Traffic Safety Information Systems International Scan: Strategy Implementation White Paper

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Research, Development, and Technology
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FOREWORD

In October 2003, the Federal Highway Administration (FHWA) and the American Association of State and Highway Transportation Officials (AASHTO) sponsored an international scanning study to visit and learn from the Netherlands, Germany, and Australia. The scanning study's objective was to understand how these countries built and used traffic safety information systems and to learn what brought success at reducing the level of harm on their roadways. The goals of this white paper are to build on that study's final report and the implementation plan developed by the scanning team; and to support critical strategies with action-related details as well as to add new strategies toward the team's goals. Furthermore, this white paper discusses the critical element of access to complete, accurate, and timely data.

It is our hope that this effort will expand the national discussion of improving safety data. Additionally, we hope that some of the suggested solutions, once implemented, and the resulting improvements in data, will lead to decisions that will help solve one of the largest public health problems faced by the United States—highway crashes.

Mike Trentacoste, Director
Office of Safety Research
and Development

Notice

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16. Abstract

Safety data provide the key to making sound decisions on the design and operation of roadways, but deficiencies in many States' safety databases do not allow for good decisionmaking. The Federal Highway Administration (FHWA), the American Association of State Highway and Transportation Officials (AASHTO), and the National Cooperative Highway Research Program (NCHRP) sponsored a scanning study of how agencies in the Netherlands, Germany, and Australia develop and use traffic safety information systems. That scan produced a report that included recommendations for advancing safety themes in the areas of strategy, efficiency, and utility. This current report is the result of a follow-on effort to build on the scan team's final report and draft implementation plan by reviewing in detail the strategies suggested, providing action-related details to some of the critical strategies, and adding new strategies to help reach the team's goals. Although strategies related to both crash data and other safety data such as roadway inventory and traffic volumes are included in this paper, more emphasis is placed on the latter because more effort has traditionally been spent on improving crash data. The five critical strategies detailed here include: (1) increase support for both safety programs and safety information systems from top-level administrators in State and local transportation agencies; (2) improve safety data by defining *good inventory data* and institutionalizing continual improvement toward established performance measures; (3) improve safety data by making it easier to collect, store, and use; (4) improve safety data by increasing the use of critical safety analysis tools, which themselves require good data; and (5) improve and protect safety data by storage and linkage with critical nonsafety data. Discussion and action items are presented for each strategy, along with recommendations concerning which government agency potentially could be responsible for implementing the recommendation and a priority ranking of the proposed recommendations based on input from a review panel.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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ACRONYMS

AAA	American Automobile Association
AADTs	annual average daily traffic flows
AASHTO	Association of State Highway and Transportation Officials
ADT	average daily traffic
ATSIP	Association of Traffic Safety Information Professionals
DHM	Digital Highway Measurement
DOT	department of transportation
EuroNCAP	European New Car Assessment Program
EuroRAP	European Road Assessment Program
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information System
GPS	global positioning system
HPMS	Highway Performance Monitoring System
HSIS	Highway Safety Information System
HSM	*Highway Safety Manual*
IACP	International Association of Chiefs of Police
IHSDM	Interactive Highway Safety Design Model
ITE	Institute of Transportation Engineers
MMIRE	Model Minimum Inventory of Roadway Elements
MMUCC	Model Minimum Uniform Crash Criteria
MPO	metropolitan planning organization
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SPR	State planning and research
STRCC	State Traffic Records Coordinating Committee
TraCs	Traffic and Criminal Software
TRB	Transportation Research Board
TSIMS	Transportation Safety Information Management System
TSSMU	Traffic Safety Systems Management Unit
USRAP	United States Road Assessment Program
XML	eXtensible Markup Language

INTRODUCTION

ROLE OF SAFETY DATA

State and local transportation agencies are responsible for the operation of a safe and efficient transportation system. Within the agency, there is often a department that focuses on road safety. As an example, the Traffic Safety Systems Management Unit (TSSMU) within the North Carolina Department of Transportation (DOT) has a mission statement that reads:

> The mission of TSSMU is to reduce the number and severity of crashes and reduce the crash potential on all of North Carolina's roadways by implementing safety in the planning, design, construction, maintenance, and operation phases of the highway program.

Accomplishing this type of mission requires making resource allocation decisions for roadway investments, establishing local or statewide policies, investing in needed research, and working with other agencies, such as enforcement and education, to accomplish multidiscipline programs. A key requirement for enabling an agency to make appropriate and confident decisions is to have available complete, accurate, and timely data. Although the emphasis is often on crash data, it is important to understand that other types of data such as roadway characteristics, roadside features, driver history and exposure, traffic mix and volume, and the ability to link these data to crash data, are just as critical to the decisionmaking process.

By the 1990s, the trend in many States was to reduce both the quantity and quality of data collected, which in turn, has affected the decisionmaking capabilities of State and local transportation agencies. The need to reverse this trend was recognized in 1998 by the American Association of State Highway and Transportation Officials (AASHTO) in its publication of the *Strategic Highway Safety Plan*. One of the six core elements of this plan was management, which focuses on the problems associated with gathering and analyzing crash data. The two goals within this element are to (1) improve the information and decision support systems, and (2) create more effective process and safety management systems.

LEARNING FROM OTHER COUNTRIES

While the fatality rate in the United States has essentially flattened in recent years, other countries have continued to succeed at reducing fatal and serious injury crash rates. In October 2003, the Federal Highway Administration (FHWA) and AASHTO sponsored an international scanning study to visit and learn from several of these countries. An 11-member panel that included expertise in engineering, enforcement, drivers and motor vehicles, administration and policy, systems and technology, and traffic safety research visited the Netherlands, Germany, and Australia. The objective of the study was to understand how these countries built and used traffic safety information systems and to learn what made them successful at continuing to reduce the level of harm on their roadways.

OVERVIEW OF UMBRELLA PROJECT

The final report from the international scan documented what was learned from the three countries visited and included a set of recommendations and implementation strategies for improving traffic safety information systems in this country.[1] The scanning team proposed an umbrella project to acquire input and update the strategies associated with the goal of improving information and decision support systems, which coincides with the goals of the management element within the AASHTO *Strategic Highway Safety Plan*. This project includes the following tasks:

1. Prepare a white paper to describe in greater detail the guiding principles and implementation strategies that were included in the final report of the scanning team.
2. Conduct a focus group meeting to solicit feedback on the white paper and develop additional details as necessary.
3. Develop a framework for, and then conduct, a National Safety Data Forum with sponsorship from various highway safety organizations.
4. Prepare final implementation documents, which will include updated strategies for the appropriate goals within the AASHTO *Strategic Highway Safety Plan*.

GOAL OF THIS PAPER

This paper is the result of the first task just described. The goal of the paper is to build on the final report and the implementation plan that was developed by the scanning team and to provide action-related details to some of the critical strategies as well as adding new strategies to reach the team's goals.

FINDINGS FROM THE SCAN

The principal finding from the scan was that each of the countries visited had a well developed strategic plan and were very well coordinated with respect to collecting, managing, and using safety data. The findings were summarized in terms of safety data themes divided among the headings of strategy, efficiency, and utility. Strategic themes refer to those requiring buy-in at the upper levels of an organization such as funding and top-level support. Efficiency themes focus on the collection and management of data, and utility themes are aimed at the actual application of the data. Below are the seven themes (as stated in the scanning team report) that were deemed most important by the scanning team.

STRATEGY

- Top-level State and national support needs to be demonstrated. National level creation of a set of measures should be followed with clear communication to the States. The State leadership, in turn, should work to develop goals and ways to assess the completion of those goals.
- Top-level meetings of stakeholder agencies in the public sector should have a singular focus on safety. Safety should be clearly defined as a core business, and performance measures should be established by which safety improvement can be assessed.

EFFICIENCY

- A main goal is to streamline and simplify data collection, especially for the officer in the field. This activity requires reviewing the data requirements and looking at quality assurance and collecting only the information needed.
- Current technology can be used more efficiently to simplify data collection (through linkage rather than field data collection) and improve overall data quality.
- New technology can be used where it will increase efficiency and/or improve data quality by also decreasing the amount of data collected onsite and through use of edit checks or other quality assurance methods.

UTILITY

- Because usage of safety data is a fundamental precursor to improving data quality, marketing traffic safety information is a crucial activity. The use of marketing to raise awareness of the issues and the uses of data will in turn support data improvements.
- Analytic tools are crucial for helping users get the most of the data and for supporting specific job functions such as performance monitoring, evaluation, and countermeasure selection. Increasing access to the data and the availability of user-friendly analytic tools will help to ensure data quality improvements.

PROPOSED STRATEGIES TO IMPROVE SAFETY DATA

OVERVIEW

The original seven themes described previously and the additional action items in the related implementation plan have been organized into five critical strategies as follows:

- Strategy 1—Increase support for both safety programs and safety information systems (the data) from top-level administrators in State and local transportation agencies.
- Strategy 2—Improve safety data by defining good inventory data and institutionalizing continual improvement toward established performance measures.
- Strategy 3—Improve safety data by making it easier to collect, store, and use.
- Strategy 4—Improve safety data by increasing the use of critical safety analysis tools, which themselves require good data.
- Strategy 5—Improve and protect safety data by storage and linkage with critical nonsafety data.

Each strategy includes multiple substrategies and action items. Although the organization does not exactly parallel the scanning team's final report or implementation plan, the five critical strategies covered in detail here capture the essence of the scanning team's goal. Appendix A provides a table that shows the cross-mapping between these five critical strategies and the themes and action items in the original safety scan report and implementation plan.

Within each of the five major strategies, possible efforts are discussed that relate to improving two basic types of safety data: (1) crash data and (2) inventory and traffic data. The accuracy and completeness of both types of data, as well as the integration of the two, are critical to operating a successful safety program. Although both types are housed in many States in the same DOT, the distinction between the two is drawn because of significant differences in who collects, computerizes, and stores the data; differences in the primary users; and differences in current national efforts to improve the two data types, among other factors. Significant problems with crash data continue to exist, particularly those related to data accuracy and data completeness, and solving these problems is difficult because the primary data collectors are in multiple police agencies, each with their own priorities and policies. However, there are more current national efforts to improve crash data than to improve other types of safety data. For example, a data element dictionary includes definitions of and suggested data codes for crash, roadway inventory, and traffic variables.[(2)] However, although this document lists many roadway inventory variables, it does not include all critical variables nor does it provide any guidance on which variables are more important than others for conducting safety analyses. In contrast, there has been a long-term effort in the United States to improve crash data, led by the National Highway Traffic Safety Administration (NHTSA). This effort has resulted in a data element guideline known as the Model Minimum Uniform Crash Criteria (MMUCC).[1] Although

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[1] For more information on MMUCC, refer to http://www.mmucc.us/.

implementation of MMUCC is voluntary, it has become an unofficial national standard for crash variables across the United States, and many States are turning to MMUCC for guidance when they redesign their crash data forms. In addition, an international organization of safety data specialists called the Association of Traffic Safety Information Professionals (ATSIP) and an annual meeting by the International Forum on Traffic Records and Highway Information Systems both concentrate primarily (but not solely) on crash and other driver data. In contrast, no such national standard, professional organization, or annual meeting exists for practitioners who collect, store, and use roadway inventory data or traffic data for safety purposes. (Note that ATSIP's scope includes roadway data professionals, but very few members are represented in this professional category at present.) Although guidance on some roadway inventory and traffic data elements exists [e.g., FHWA Highway Performance Monitoring System (HPMS) standards on core roadway inventory items and traffic volume counting and storage], the guidance is not safety based, and there is little guidance available on the collection of critical inventory items such as curvature and intersection inventories. Finally, a number of national studies have aimed at improving crash data systems; the most recent one was National Cooperative Highway Research Program (NCHRP) Project 20-5, Synthesis Topic 35-03, *Crash Records Systems*.(3) The report from that study includes a detailed discussion of critical issues in crash data and possible solutions. No similar national program efforts have been done for roadway-related safety data.

Note also that other data types (e.g., driver history, vehicle files, and the like) are covered in the final scanning team report. All are critical components of a good safety program, and many of the strategies detailed here would also help improve those files. However, in most States, those files are mandated by State law, are retained by one organization, and are tied to legal/administrative proceedings. For these reasons, fewer problems seem to be related to the overall collection and storage of those files. We note that there are more problems with manipulating these data in some States, simply due to the massive size of the files. Linkage with other safety data, e.g., linkage of driver history data to crash files, will require accurate information on driver license number or driver descriptors on both files and may also be somewhat problematic. And linkage for research use, or easy access by the public to identify problem drivers (e.g., screening by rental car or rental truck companies), is often even more problematic due to privacy concerns. However, because these variables are critical to legal proceedings in which the police are involved, the police are more likely to collect and record accurate data for these variables than for other variables.

For these reasons, and because basic safety analysis in all areas requires crash data, and basic safety analyses related to roadway issues require inventory and traffic data, this paper concentrates on these two data types. The following sections describe each of the five critical strategies in detail.

STRATEGIES

Strategy 1—Increase Support for Both Safety Programs and Safety Information Systems (the Data) from Top-Level Administrators in Federal, State, and Local Transportation Agencies

In the 2005 report describing a recently completed companion international scan tour concerning human factors in road safety, the importance of top-level administrative support for safety was strongly supported by experience in France.[4] In 2002, the President of France decided to make road safety one of three major initiatives to be undertaken during his 5-year term. The result was a significant decrease (approximately 25 percent) in traffic fatalities.

In the United States, there is support for safety programs. However, the safety data scanning team found that the focus on safety as a *core business* is clearly not as strong as in other nations. This need for increased top-level support for safety has also been noted by others.[5, 6] The issue is how to develop support that will translate into (1) long-term funding for improvements in the safety data system and (2) higher status for safety data administration so that bright, energetic engineers and safety specialists will be drawn to the program.

Although the basic goal driving this effort is the improvement of safety data, we believe that selling good data will continue to be a difficult job, particularly to people who do not use it directly on a day-to-day basis (such as the public and top-level transportation agency administrators). Data are only a tool. What is important is what can be done with data, and how it affects safety programs. The public and administrators do understand safety programs, and they also understand the need to improve these programs in order to save lives and reduce injuries. And better data are critical so that programs can be improved. Thus, the ultimate goal of improving safety data can be reached by marketing improvements in safety programs that use these data.

