	Goal 16: Minimizing Consequences of Leaving Road	Goal 17: Design and Operation of Hwy Intersections	Goal 18: Head-on and Across- Median crashes
Alabama						
Arizona			1			
Arkansas		1				
California						
Colorado		1	1	1	1	1
Connecticut		1		1		
Delaware						
District of Columbia						
Florida						
Georgia						
Hawaii						
Idaho		1	1			
Illinois						
Indiana				1		
Iowa						
Kansas						
Kentucky						
Louisiana		1				
Maine						
Maryland						
Massachusetts						
Michigan					1	
Minnesota						1
Mississippi						
Missouri						
Montana						
Nebraska						
Nevada						
New Hampshire		1				
New Jersey						
New Mexico						
New York						
North Carolina						
North Dakota						
Ohio						
Oklahoma		1				
Oregon					1	
Pennsylvania		1	1	1	1	1
Rhode Island						
South Carolina						
South Dakota			1		1	1
Tennessee			1	1	1	1
Texas		1				
Utah			1		1	
Vermont			1		1	
Virginia		1	1	1	1	1
Washington						
West Virginia						
Wisconsin						
Wyoming						
<b>Totals:</b>	<b>0</b>	<b>10</b>	<b>9</b>	<b>6</b>	<b>9</b>	<b>6</b>
<b>Percentages:</b>	0.00%	20.00%	18.00%	12.00%	18.00%	12.00%

**Table A-1 (Continued). Goals by State**

	<b>Goal 19: Safer Work Zones</b>	<b>Goal 20: Emergency Medical Capabilities</b>	<b>Goal 21: Improving Information and Decision Support Systems</b>	<b>Goal 22: Effective Processes and Safety Management Systems</b>	<b>Number of Goals Being Addressed</b>
Alabama					4
Arizona	1	1	1		9
Arkansas			1		4
California		1	1		11
Colorado	1		1		17
Connecticut	1		1		9
Delaware			1		6
District of Columbia			1		7
Florida	1		1		9
Georgia			1		9
Hawaii		1	1		8
Idaho		1	1		13
Illinois			1	1	7
Indiana		1	1		10
Iowa			1	1	7
Kansas		1	1		8
Kentucky					6
Louisiana			1		9
Maine		1	1		9
Maryland			1	1	10
Massachusetts			1		8
Michigan			1		11
Minnesota			1		7
Mississippi			1		5
Missouri					10
Montana		1	1		6
Nebraska			1		6
Nevada		1	1		8
New Hampshire	1	1	1	1	11
New Jersey			1		8
New Mexico			1		7
New York			1	1	9
North Carolina					8
North Dakota		1	1		7
Ohio			1	1	7
Oklahoma			1		7
Oregon			1		9
Pennsylvania	1	1	1		20
Rhode Island			1		9
South Carolina		1	1		8
South Dakota	1	1	1	1	15
Tennessee	1	1	1	1	17
Texas	1	1	1	1	13
Utah		1	1		11
Vermont	1	1	1		14
Virginia	1				8
Washington		1	1		6
West Virginia			1	1	5
Wisconsin		1	1		9
Wyoming			1	1	9
<b>Totals:</b>	<b>11</b>	<b>20</b>	<b>45</b>	<b>11</b>	
<b>Percentages:</b>	22.00%	40.00%	90.00%	22.00%	

## **APPENDIX B: DRAFT RESEARCH PROBLEM STATEMENTS**

The research team recommends the following rural transportation safety research topics as focus areas for the KSU UTC. While the following list is prioritized, it is recognized that it may be necessary to modify the priorities based on available funding opportunities. Guidance concerning the general nature of the basic research needed within each of the recommended research areas is provided in this Appendix. Much of the material in the following problem statements has been extracted directly from the *AASHTO Strategic Highway Safety Plan* [AASHTO, 2005].

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 the Roadway 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.
12. Transportation Planning for Terrorism, Natural Disasters, Traffic Incidents and Other Emergencies in Rural Areas.

## **1. Sustaining Proficiency in Older Drivers and Providing Mobility Options for the Elderly in Rural Areas.**

The increasing number and percentage of older drivers using the nation's highways in future decades will pose many challenges. The 65 and older age group, which numbered 35 million in 2000, will swell to 70 million in 2030, accounting for roughly one-fifth of the country's driving population. Most older drivers are good drivers, but the effects of aging ultimately affect driving abilities of some seniors. Once in a crash, adults age 65 and older are far more likely to sustain fatal injuries because of physical frailty resulting from aging. In 2003, more than 6,600 seniors died in motor vehicle crashes – 15 percent of all fatalities. Most traffic fatalities involving older drivers occur during weekday daytime hours, and three-quarters involve another vehicle. In two-vehicle crashes involving an older driver and a younger driver in 2003, the vehicle driven by the older individual was more than twice as likely to be the one that was struck. In 44 percent of these crashes, both vehicles were proceeding straight at the time of the crash. In 27 percent, the older driver was turning left – seven times as often as the younger driver. Safety issues associated with older drivers must be addressed in order to stem the growing number of crashes involving these drivers.

