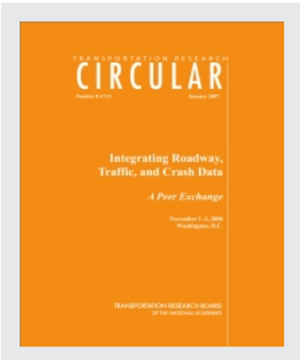

Integrating Roadway, Traffic, and Crash Data: A Peer Exchange

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James P. Hall
Editor

Transportation Research Board
Transportation Asset Management Committee
Statewide Transportation Data and Information Systems Committee
Geographic Information Science and Applications Committee

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Jennifer Correro, Proofreader and Layout

Contents

Executive Summary

The Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) legislation encourages state departments of transportation (DOTs) to develop strategic highway safety plans (SHSPs). Developing an SHSP calls for a comprehensive, collaborative, and data-driven approach to highway safety that brings together all appropriate safety stakeholders in the state to work together towards a common highway safety goal. An SHSP is to be based on accurate and timely safety information systems, processes to analyze this information to identify highway safety problems and opportunities, and planning and implementation of a comprehensive set of countermeasures.

The Transportation Research Board's (TRB's) Transportation Asset Management (ABC40), Statewide Transportation Data and Information Systems (ABJ20), and Geographic Information Science and Applications (ABJ60) Committees hosted a peer exchange to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating roadway, traffic, and crash data sources used to support safety management and introducing asset management concepts into the highway safety management arena. Nine state transportation agencies were selected for participation in the peer exchange based on their leadership and interest in integrating roadway, traffic, and crash data. Prior to the workshop, state agency participants completed an extensive questionnaire on their current situation for data management and integration practices. Agencies also responded to questions on the on their data analysis capabilities and the value of data integration to asset management and safety management functions.

Results of the completed questionnaires, and subsequent peer exchange discussions, provided insights into the status and application of data integration efforts.

In general, many agencies had made significant progress in developing a formal process to integrate their data resources on an enterprise basis; usually through spatial technologies. Several states were also developing comprehensive tools to develop decision support products for use in asset management and safety management activities in the program development process.

However, many agencies indicated that significant issues remain before they reach full data integration capabilities. These issues include difficulties in accessing and incorporating local agency data, a perceived lack of resources to properly maintain the completeness, quality and accuracy of the data resource, ineffective management of historical data files, and an inability to spatially integrate disparate systems due to differing spatial identifiers.

In breakout groups, the peer exchange participants focused on three major issue areas in moving data integration efforts to the next level: data management challenges, the value and benefits of data integration, and managing safety as an asset. Upon a thorough discussion of these issues, the peer participants developed research problem statements to address specific areas of interest including safety asset management practices, data integration business process review guidelines, open architecture issues, data visualization techniques, and local agency data integration.

Background

James P. Hall
University of Illinois at Springfield

ORGANIZATION AND SPONSOR

This peer exchange was organized by TRB's Transportation Asset Management Committee (ABC40), Statewide Transportation Data and Information Systems Committee (ABJ20), and the Geographic Information Science and Applications Committee (ABJ60). The FHWA's Office of Asset Management provided funding support.

PEER EXCHANGE OBJECTIVES

The purpose of this peer exchange was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

The basic principles of the peer exchange were as follows:

- Relate to roadway and traffic data interests of the Statewide Transportation Data and Information Systems Committee members;
- Illustrate practical data integration principles;
- Be relevant to asset management practice;
- Relate to the real experience or plans of participants; and
- Move the current practice forward but not necessarily "solve" all the issues.

The specific objectives of the peer exchange were as follows:

- Better understand both requirements and current state practices in integrating roadway, traffic, and crash data;
- Illustrate practical data integration principles for state DOTs; and
- Develop relevant research problem statements.

PEER EXCHANGE PARTICIPANTS

In 2006, a peer exchange planning committee was formed to formulate the objectives of the peer exchange and to administer preconference activities. The planning committee consisted of the following members:

Planning Committee

- Anita Vandervalk, Cambridge Systematics, Inc., Chair;
- James P. Hall, University of Illinois at Springfield;
- Tom Maze, Iowa State University;
- Vicki Miller, FHWA;
- Tom Palmerlee, TRB;
- Robert Pollack, FHWA;
- Jack Stickel, Alaska Department of Transportation and Public Facilities (ADOT&PF); and
- Reginald R. Souleyrette, Iowa State University.

The planning committee identified and selected nine state transportation agencies for participation in the peer exchange based on their leadership and interest in the integrating roadway, traffic, and crash data. The participating state transportation agencies were

- ADOT&PF;
- District of Columbia DOT (DDOT);
- Michigan DOT;
- Mississippi DOT;
- Iowa DOT;
- Ohio DOT;
- Oregon DOT;
- Pennsylvania DOT; and
- Wisconsin DOT.

Ultimately, a total of 17 state agency representatives and 15 other federal, university, and private agency representatives participated in the peer exchange. Table 1 is a listing of peer exchange participants.