Although these safety programs (and their associated data) could be marketed to a variety of audiences (e.g., top-level transportation agency administrators, mid-level safety program administrators, the public), the ultimate target of the marketing effort is the person who controls funding and agency power, or in other words, the top-level administrator.

Possible approaches to gaining an administrator’s support can be divided into two types: (1) efforts aimed at improving safety programs, which will ultimately require better data; and (2) efforts aimed at developing direct support for safety data from top-level administrators or people they listen to.

Strategy 1.1—Sell safety programs to the public, who will then demand improved data

Assume that, as stated above, most top-level State transportation agency administrators do know the importance of good safety programs. This assumption is validated by current efforts by AASHTO in developing, modifying, and implementing their *Strategic Highway Safety Plan*. The States involved in this effort are defining their own safety program performance measures (e.g., a 10 percent decrease in lane-departure crashes by 2008), and are working toward meeting these goals. A critical component of this program yet to be implemented is the downstream monitoring of how well the goals are being met, and the subsequent program refinements/modifications to move toward goal attainment in all 50 States. Currently, programs are only being planned and implemented in a limited number of lead States that have volunteered to participate. AASHTO will have to continue to sell the use of these performance-based efforts to other States.

Given this current effort, and the expected continuation of this long-term push from AASHTO, additional safety-program marketing *directly* to administrators may not yield much added benefit. Thus, the need is to sell improved safety programs to others, who in turn will influence administrators. At this point, we believe that the primary target of such safety-program marketing/awareness-raising should be the driving public.

One often-proposed example of this approach would be to use marketing campaigns that advertise the need for safety and safety programs to the public. The rationale for such an approach is as follows: if the public is made more aware of the importance of safety programs, they, in turn, will force administrators to improve safety programs. The assumption here is that the public is not aware there is a problem and that a well-designed marketing campaign will not only educate them about the problem, but will convince them that they need to take action and demand better safety programs.

However, there is some question about both parts of this assumption. First, it is unclear whether the general driving public is unaware that safety is a major national concern. Over the past two decades, numerous public educational efforts and programs have included:

- Billboard, TV, radio, and newspaper spots and articles on general highway safety and the specific need to wear seatbelts and not combine alcohol with driving.
- Normal media coverage of high-profile crashes on an almost daily basis.
- Automobile advertisements emphasizing safety features.
- Increasing publicity of (and advertisement for) court suits resulting from crashes.

All these reinforce the fact that highway crashes are indeed a major national health problem. Thus, it is not clear whether the public is unaware of the magnitude of the safety problem.

Second, it is also unclear whether a public education program can be designed that will actually change current behaviors and thus cause the public to demand these types of safety programs. A review of past research indicates that we have had little success in changing actual *driver* behaviors with implementation of these types of programs in the past. Indeed, as noted by Evans[7] and other authors, changes in actual driving behaviors resulting from public information programs may be limited by two facts: (1) almost all drivers (and passengers, bicyclists, and pedestrians) believe they will not get involved in a crash because they rate themselves as above average drivers (similar to the children in Lake Woebegone), and (2) major changes in behavior (e.g., slower speeds on interstates) would require them to give up the driving freedoms they have. Evans makes the point that over a driving lifetime, individual drivers very seldom are involved in crashes, reinforcing their feelings of above average. Although changing a behavior related to pressuring public officials for better safety programs may be significantly easier than changing actual onroad behaviors, we have yet to successfully demonstrate that we can do that. However, until we can demonstrate that education will lead to such public demand and pressure for improved data, such educational efforts are not recommended.

A second approach to selling safety programs to the public could include involving the public more directly in the jurisdiction's safety program by determining the public's desires and needs through public surveys, and similar measures. If we cannot sell the public on the need to press for better programs with marketing, can we indirectly develop this type of support by systematically surveying their needs and desires? The scanning team noted that this type of survey existed in the Netherlands, and officials there believed that it did generate public support for their programs. The issue here is how to design this type of survey so that it results in the identification of real safety issues or appropriate safety programs. Just as would be the case if asked about medical programs, the public would usually have little knowledge of which safety programs have been shown to be effective and which have been tried and failed. They may well give priority to programs which enhance their mobility (e.g., travel speeds or congestion mitigation) rather than their true level of safety. For example, past informal public surveys indicated that improvements in nighttime roadway delineation were high-priority safety needs. However, if such delineation results in higher speeds without related changes in roadway alignment or roadside features, the result could be decreased safety. Thus, surveying the public on specific program ideas or safety issues could lead to public demand for treatments that cannot be implemented, since they would decrease safety. This could lead to less, rather than more, public support for the best safety programs. If a survey were attempted, it would have to be designed with caution to ensure that the public is being asked for feedback on treatments that increase rather than decrease safety.

The above two approaches have involved marketing to the public and surveying the public. No clear evidence shows that either approach will generate public demand for improved safety programs (and thus improved safety data). However, there is one approach to selling the public that has had significant success in Europe, and is now being considered in the United States. It is known as the United States Road Assessment Program (USRAP).

The European Road Assessment Program (EuroRAP) is an international not-for-profit organization formed by motoring organizations (auto clubs) and highway agencies throughout Europe to work together to improve the safety of Europe's roads. It is the sister program to European New Car Assessment Program (EuroNCAP), a safety program that crash-tests cars and assigns them star ratings for safety. More information about EuroRAP can be found at www.eurorap.org.

The goal of EuroRAP is to provide safety ratings for roads across Europe. Doing so will generate consumer information for the public and give road engineers and planners vital benchmarking information to show them how well, or how badly, their roads are performing compared with others, both in their own and other countries. EuroRAP is using two assessment protocols:

- *Risk mapping* based on statistical analysis of historic crash and exposure data, to document the risk of death and serious injury accidents and show where risk is high and low.
- *Star ratings* based on inspection of roads (a type of road audit) to examine how well they protect users from accidents and from deaths and serious injuries when accidents occur.

Currently, no similar systematic road assessment program exists in North America. This type of program would attempt to inform motorists of the safety level of roads they travel and help auto clubs and others provide informed advice to highway agencies on needs for safety improvement. However, the American Automobile Association (AAA) Foundation for Traffic Safety is currently funding a pilot program to test the technological and political feasibility of instituting this type of road assessment program in North America.[(8)] The pilot will examine the various technological barriers, such as the appropriateness of available data and how those data should be aggregated. The pilot test will also examine political barriers, such as the cooperation of highway agencies, and the ability to overcome liability concerns.

The pilot effort is being conducted for AAA by Midwest Research Institute and the Center for Transportation Research and Education at Iowa State University and includes an advisory panel of key stakeholders. A sufficient amount of the assessment will be completed in test jurisdictions in Iowa and Michigan to demonstrate not only the feasibility but also the utility of such a program. There is concern that crash investigations and road safety data in many jurisdictions are not adequate to support comprehensive analyses of road safety features. As noted previously, there is also concern that this program could lead to increased legal liability for States and local jurisdictions. It is hoped that the national dialogue initiated by this effort will help resolve these concerns and create public support for higher funding to upgrade data systems and make road safety improvements.

Two facts about the design of this program make it worthy of continued significant attention by FHWA, AAA, and other organizations: (1) the program provides scientifically sound feedback to drivers on the safety of the roads they drive on (rather than some nebulous class of roads in a particular State or U.S.), and (2) the program could generate support for safer roads through treatments chosen by safety engineers and other experts.

Note that the above discussion has focused on how to sell improved safety data to transportation agency administrators by increasing public demand for improved safety programs. As noted in the initial review by a scanning team member, public support for improved safety programs could also result in improvements in crash data, particularly in jurisdictions where the priorities of the top law enforcement administrators are oriented toward crime and other nontraffic police duties. This is the case in many local police departments. USRAP could clearly be implementable in these local jurisdictions, as would other driver-oriented programs such as better targeting of drinking-while-driving enforcement efforts and efforts related to reducing risky driving among young drivers.

Strategy 1.2—Sell safety data directly to top-level administrators

Strategy 1.1 above is focused on generating better safety data as a byproduct of improved safety programs. That set of strategies was highlighted first because, as noted previously, the direct marketing of safety data to top-level administrators will be difficult in many cases. The administrator has multiple operational issues that they face daily. Improving safety data is not often seen as an operations issue, even though crashes can result in significant nonrecurring congestion. Improvement of the data is also not a short-term proposition. And finally, data are not sexy; there are no ribbon-cutting ceremonies for a new data acquisition system.

However, even with these difficulties, improving safety data must be a multistrategy effort, and one of the strategies must involve better marketing to top-level administrators. Indeed, administrators currently are involved in at least two new directions that directly require improved safety data:

- State governments are moving to *performance measures* as budget drivers in many different areas. Developing these measures for the safety of the transportation system, and systematically comparing existing safety programs against the developed measures, will require highway safety information systems, and thus detailed crash, roadway, and traffic data that can be linked.

- State DOTs (assisted by AASHTO and FHWA) are moving to *asset management systems* as foundations for better decisionmaking. These systems require up-to-date inventory data and a data system for infrastructure data (e.g., pavement inventory, roadside hardware inventory, signing, marking, and the like). These data elements and systems are an essential part of a sound safety data system. This system will not only have the support of the top-level administrator, but also of key (nonsafety) offices within the DOTs (see strategy 1.3 below).

Asset management systems are a major focus of both FHWA and AASHTO. FHWA created an Office of Asset Management in 1999,[2] and has developed guidance documents, communications/training avenues, and other resources to assist the State and local transportation agencies.[3] The Turner-Fairbank Highway Research Center Web site also contains specific guidance on roadway safety hardware inventories.[4] The Transportation Research Board (TRB) Web site contains documentation of a multistate peer-exchange on asset management programs sponsored by FHWA and TRB.[5][(9)] Idaho DOT has developed a new method of updating the State's guardrail inventory file.[6] Their system integrates the existing guardrail inventory (originally compiled in 1995) with information that is captured through a videologging system. Data elements such as guardrail location, distance, and offset are extracted from digital video and automatically recorded to the system to update the inventory. Images of deficient guardrail are also compiled for use in decisions concerning guardrail replacement and modification efforts. Thus, asset management systems generally would be expected to provide sources of new safety-related inventory data. However, convincing States to further expand the basic asset management system to include more safety variables (e.g., guardrail inventory) may require additional guidance and selling. The inclusion of a series of case studies highlighting collection methods for, and benefits of, safety-related variables might be a useful addition to the FHWA or AASHTO Web sites.

Although asset management efforts, including those directly related to inventories of safety-related roadway and roadside components, are increasing rapidly, it does not appear as if as much attention has been paid to the issue of safety program or safety data performance measures. Strategy 2 below provides more detail on how good safety data can be defined and how to measure existing programs against performance measures or criteria. These measures should be particularly helpful to a Chief Executive Officer not well versed in safety data; they will provide administrators with nationally vetted measures to use in assessing their own safety data needs. As noted in more detail in strategy 2, getting State top-level administrators to accept and apply these measures will require the strong endorsement of AASHTO, with assistance from FHWA and others.

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[2] See www.tfhrc.gov/pubrds/novdec99/asset.htm.

[3] See also www.fhwa.dot.gov/infrastructure/asstmgmt/resource.htm.

[4] See www.tfhrc.gov/safety/pubs/04102/index.htm.

[5] This documentation can be found at trb.org/news/blurb_detail.asp?id=5094.

[6] See www.tfhrc.gov/safety/pubs/05055/index.htm.

A third sales path to top-level administrators may be through the State Traffic Records Coordinating Committee (STRCC), an existing interagency group that is already focusing on improved safety data. As described by DeLucia[(3)] and as noted in strategy 3.1 below, this committee usually includes a broad spectrum of safety data collectors and users from both the crash and roadway inventory sides. If the existence, mission, and work of this group is not known to top-level administrators in all participating agencies, it is highly recommended that the STRCC make themselves known to these administrators through one-on-one briefings, summary memos that discuss concerns and actions, and other methods.

Finally, we note that even though this action has focused on selling good safety data systems to administrators, there are top-level State DOT administrators who are already sold on good safety data, but who face major difficulties in getting a good system developed. Other strategies that address that issue will be included later in the paper (e.g., strategy 5.1).

Strategy 1.3—Market improved safety data to other nonsafety power players in the agency

Selling safety data to top-level administrators can also be done indirectly by educating/selling other staff to whom the administrator listens. For example, asset management is an increasingly important area in many State and local agencies. If the asset managers become supporters for needed safety-related data, they are more likely to both protect and retain currently available critical data items in their databases and to support and fund needed additions or improvements.

Both the maintenance departments and the planning offices within State DOTs would be additional power players who would logically need data items that are safety related. To combine safety programs with these programs, it is necessary to determine (1) how to facilitate usage of safety-related data elements found in the maintenance and planning files in safety analyses, and (2) how to ensure continuing protection and improvement of key safety-related elements found in those files.

With respect to the first issue, even though these departments systematically collect and store safety-related data (e.g., pavement condition, pavement markings, predicted changes in traffic volumes), sometimes their databases are not easily linkable with the basic safety files containing crash and roadway inventory data due to different location referencing schemes. Strategy 5 covers the development of a data warehouse as a solution to this problem.

Ensuring that these agencies protect, improve, and even add to the list of variables they consider critical to safety analyses seems to require at least two things: (1) continuing education of the nonsafety agency concerning the safety-related importance of the variables, and (2) defining ways that critical safety variables are, or can be, valuable to these nonsafety agencies. The first might require that the safety agency initiate a series of discussions of data needs with the sister agency and a continuing series of memos or other communications describing examples of uses of the data in important safety analyses (e.g., a thank you). This type of continuing communications would also serve to alert the safety agency when the sister agency is planning to stop collecting certain variables, allowing the safety agency to either find an alternative collection method, try to convince the sister agency to continue collection due to the safety importance, work out less expensive data collection methods (e.g., modify the variable) so that collection can be continued, or work with the sister agency to jointly lobby for the resources to continue collecting the data. Two States with excellent roadway inventory data, Ohio and Washington, both employ such continuous communication. Ohio DOT staff from information technology, pavement, roadway inventory, and Geographic Information System (GIS) departments meet once every 2 months to discuss data issues. Washington State DOT has established a data council that meets on a regular basis.