Specific issues that need to be addressed include: screening, assessment and licensing of elderly driver; synthesis of factors known to affect the safety of elderly drivers (e.g., medical conditions, cognitive limitations); legislative/regulatory approaches to licensing elderly drivers; and training/refresher courses for elderly drivers. In addition to research directed at sustaining proficiency in older “drivers”, research efforts should be directed at pedestrian issues facing the elderly (e.g., pedestrian signal timing practices) and the need for rural transit and paratransit services and facilities for the elderly.

## **2. Improving the Traffic Safety Culture in Rural Areas**

Although ignorance and cavalier attitudes about traffic safety issues are common-place, they are still difficult to quantify. It is clear, however, that many drivers fail to understand the seriousness and potential adverse consequences of aggressive driving, DUI, and failing to properly use safety belts—all of which are major factors in crashes and their resulting injuries and fatalities. Research indicates that approximately 85 percent of causation factors associated with crashes is attributed to the driver. Many drivers are unaware of or have underestimated the risks and consequences associated with various unsafe driving behaviors. States have a vested interest in ensuring their drivers are as knowledgeable of highway safety issues as is reasonably possible. Nevertheless, road traffic injuries are the only public health problem for which society and decision-makers still accept death and disability among our citizens on a large scale. The human sacrifice is seen as a justifiable externality of doing business: the only discussion revolves around the number of deaths and injuries that are acceptable. The general apathy towards the problem is typically attributed to the fact that although there are more than 100 highway deaths on an average day in the US, they happen primarily in ones and twos scattered around the country [Mohan, 2003].

The basic research in this area should use established programs, safety research information, and techniques now available, to initiate, develop, and market a coordinated public information and education campaign that targets at least the following areas: the psychology of driving, drinking and driving, occupant protection, aggressive driving (including speeding), fatigue, inattention, roadside hazards, unsafe driving, understanding traffic control devices, work zones, tailgating, and rear-end collisions.

### **3. Increasing Seatbelt Usage in Rural Areas**

Seat belt usage has frequently been identified as one of the most effective ways of improving highway safety and reducing fatalities. Because safety belts are approximately 50 percent effective in preventing fatalities in crashes in which motorists would otherwise die, NHTSA believes the number of lives saved could be substantially increased – an additional 7,000 lives – if more people used safety belts. Even though the effectiveness of seat belts is widely known and accepted, seat belt use remains low in the United States compared to Australia, Canada and some Northern European countries, which have average usage rates above 90 percent. Seat belt use rates in US vary from state to state reflecting the public attitude, state seat belt laws, enforcement practices, legal provisions, and education programs. Particularly low seat belt usage rates have been observed in rural areas, which could be one of the contributory factors in unusually high fatality rates in such areas. According to data from Insurance Institute of Highway Safety, greater reductions in driver and passenger deaths could be observed when seat belts are combined with frontal airbags.

Research in this area should focus on: encouraging states to adopt standard (primary) seat belt laws and model child restraint laws; implementation of periodic, intensive, and coordinated enforcement and public information and education initiatives.

### **4. Keeping Vehicles on the Roadway in Rural Areas**

In rural areas, two-thirds of fatalities result from vehicles first leaving the road and then overturning or hitting a fixed object such as trees or embankments. Such crashes are three times more likely to occur at night than during daylight hours. In order to reduce the number of fatalities resulting from vehicles leaving the roadway, efforts must be made to keep vehicles from leaving the roadway and reduce the likelihood of errant vehicles overturning or crashing into roadside objects.

In order to do this, the question that must be asked is why are vehicles leaving the roadway? The answer to this question seems to fall into one of the following categories: the driver's inability to recognize the edge of the roadway, driver in-attentiveness, or loss of control of the vehicle. Thus, solutions to this problem must address each of these scenarios.

Methods of preventing vehicles from leaving the roadway due to inability to recognize edge of road, inattentiveness and loss of control need to be researched, developed, and implemented. The visibility of road marking systems should be evaluated to ensure that

the driver can see where the road is going. Modern headlight types should be taken into consideration. Methods of alerting the inattentive driver that they are approaching the edge of the roadway should be researched. Low-tech solutions, such as rumble strips, are currently used on many roadways. Other, more high-tech systems should be considered. To prevent drivers from losing control of the vehicle, methods of reducing speed variation should be considered. Determining ways to implement findings into the design process is crucial in reducing the number of fatalities resulting from vehicles leaving the roadway.