STATE TRANSPORTATION AGENCY QUESTIONNAIRE

Prior to the workshop, state agency participants completed an extensive questionnaire on their current situation for data management and integration practices. Agencies also responded to questions on the on their data analysis capabilities and the value of data integration to asset management and safety management functions. Each individual state agency response is included in this e-circular.

The state agency questions were as follows.

Value

What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions? In your response, please include

TABLE 1 Peer Exchange Participants

Name and Title	Organization
Jack Benac, Project Manager	Michigan Department of Information Technology
Tony Bianchi, Project Manager, AASHTOWare	AASHTO
Kenneth Campbell, SHRP 2	TRB
Ralph Craft	FMCSA
Jeffery K. Ely, Planning Division Data Manager	Mississippi DOT
Leonard Evans, Administrator, Systems Analysis Planning	Ohio DOT
Martha Florey, Assistant Director, Bureau of Transportation Safety	Wisconsin DOT
David Floyd	TRB
Suzie Ford, Chief, Data Management Section	Wisconsin DOT
James P. Hall, Associate Professor	University of Illinois at Springfield
Laine Heltebridle, Transportation Planning Manager	Pennsylvania DOT
Bill Hunter, Manager, Crash Information Systems and Analysis	Pennsylvania DOT
Anthony Kane, Director, Engineering and Technical Services	AASHTO
Peggi Knight, Director, Office of Transportation	Iowa DOT
Ron Martindale, Central Region Preconstruction Traffic Safety and Utilities	ADOT&PF
Jianming Ma, Transportation Engineer	DDOT
Thomas Maze, Professor	Iowa State University
William McGuirk, Manager, Traffic Safety, Standards	DDOT
Sue McNeil, Professor	University of Delaware
Vicki Miller	FHWA
Thomas M. Palmerlee, Senior Program Officer	TRB
Jeff Pierce, State Planning Engineer	Mississippi DOT
Robert Pollack	FHWA
David Ringeisen, Transportation Data Manager	Oregon DOT
Francine Shaw-Whitson	FHWA
Keith Sinclair, Highway Safety Engineer	FHWA
Reginald R. Souleyrette	Iowa State University
Jack Stickel, Transportation Planner	ADOT&PF
Anita Vandervalk, Director, Florida Operations	Cambridge Systematics, Inc.
Ronald L. Vibbert. Manager, Asset Management Section	Michigan DOT
Thomas M. Welch, State Transportation Safety Engineer	Iowa DOT
Mark Wills, OTMS Program Manager	Oregon DOT

a. In what specific activities does/will this information result in better, more informed, fact-based decisions e.g. program development, investment decisions, determination of countermeasures?

b. Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection/management activities?

c. Do you have a formal safety management system (SMS)? If so please describe.

d. How is integrated information used in your agency's project management and program development activities including your safety improvement program?

e. Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Current Situation

Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency. In your response, please include:

a. Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases?

b. Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

c. What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

d. Are the data integrated with geographic information system (GIS) technologies?

e. In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

Data

Each state agency completed a table indicating the degree to which their agency had complete data for specific roadway, traffic, and crash data categories. In addition, they responded to the following questions.

a. Are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

b. How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

c. Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability (please see the following description of the characteristics of data quality). What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

d. What roadway, traffic, and/or crash data do you most need but you do not have?

e. What data categories do you believe provide the greatest benefit to your agency?

Analysis

These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

a. What techniques have been particularly useful? Please provide examples of how this improved agency decisions such as safety program development, countermeasure selection and/or changes in policy.

b. What additional analysis capabilities would you like to have?

Characteristics of Data Quality

Timeliness

Information should be available within a timeframe to allow for meaningful analysis of the current status of the issue under investigation, (e.g. a state's crashes, roadway inventory, drivers licensing information etc.)

Consistency

Information collected should be consistent with nationally accepted and published guidelines and standards, MMUCC, ANSI D16, ANSI D20 and the information collected should be consistent among all reporting jurisdictions (i.e. all reporting jurisdictions use the same reporting threshold or the same reporting format).

Completeness

Information within the database should be complete in terms of: all reportable instances of the event/characteristic should be available within the database and all variables within the record should be completed with appropriate responses.

Accuracy

Information within the database should be reliable in describing the characteristic it purports to describe. The accuracy is typically enhanced through the practice of conducting consistency checks and validations on the data being entered into the database.

Accessibility

Information within the database should be readily available to all authorized users of the information.

Integration

Information should be capable of being linked with information from other data sources through the use of common identifiers. An example of integration would be the linkage of a crash with the roadway inventory database by means of latitude and longitude.

PEER EXCHANGE STRUCTURE AND RESULTS

Introductory Remarks

Anita Vandervalk, Chair of the TRB Statewide Transportation Data and Information Systems Committee (ABJ20) and facilitator of the peer exchange, welcomed the participants. She reiterated the objectives of the workshop, including identification of priority research issues to develop draft research problem statements for the 2009 Cooperative Research Programs process.