The issue of how to make the sister agency the user/owner of new critical safety variables will require innovative thinking. Can nonsafety uses be defined for critical safety variables? Perhaps the most critical examples of this type of need are curvature and grade data. Very few roadway inventory files currently include data on roadway curvature or grade for all segments. For example, although the eight States currently participating in FHWA's HSIS were chosen because of the quality of their crash and their roadway inventory and traffic data, only three have curvature data on all State roads, and only two have grade data. These variables are critical to safety analyses. Collection and maintenance of the data is time consuming and expensive, usually requiring conversion of as-built plans to a computer database and a continuing systematic review of roadway modifications to update the data. Although strategy 3 below addresses possible technology-based means of making the data collection easier, the issue here is whether nonsafety uses can be defined for these data. Ohio DOT has very recently developed a sufficiency rating for each section of highway. The rating includes both safety and nonsafety components, and variables used include both curvature and grade data, along with other variables such as pavement condition. This rating is being used in corridor studies, responses to media and public inquiries, and other efforts. As a second example, if collected, it would appear that both curve and grade data would be useful in planning routes for use by large trucks and/or school bus operations. In short, there is a need for a concentrated effort to first define critical safety variables (see strategy 2), and to define possible nonsafety uses for them.

We also suggest considering a third power player group: DOT legal staff. Given the increasing amount and cost of safety-related litigation against State DOTs, if improved safety data were to be useful to agency attorneys, an excellent group of safety data supporters would already exist. To further examine this possibility, we interviewed two DOT attorneys, both from States that are very progressive with respect to safety programs. Interestingly, their views were almost polar opposites at first glance. One attorney strongly agreed that good safety data drives informed decisionmaking and appropriate priorities and that developing such priorities is both good business and beneficial in litigation. He also noted, however, that problems arise when DOT collects the data but does not use it. The data puts the DOT on notice that it has a safety problem that is going uncorrected. If there is no systematic program to make improvements, the DOT can be held liable for injuries caused by the known uncorrected highway safety problem.

The second attorney noted that although he advocated the collection and use of good safety data in his agency (and would continue to do so), the current legal system in his State is structured in a way that good safety data can increase rather than decrease liability. In his State (like almost half the States in the Nation, in his opinion), a State not only can be sued for errors in construction, failure to maintain, and failure to provide signs that warn of dangerous locations, it also can be sued for the failure to improve existing facilities when they could be upgraded to improve safety (e.g., addition of guardrail or median barriers to older highways, widening lanes, adding modern traffic signals, and the like). In these States, there is no law that prevents highway authorities from being sued on the basis that they are liable for failing to make expensive capital improvements to existing facilities that can now be considered unsafe because they were designed and built to older standards or built without safety features that have become standard in later years. Because these roads generally meet the design standards to which they were built and are generally signed in compliance with the current Manual on Uniform Traffic Control Devices (MUTCD), the primary evidence used by plaintiffs in most of these cases to prove that the road is unsafe and defective is the safety data developed by highway authorities, particularly the historical collision record database, to analyze where improvements might be made if funding is available. In these States, judges often hold that even if an existing systematic program of safety improvements exists, the State is not justified in using lack of funds as a valid defense in a given situation where no improvement has been made.

The attorney went on to note that the Federal government had enacted section 409 of title 23 of the U.S. Code in 1987, which ostensibly prevents the use of federally required safety data in litigation against highway authorities. However, while helpful, this requirement is not wholly effective because the State courts in the States with this broad highway liability tend to refuse to apply the Federal law or they allow liberal avoidance of its requirements.

The contrasting views do suggest two action items. First, in States whose tort systems do not allow failure-to-improve suits, it appears that the local safety engineer could indeed use the DOT attorney as an ally in developing a better safety data system. For the remaining States, this may not be feasible. In those States, an effort is needed to clarify and market the protection afforded to States under section 409 with the goal of not only protecting the States, but also creating additional safety data advocates.

Note that both FHWA and AASHTO are continuing efforts on clarifying whether safety data are protected, even for these States. Indeed, the issue of whether section 409 does indeed protect safety data from use in litigation reached the U.S. Supreme Court in 2003. In the case, Pierce County, Washington v. Guillen, the court decided that safety data used by the State agency in FHWA-funded hazard elimination programs (e.g., crash reports, collision diagrams, decisions memos, and the like) could not be used in litigation against the State. However, the court also noted that if the data were originally collected by another agency (e.g., a sheriff's department) for non-409 purposes (e.g., collision reports collected for enforcement purposes), the data were not protected. FHWA subsequently issued an interpretation memo to their field staffs (and thus the States) indicating that although the court did not specifically rule on whether all data held in a single State-based data warehouse were protected, the FHWA interpretation is that section 409 would apply to all crash reports contained in the system, regardless of the agency that may possess or retrieve a report.[10] A subsequent FHWA memo clarified that the protection is only from litigation use, and that response to requests under the Freedom of Information Act (FOIA) (e.g., from a newspaper) would be based on the State's FOIA.

Unfortunately, the FHWA interpretation very likely will not resolve the issue in the courts of States allowing failure-to-improve litigation. And the confusion related to data protection has resulted in at least one State DOT questioning whether they can share data with local agencies in their States. Clearly, this critical question must be answered quickly. Currently, NCHRP is conducting Project 08-54, "Identification of Liability–Related Impediments to Sharing 409 Safety Data among Transportation Agencies, and Synthesis of Best Practices," which is attempting to provide guidance and assistance to States and local agencies concerning the collection and sharing of all transportation safety data. It is hoped that these best practices will provide assistance that ultimately will increase the chance that DOT lawyers will become champions for the collection of better safety data. FHWA and AASHTO should distribute widely the findings from this effort, targeting the legal sections in the State DOTs.

As noted by a scanning team member, depending on the nature of the findings, FHWA and AASHTO could consider convening an expert panel or focus group consisting of State DOT attorneys and risk managers to review the findings of NCHRP 08-54, discuss and analyze this issue further, and chart a future direction.

Finally, given the importance of this issue with respect to future datasharing among jurisdictions and use in safety tools and planning efforts, it may become necessary for FHWA, NHTSA, AASHTO, and other agencies to request that Congress reexamine the 409 statute and make changes that would ensure the much-needed broader interpretation and protection of the data. A broader protection would have significant beneficial effects on the marketability of tools such as SafetyAnalyst, safety data warehousing, USRAP, and other measures covered elsewhere in this paper that promote open sharing and use of crash data.

Strategy 1.4—Market knowledge of how to develop better safety data to the engineers/mid-level administrators now in charge of the data

The above strategies have focused on reaching the top-level administrator who ultimately controls data funding. However, there is already one group of safety data supporters in each State DOT: the engineers and data specialists who are in charge of the data. Our experience is that these individuals are generally dedicated to improving their data. What is often missing (in addition to increased funding) is good information on how to make such improvements as well as an organized interstate peer group to talk with and learn from. This is particularly true for those in charge of the inventory and traffic data. Indeed, as noted earlier, there is both an annual meeting—the International Forum on Traffic Records and Highway Information Systems—and a national organization of safety data professionals—the Association of Traffic Safety Information Professionals (ATSIP)—both of which focus primarily on the collection, storage, and use of crash and other driver-related data. Although both the forum and ATSIP are designed to include safety data professionals in charge of more than crash data, there is only minimum participation by these individuals. Thus, there is no central point of data-knowledge distribution for those who are in charge of roadway inventory and traffic data. Safety data specialists in FHWA's HSIS States have indicated that they would welcome this knowledge.

Although the development of a parallel knowledge exchange system for roadway inventory and traffic data specialists should be the long-term goal, and ultimately may be incorporated into the Traffic Records Forum and ATSIP, three suggestions arise for the short term. First, FHWA could consider supporting the development of a knowledge base for improving these data and the dissemination of this knowledge through a newsletter. These activities would require gathering information on best practices among agencies and new beneficial technologies, getting administrative advice, and developing a nationwide mailing list for the newsletter.

Second, as a cosponsor of both the Traffic Records Forum and TRB's annual meeting, FHWA could explore the possibility of developing special roadway inventory and traffic data sessions as part of both agendas. A logical avenue would be the TRB premeeting Sunday workshop series. Getting safety data managers to attend may be difficult because they may have travel restrictions. However, if an innovative and interesting session is developed for the TRB meeting, sufficient numbers of data managers (or their bosses) might attend. Another possible venue for such an add-on meeting would be to hold it in conjunction with the annual HPMS training meeting, but only if the inventory and traffic data managers in charge of the full inventory system are also the ones who would be attending the HPMS training.

Third, FHWA could consider developing and funding an invitation-only meeting of 25 to 50 State roadway inventory and traffic managers, covering travel for the attendees. Attendee cost at a 1- to 2-day meeting might be as little as $20,000 to $30,000. If this were repeated annually for 2 to 3 years, a core peer group would be established. This meeting could be held in conjunction with TRB or the Traffic Records Forum, but only if there seems to be an adequate number of other related sessions for this group of attendees.

Summary of Suggested Tasks for Strategy 1

- FHWA and AAA should support additional exploration of a USRAP program, and FHWA should fund such a program if it is found to be feasible. (1.1c)
- FHWA should explore the feasibility of collecting and improving safety data through the asset management programs in the States, and FHWA and AASHTO could consider adding case studies about the collection and benefits of critical safety variables to their asset management Web sites. (1.2)
- State Traffic Records Coordinating Committees should communicate concerns, issues, and actions regularly to top-level administrators in all represented agencies. (1.2)
- State safety data managers should initiate regularly scheduled meetings with and provide feedback to sister agencies such as asset management, maintenance, and planning that collect or have the potential to collect roadway inventory and traffic data. (1.3)
- FHWA should consider funding an effort to identify nonsafety uses of critical safety data elements. (1.3)
- If a State’s tort system does not allow failure-to-improve litigation, the State safety data managers should communicate and cooperate with their department attorneys to foster more support and use of safety data. (1.3)
- FHWA and AASHTO should ensure that findings from NCHRP Project 08-54, “Identification of Liability–Related Impediments to Sharing 409 Safety Data among Transportation Agencies, and Synthesis of Best Practices” are distributed to all State safety managers and DOT legal staffs. (1.3)
- FHWA and AASHTO should consider convening an expert panel/focus group of DOT attorneys and risk managers to review NCHRP Project 08-54 and chart possible additional actions. (1.3)
- If needed, FHWA, AASHTO, and other agencies should consider requesting that Congress reexamine and modify the current section 409 legislation. (1.3)

- FHWA should consider supporting the development of a roadway inventory and traffic-data knowledge base and the dissemination of the knowledge to State data managers through a newsletter or other mechanism. (1.4)
- FHWA should consider developing special sessions on roadway inventory and traffic data in both the International Traffic Records Forum and the TRB annual meeting. (1.4)
- FHWA should consider developing and funding an invitation-only meeting of key roadway inventory and traffic data managers to disseminate knowledge and foster the development of a peer group. (1.4)

Strategy 2—Improve Safety Data by Defining Good Inventory Data and Institutionalizing Continual Improvement toward Established Performance Measures

Strategy 1.2 above noted that top-level administrator support for improvements in safety data likely would be facilitated by nationally vetted performance measures related to safety data collection, storage, and use. The primary building block for these performance measures would be a clear definition of good safety data. NHTSA, the Governors Highway Safety Association, and safety data advocates across the Nation have developed this definition for crash data over the past decade through the MMUCC. Although not an official national standard, this data element guideline has become the de facto standard, which is used by almost all State agencies when they reexamine and modify their crash report form.

No similar data element guideline (i.e., listing of critical data) exists for safety inventory data. FHWA and AASHTO initiated efforts to develop a "Draft Model Highway Data Dictionary" for subsequent use in the development of the Transportation Safety Information Management System (TSIMS). The data dictionary is viewed as a starting point for developing a comprehensive, uniform set of roadway characteristic data attributes.[7]

An initial attempt has been made at categorizing data elements into three categories: minimum, basic, and extended. However, review of the listings indicates that problems remain in both the explanatory descriptions of the items, missing critical safety elements (e.g., clear-zone width), and in the classification of the elements. (For example, curvature data, one of the most important predictors of roadway safety, are only captured in summary form rather than as individual curves, and these data are classified as extended, the lowest priority.) Although the dictionary provides a starting point for the definition of good inventory data, it is not sufficient to provide such a definition at this point.

More generally, FHWA has produced guidance/standards for the capture of both roadway inventory data and traffic volume data as required by HPMS.[8] Although HPMS has been the

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[7] For more information, refer to http://tsims.aashtoware.org/ContentManagement/PageBody.asp?PAGE_ID=3&CONTENT_ID=23

[8] For more information on HPMS, refer to http://www.fhwa.dot.gov/policy/ohpi/hpms/

driving force behind the collection of roadway inventory and traffic data by State DOTs, it cannot be considered a safety data guideline because:

- It is based on the need for data on highway condition, performance, use, and operating characteristics of highways and is not driven by safety considerations.
- It requires complete inventory data of only basic (universe) variables, while other variables are only captured for certain sample sections of roadways (e.g., lane width, shoulder width).
- The format of certain variables, even those captured on only sample sections, is not conducive to safety use (e.g., horizontal curvature data specifies the length within the sample for certain curve classes, but not the location of the individual curves within the section).

Many States' current inventory systems represent an expansion of the HPMS sample elements to all roads in the full State system. For example, most systems capture lane width, shoulder width and type, speed limit, and other cross sectional variables for their full systems. However, very few capture curvature or grade data, intersection inventory data, roadside inventory data, or other critical safety data elements.

Strategy 2.1—Develop definitions of good safety inventory data

First an effort is needed to document a listing of roadway inventory and operations data elements that are critical to safety analyses, fitting the definition of good safety inventory data. [We propose that this listing be called the Model Minimum Inventory of Roadway Elements (MMIRE) as a suitable companion for MMUCC.] The listing should be developed (perhaps under FHWA contract), and vetted by review committees of State and local agency safety and inventory engineers and users. The vetting effort should include strong participation from appropriate individuals and committees in AASHTO, because their endorsement and support will be critical to gaining State agency acceptance.