## **5. Making Rural Truck Travel Safer**

In 2004, 416,000 large trucks were involved in traffic crashes. Roughly 4,900 of those were fatal crashes. A total of 5,190 people (12 percent of all traffic fatalities reported in 2004) died as a result of a truck related crash. An additional 116,000 were injured. Among those killed in crashes involving large trucks, 77 percent were occupants of another vehicle, 8 percent were non-occupants, and 15 percent were occupants of a large truck. Most of the fatal crashes involving large trucks occurred in rural areas (66 percent), during daytime (67 percent) and on weekdays (80 percent).

The Federal Motor Carrier Safety Administration has set a goal for reducing commercial truck related fatalities by 50 percent by 2010, which has placed an increased importance on truck related research. Much of the research in the past has focused on Interstate or freeway related driving conditions. Similar research efforts are needed in rural areas, at intersections, and along undivided highways.

Research in this area should be directed at identifying characteristics and factors that contribute to truck crashes and identifying countermeasures that could improve truck safety on rural highways.

## **6. Enhancing Rural Emergency Medical Capabilities**

No amount of preventive action will completely eliminate crashes and injuries from highway crashes. As a result, the level of care and preparedness for such crashes must be at its maximum. Emergency care scenarios are markedly different in urban, rural and remote settings and require strategies tailored to meet the realities of each.

Research strategies in this area should focus on development and implementation of a model comprehensive approach that will ensure appropriate and timely responses to emergency needs of crash victims. The model, at a minimum, should address emergency vehicle routing schemes and require first responder training for all public safety emergency response personnel, including police officers. Additionally, the model should have provisions to increase education and involvement of EMS personnel in the principles of traffic safety. Technology-related research should focus on the use of GPS, cell phones and vehicle instrumentation to assess crash severity and to reduce emergency vehicle response times.

## **7. Designing Safer Rural Work Zones**

Highway work zones create a major safety concern for motorists and workers alike. In 2003, fatalities in work zones totaled 1,028. This number included 117 pedestrians, most of which were construction workers, and 903 vehicle drivers and occupants. The basic research needs in this area include: methods to reduce the number and duration of work activities; improved procedures to ensure more effective practices, including traffic control devices, for managing work zone operations; training for the planning, implementation, and maintenance of work zones to improve safety; and public education and enforcement programs to enhance work zone safety.

## **8. Improving Design and Operations of Rural Highway Intersections**

One in every four fatal crashes occurs at or near an intersection, one-third of which are signalized. On average, one person dies every hour at an intersection somewhere in the United States. The most prominent types of intersection crashes involve left turns and being struck from the rear. Right-angle collisions are a predominate cause of death at signalized intersections. Collisions at non-signalized intersections may have many causes including driver's inability to properly judge the speed of on-coming traffic, failure to obey traffic laws, and failure to see on-coming traffic. Collisions at signalized-intersections are generally a result of at least one driver not obeying traffic laws.

Since many intersection crashes are a result of failure to comply with traffic laws, methods of deterring drivers from such behavior should be developed. The use of automated methods to monitor and enforce intersection traffic control should be considered. Signal controls should also be updated to improve signal timing and traffic flow. Traffic flow near intersections can be greatly affected by nearby developments. Thus, effective access management policies should be enforced to ensure that safety is not adversely affected by major developments.

Research should be directed at evaluating and implementing alternative intersection designs. Modern roundabouts, for example, have the potential to substantially reduce intersection crashes and fatalities. Properly designed they eliminate the most serious traffic conflicts that cause crashes at traditional intersections. They eliminate traditional left turns, which are a major cause of crashes at traditional intersections, and right angle side crashes. Roundabout crashes tend to be low speed sideswipe and rear end crashes that are much less severe. Research worldwide supports the finding that roundabouts substantially reduce injury crashes and fatalities. A major US study in 2000 by the Insurance Institute for Highway Safety concluded that converting 24 traditional intersections to roundabouts reduced all crashes 39 percent; injury crashes 76 percent and a 90 percent reduction in fatalities.

Finally, research in this problem area should consider the safety and needs of pedestrians and bicyclists at and near the intersection.

## **9. Creating More Effective Rural Safety Management Systems**

In the early 90s, several “Management Systems” were mandated by USDOT/FHWA. Among others, all states were required to have a safety management system (SMS). The rules or requirements were extremely complex and states struggled with compliance. The mandate was eventually dropped and the push for state SMSs diminished. States were no longer required to have safety management plans and many dropped or altered the concept. The Kansas DOT published what was essentially a directory of all state and local organizations that should be involved in safety by county, e.g., engineers, police, emergency management, hospitals, etc. As good as the idea was, it never evolved into a practical tool for local road safety. Local officials and personnel with safety responsibilities are in need of a practical, useable safety management program that emphasizes locating, analyzing, correcting and evaluating the cost-effectiveness of rural, local road safety improvements.