The peer exchange started with presentations providing an overview of national efforts on the inventory of roadway elements for safety purposes, and the concept of integrating physical asset management systems with safety management. Another presentation summarized the results of the state agency questionnaires.

Then each state agency gave a 15-min presentation centered on three key themes:

- Major successes in their state with respect to integrating roadway, traffic, and crash data;
- Primary challenges facing them in the integration process; and
- Specific research topics that would be of interest to them.

Subsequently, peer exchange participants participated in individual Breakout Group discussions.

Breakout Group Themes and Discussion Questions

The expected outcome of the breakout group discussions was to develop a basis for research areas to solve priority issues. Volunteers prepared draft research proposals for both near term and longer term funding including the 2009 Cooperative Research Programs process.

Breakout groups had the same participants throughout the day. Ninety minutes were allocated for discussion in the afternoon of the first day and 2 h in the morning of the second day. Groups reserved the final 30 min in the morning to summarize and prioritize the issues discussed.

The discussion themes were derived from the state responses to the questions sent to the peer exchange participants. The themes were designed to serve as a guide for discussion, with groups having considerable leeway to define issues, as they felt best, based on their collective experience. Each group started with the Data Integration—Existing Situation theme first. Then each group concentrated on their assigned priority theme in detail with discussion of other themes as time was available. The priority theme assignments for each group were:

- Group 1, Data Management Challenges—Leaders: Sue McNeil and Bob Pollack;

- Group 2, Value and Benefits of Data Integration—Leaders: Vicki Miller and Jack Stickel; and
- Group 3, Managing Safety as an Asset: Integrating Safety Issues with Physical Resource Allocation Decisions—Leaders: Tom Maze and Reginald R. Souleyrette.

The specific questions for each theme discussed by the various breakout groups follow:

Data Integration: Existing Situation (All Breakout Groups)

- What methods do you use to integrate roadway, traffic, and crash data?
- What are the major impediments in your organization to achieving enterprise data integration for roadway, traffic, and crash data?
- To what extent are your data integrated with Geographic Information Systems (including historical data)?
- In what specific data categories are you experiencing the most problems with data integration and data quality?
- Are your integrated data accessible across the organization, including district offices?
- What are your success stories and challenges forming partnerships for with local and regional governments for data collection and integration?

Data Management Challenges (Breakout Group 1)

For the integration of roadway, traffic, and crash data to be useful for decision makers, it is important that the databases contain good quality data that is capable of being linked. To achieve this, database managers face many challenges that have been identified by the states. Among the problems identified are lack of institutional support, resource constraints, communication among database managers, lack of trained personnel and inappropriate use of technology. The following questions are intended to explore these issues and to identify potential strategies for addressing these issues.

- To improve data quality some organizations have agencywide standards and tools, while others delegate it to program areas. What is your approach and why?
- How is quality defined and assessed? Do quality expectations differ from some users who are different from the producers?
- In what specific data categories are you experiencing problems with data quality (accuracy, timeliness, completeness, consistency)?
- How do you integrate multimedia information (video, maps, photography)?
- How do you manage historical data for roadway, traffic, and crash data? Can you integrate these historical data into a common format over time for analysis? How accessible is historical information?
- Can technology help? In what areas? How? Do we need new technology or do we need to apply existing technology?
- Do we need model standards? Who would use these model standards and how?
- Do we need training? Do we need training in different areas or more training? How is training best delivered?

- How do we identify the need for institutional change? What strategies can we adopt to jump start institutional change and then keep it on track?
- What are common themes?

Value and Benefits of Data Integration (Breakout Group 2)

Data integration can provide fact-based analyses for program development, funding allocation, asset preservation, and highway safety improvement alternative considerations. Transportation agencies can evaluate changes in the transportation network and performance measures for a multimodal transportation network through effective data integration techniques.

- For which specific high benefit decisions has data integration played a key role? For which decision making scenarios does integrated information demonstrate the greatest payback?
- Has your agency made effective use of shared data for developing and evaluating agency programs through performance measures? Shared data may involve receiving and providing data both within your organization and with local agencies.
- How has your agency effectively used data integration in developing a highway safety countermeasures and a highway safety program?
- What additional analysis capabilities would like to have available in your agency to better integrate existing highway safety databases for identifying and selecting highway safety improvement countermeasures and strategies?
- What are common themes?

Managing Safety as an Asset: Integrating Safety Issues with Physical Resource Allocation Decisions (Breakout Group 3)

SMSs have largely focused on past safety performance, as observed through past crashes, while physical asset management systems (e.g., pavement management, congestion management, bridge management, etc.) have largely focused on current or forecasted future performance. Safety management has generally focused on the allocation of resources based on past performance while other physical asset management systems forecast performance into the future.