During this effort, attention should also be given to whether current definitions of variables in HPMS should be modified for safety purposes. In our experience, most operating definitions and data collection guidance presented in HPMS are adequate for safety use. However, a detailed examination of the coding for each HPMS element and the data collection protocols may reveal possible improvements from a safety point of view.

We note that to some extent this effort has been initiated by the definition of critical variables in current national safety databases and tools. Guidance on the list of current variables (and definitions) could be extracted from both data elements found to be important in research conducted with the FHWA Highway Safety Information System (HSIS), and from listings of elements needed in the FHWA Interactive Highway Safety Design Model (IHSDM).[11, 12]

We further recommend that this effort to identify critical inventory and operations variables should not be limited to existing data elements. Thought should be given to needed critical elements not currently collected, because innovations in technologies noted in strategy 3 below might make it possible to acquire them. For example, pedestrian and bicycle exposure data are not currently collected. However, these counts may be possible by using digital-image-based methods.

Finally, support for this recommendation exists in section "e" of section 2006, "State Traffic Safety Information System Improvements" in the new Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation (see appendix B). There, Congress has requested the following of the Secretary of Transportation:

> (1) Model data elements.**—**The Secretary, in consultation with States and other appropriate parties, shall determine the model data elements that are useful for the observation and analysis of State and national trends in occurrences, rates, outcomes, and circumstances of motor vehicle traffic accidents.

The section goes on to say that States that receive safety-data improvement grants under this section will have to certify that they have adopted and are using the model elements, or certify that they are using the grant funds to work toward adopting and using them. There has been no interpretation of this section to clarify whether this refers only to the crash-related MMUCC elements or whether it could also be related to other safety data such as inventory and traffic data. If it refers to the latter, then a requirement for this strategy now exists in law.

Strategy 2.2—Develop performance measures to capture the current status of incorporation of these critical safety inventory elements in an agency's safety database

As noted in strategy 1.2, and following the development of the listing and definitions of critical safety inventory and operations variables, an effort is needed to establish a set of performance measures for the collection and storage of critical crash, roadway inventory, and traffic safety elements. The performance measures could be applicable to either individual data elements or to the full data system. For example, consideration should be given to goals for data accuracy (e.g., horizontal curvature data captured either from as-built plans or from fully validated technologies such as on-road vans or extraction from GIS mapping), data maintenance (e.g., an ongoing system which captures on-road modifications or additions in the computerized inventory files within X weeks of the change), and data storage (e.g., all safety variables being computer linkable with each other). The proposed performance measures should be vetted by representatives of agencies they will affect (e.g., enforcement agencies, inventory specialists, data linkage specialists). Finally, this effort to establish performance measures will also require a concerted companion effort to get them endorsed, supported, and pushed by AASHTO. (Note that NHTSA has published performance measures for different types of safety data in a 1997 publication, *Traffic Records – A Highway Safety Program Advisory*.[9] Although this document contains more detailed measures for crash data than for roadway files, it is an example of performance measures that already exist for safety data. This advisory is currently being updated.)

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[9] For more information, refer to http://www.nhtsa.dot.gov/people/perform/pdfs/NHTSA_TR_Advisories.pdf

Strategy 2.3—Increase the emphasis on safety inventory data in State traffic records assessments conducted by NHTSA, FHWA, and Federal Motor Carrier Safety Administration (FMCSA)

Although the above strategy is more long term in nature, a shorter-term strategy would be to modify the current Traffic Records Assessment process. Managed by the NHTSA National Driver Register and Traffic Records Division, this assessment is a technical assistance tool that NHTSA, FHWA, and FMCSA offer to State offices of highway safety to allow the State management to review their traffic records program. NHTSA coordinates the formation of assessment teams representing people from throughout the United States who have extensive knowledge about traffic safety data systems. These teams spend a week interviewing the various stakeholders, data managers, and users within a State and preparing a confidential assessment of how well the State data systems meet the guidelines contained in the Traffic Records System Advisory.[10] The State's traffic records strengths and accomplishments are documented, and suggestions are offered where improvements can be made.

Although roadway inventory data are one component of the assessment effort, a review of past State assessment reports indicates that only limited attention is given to these data, and the detail provided is much less than that given for the crash, driver history, and other safety files. Although information on the capability to link to other files is often available, the reports provide little detail about whether critical roadway inventory items are present. This is very likely due in part to the fact that there is no companion volume to MMUCC – there is no definition of or coding for critical roadway inventory and traffic data elements.

Thus, a short-term strategy would be to modify the current assessment process to include more emphasis on the roadway inventory variables. This strategy could be accomplished by perhaps adding more roadway inventory and traffic expertise to the team. More important, however, the team should be equipped with a listing of critical roadway inventory and traffic variables and information on how these data elements might be improved. Although the final vetted list of critical variables, coding, and collection processes will not be available until the above strategy 2.1 is completed, as suggested above, an initial critical element list could be developed relatively quickly through review of HSIS, IHSDM, and SafetyAnalyst data needs. Because FHWA is a participant in the assessments, the organization could both fund this initial list development and take the lead in modifying the assessment process.

Note that this recommendation is based on the assumption that States will request these traffic records assessments on a regular basis, and that they will then find the resources (funding, labor, leadership) to implement the recommendations. This State process is clearly strongly recommended.

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[10] For more information on traffic records assessments and the Advisory, refer to http://www.nhtsa.dot.gov/people/perform/Pages/Programs/State_Assessments.htm.

Strategy 2.4—Ensure that good data are incorporated into efforts related to the development of XML schemes

XML (eXtensible Markup Language) is Web-friendly computer code that can make data from different sources (e.g., State transportation agencies) accessible by many users and easily exchanged. AASHTO and FHWA are incorporating XML in the TSIMS project noted previously. Many of the outputs in Iowa and FHWA's Traffic and Criminal Software (TraCs) system are in XML format. Other States are using XML in crash, citation, and adjudication data files. NHTSA is actively advancing the use of XML in Fatality Analysis Reporting System (FARS).

NCHRP 20-64, "XML Schema for Transportation Data Exchange: Project Overview and Status," is designed to extend XML into all areas of transportation data, including roadway inventory data and crash data. The importance of these diverse efforts to our focus here is that XML requires that common schema (data structures) be defined for each included data item. Thus, the XML work currently in progress, and conducted primarily by information specialists, is establishing both a list of critical roadway elements and the formats (internal codes) for each element. Given that these efforts involve many States and that Web-based systems are increasingly becoming the norm, these schema could become default definitions of good safety data.

Given that reality, it is important that these schema/definitions be defined by safety expertise rather than just by information systems expertise, and the work proposed previously to better define good data should be incorporated into these national efforts. Although it would appear that the schema coding could be easily modified, it is critical that the initial schema used in TSIMS or distributed to or used by States from the NCHRP project reflect the latest thinking on both crash and roadway inventory and traffic variable definitions and formats. It is recommended that FHWA and NHTSA monitor and make inputs into these projects.

Summary of Suggested Tasks for Strategy 2

- FHWA or AASHTO should fund the development of a listing of critical roadway inventory and traffic data elements. (2.1)
    - The development should include review of HPMS data elements and coding and critical elements from HSIS research efforts, IHSDM, and SafetyAnalyst.
    - The listing should be vetted by AASHTO, State data personnel, researchers, and other safety data experts.
- FHWA or AASHTO should fund the development of performance measures that concern data accuracy, maintenance, and storage. (2.2)
- NHTSA, FHWA, and FMCSA should strengthen the roadway safety data components of the existing traffic records assessments by adding additional roadway data expertise and by developing a checklist of critical roadway inventory and traffic data elements. This list could be based on existing FHWA uses (e.g., HSIS) and tools (i.e., IHSDM and SafetyAnalyst). (2.3)

- States should request traffic records assessments on a regular basis and they should find the resources necessary to implement the recommendations. (2.3)
- FHWA and NHTSA should monitor XML-related efforts and projects to ensure that appropriate variables and formats are incorporated into the schema (data structures) being developed. (2.4)

Strategy 3—Improve Safety Data by Making Them Easier to Collect, Store, and Use

The general assessment of both data collectors and users is that safety data (crash, roadway inventory, and traffic) are difficult to collect, that the collectors often are not the users, and that there are few incentives for the data collectors to collect good data. In addition, there are always issues with respect to data accuracy and timeliness for reporting and analysis purposes. Pfefer, et al.[(6)] did an excellent job of defining these issues with crash, roadway inventory, and emergency medical care data and of providing suggested improvements. Although technology should help make data collection more efficient and accurate in the near future, we have yet to implement existing technology on a widespread basis, and have no national program aimed at continuing the development of newer needed technologies. The following sections provide more detail on these issues for both crash and roadway inventory and traffic data and offer specific strategies and action items to improve the data collection and management processes.

An ongoing NCHRP Synthesis Project (36-03) is also addressing the topic of technologies for improving safety data. The objective of the study is to summarize the state-of-the-practice and the state-of-the-art technologies that offer the greatest potential for efficient and effective collection and maintenance of data needed for safety analyses. The results of this effort should be monitored and incorporated into the various strategies below.

Finally, the crash data variables most critical to all roadway-based safety programs are those related to the location of the crash: the route on, distance from a crossing route/road, or other permanent marker (e.g., a physical milepost). These data are also often the least accurate data in a crash file. A high-priority recommendation is that these location data be improved in any way possible. Rather than make this a broad recommendation, we have chosen to incorporate location-data improvements into several of the following specific strategies and actions (e.g., improved officer training, increased use of GPS-based crash and inventory information). However, if those recommendations are not implemented, it remains critical that States and local jurisdictions find other ways to improve this information.

Strategy 3.1—Improve crash data by making collection easier

In the 1998 FHWA report, Pfefer, et al.[(6)] described a series of issues with crash data and suggested and ranked specific improvement strategies based on an estimate of cost effectiveness and the reduction in overall crash system costs (see table 14). Strategies ranked high on these two criteria ranged from crash form improvements to data collection driven by expert systems. Strategies ranking lower included training strategies.

In a more recent NCHRP report, DeLucia[(3)] presents a detailed coverage of broader strategies aimed at improving the collection, storage, and use of crash data. Although the details of that report will not be repeated here, the basic conclusion of the report is that coordination, communication, and cooperation are keys to successful development of crash records systems. Suggested strategies in that report are as follows:

- Establish a State Traffic Records Coordinating Committee (STRCC).
- Develop and implement a strategic plan for traffic records improvements.
- Budget for the entire lifecycle of the system.
- Develop data-for-data partnerships.
- Develop a knowledge base for traffic records systems.
- Simplify crash data collection.

The following proposed actions build on some of those found in that document.

Action 3.1a—Disseminate widely the results of *Practices in Crash Reporting and Processing*. The material in DeLucia's report should be disseminated widely. Although NCHRP has a dissemination system, FHWA and NHTSA should consider developing a more targeted plan for additional dissemination to State and local agencies and individuals involved with crash data. This plan would include targeting existing STRCCs in each State. Consideration should also be given to presenting the report recommendations at the International Traffic Records Forum and other stakeholder venues, as well as the development of a downloadable presentation that could be used at meetings of STRCCs.

Action 3.1b—Increase use of high-end automated crash recorders. DeLucia[(3)] discusses high-end automated crash data collection systems such as the Traffic and Criminal Software (TraCs)[11] system developed by FHWA and Iowa. These systems not only use mobile onboard computers for data collection, but provide the means to ensure more accurate crash locations and provide linkage to other files, allowing downloads of (accurate) information to the crash form (e.g., vehicle and driver license data). The usage of such systems is increasing, but slowly. The question is: what would accelerate the use of these technologies nationwide?

It is suggested that NHTSA and FHWA, with input/assistance from the International Association of Chiefs of Police (IACP), fund a research effort to identify factors that would lead to increased use of the technology (e.g., cost reductions, technology-dissemination grants to police agencies, officer training, changes in hardware and software design, and the like). This effort should include a detailed review of current TraCs usage experiences and of parallel technology development efforts by individual States and localities. For example, after study of the TraCs system, the Washington State's Traffic Records Committee decided to develop their own TraCs-like system due to officer concerns with some TraCs features (e.g., the data bar), technical concerns related to the fact that the current system architecture does not conform to current IT industry architecture standards (e.g., .Net Framework) which could affect future support and improvements, and concerns that the National Model Steering Committee that owns TraCs has a somewhat unwieldy decisionmaking process.

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[11] For more information about TraCs, see http://www.tracsinfo.us/tracs_home.asp

This research effort to identify key usage determinants could be expanded to a broader research effort involving IACP, ATSIP, and other police and user experts aimed at also identifying critical modifications to the existing technology and new technologies needed to improve crash data collection (e.g., to ensure built-in data quality checks, data audits, and changes related to new security needs). (See the related discussion of a safety data technology clearinghouse under action 3.2b below.)

Action 3.1c—Increase accuracy of crash data. DeLucia[(3)] notes that onboard computers can increase the accuracy of crash data (including crash location data) by decreasing the number of times the data are entered or transcribed, facilitating supervisory review, replacing data entry with downloads of data from other (accurate) files, incorporating built-end data quality checks, and by allowing the use of built-in expert systems (as developed and tested by FHWA). As the technology is used more often, additional methods for improving data accuracy will be found. NHTSA, FHWA, and FMCSA should continue to support efforts aimed at improving accuracy through the technology.

Even with improved technology, data accuracy will continue to be a function of officer training and the officer's desire to collect the data. NHTSA has an ongoing program for crash data improvement through training.[12] A remaining issue would appear to be agency desire and officer desire, particularly given the facts that other nontraffic police responsibilities (e.g., crime enforcement) are often given higher priority than crash reporting by agency administration, that collecting accurate crash data is only one of the jobs that officers must perform while onscene, and that although the officer is the primary collector of the data, neither the agency nor the individual officer is always the primary user/owner of the data. What is not known at this point is whether improved training or some other desire-based factors are most important in producing accurate data. Although this determination may be difficult to make, we suggest that NHTSA and FHWA consider a research study aimed at determining what factors could lead police agencies to encourage or require more accurate data (including crash location information), and what factors could lead to more accurate reporting by police officers themselves, including exploration of training effects (and if effective, improved training techniques), incentives for accuracy, and other possible factors. This research should involve input and assistance from IACP. As part of this effort, FHWA, NHTSA, and FMCSA should explore with IACP the possibility of a safety training standard for police, similar to training standards for other aspects of police work.