In order to implement cost-effective improvements local personnel need to: evaluate the safety performance of their transportation network, identify the key locations of safety concern, compare the effectiveness of possible solutions, obtain appropriate funding, implement the improvement, and evaluate the improvement.

There is widespread support for road safety at the local level but lack of resources, both financial and personnel, make implementation of a Safety Management Program difficult. Local agencies generally concentrate on their current pressing concerns and rarely look at the whole network in a systematic way.

Research is needed to develop guidelines for a practical, local road safety program. The result would be a model for local agencies to follow to develop a program within their resources that integrates both reactive and proactive tools into a local agency’s road and street program and expanding it to the network level. An example of the reactive approach would be to find high-risk roads, sections or locations and develop a program to correct the identified deficiencies; and example of the proactive approach would be road safety audit reviews.

## **10. Making Non-Motorized Rural Travel Safer**

Despite the modest positive trend in recent years, in 2003, 622 bicyclist fatalities and 46,000 injuries were recorded in State crash statistics. As with pedestrian injury and fatality statistics, those for bicyclists have experienced a modest improvement (fatalities down 7 percent from 1986). However, the number of bicyclists who died (one quarter of whom were between 5 and 15 years old) remains unacceptably high.

In nearly three-fourths of the bicycle fatalities, investigation indicated that an error or some other factor related to the cyclist’s behavior was involved. The most frequent cause of bicycle crashes with vehicles was the failure to yield the right of way, followed by a variety of inappropriate use of the roadway such as playing, standing, sitting, etc., and improperly crossing the roadway or intersection.

The strategies needed to reduce the numbers of bicyclists killed and injured involve engineering, educational, enforcement, and legislative initiatives designed to raise awareness and promote actions that will ultimately make bicycling on the nation's roadways a safer and friendlier activity.

On average, a pedestrian was killed about every hour and a half on the nation's roadways during 2003. This represents nearly 4800 men, women, and children. Though this represents an encouraging 18 percent decrease over the last decade, new strategies that address the various issues associated with pedestrian collisions are needed to further reduce pedestrian deaths and injuries.

Four main areas of concern have been identified, with the highest priority involving inadequacies in pedestrian facilities as well as the lack of good design information for such facilities. Another major concern identified is the lack of awareness of the risks and responsibilities that both drivers and pedestrians have when they interact. The third and fourth areas recommended for action involve the more familiar concerns of motorist and pedestrian noncompliance with traffic statutes and, finally, the predictable high involvement of alcohol in pedestrian collisions.

## **11. Economic Issues Associated with Rural Transportation Services and Facilities**

Transportation serves an important role in rural America. By offering mobility and access for rural residents to jobs and services and enhancing the movement of agricultural products, transportation functions as an essential cornerstone of rural development. However, evidence suggests that the transportation network in non-metro America has fallen into a state of disrepair in many areas. Not only are portions of the physical infrastructure in need of overhaul, but the system requires many technological changes to be brought up-to-date [Brown and Flake, 1999]. In addition to the need to improve and expand the basic transportation physical infrastructure in many rural areas there is a need for similar improvements in the areas of financing/funding, planning and management, regulatory issues, social services and environmental issues. Research in this area should focus on the economic development potentials of agriculture-related transportation improvements (farm-to-market routes, railroads, trucking), general aviation facilities and services and rural public transportation services.

## **12. Transportation Planning for Terrorism, Natural Disasters, Traffic Incidents and Other Emergencies in Rural Areas**

If transportation safety is examined more broadly to include basic infrastructure and "environmental" factors, a wide range of other critical safety issues come into play. For example, the American Society of Civil Engineers has estimated that nearly 30 percent of the nation's bridges are structurally deficient or functionally obsolete [ASCE, 2005]. This is as much a highway safety issue as it is a mobility issue. Environmental and natural or man-made disasters are becoming increasingly significant transportation safety

factors. Many of these factors are applicable to both rural and urban transportation systems. Recent natural disasters and the continuing threats of terrorism (including bio-terrorism) have underscored the central role of our highway transportation infrastructure in protecting the safety of our citizens before, during and after such events. These disasters and threats have made us painfully aware of the weaknesses and vulnerability of our nation's highways, tunnels, bridges and transit facilities.

The initial research in this area is likely to be largely exploratory in nature. Initial research should focus on identifying federal, state and local efforts in emergency planning and to identify potential gaps in these efforts as they relate to the role(s) of transportation facilities and services in preparing for and responding to natural and manmade disasters and emergencies.