- What types of processes does your agency use to allocate resources across safety, asset condition, and capacity considerations?
- Do you feel that current financial allocation processes make efficient resource allocation decisions between safety investments and other investment?
- In programming of resources for future roadway design improvements, does your agency typically make decisions on future traffic operations (congestion) or does future safety performance enter into decision making?
- What additional analysis capabilities or tools would you like to have available in your agency to better integrate safety resource allocation decisions with programming decisions based on results of physical asset management systems?
- What are common themes?

Workshop Results

At the end of the workshop, each breakout group presented their top research issues based on discussion and consensus. Volunteers were solicited to draft research proposals for the 2009 Cooperative Research Programs process. The peer exchange planning committee further evaluated and refined the proposals and then distributed them to the peer exchange participants to assess priority. This process resulted in seven distinct research project proposals as follows:

Research Problem Statements

1. Highway Safety as an Asset: Incorporating Safety Performance Metrics in State-Level Planning and Programming.
2. Guidelines for Conducting Business Process Reviews for Successful Data Integration Projects to Support Asset Management and SMSs.
3. Open Architectures to Support Data Integration Projects.
4. Synthesis for Visualizing Roadway, Traffic, and Crash Data Integration.
5. How Do We Convince the Locals to Participate in Statewide Highway Safety Data Programs?
6. Incorporating Traffic Safety Risk Management into the Asset Management Process.
7. Life-Cycle Analysis of Designing Highways for Safety.

In addition, a proposed synthesis project and a proposed topic for a future peer exchange were identified.

Proposed Synthesis Topic

Viable options and design choices for data integration strategies to support asset management and SMSs.

Proposed Peer Exchange

Best Practices on Migration from Mainframe Systems. The full text of the seven research project proposals, the proposed synthesis, and the proposed peer exchange are included in this e-circular, starting on page 105.

Summary of the Model Minimum Inventory of Roadway Elements Workshop, August 2006

ROBERT POLLACK
Federal Highway Administration

BACKGROUND

In 2003, FHWA, AASHTO, and NCHRP sponsored a scanning study of how transportation agencies in the Netherlands, Germany, and Australia develop and use traffic safety information systems. This tour resulted in the report entitled *Traffic Safety Information Systems in Europe and Australia*. In a follow-up effort, the scan team's report was reviewed and the white paper report, *Traffic Safety Information Systems International Scan: Strategy Implementation White Paper*, was developed to provide greater detail on the scanning report's guiding principles and more specific action-related details on the strategies. One of the report's key strategies called for development of a minimum set of roadway data elements on which states should be collecting information.

INVENTORY RATIONALE

Good safety data are essential to sound decisions on the design and operation of roadways. However, the quality of safety databases in many states and local agencies appears to be eroding. A major recommendation in the white paper is the need to better define good safety inventory data—those data that are important in today's safety decisions, and which will become even more important given the current development of a new generation of safety analysis tools [e.g., FHWA's Interactive Highway Safety Design Model (IHSDM) and SafetyAnalyst, AASHTO's Data and Analysis Guide, and the Highway Safety Manual (HSM)]. Development of a Model Minimum Inventory of Roadway Elements, referred to as MMIRE, was recommended so that state and local agencies understand the importance of roadway inventory and traffic data for safety programs and know what critical roadway data variables are required to take advantage of current and future cutting-edge analytical tools and resources.

The establishment and adoption of MMIRE has potential benefits beyond improved safety. State asset management systems will also be the beneficiaries of a MMIRE process. Since a major portion of MMIRE will be comprised of an inventory of various roadway assets, asset managers can benefit from standardized definitions, measurements and geo-spatial location of these assets. This joint effort with safety can result in shared data and improved interdepartmental cooperation, reductions in data discrepancy, improved data collection, improved data reliability and an overall improved asset management program.

MMIRE CURRENT STATUS

An initial presentation of the proposed MMIRE data elements occurred on August 3, 2006, in a workshop at the 32nd International Traffic Records Forum. At the workshop, a group of engineers, data managers, researchers and other safety professionals representing state and local agencies provided three valuable areas of input. First, they provided feedback, comments, and ideas regarding the adequacy of the proposed MMIRE making suggestions for additional elements or deleting proposed elements. The participants also expressed concerns regarding the ease of collecting the data elements and changes in methodology that may be required to collect data. Finally, they recommended how best to proceed toward the development of a MMIRE implementation plan. Based on the input from the Traffic Records Forum Workshop, a report regarding the proposed MMIRE elements will be submitted to the FHWA in November 2006.

Moving into 2007, the MMIRE process will be continued by obtaining additional input from the collectors, maintainers and users of MMIRE regarding the selection of data elements, element definitions and recommended element collection practices. This process is expected to result in the release of MMIRE version 1.0.

MMIRE as a Guideline

The collection of MMIRE elements by the states will be voluntary. MMIRE may be considered as the functional equivalent of the Model Minimum Uniform Crash Criteria (MMUCC), which has become the de-facto standard for crash data variables used by state and local jurisdictions when improving their crash data systems. Like MMUCC, MMIRE is envisioned as a tool to be used by state and local agencies in their safety data improvement efforts.