Both the technology and training might be improved if modification efforts could be targeted to the crash elements most difficult to collect accurately (e.g., crash location, driver inattention/fatigue, scene measurements due to traffic problems, accurate occupant injury severity, and the like). We suggest that NHTSA and FHWA develop a research effort aimed at identifying and ranking these most-difficult-to-collect critical elements and at developing new technologies or methods to overcome the problems.

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[12] For more information about the NHTSA program, refer to the NHTSA traffic records Web site ("training and resources" section) at http://www.nhtsa.dot.gov/people/perform/Default.htm.

Finally, the use of nonpolice (civilian) crash data collectors needs further exploration and examination. DeLucia[3] notes that the use of civilian crash investigators for all crashes that do not require a sworn officer's presence has been implemented successfully in cities in Florida and other States. Pfefer, et al.,[6] rates this strategy highly in both reducing overall system costs and being cost-effective. Comments from at least one very safety-conscious police agency indicate some problems with this strategy. A more detailed examination of this practice is needed to determine:

- What issues need additional examination
- Whether the strategy might be more effective in only certain types of agencies
- Whether there are both cost savings and accuracy increases that might result from modifying this practice (e.g., using the civilian investigator in combination with the sworn officer when required)

And if the method is found to be efficient and effective for some agencies, further examination should define the factors and methods that would lead additional police agencies to implement it.

Strategy 3.2—Improve roadway inventory and traffic data by making collection of these elements easier

Strategy 2.1 above described the need for a methodology to develop a listing of critical roadway inventory and traffic data elements. Once identified, attention should be focused on how to make this data collection easier. The following actions describe some potential avenues that could be considered.

Action 3.2a—Increase the use of validated automated roadway inventory collection technology. Although it does not match the level of technology developments in crash data collection, commercially available technology is available to State DOTs that automatically collects certain inventory items. These are usually automated vans that can collect at highway speeds images of the roadway (and now roadsides), GIS-based location information, and gyroscope-based readings that theoretically can be converted to horizontal and vertical alignment data. As noted earlier, curve and grade data are strongly related to safety, but are rarely available in State roadway inventory systems due to collection and maintenance cost. If successful, this onroad technology could lead to significant improvements in the availability of roadway inventory and traffic data. Because of the importance of technology-based collection of curve and grade data, the FHWA HSIS project conducted two studies, the first validating the accuracy of one of the more popular commercial technologies,[13] and the second validating Connecticut DOT software aimed at improving the accuracy of the output data.[14] Unfortunately, the first study found the outputted curve and grade data to be both inconsistent over repeated runs and inaccurate when compared to ground surveys. The second study indicated that the improved curvature data was indeed a significant improvement over the first test, but still required significant manual input and judgment.

However, FHWA has now developed an advanced data collection vehicle, known as the Digital Highway Measurement (DHM) System,[15] which captures, among many other items, curve and grade data. Initial validation testing indicated significant improvements over other technologies. In its current state, the van will output detailed curve and grade information (e.g., point of curvature, degree and length of curve) and the output can be in either coordinates (for GIS use) or in a linear-reference mode (e.g., route/milepost), thus making it possible to easily integrate the outputs into a State's current location referencing system. Documentation of this project is expected to be completed by summer 2006. Current efforts involve building a second van with additional instrumentation for use by the FHWA Federal Lands Office.

New similar commercial technologies may evolve. Like those just described, these products should be validated for accuracy before State DOTs purchase them. Because there is no safety technology certification process, we suggest that FHWA explore the possibility with AASHTO of sending a technical memo to the States suggesting that they only purchase safety data collection equipment that has been validated for accuracy and that FHWA then provide technical guidance/responses to States concerning these technologies. (See action 3.2b for additional clearinghouse recommendation.)

Second, FHWA should continue its own development, validation, and refining of its DHM system. Once the accuracy has been validated, FHWA should develop and implement a technology transfer effort that provides access to the vehicle by State DOTs. We suggest that States who participate in the FHWA HSIS system who do not currently have curve and grade data in their inventory files be given first priority, because their data are continually being used in national safety research efforts funded by FHWA, NCHRP, and other major funders.

We note that the above discussion has focused on curvature and grade data due to their safety importance. However, the automated data collection vehicles, particularly the FHWA vehicle, can collect other safety data (e.g., distance to and type of roadside hardware). The same procedures would be recommended for those data: internal validation and the development and implementation of a technology transfer plan.

Action 3.2b—Develop new technologies to ease collection of roadway inventory and traffic data, and assist users in their adoption of these technologies. Strategy 2.1 above would develop a listing of critical roadway inventory and traffic data elements. We suggest that FHWA and AASHTO then establish an ongoing research program to develop new technologies aimed at easing collection of these critical elements. This effort could include both new development and the modification of technologies and methodologies now being used in nonsafety areas (e.g., GIS inventories, object recognition technology for roadside hardware inventories, image-based counts for pedestrian exposure data, etc.) This type of technology adaptation is currently being done in the FHWA Advanced Research Program to collect and develop nonsafety data; thus, a model exists.

As noted in the preceding action 3.2a, once a data-related technology is developed and validated by FHWA or by a commercial firm, technical and usage questions will arise. Although companies are expected to provide technical assistance for their products, a central technology clearinghouse is needed so that on-call expertise can be provided to users and potential users. FHWA already provides this type of expert assistance for IHSDM and will provide this assistance for SafetyAnalyst and the DHM. Similarly, in the 2004 report entitled *Initiatives to Address Improvement of Traffic Safety Data*, NHTSA has proposed that "the U.S. DOT Highway

Safety TRCC will maintain an inventory/clearinghouse of State traffic safety data technology."[16] The scope of this proposed clearinghouse is not fully described, and it is not clear whether the information stored and distributed would only concern outputs from federally funded projects. (Note that the U.S. DOT TRCC now has a national Web page that provides information on many of that Committee's efforts (see http://www.dottrcc.gov/pages/members.htm).)

We recommend that FHWA consider expanding its current technology-assistance efforts and that NHTSA consider expanding its vision of a technology clearinghouse to jointly develop a U.S. DOT safety data technology clearinghouse that will encompass all governmental or commercially developed validated technologies related to both crash and roadway inventory and traffic data. FMCSA should join this effort. This type of central clearinghouse would consolidate technical assistance, information on adaptation strategies, and other guidance to users into one central point of contact. The actual technical experts could continue to reside in different offices and even in private firms, but the user would only need to reach one central point to be guided to the expertise and assistance needed.

Action 3.2c—Identify alternative sources for roadway inventory and traffic data. As indicated above, other databases within State DOTs may already include safety data elements not currently found in the basic roadway inventory file (e.g., asset management inventories, traffic operations data related to vehicle speeds, turning movement counts on selected intersections, vehicle operator data in census and metropolitan planning organization (MPO) transportation planning models that might be used to categorize average daily traffic (ADT) by driver type, etc.) However, no inventory of possible safety data sources currently exists. We suggest that FHWA and/or AASHTO fund a research effort that would examine in detail all nonsafety data sources held in State and local transportation agencies and define the source of each safety-related variable found in these files. This element and source list could then be incorporated into a survey document that STRCCs, safety inventory managers, safety data users, and safety data computerization staff could use to examine their own State files.

Summary of Suggested Tasks for Strategy 3

- FHWA and NHTSA should consider supplementing the normal NCHRP distribution of "Practices in Crash Reporting and Processing" by targeting additional dissemination to State and local agencies and individuals involved with crash data, including STRCCs. (3.1a)
- NHTSA, FHWA, and FMCSA, with input/assistance from IACP, should fund a research effort to identify the factors that would lead to increased use of high-end crash data collection technology by police agencies. (3.1b)
- NHTSA, FHWA, and FMCSA should continue to support efforts aimed at improving crash data accuracy through improvements to the onboard computer technology. (3.1c)
- NHTSA, FHWA, and FMCSA, with input/assistance from IACP, should consider a research study aimed at determining what factors could lead to more emphasis on accurate data by law enforcement administrators and more accurate reporting by police officers, including exploration of training effects (and if effective, techniques), incentives for accuracy, and other possible factors. (3.1c)

- FHWA, NHTSA, and FMCSA should explore with IACP the possibility of a safety training standard for police, similar to training standards for other aspects of police work. (3.1c)
- NHTSA, FHWA, and FMCSA should consider developing a research effort aimed at identifying and ranking critical crash data elements that are most difficult to collect and developing new technologies or methods to overcome the data collection problems. (3.1c)
- NHTSA and FHWA should consider funding a detailed examination of the cost savings and accuracy increases that might result from the use of civilian crash investigators and of possible modifications to current practices to make them more efficient. If current or new practices prove to be effective and efficient, NHTSA and FHWA should determine factors that would lead other agencies to implement this practice. (3.1c)
- FHWA should explore the possibility with AASHTO of jointly distributing a technical memo to the States suggesting that they only purchase safety data collection equipment that has been validated for accuracy. FHWA should then provide technical guidance/responses to States that have questions concerning these technologies. (3.2a)
- FHWA should continue the development, validation, and refining of its data collection vehicle, and once this is validated, FHWA should develop and implement a technology transfer effort that provides State DOTs with access to the vehicle. Top priority for use should be given to States participating in the FHWA Highway Safety Information System. (3.2a)
- FHWA and AASHTO should establish an ongoing research program to develop new technologies, which would ease collection of critical roadway inventory and traffic safety elements. This effort could include both new development and the modification of technologies and methodologies now being used in nonsafety areas. (3.2b)
- NHTSA, FHWA, and FMCSA should consider jointly developing a U.S. DOT safety data technology clearinghouse that will encompass all governmental or commercially developed validated technologies related to crash, roadway inventory, and traffic data. (3.2b)
- FHWA and/or AASHTO should fund a research effort that would examine in detail all nonsafety data sources held in State and local transportation agencies, define the source of each safety-related variable found in these files, and incorporate these elements and sources into a survey document that would be used by State and local traffic records coordinating committees and other safety managers. (3.2c)

Strategy 4—Improve Safety Data by Increasing the Use of Critical Safety Analysis Tools (Which Themselves Require Good Data)

If decisionmakers are provided safety analysis tools that output better safety decisions or make the decisionmaking process easier, these tools will be used. If these tools require improved safety data, then these same decisionmakers will find ways to generate these improved data.

FHWA and AASHTO have begun the process of developing such safety analysis tools, and the currently existing tools do indeed require better safety data than is available in some State and local jurisdictions for optimum performance. This strategy is focused on the marketing of existing tools and tools currently under development and on establishing an ongoing research program aimed at identifying and developing additional tools.

Strategy 4.1—Market existing safety analysis tools and those under current development

FHWA has developed IHSDM, a suite of software analysis tools for evaluating safety and operational effects of geometric design decisions on two-lane rural highways (see http://www.ihsdm.org). IHSDM is a decision-support tool that checks existing or proposed two-lane rural highway designs against relevant design policy values and provides estimates of a design's expected safety (e.g., predicted crashes) and operational performance. The results are intended to support decisionmaking in the highway design process and may be used by highway project managers, designers, and traffic and safety reviewers in State and local highway agencies and engineering consulting firms. IHSDM has undergone extensive development and beta-testing, and the 2004 version can be downloaded from the IHSDM Web site.

The second major FHWA safety analysis tool is SafetyAnalyst.[13] This tool is currently under development, with a 2006 expected release. When completed, SafetyAnalyst is envisioned as a set of software tools to be used by State and local highway agencies to improve their programming of site-specific highway safety improvements. All State DOTs have programs aimed at identifying sites on their roadway systems that are most in need of safety improvements. The sites are then ranked, and improvements are implemented as funding allows. SafetyAnalyst will provide computerized analytical tools that will greatly upgrade all steps in this process: network screening to identify hazardous sites, crash pattern diagnosis at the site, countermeasure selection including economic appraisal of cost and benefits, priority ranking of the set of potential treatment sites, and methods for evaluating the treatments ultimately implemented.

FHWA is coordinating both of these tools with the development of the *Highway Safety Manual* (HSM), which is being developed by TRB with significant funding from AASHTO through the NCHRP program.[14] Development of the first edition of the HSM is proceeding with a 2007 publication date. Similar to the *Highway Capacity Manual*, the *Highway Safety Manual* will be designed to serve as a useful tool for safety practitioners in helping them make decisions. It will provide the best factual information about safety and will provide safety analysis tools that will facilitate roadway design and operational decisions based on explicit consideration of their safety consequences. The HSM should greatly strengthen the role of safety in road planning, design, maintenance, construction, and operations decisionmaking. The HSM will include:

- A synthesis of validated highway research—the current knowledge about safety.
- Procedures that are adapted and integrated into practice.
- Analytical tools for predicting impact on road safety.

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[13] For more information, refer to http://www.safetyanalyst.org.

[14] For more information about this manual, refer to http://www.highwaysafetymanual.org/

All three of these efforts will push the safety field to better decisionmaking, and all three will require good crash, roadway inventory, and traffic data. The key to significant improvements in data will be ensuring a high level of use of these tools by State and local agencies. FHWA has implemented a vigorous marketing campaign for IHSDM. The initial 2001–2002 efforts included presentations and exhibits at national conferences, direct marketing by the FHWA Division Offices, demonstrations in 20 or more States, and a wide distribution of a preview CD-ROM. The 2003–2004 effort has shifted to training, including 12 courses in 10 States (with 5 other outside States participating), and training for staff of the Central and Western Federal Lands Highway Division Offices (who have actively implemented IHSDM). In addition, FHWA conducted a program targeting 12 States with high 2-lane rural road mileage in which scholarships were provided to 2 representatives to attend an IHSDM training course in Arlington, VA. FHWA is planning to upgrade the IHSDM package with the development of case-study summaries, which will summarize current applications of IHSDM by user States and provide more information to potential users who want to know who is using the program and how it is being used.[15] Although no survey has been done on the 27 States trained, preliminary conversations and other anecdotal evidence indicate that at least 10 have either used IHSDM to some extent, or it has been used by their contractors. This is an excellent marketing program, which should serve as a model for marketing other FHWA, NHTSA, and FMCSA products.

Given this extensive effort, the question remains as to what other strategies will increase the level of use. First, given that AASHTO has considerable influence over its State agency members, one suggestion that FHWA could consider for both IHSDM and SafetyAnalyst (when completed) is to request formal endorsement of the tools from AASHTO, and request that AASHTO publicize the tools. Similarly, if these tools are suitable for use by local agencies, then endorsement from the Institute of Transportation Engineers (ITE) and a joint advertising effort might also be considered. As noted previously, the current IHSDM marketing program should serve as a model for these efforts.

Second, FHWA is currently using a lead State concept in this IHSDM marketing, where information from current user States will be captured in the case studies that are being developed. FHWA could consider expanding this lead State effort by funding representatives from current user States to participate in the training programs or in peer-to-peer visits or phone calls. This activity would facilitate the exchange of success stories from existing to potential users, a marketing component considered extremely important by many States and local agencies. This concept has worked well in other fields and in other FHWA technology transfer efforts.

The *Highway Safety Manual* has developed a detailed marketing plan and has begun to identify and involve key potential users. The current plan is that IHSDM will be an integral part of HSM analytical tools. It will serve as the software product for the HSM analytical tools. FHWA should (and would be expected to) support and coordinate with the HSM marketing efforts to the extent possible.

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[15] The IHSDM training material and resources available are summarized at http://www.tfhrc.gov/safety/ihsdm/pubs/04152/index.htm.

Finally, there may also be tools developed by non-DOT sources that can enhance data analysis and thus the quality of safety data. One example is the Critical Analysis Reporting Environment (CARE) system developed at the University of Alabama (see http://care.cs.ua.edu/care.aspx). This system provides analytical tools to the user to help conduct problem/issue scoping, location-specific analysis (e.g., collision diagrams), and other safety-related efforts. FARS data and data from seven States have been loaded into CARE and are available for analysis to users approved by the individual States. NHTSA, FHWA, or FMCSA should consider the development of advertising programs for these non-DOT tools if it's deemed permissible.

Strategy 4.2—Develop the next generation of safety analysis tools

NHTSA conducts higher level fatal crash data analyses each year on a state-by-state basis using FARS data.[16] These analyses provide statewide statistics for fatality trends across years, fatalities related to alcohol use, occupant restraint use, motorcycle use, and other variables. Additional state-by-state reports can be downloaded from the reports link of the FARS Web site.[17] The FARS query function at that same site allows the user to develop more specific queries for a given State (or the Nation). NHTSA also provides a data analysis and evaluation course available through their training institute. FHWA provides fatality data on a state-by-state basis on specific targets such as intersections, work zones, roadway departure crashes, and pedestrian crashes. FHWA has also expanded earlier work by NHTSA in the development of software to analyze pedestrian and bicycle crashes. The second generation of the Pedestrian and Bicycle Crash Analysis Tool (PBCAT) is now being developed.[18] However, although NHTSA and FHWA are providing these valuable safety data outputs and the current set of analysis tools, it appears that neither have an ongoing effort aimed at identifying and developing the next generation of critical safety-data analysis tools. It is suggested that each organization consider developing this type of program to ensure that all safety data users are covered (e.g., roadway safety engineers, driver compliance agencies, and enforcement agencies). An initial step might be a research project aimed at determining the feasibility of this type of program by attempting to identify critical tools that are needed. This effort would draw from both interagency knowledge at NHTSA, FHWA, and FMCSA and from knowledge of State and local safety analysts and safety researchers. Examples of possible tools might include:

- Additional analytical improvements to FARS query
- User-friendly crash-related problem-identification software for driver and vehicle issues (paralleling the developing of SafetyAnalyst for problem spot identification)

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[16] For more information, refer to http://www.nhtsa.dot.gov/stsi

[17] For more information, refer to http://www-fars.nhtsa.dot.gov.

[18] More information is available at http:/www.walkinginfo.org/pbcat.

- User-friendly analysis software for GIS-based crash and roadway inventory and traffic data that would be useful for roadway, driver, and enforcement programs
- Easy-to-use economic analysis tools for countermeasure comparisons
- Analysis software to identify sites or corridors that are likely to have future safety problems based on onsite characteristics rather than past crash history
- Improved crash surrogates and methods to analyze them
- An IHSDM-like tool for pedestrian and bicycle facility planning
- "PedBikeAnalyst," a suite of tools for problem identification, crash typing, economic analysis, and countermeasure selection for pedestrian and bicycle issues. This could be developed from the multiple software products developed by FHWA during the past decade.

Summary of Suggested Tasks for Strategy 4

- FHWA should seek AASHTO formal endorsement of IHSDM, SafetyAnalyst, and future tools they develop, and should pursue a joint tool advertising campaign with AASHTO. The current IHSDM marketing program should serve as a model for these efforts. (4.1)
- FHWA should consider funding lead States currently using IHSDM to help them sell IHSDM to other States through peer-to-peer phone calls, meetings, etc. (4.1)
- Because the *Highway Safety Manual* is likely to incorporate SafetyAnalyst in its set of approved tools, and IHSDM will serve as the software for the HSM analytical tools, FHWA should support and coordinate with the HSM marketing plan. (4.2)
- NHTSA, FHWA, and FMCSA should consider establishing an ongoing effort aimed at identifying and developing the next generation of critical safety-data analysis tools. An initial step might be a research project aimed at determining the feasibility of such a program by attempting to identify critical tools needs. (4.2)

Strategy 5—Improve and Protect Safety Data by Storage and Linkage with Critical Nonsafety Data

Strategies 1 and 3 above noted that new safety data elements, particularly roadway inventory and traffic elements, are likely to be available from other nonsafety State databases, but that linkage between these databases may be problematic due to the use of different referencing systems. In addition, collection and storage of critical safety data elements is sometimes stopped for budgetary (and lack of use) reasons. Both of these issues could be resolved or lessened if crash and roadway inventory and traffic data are not retained in stand-alone databases, but are institutionalized by storing them with critical nonsafety data. This strategy is aimed at this goal.

Strategy 5.1—Warehouse safety data with other critical nonsafety data

As noted by both DeLucia[(3)] and Depue,[(5)] some State DOTs have developed or are developing a central electronic data warehouse that houses all their databases, both safety and nonsafety. We interviewed a limited sample of the HSIS States who are believed to have the most complete roadway inventory and traffic data, asking them what factors or practices led to their superior systems. All of them responded that a key to their success has been the incorporation of their inventory data into such a data warehouse. This combination with other high-priority State databases helps ensure that the safety data are of higher quality, linkable with other files, have guaranteed funding, and are more likely to be used by more than the traditional safety users.

The DeLucia[(3)] report cited earlier noted that the goal should not be to just develop better safety databases, but to build a safety knowledge base, which not only contains the data, but also data content expertise, data dictionaries, analytical assistance, and a customer service component. This concept could be incorporated into the safety component of the data warehouse, and should help increase data users, thus generating more support for the data. The specific data content expertise and analytical assistance would not necessarily need to be housed in the same location/office as the data warehouse; it could reside in a separate pertinent office (e.g., traffic engineering department) or in an outside agency (e.g., a university with data expertise, as is currently the case in Massachusetts.) However, the customer-service component of the warehouse would have to ensure that the user's initial contact could be linked to the right expert, and the experts would need to have this service task as part of their job description covered by their salaries.

Even before such a data warehouse is fully implemented, safety databases can be protected and improved by incorporating into them critical nonsafety data. For example, Ohio roadway inventory staff feel that at least part of the reason that their safety inventory data continues to be adequately funded and receives timely updates of data from local agencies is because it is the source of official mileage for the State, which establishes the level of State funding allocated to local road agencies.

We recommend that all States consider developing these data warehouses. However, data warehouses are a relatively new concept, particularly with respect to crash and roadway inventory and traffic data. Knowledge of how to successfully incorporate safety data into a warehouse is just being developed. We further recommend that FHWA and NHTSA consider funding an effort that would gather input from successful States and document the procedures and other keys that ensure success, in other words, produce a primer for those interested in incorporating safety data into a data warehouse. Based on comments from reviewers in a workshop, some critical issues to be covered in the primer would be:

- How to include off-system mileage (i.e., local county or municipal mileage) in the system to facilitate statewide safety planning.
- Guidance on where to find the critical files; there is a wide range of data owners under the current nonintegrated system.
- The need to catalog data definitions/dictionaries for each data source before incorporation.
- How to develop the required common location reference system.
- The need to ensure that (1) all data in the warehouse are compatible with spatial referencing (e.g. GIS), because all data users are moving toward such systems, and that (2) spatial data expertise is included in the knowledge base.

- The need to ensure that what are now relatively simple, short-term user inquiries do not require additional time or user expertise.
- The issue of how the development of a data warehouse might affect the section 409 data protection discussed in strategy 1.3 above.
- The issue of an incremental development project: starting small.
- The incorporation of, or transparent linkage to, non-DOT datasets that may include medical data (e.g., hospital, emergency medical services, trauma center) and enforcement data (e.g., driver history files, citation files). All of these datasets will both enhance safety data analyses and develop an expanded core of warehouse users/supporters.
- Guidance is needed on the components of and how to develop the critical knowledge base to accompany the data files (necessary knowledge, user training, tools, etc.)

Finally, because the AASHTO TSIMS effort (see strategy 2) is related to common linkage and use of various safety files, FHWA and NHTSA should coordinate these efforts with that TSIMS effort.

Strategy 5.2—Establish a data user/owner committee that includes both roadway inventory and traffic safety and nonsafety data administrators

Action 3.2c above noted the need to identify sources of roadway inventory and traffic data from what are traditionally considered nonsafety databases (e.g., asset management database). The incorporation of safety data into a data warehouse will make the identification of and linkage to such databases much easier. However, even without such a warehouse, it is important that States begin to institutionalize roadway inventory and traffic data with other transportation databases. Doing so will not only help broaden the safety data, but can also increase the number of new users of safety data (and thus support for safety data). To coordinate the collection, storage, and linked use of these disparate databases, we suggest that a State establish a data user/owner committee that would include representatives of all potentially linkable roadway inventory and traffic databases and files (e.g., inventory, traffic, asset management, pavement, etc.) This committee of data stewards should meet regularly to discuss issues, avenues for improvement, mutual use of the data, and other issues. This will require a secretariat—a leader and staff who will cause meetings to occur, establish the agenda, coordinate followup actions, etc. We suggest that because the roadway-related safety interests may gain the most benefit from this committee, that the secretariat should be part of the safety engineering office. Finally, it is noted that the long-term, successful operation of this committee will require both a strong leader and strong data stewards from each agency, because the integration/coordination of the many different existing databases contrasts markedly from the current situation of autonomous ownership and operation in many State and local DOTs.

Note that this committee differs from, but would be closely coordinated with, the State's Traffic Records Coordinating Committee. Because the data user/owner committee is focused on roadway inventory and traffic data (at least initially), the membership would primarily be drawn from the roadway side of transportation databases. (We recommend that this committee focus on the roadway inventory and traffic data because coordination of crash data is less often an issue given that collectors, police agencies, and users such as driver licensing agencies are members of the STRCC. After initial meetings of the data user/owner committee, a decision might be made concerning who should become a member of the STRCC. Strong liaison with the STRCC would be guaranteed by having this user/owner committee coordinated by the safety engineering office, which is always represented on the STRCC.

Strategy 5.3—Move as rapidly as possible to a geospatial reference (e.g., GIS) system for all types of safety data

All States are developing GIS-based or other spatial-enabled computer systems in a variety of applications. Roadway inventory data files are moving from linear referencing systems to coordinate systems. Crash locations are being captured by some police agencies with global positioning system (GPS) devices. Although there are still problems with these applications, the move to GIS-based or other geospatial referencing systems in all safety files will lead to better data, both in terms of greatly improved crash and inventory item locations, linkage of existing safety files (e.g., crash to inventory), and linkage of existing files to new files (e.g., linkage of roadway inventory to weather data and maintenance records). We recommend that States accelerate this process to the extent possible.

The SAFETEA-LU legislation (section 1401) mandates States to report on the safety of all public roads, which requires road inventory and crash information for all these roads. Many State DOTs do not maintain all public roads in their States. Meeting this requirement in those cases will require cooperative strategies among agencies and the application of new technologies for data acquisition and processing. Spatially enabled data systems may be the best option for acquiring these data from multiple agencies and conducting the analysis to meet the reporting requirements of the legislation.

FHWA safety offices has been active in assisting States in this move to GIS-based data through the development of tools such as the TraCs system, the conversion of traditional State safety analysis tools (e.g., hazardous location identification), the development of new analysis tools (e.g., a corridor analysis tool) in a GIS format, and the development of a GIS-based roadway inventory data collection van (the DHM system).

We recommend that FHWA expand targeted efforts in this area. The term targeted is emphasized here because not all past efforts have been implemented by States. For example, a recent user survey of more than 200 people who had requested and received the GIS analysis tools developed by FHWA indicated very little documented usage. Part of the problem is that the tools were originally developed in an older GIS format that is no longer used. However, even when the tools were converted to a more used format, increased usage could not be documented. This may also result from the fact that although States and local transportation agencies are rapidly moving to GIS-based systems, many such systems have not yet been completed, so that the tools are still too innovative. It could also reflect the lack of knowledge within individual offices and units within local and State DOTs about current technology and advances in these geospatial referenced databases (i.e., what new or enhanced capabilities these systems will provide to users). The FHWA effort should begin by developing knowledge of what tools, methods, or technical assistance would be most beneficial to the State and local users, i.e., identify what would help accelerate the process. This knowledge development could include focus groups at national meetings of both GIS specialists and safety engineers. The information obtained at focus groups could then be used to develop high-priority products and a marketing campaign (i.e., similar to what is being done for IHSDM—strategy 4.1). For example, some States (e.g., Iowa) have developed geospatial data models that might be useful in other States.

We further recommend that FHWA continue and expand the assistance given to State and local agencies in the actual GIS-file building/conversion process. FHWA has long supported this development and conversion. One State-DOT GIS agency currently involved in this conversion effort noted that their experiences and those of other States they communicate with indicate that it would be helpful if FHWA provided more visible support for the use of State planning and research (SPR) funds in this conversion effort.

Strategy 5.4—Provide local agency access to the data, analysis tools, and other products

Increasing the use of safety data by local agencies could also generate added support for retaining and improving critical safety data. These increases could be facilitated by outreach programs from the State data agencies. These programs could range from allowing direct access into the State database, to developing and distributing locally specified safety reports, to developing user-friendly data retrieval and analysis tools for the local agencies.