MMIRE Compatibility

It is envisioned that final MMIRE data elements will share common definitions with the elements of other systems. The Highway Performance Monitoring System (HPMS) is currently undergoing a reassessment process within the FHWA. This reassessment process is expected to result in changes and modifications to the HPMS reporting elements and (perhaps) the data collection process for the HPMS. It is anticipated that any MMIRE elements that will be collected through the HPMS will be completely compatible with the revised HPMS process since the MMIRE development and HPMS reassessment processes are being coordinated. Similarly, the MMUCC is about to undertake its third revision. Again, any common elements between MMUCC and MMIRE are expected to share common definitions.

SUMMARY

Uniform high quality roadway inventory data are the key to sound decisions on the design and operation of safe roadways. States and local agencies will need improved data to meet future challenges. The establishment of MMIRE will assist both safety and asset management agencies by providing standardized roadway inventory and traffic data elements needed to meet these challenges.

For more information about MMIRE, contact Carol Tan, FHWA Office of Safety Research and Development (Carol.Tan@dot.gov) or Robert Pollack, FHWA Office of Safety (Robert.Pollack@dot.gov).

Integrating Physical Asset Management Systems with Asset Management

A Summary from the July 2006 Asset Management Committee Meeting

TOM MAZE
Iowa State University

TIMEFRAME SCHISM BETWEEN SAFETY MANAGEMENT SYSTEMS AND PHYSICAL ASSET MANAGEMENT SYSTEMS

Physical asset management systems [pavement management systems (PMS), bridge management systems (BMS), culvert management systems, etc.] typically are used to plan and allocate future budgets. To support the forecasting of a budget, these systems almost always have some type of underlying asset performance model. In other words, models that can forecast what the condition of the asset will be given either the neglect or application of future resources. Using future performance models, future budget scenarios can be tested to determine which future budget, given the resources available, will result in the most desirable solution. By their very nature, physical asset management systems are prospective and help agencies make short term budget plans (2 to 5 years) and can be used for scenario analysis for even more distant forecast given that long-term planning analysis requires less detail (network level analysis).

On the other hand, most safety analysis uses past crash records to determine where safety problems have occurred to select crash countermeasures. These countermeasures are intended to counteract past safety performance issues that should relate to better safety performance in the future. As a result of being dependent on past safety performance and focusing on mitigating issues that resulted in crashes in the past, safety analysis is always retrospective while other asset management systems are prospective. This may create a problem when comparing investments across safety and other classes of highway investment. The purpose is then to bring system management into the same planning level, and future timeframe, to enable safety decision inputs consistent with those of physical asset management systems. At the planning and budgeting analysis level, SMSs need to make forecasts of future safety performance that are consistent with future performance forecasts of other assets.

Themes from the Peer Exchange Questionnaires
Funding Process for Research Problems

JAMES P. HALL
University of Illinois at Springfield

James P. Hall presented a summary of the agency responses to the questionnaire. As detailed in the background section, nine state transportation agencies completed an extensive questionnaire on their current situation for data management and integration practices. Agencies also responded to questions on their data analysis capabilities and the value of data integration to asset management and safety management functions.

The results provide a comprehensive background of state transportation agency current practice, capabilities, issues and needs for data integration. The following summarizes agency responses to the questions.

VALUE

Question 1: Value to agencies of integrating roadway, traffic, and crash data in the context asset management and safety management functions

Specific activities where integrated information results in better, more informed, fact-based decisions:

- Program development;
- Increased ability to identify and target hotspots;
- Better investment decisions—more accurate cost–benefit analysis;
- Determination of countermeasures;
- Safety Priority Indexing (Oregon);
- Highway Safety Improvement Program;
- State Transportation Improvement Program (STIP);
- Cluster analysis; and
- To identify biggest safety problems, e.g., aggressive driving, seat belt, and driving under the influence (DUI) (PennDOT).

Assessment of the Value of this Information for Better Decision Making

- Reduce injuries, fatalities, and property damage.
- Evaluate safety programs.
- Some states had performed limited assessment of benefits.

Formal Business Plans for Identifying and Prioritizing Data Collection–Management Activities

Agencies varied in their response to this question. Some agencies had implemented extensive data business plans while others had no data business plan; many were somewhere in between.

- Several states had formal business plans for data.
- Several states formally prioritize data collection activities, e.g., Michigan.
- Some states had specific business rules for application of data.
- Pennsylvania DOT—each bureau develops yearly business plan including data collection.
- Wisconsin DOT—Traffic Safety Council and Traffic Records Coordinating Committee formalize the business plan.

Existence of a Formal Safety Management System

- Five states have a formal SMS, others are under development.
- Primary purpose of the SMS is to locate and analyze crashes for asset management and program development.
- Many SMS-incorporated agencies external to state DOT, e.g., Traffic Safety Council.