The needs may be different for crash versus roadway inventory and traffic data. Crash data are collected by the local agencies (often due to State statute) and incorporated into the full State database by State agencies. Unfortunately, local agencies often retain (i.e., code, enter, and store) their own crash records into their own systems at the same time that the State is duplicating the effort to get the data into the State system. Increasing the use of high-end electronic data recorders as described in action 3.1b above will help eliminate the duplicate effort. However, there will still be a need for user-friendly access to the State system to enable the locals to extract and use their own crash data.

For roadway inventory and traffic data, the issue concerns the lack of such data in local jurisdictions, i.e., the lack of street inventory, traffic counts, signal inventories, and the like, which are needed to make good safety decisions. This lack of information is becoming more critical due to recent requirements in SAFETEA-LU for a strategic highway safety plan that incorporates these local roads. Although some larger municipalities do have their own data systems, even there, critical data such as annual average daily traffic flows (AADTs) on all street segments is missing. And much of the data present are often in paper rather than computerized files. So what is needed is not only submission of collected data, but also the initial collection and computerization of the data. (A similar problem may exist for crash data: some local agencies do not submit the data, or they submit it very late, even though State statutes require submission.)

One possible solution to this noncollection/submission problem is to start an incentive program where the local agency agrees to collect and submit data in exchange for data they need access to from State files and resources. As noted by DeLucia[3], the most successful of these data-for-data partnerships provide some form of sharing data, software, and/or hardware resources with local jurisdictions. Examples of incentives for improved crash data have included not only easy access to the data resources in the State system (e.g., Chicago with the IL DOT), but also access to detailed DOT mapping software, free crash data collection tools, and distribution of GPS readers to obtain locations that are more accurate. (Note that incentives might also include guidance and assistance to the local agency in acquiring grants or other funding to improve the local data.)

As noted in the scanning tour report,[(1)] a similar partnership has been implemented in the Netherlands concerning roadway inventory data. There, locals collect and submit inventory information on their new street and roadway segments to the national agency, which enters the information into the national database. This national database is maintained in a GIS format by the State and is made available to all local users. The national office also produces and distributes GIS-based data extraction and analysis tools for use by its member localities. And, finally, as noted above, perhaps the ultimate data-for-something partnership for inventory data is in Ohio, where the locals receive road funding based on the data they submit to the State inventory system.

The success of the crash-based partnerships in the United States and the inventory data partnerships in the Netherlands indicates that States should consider them as a possible avenue to better crash and roadway inventory and traffic data. Similar partnerships might be possible for not only data on newly constructed roadways, but for updated data resulting from maintenance and renovation efforts. We recommend that States also consider developing, distributing, and supporting appropriate data extraction and analysis tools to their local partners (by providing any assistance possible that makes the data more accessible and easier to use by local agencies—MPOs, counties, and municipalities). Critical to this tool development is to recognize the widely differing levels of analysis expertise and ability in these local agencies. Data collection, extraction, and analysis tools developed must be extremely user-friendly, and should include a well-designed knowledge transfer component. The latter could include Web-based training programs or dedicated training workshops held at the local levels, but consideration should also be given to funding a local data help desk, which would assist local users in their analyses, as well as provide answers to the local agencies when local analysis expertise is not available. For example, some States such as the Minnesota DOT regularly provide local-agency-specific listings of problem locations and other jurisdiction-based data. The NC Governor's Highway Safety Program has provided long-term funding for a Quick Response project at the UNC Highway Safety Research Center that not only provides advice and assistance to local safety data users, but also conducts the necessary computer runs to provide local agencies with either tailored databases or answers to specific questions (e.g., the number of alcohol- or young-driver-related crashes in a given county or municipality).

Summary of Suggested Tasks for Strategy 5

- All States should consider developing data warehouses that incorporate crash and roadway inventory and traffic data with other State transportation databases. To generate new safety-data users and to make data use easier for existing users, the data warehouse should include a safety knowledge base, including data content expertise, data dictionaries, analytical assistance, and a customer service component. (5.1)
- NHTSA, FHWA, and FMCSA should consider funding the development of a primer that would assist States in successfully incorporating safety data in a data warehouse. This effort should be coordinated with the AASHTO TSIMS effort. (5.1)

- States should consider establishing a data user/owner committee that would include a well-staffed secretariat and representatives of all potentially linkable roadway inventory and traffic bases and files (e.g., inventory, traffic, asset management, pavement, and the like). (5.2)
- State DOTs should continue to accelerate the development of GIS-based computer systems for all types of safety files, crash and roadway inventory and traffic. (5.3)
- FHWA should continue the targeted development and marketing of, and technical assistance for, GIS-based safety data collection, extraction, and analysis tools that users indicate would be most beneficial to them. (5.3)
- FHWA should consider providing more visible support for the use of SPR funds in the development of GIS systems in State DOTs. (5.3)
- States should make local-agency access to the State database as user friendly as possible, including the development, distribution, and support of appropriate data extraction and analysis tools to their local partners. (5.4)
- State crash and roadway inventory and traffic agencies should consider establishing data-for-data partnerships with local agencies as a possible avenue to increased collection of improved safety data. (5.4)

SUMMARY AND CONCLUSIONS

The international safety data scanning tour organized and led by FHWA produced a detailed description of major safety data initiatives in Europe and Australia, and the accompanying implementation paper presented suggested strategies for bringing these and other initiatives and improvements to safety data in the United States. This paper has built on those documents by further describing major issues in U.S. safety data and by presenting a listing of detailed recommendations for improving these data. The text of this paper has been organized into the following five major strategies.

- Strategy 1—Increase support for both safety programs and safety information systems (the data) from top-level administrators in State and local transportation agencies.
- Strategy 2—Improve safety data by defining good inventory data and institutionalizing continual improvement toward established performance measures.
- Strategy 3—Improve safety data by making it easier to collect, store, and use.
- Strategy 4—Improve safety data by increasing the use of critical safety analysis tools, which themselves require good data.
- Strategy 5—Improve and protect safety data by storage and linkage with critical nonsafety data.

Recommended substrategies and actions have been presented for each of these five strategy areas. This final section presents the recommendations again, but reorganizes them by potentially responsible agency.

RECOMMENDATIONS BY POTENTIALLY RESPONSIBLE AGENCY

All recommendations from the five strategies have been captured in table 1 below. Although it is clear that many of the proposed strategies could be implemented by more than one agency, the strategies in table 1 are organized by the agency who, in the opinion of the authors, would be most likely to lead the implementation—FHWA alone, FHWA and AASHTO jointly, NHTSA and FHWA and FMCSA jointly, and the States. The bulk of the recommendations are directed to FHWA—alone and in partnership with AASHTO and NHTSA/FMCSA. This is primarily due to the fact that as noted earlier, this paper focused more on deficiencies in, and thus solutions to, roadway inventory and traffic data needs than on deficiencies in crash data needs.

In each case, an attempt has been made to provide an estimate of the time frame required to capture the full benefit of the recommendation (including both development and implementation timeframe), and the relative cost of implementing the strategy (low, medium, high). With respect to timeframe, short-term represents less than 2 years, medium-term represents 3 to 5 years, and long-term represents more than 5 years. Note, however, that in some medium-term and long-term cases, the actual development of the recommended action could be less than 2 years, but the implementation would require a long-term commitment. The cost-level estimates include both development efforts (e.g., a specific research effort) and implementation and maintenance costs

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost.

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
FHWA should consider the following strategies:			
Low Cost	• Assess feasibility of improving safety data through asset management programs in the States. (1.2) • Develop sessions on roadway inventory and traffic data at Traffic Records Forum and the TRB annual meeting. (1.4) • Conduct an invitation-only meeting of roadway inventory and traffic data managers to disseminate knowledge and foster the development of a peer group. (1.4)	• Support and coordinate with the HSM marketing plan because the HSM is likely to incorporate SafetyAnalyst in its set of approved tools, and IHSDM will serve as the software for the HSM analytical tools. (4.1)	• Consider providing more visible support for the use of SPR funds in the development of GIS systems in State DOTs. (5.3) • Provide technical guidance/responses to States that have questions related to automated data collection technologies. (3.2a)
Medium Cost	• Fund an effort to identify nonsafety uses of critical safety data elements. (1.3) • Fund lead IHSDM States to sell IHSDM to other States through peer-to-peer phone calls, meetings, etc. (4.1)	• Further explore development of a USRAP program – fund such a program if found to be feasible (with support from AAA). (1.1c) • Support development of a roadway inventory and traffic-data knowledge base and dissemination of the knowledge to State data managers through a newsletter or other mechanism. (1.4) • Continue development of the digital highway measurement system. Once the system is validated, develop and implement a technology transfer effort that provides access to the vehicle by State DOTs. (3.2a)	• Continue targeted development and marketing of, and technical assistance for, GIS-based safety data collection, extraction, and analysis tools. (5.3)

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost—*continued*

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
FHWA and AASHTO should consider the following strategies:			
Low Cost	• Ensure that NCHRP Project 08-54 - “Identification of Liability–Related Impediments to Sharing 409 Safety Data among Transportation Agencies, and Synthesis of Best Practices” are distributed to DOT safety managers and legal staffs. (1.3) • Explore the distribution of a technical memo to the States suggesting that they only purchase data collection equipment that has been validated for accuracy. (3.2a) • Obtain AASHTO’s formal endorsement of existing and future FHWA safety analysis tools; pursue a joint tool advertising campaign.(4.1)	• Consider convening an expert panel/focus group of DOT attorneys and risk managers to review NCHRP 08-54 and chart possible additional actions. (1.3) • If needed, consider requesting that Congress reexamine and modify the current section 409 legislation. (1.3)	
Medium Cost		• Fund the development of a list of critical roadway inventory and traffic data elements. (2.1) • Fund the development of performance measures that concern data accuracy, maintenance, and storage. (2.2) • Fund a research effort to examine all nonsafety data sources held in State and local transportation agencies,	

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost—*continued*

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
Medium Cost—Continued		Define the source of each safety-related variable found in these files, and incorporate these elements and sources into a survey document that would be used by State and local TRCCs and other safety managers. (3.2c)	
High Cost			• Establish an ongoing research program to develop or enhance technologies for the collection of critical roadway inventory and traffic safety elements. (3.2b)
FHWA, NHTSA, and FMCSA should consider the following strategies:			
Low Cost	• Supplement the normal NCHRP distribution of “Practices in Crash Reporting and Processing” by targeting additional State and local agencies and individuals involved with crash data including STRCCs. (3.1a)	• Monitor XML-related efforts and projects to ensure appropriate variables and formats are incorporated into the schema (data structures) being developed. (2.4)	• Strengthen the roadway safety data components of traffic records assessments with additional roadway data expertise and by developing a checklist of critical roadway inventory and traffic data elements. (2.3)
Medium Cost		• A research effort to identify the factors that would lead to increased use of high-end crash data collection technology by police agencies (with IACP support). (3.1b) • A research study to determine what factors could lead to more emphasize on better data by law enforcement administrators and more accurate	• Continue to support efforts aimed at improving crash data accuracy through improvements to onboard computer technology. (3.1c) • Consider jointly developing a U.S. DOT safety data technology clearinghouse that will encompass all governmental

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost—*continued*

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
Medium Cost—Continued		reporting by police officers (e.g., training techniques, incentives for accuracy). (3.1c) • Explore with IACP the possibility of a safety training standard for police, similar to training standards for other aspects of police work. (3.1c) • A study to identify and rank critical crash data elements that are most difficult to collect and develop methods or technologies to overcome the issues. (3.1c) • A study to examine the cost savings and accuracy increases that might result from the use of civilian crash investigators. If this avenue is found to be effective, identify factors that would lead other agencies to implement this practice. (3.1c) • The development of a primer to assist States in the successful incorporation of safety data in a data warehouse. (5.1)	or commercially developed validated technologies related to both crash and roadway inventory and traffic data. (3.2b)
High Cost			• Consider establishing an ongoing effort aimed at identifying and developing the next generation of critical safety-data analysis tools. (4.2)

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost—*continued*

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
State Departments of Transportation should consider the following strategies:			
Low Cost	• STRCCs should communicate concerns, issues, and actions regularly to top-level administrators in all represented agencies. (1.2)		• State safety data managers should initiate regular meetings with, and provide feedback to, sister agencies who collect or have the potential to collect roadway inventory and traffic data. (1.3) • If a State's tort system does not allow failure-to-improve litigation, the State safety data managers should communicate and cooperate with their department attorneys to foster more support and use of safety data. (1.3)
Medium Cost			• Request traffic records assessments on a regular basis, and find the resources necessary to implement the recommendations. (2.3) • Consider establishing a data user/owner committee that would include a well-staffed secretariat and representatives of all potentially linkable roadway inventory and traffic databases. (5.2)

Table 1. Agency responsible for implementation of recommendations and estimated timeframe and relative cost—*continued*

Potential Responsible Agency and Relative Cost	Timeframe for Development and Implementation of Recommendation		
	Short-Term	**Medium-Term**	**Long-Term**
Medium Cost—Continued			• Consider establishing data-for-data partnerships with local agencies as a possible avenue to increase collection of improved safety data. (5.4)
High Cost			• Consider developing data warehouses to incorporate crash and roadway inventory and traffic data with other State transportation databases. (5.1) • Accelerate and expand the development of GIS-based computer systems for all crash and roadway inventory and traffic data. (5.3) • Make local-agency access to the State database as user-friendly as possible, including the development, distribution, and support of data extraction and analysis tools. (5.4)

to the sponsor. For reference, recommendations requiring a specific research project were defined as “medium cost.” Again, these are only relative judgments to provide some input into decisions concerning programming of the recommendations.

PRIORITIZATION OF RECOMMENDATIONS

All of these recommendations are considered important, or they would not be included in this paper. Initially, consideration was given to providing a further prioritization of the 38 recommendations captured in the above text by providing top-two recommendations for each responsible-agency group. However, this was not done for three reasons. First, it is extremely difficult to predict in advance which of the many recommendations will lead to the greatest improvements in safety data. Their ultimate benefit will depend on a number of factors including the success of necessary development efforts (e.g., research studies) and the degree to which the ultimate collectors of safety data—the State and local transportation agencies—implement a given recommended change. Second, this type of prioritization within a responsible-agency group could fail to recognize an even more important recommendation in a different group. Thus, a recommendation judged to be in the top two within one of the five strategy areas may not be as important as a strategy that did not make the top-two list in another strategy area. Third, there is some fear that paring down the full list of 41 recommendations to only 10 will ultimately result in the other 31 being denied the attention they deserve. As noted above, all are believed to be important, and presenting the full list will allow the responsible agencies to choose the ones they believe are most important and most feasible.

Given these concerns and after careful consideration, a decision was made to include a listing of most-important recommendations, which was determined by a focus group of safety data experts convened to review and discuss the draft version of this paper. The group consisted of eight State and local roadway safety engineers, crash data specialists, roadway inventory data specialists, and information technology experts. The list of focus group participants is included in appendix C. Following a detailed discussion by the group of all 38 recommendations present at the time of the meeting, each participant (including the authors and the FHWA Task Manager) rated each recommendation as “high,” “medium,” or “lower.” Participants were asked to distribute their ratings so that approximately one-third were high, one-third were medium, and one-third were in the “lower” category. The rankings were then combined, and table 2 lists the highest-ranked 13 of the 38 recommendations, the top one-third.

Note that three recommendations were added after the panel meeting and were not rated by the panel: explicit recommendations for (1) States to regularly request traffic records assessments by an independent agency, (2) for STRCCs to report regularly to top-level administrators to raise agency awareness of records issues and needs, and (3) for FHWA, NHTSA, and FMCSA to explore with IACP the possibility of a safety training standard for police, similar to training standards for other aspects of police work. Finally, also note that the composition of the panel, which was weighted heavier to the roadway and inventory data rather than to crash data, clearly might have affected the rankings. Clearly, any other group may have developed a different priority list. Given all these caveats, table 2 provides at least some input concerning priorities from a group of national safety-data experts.

CONCLUSION

Excellent crash, roadway inventory, and traffic data are critical to making decisions concerning roadway planning, roadway design and improvement, vehicle design, and driver programs—all of which affect the safety of the driving public. Safety data will become even more critical as our national, State, and local departments of transportation, and indeed the entire safety field, move to more fact-based safety decisions and to performance-based programs. Current safety data will not meet these challenges in many cases. AASHTO recognized this fact in the publication *Strategic Highway Safety Plan*, where the core element of management included the need to (1) improve the information and decision support systems and (2) create more effective process and safety management systems. The recently passed SAFETEA-LU legislation has subsequently mandated improvements in safety data and includes provisions for Federal funding to help address some of the data issues presented in this paper.

This paper has described a number of issues with current data and a series of potential solutions to these issues. It is hoped that this description will not only increase the national discussion of how safety data can be improved, but that at least some of the solutions suggested will be implemented and will result in improvements in data that will lead to decisions that will help solve one of the largest public health problems faced by the United States—highway crashes.

Table 2. Highest priority strategies as ranked by focus group attendees.

Strategy	Strategy Task Description
3.1d	NHTSA and FHWA, with input/assistance from IACP, should consider a research study aimed at determining what factors could lead to more emphasis on accurate data by law enforcement administrators and more accurate reporting by police officers, including exploration of training effects (and if effective, techniques), incentives for accuracy, and other possible factors.
5.3a	State DOTs should continue and accelerate the development of GIS-based computer systems for all types of safety files, crash and noncrash.
2.1	FHWA or AASHTO should fund the development of a listing of critical noncrash data elements.
5.1a	All States should consider the development of data warehouses that incorporate crash and noncrash data with other State transportation databases. To generate new safety-data users and to make data use easier for existing users, the data warehouse should include a safety knowledge base, including data content expertise, data dictionaries, analytical assistance, and a customer service component.
3.1b	NHTSA and FHWA, with input/assistance from IACP, should fund a research effort to identify the factors that would lead to increased use of high-end crash data collection technology by police agencies.
3.1c	NHTSA and FHWA should continue to support efforts aimed at improving crash data accuracy through improvements to the onboard computer technology.
5.4a	States should make local-agency access to the State database as user-friendly as possible, including the development, distribution, and support of appropriate data extraction and analysis tools to their local partners.
1.4c	FHWA should consider developing and funding an invitation-only meeting of key noncrash data managers to disseminate knowledge and foster the development of a peer group.
2.2	FHWA or AASHTO should fund the development of performance measures that concern data accuracy, maintenance, and storage.
2.3	NHTSA and FHWA should strengthen the roadway safety data components of the existing traffic records assessments by adding additional roadway data expertise and by developing a checklist of critical noncrash data elements. This list could be based on existing FHWA uses (e.g., HSIS) and tools (i.e., IHSDM and SafetyAnalyst).
1.3e	FHWA and AASHTO should consider convening an expert panel/focus group of DOT attorneys and risk managers to review NCHRP 08-54 and chart possible additional actions.
1.4b	FHWA should consider developing special sessions on noncrash data in both the International Traffic Records Forum and the TRB annual meeting.
3.2b	FHWA should continue the development, validation, and refining of its data collection vehicle, and once the vehicle is validated, FHWA should develop and implement a technology transfer effort that helps State DOTs access the vehicle. Top priority for use should be given to States participating in FHWA's Highway Safety Information System.
3.2c	FHWA and AASHTO should establish an ongoing research program to develop new technologies, which would ease collection of critical noncrash safety elements. This effort could include both new development and the modification of technologies and methodologies now being used in nonsafety areas.

APPENDIX A: CROSS-MAPPING OF THE ORIGINAL STRATEGIES AND ACTIONS DEVELOPED BY THE SCANNING TEAM TO THE FIVE CRITICAL STRATEGIES COVERED IN THIS PAPER

Table 3. Cross-mapping of original strategies and actions.

Strategy or Action from Plan and Implementation Paper	Strategy/Action in this Report
Strategy	
(Theme) Generate top-level support for safety programs and data. Define safety as core business.	Strategy 1.1, 1.2, 1.3, 1.4
(Theme) Create safety program performance measures for use by FHWA and States.	Alternative—Strategy 2.2—safety data performance measures
(Action) Disseminate widely the findings of Project “Practices in Crash Reporting and Processing.”	Strategy 3.1(Action 3.1a)
(Action) Survey the public and DOTs to determine the most important safety issues and use these to push administrators to improve programs and data.	Alternative—Strategy 1 (Action 1.1c)
(Action) Educate the public that problems with safety are epidemic and need more attention.	Strategy 1.1—Action 1.1a, 1.1b (Alternative—see Action 1.1c)
(Action) Develop a marketing/media plan for use by TRCCs.	Alternative—Strategy 3 (All actions)
Efficiency	
(Theme) Simplify data collection, particularly for police.	Strategy 3.1, 3.2
(Action) Encourage the widespread use of high-quality automated collision reporting software by 402 funding, licensing in States, and police peer reviews of competing software.	Strategy 3 (Action 3.1a, 3.1b)
(Theme) Review crash data and eliminate unneeded variables.	Strategy 2.1
(Action) Develop an analysis methodology which will allow a cost-benefit analysis of each safety data element collected or proposed for collection. Test and market.	Alternative—Strategy 2.1
(Action) Identify all data variables that are collected and might be useful in safety analysis for use by TRCCs in inventories of their own States.	Alternatives—Strategy 2.1, 2.3, 2.4

Table 3. Cross-mapping of original strategies and actions—*continued*

Strategy or Action from Plan and Implementation Paper	Strategy/Action in this Report
Efficiency continued	
(Action) Develop a national synthesis of all sources of crash, inventory, and traffic operations data and the technology being used to collect it.	Alternatives—Strategy 2.1, 2.3, 2.4, Strategy 3.2 (Action 3.2c). In addition, current NCHRP Synthesis Project 36-03, "Technologies for Improving Safety Data," is focusing on the technology aspects of this issue.
(Theme) Increase use of current data collection technology, including nonfield file linkages.	Strategy 3 (Action 3.1b, 3.2.a)
(Theme) Develop needed new technology to improve data collection and linkage.	Strategy 3 (Action 3.1c, 3.2b)
(Action) Develop a short-term research and development program aimed at (1) validating existing data collection technology where needed (e.g., onroad inventory data vehicles), and (2) developing new technology which will take advantage of (i.e., retrieve, store, link, analyze) data collected for other purposes (e.g., signal loops, weather monitoring (all types of ITS data)) which can be used in safety analysis.	Strategy 3.2 (Action 3.2a, 3.2c)
(Action) Develop a long-term research plan that will monitor technology development (e.g., wireless technology) and explore ways to use the technology in the development and utilization of safety data systems.	Strategy 3.2 (Action 3.2.b)
Utility	
(Theme) Market safety data to new potential users (including the public) to increase its use.	Strategy 1.1, 1.3, 5.4
(Theme) Develop, deploy, and facilitate use of analytical safety tools in order to increase need for better safety data.	Strategy 4
(Action) Develop and market the data dictionaries for each tool to encourage States to improve their data.	Strategy 4
(Action) Examine the possibility of encouraging use of the three-tier analysis plan (i.e., encourage sound safety evaluations).	Strategy 4.1, 4.2

APPENDIX B:
SAFETEA-LU INFORMATION RELATED TO "STATE TRAFFIC SAFETY INFORMATION SYSTEM IMPROVEMENTS"

SEC. 2006. STATE TRAFFIC SAFETY INFORMATION SYSTEM IMPROVEMENTS.

(a) In General.—Section 408 of title 23, United States Code, is amended to read as follows:

"Sec. 408. State traffic safety information system improvements

(a) Grant Authority.—Subject to the requirements of this section, the Secretary shall make grants to eligible States to support the development and implementation of effective programs by such States to—

(1) improve the timeliness, accuracy, completeness, uniformity, integration, and accessibility of the safety data of the State that is needed to identify priorities for national, State, and local highway and traffic safety programs;

(2) evaluate the effectiveness of efforts to make such improvements;

(3) link the State data systems, including traffic records, with other data systems within the State, such as systems that contain medical, roadway, and economic data; and

(4) improve the compatibility and interoperability of the data systems of the State with national data systems and data systems of other States and enhance the ability of the Secretary to observe and analyze national trends in crash occurrences, rates, outcomes, and circumstances.

(b) First-Year Grants.—To be eligible for a first-year grant under this section in a fiscal year, a State shall demonstrate to the satisfaction of the Secretary that the State has—

(1) established a highway safety data and traffic records coordinating committee with a multidisciplinary membership that includes, among others, managers, collectors, and users of traffic records and public health and injury control data systems; and

(2) developed a multiyear highway safety data and traffic records system strategic plan—

(A) that addresses existing deficiencies in the State's highway safety data and traffic records system;

(B) that is approved by the highway safety data and traffic records coordinating committee;

(C) that specifies how existing deficiencies in the State's highway safety data and traffic records system were identified;

(D) that prioritizes, on the basis of the identified highway safety data and traffic records system deficiencies of the State, the highway safety data and traffic records system needs and goals of the State, including the activities under subsection (a);

(E) that identifies performance-based measures by which progress toward those goals will be determined; and

(F) that specifies how the grant funds and any other funds of the State are to be used to address needs and goals identified in the multiyear plan.

(c) Successive Year Grants.—A State shall be eligible for a grant under this subsection in a fiscal year succeeding the first fiscal year in which the State receives a grant under subsection (b) if the State—

(1) certifies to the Secretary that an assessment or audit of the State's highway safety data and traffic records system has been conducted or updated within the preceding 5 years;

(2) certifies to the Secretary that its highway safety data and traffic records coordinating committee continues to operate and supports the multiyear plan;

(3) specifies how the grant funds and any other funds of the State are to be used to address needs and goals identified in the multiyear plan;

(4) demonstrates to the Secretary measurable progress toward achieving the goals and objectives identified in the multiyear plan; and

(5) submits to the Secretary a current report on the progress in implementing the multiyear plan.

(d) Grant Amount.—Subject to subsection (e)(3), the amount of a year grant made to a State for a fiscal year under this section shall equal the higher of—

(1) the amount determined by multiplying—

(A) the amount appropriated to carry out this section for such fiscal year, by

(B) the ratio that the funds apportioned to the State under section 402 for fiscal year 2003 bears to the funds apportioned to all States under such section for fiscal year 2003; or

(2)(A) $300,000 in the case of the first fiscal year a grant is made to a State under this section after the date of enactment of this subparagraph; or

(B) $500,000 in the case of a succeeding fiscal year a grant is made to the State under this section after such date of enactment.

(e) Additional Requirements and Limitations.—

(1) Model data elements.—The Secretary, in consultation with States and other appropriate parties, shall determine the model data elements that are useful for the observation and analysis of State and national trends in occurrences, rates, outcomes, and circumstances of motor vehicle traffic accidents. In order to be eligible for a grant under this section, a State shall submit to the Secretary a certification that the State has adopted and uses such model data elements, or a certification that the State will use grant funds provided under this section toward adopting and using the maximum number of such model data elements as soon as practicable.

(2) Data on use of electronic devices.—The model data elements required under paragraph (1) shall include data elements, as determined appropriate by the Secretary, in consultation with the States and appropriate elements of the law enforcement community, on the impact on traffic safety of the use of electronic devices while driving.

(3) Maintenance of effort.—No grant may be made to a State under this section in any fiscal year unless the State enters into such agreements with the Secretary as the Secretary may require to ensure that the State will maintain its aggregate expenditures from all other sources for highway safety data programs at or above the average level of such expenditures maintained by such State in the 2 fiscal years preceding the date of enactment of the SAFETEA-LU.

(4) Federal share.—The Federal share of the cost of adopting and implementing in a fiscal year a State program described in subsection (a) may not exceed 80 percent.

(5) Limitation on use of grant proceeds.—A State may use the proceeds of a grant received under this section only to implement the program described in subsection (a) for which the grant is made.

(f) Applicability of Chapter 1.—Section 402(d) of this title shall apply in the administration of this section.

(b) Clerical Amendment.—The analysis for chapter 4 of such title is amended by striking the item relating to section 408 and inserting the following:

“408. State traffic safety information system improvements."

APPENDIX C:
ATTENDEES AT FOCUS GROUP MEETING TO REVIEW WHITE PAPER

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