Use of Integrated Information in the Agency's Project Management and Program Development Activities Including the Safety Improvement Program

- Allocating funds;
- Metropolitan planning organization (MPO) and rural planning organization (RPO) analysis;
- Managing assets;
- Site selection;
- Countermeasure identification;
- Countermeasure evaluation;
- Identification of the top 5% of crash sites; and
- Make the case for additional funds.

Coordination Between Safety and Planning (or Data) Offices for the Development of the State's SHSP or Traffic Records Plan?

Most states indicated that they are coordinating these activities. Relevant business areas included program development, roadway data, traffic operations, engineering, information systems, safety and motor carrier.

CURRENT SITUATION

Question 2: Agency Status of the Integration of Roadway, Traffic, and Crash Data

Technical Infrastructure of Roadway, Traffic, and Crash Databases

- Many integrate existing legacy systems, including inventory and management systems, into data warehouses, spatial data warehouses, and data marts.
- Most agencies use Oracle Spatial and ESRI GIS software.
- Some agencies are using SQL products.

How Are Databases Integrated?

- Several agencies have full data integration
- Most state agency integration efforts are still under development
- Most common - spatial integration
- More difficulties with integration of data for the off-state roadway network

Major Data Integration Problem Areas for Roadway, Traffic, and Crash Data

- Lack of a common Linear Referencing System (LRS).
- Temporal issues—how to integrate historical data into the current spatial and nomenclature context.
- Data collection on local roads.
- Some states have successfully addressed the data integration issue (Michigan and Iowa).

All state agencies indicated that they integrated data using geographic information system (GIS) technologies.

Status of Integration of Roadway, Traffic, and Crash Information for the Nonstate System

- All states have local agency crash data but for most, these are not fully spatially identified.
- Most states experience some loss in data quality and accuracy for local agency inventory data.
- Some state agencies are working with MPOs and local agencies through multiagency committees.

DATA

Table 2 summarizes the results of the state agency survey on the extent to which they have complete data for specific roadway, traffic, and crash data categories. An analysis of the results in Table 2 follows.

TABLE 2 State Agency Data Completeness Survey Summary: From the Peer Exchange on State and Nonstate Roadway System for Integrating Roadway, Traffic, and Crash Data

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	**6**	3		3	**4**	2
Pavement/shoulder type	**7**	2		3	**4**	2
Capacity	**3**	**3**	**3**		3	**6**
Geometrics	**4**	3	2		**4**	**4**
Intersection—lanes, signalization	**4**	**4**	1	1	**6**	2
Lighting inventory	1	**4**	**4**		1	**8**
Guardrail inventory	3	**4**	2			**9**
Pavement striping	1	3	**4**		1	**8**
Signage inventory	2	**5**	1		1	**8**
Rail crossing information	**7**	2		**4**	2	3
Pavement friction	**3**	**3**	2		1	**8**
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	**6**	1	2		4	**5**
Construction zones	2	**4**	2			**8**
Ramp geometrics/characteristics	**3**	**3**	**3**			**9**
Videologging	**6**		3		1	**8**
Traffic Data						
AADT	**9**			2	**7**	
AADT trucks	**8**	1		1	**7**	1
Congestion	2	**4**	3		3	**6**
Average speed	3	**5**	1		3	**5**
Travel characteristics—hour, day, holiday, month, annual	**5**	2	2	1	**5**	3
Intersection turning movements	1	**6**	1		**4**	**4**
Crash Data						
Spatial location	**4**	3	2	2	2	**3**
Crash Record Information	**9**			**9**		

Notes: Responders: ADTPF, DDOT, Michigan DOT, Mississippi DOT, Iowa DOT, Ohio DOT, Oregon DOT, Pennsylvania DOT, Wisconsin DOT. Not all states provided a response to each data category.
Bold squares indicate the highest number of responses for that category.
AADT = Annual average daily traffic.

Roadway Data

For the state roadway system, most state agencies indicated that they had complete data on roadway physical characteristics such as pavement/shoulder type, and lane shoulder widths. Six states also had information on pavement distress and videologging. However, the majority of states indicated that they had partial or no information on capacity, geometrics, intersections, ramp characteristics, lighting–guardrail–signage inventories and construction zones.

Roadway data was much less complete for the nonstate roadway system. Most states only had partial to no information on pavement/shoulder type, and lane shoulder widths, intersections, and geometrics. In addition, the majority of states had no information on local roadway capacity, ramp characteristics, pavement distress, lighting–guardrail–signage inventories and construction zones.

Traffic Data

For the state roadway system, most state agencies had complete information on AADT, AADT trucks, and travel characteristics. However, the majority of states indicated that they had partial or no information on congestion, average speed and intersection turning movements.

Again, traffic data was less complete on the nonstate system. Most state agencies had partial information on local AADT, AADT trucks, and travel characteristics. The majority of states had no information on congestion, average speed and intersection turning movements.

Crash Data

All state agencies reported that they had complete crash data for both the state and the nonstate roadway systems. However, for the state roadway system, only four of the nine agencies reported that they had full crash spatial location data with three agencies having partial spatial location data. Only two states had full crash spatial location data for the nonstate system with three agencies having no nonstate crash spatial location data.

In Addition to the Table, Additional Roadway, Traffic, or Crash Data Categories for Which Your Agency Collects and Uses Data

Several state agencies indicated additional data categories would be useful in their safety management and asset management activities, such as

- Health/adjudication records,
- New construction data,
- Cultural features,
- Environmental and weather, and
- Bridge/culvert locations, speed limits, rest areas, medians, and turnouts.

Management of Historical Roadway, Traffic, and Crash Data

- Most state agencies store annual files for roadway, traffic, and crash data.
- However; many agencies have difficulties in integration over time due to changes in spatial references.

- Michigan DOT updates historical file to current spatial reference.

Data Quality Issues Including Timeliness, Consistency, Completeness, Accuracy, Accessibility, and Understandability

- Many agencies indicated that their data collection problems were due to a lack of resources.
- Timeliness is still an issue for most agencies.
- For most agencies, data quality is less for the nonstate system.
- The adequacy of the data resources entails continuous quality control (QC) monitoring.

Roadway, Traffic, and/or Crash Data Agencies Most Need but Do Not Have

- Missing inventory data, primarily for local and rural areas;
- Spatially located local crash data;
- Intersection features; and
- Real time operational data.

Data Categories with the Greatest Benefits

Agencies generally indicated that essentially all of the data categories identified had significant benefits in their asset management and safety management activities.

ANALYSIS

Useful Tools and Techniques for the Analysis of Integrated Roadway, Traffic, and Crash Data

- High accident location identification;
- Use of GIS for internal and external decision support products;
- Enabling Internet and intranet access to data;
- Countermeasure evaluation;
- Ohio—resurfacing project analysis; and
- Oregon—corridor analysis.

Desired Additional Analysis Capabilities

- Additional spatial analysis capabilities;
- Program development tools;
- Access and integration of digital images;
- Expanded data warehouse;
- Ability to diagram crashes;
- Intersection inventory;
- Additional temporal capabilities; and
- Forecasting countermeasures.

SUMMARY

In general, state transportation agency responders provided a comprehensive assessment of their existing roadway, traffic and safety data integration practices and a frank assessment of their strengths and weaknesses. Due to advancements in data management technologies and upper management emphasis, many state agencies had made significant progress in developing a formal process to integrate their data resources on an enterprise basis. Most agencies had accomplished, or planned to accomplish, this integration spatially using GIS technologies. Several states were also developing comprehensive tools to develop decision support products for use in asset management and safety management activities in the program development process.

However, significant issues remain for many agencies. One common theme is the difficulties in accessing and incorporating local agency data, across the spectrum, into decision support products. Another common theme was a perceived lack of resources to properly maintain the completeness, quality and accuracy of the data resource and to manage the historical data files for accessibility and usability in forecasting and analysis activities. Some agencies were still struggling with an inability to spatially integrate disparate systems due to differing spatial identifiers.

State transportation agencies recognized that data management and integration needs were growing more complex with an increasingly robust user base and the growing use of data in web-based decision support products internal and external to the organization. Overall, state agencies were enthusiastic in their mission and they emphasized the importance of developing data integration capabilities and visualization techniques to develop products to promote fact-based decisions.

Alaska Department of Transportation and Public Facilities Perspective

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INTRODUCTION

ADOT&PF's mission is "to provide for the movement of people and goods and the delivery of state services." The program development division maintains the statewide roadway, traffic, and crash data in a legacy transportation database to support this mission. They are responsible for integrating road centerline, attribute, and business data in a data warehouse and GIS environment. The newly deployed spatial geodatabase and GIS application integrates the roadway, traffic, and vehicle crash data through geodatabase fields, external tables, and external databases.

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a:* In what specific activities does/will this information result in better, more informed, fact-based decisions e.g. program development, investment decisions, determination of countermeasures?

The three primary business areas that will benefit from the data integration are the

- Highway Safety Improvement Program (HSIP);
- STIP; and
- Maintenance management system (MMS).

Six additional business areas in the ADOT&PF will also be improved through the data integration efforts:

- Road Weather Information System (RWIS);
- Traffic Data Systems (TDS);
- PMS;
- BMS;
- Traveler Information System—Condition Acquisition and Reporting System (CARS/511); and
- Seasonal weight restrictions.

ADOT&PF's goal is to integrate the road network with transportation features and business data from each of these nine business areas through the geodatabase fields, external tables, and external databases. The geodatabase will provide location referencing and feature attribute information for transportation assets and will provide links to external tables or databases. The GIS will meet both program managers and decision-makers needs for making more informed, fact-based decisions in supporting the department's missions, core services, and performance measures.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making?

ADOT&PF has limited internal looks at the benefits of better decision making. However, data systems and data integration are integral in supporting the department's Program Development Division and Highway Database Management core services.

ADOT&PF Core Services

- Reduce injuries, fatalities, and property damage.
- Carry out safe ADOT&PF operations.
- Improve mobility of people and goods.
- Increase private investment.
- Provide assets and facilities to enable delivery of state services.

Program Development Division Core Services

- Provide federally required highway data collection and analysis to state, federal, and local agencies.
- Provide GIS data collection and analysis, as well as cartographic and other technical services.
- Develop and administer the State Highway Safety Program (SHSP).

Highway Database Management Core Services

- Support performance measures for reporting and tracking progress.
- Provide information to the traveling public.
- Facilitate operations (i.e., maintaining, planning, and prioritizing weight restrictions).
- Allow for federal and state reporting.
- Support project priorities and selection process.

Do you have a formal business plan for identifying and prioritizing data collection/management activities?

ADOT&PF has completed a Data Business Plan Concept of Operations (September 2005) that documents the physical infrastructure of existing data programs and how these programs fit into the ADOT&PF's mission and measures. The Data Business Plan examines only those

ADOT&PF data areas where the planning function has some role in the data stewardship process as a data collector, data processor, data analyst, data manager, data archiver, or data user.

The Concept of Operations provides expectations regarding needs, vision of future data programs, and an implementation plan for the remainder of the data business plan. The Data Business Plan architecture will include an in-depth look at how data supports performance measures and will help develop performance metrics for program managers.

Question 1*c*. Do you have a formal SMS? If so, please describe.

No. However, ADOT&PF just awarded a contract for consultant services to prepare an Alaska SHSP over the next 16 months. The Alaska SHSP is a multiagency strategic plan for all highway safety programs in the state of Alaska that will fulfill the SAFETEA-LU Section 1401, HSIP requirements. The work effort incorporates 14 tasks to complete the SHSP. The Request for Proposal (RFP) "Consultant Services to Prepare an Alaska Strategic Highway Safety Plan" is available on the State of Alaska's Online Public Notices archived procurement at http://notes5.state.ak.us/pn/pubnotic.nsf/ad4f363a31408ed98925672a00607900/1b169e579278344e8925718b007b82fe?OpenDocument.

Question 1*d*. How is integrated information used in your agency's project management and program development activities including your safety improvement program?

Specific activities in ADOT&PF where data integration is ongoing include:

- Allocating funds across work programs and STIP lines.
- Measuring changes in the road network.
- Generating condition and performance reports for the multimodal transportation network and department assets.
- Allocating funds to meet federal reporting requirements.
- Planning highway design and safety improvements.
- Managing personnel and assets in department operations.
- Providing information for government, legislative, and public request.

Question 1*e*. Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Establishing an Alaska top-level, multiagency advisory body is a top priority to guide the Alaska SHSP development. This group could involve 15 to 25 members and be broken down into emphasis areas. Stakeholder interviews with the group and further discussions with agency staffs will help identify data sources and provide the background for analysis and evaluation. Consultation and outreach, at a minimum, will include the following organizations:

- ADOT&PF Alaska Highway Safety Office;
- ADOT&PF Traffic Engineering Sections at statewide and regional offices;
- ADOT&PF maintenance managers at statewide and regional offices;
- ADOT&PF Knik Arm Bridge and Toll Authority;
- ADOT&PF Safe Routes to School coordinator;

- ADOT&PF Bike and Pedestrian coordinator;
- ADOT&PF Division of Measurement Standards and Commercial Vehicle Enforcement;
- Local and tribal officials responsible for highway maintenance;
- State officials responsible for railway–highway crossings;
- State and local traffic enforcement officials;
- MPOs:
  - Anchorage Metropolitan Area Transportation Solutions (AMATS) and
  - Fairbanks Metropolitan Area Transportation Solutions (FMATS);
- Major modes of transportation including the Alaska Trucking Association;
- Representatives conducting Operation Lifesaver and emergency medical response organizations;
- State Division of Motor Vehicles;
- Alaska Traffic Records Committee;
- Other major state, local, tribal, and nonprofit stakeholders; and
- Leadership and program working groups as established in the scope of work.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

The department's legacy transportation database, the Highway Analysis System (HAS), has a route–milepoint linear reference system (LRS). HAS contains the road network, transportation features, traffic (volume, classification, speed), pavement [international roughness index (IRI)], basic bridge information (location, feature crossing, length), and vehicle crash records. HAS is written in the NATURAL programming language and uses Software AG's Adabas database management system. The relevant HAS Adabase file structure consists of: road, segment, line, point, occupant, vehicle, and traffic files. These files are linked hierarchically, with all the roadway, traffic, and vehicle crash records contained within these files. Point feature locations are referenced by a displacement from the beginning of the segment, while line features are referenced by displacement from both the beginning and the ending of the segment. HAS contains a complete history of the road network and ADOT&PF business data through applicable dates (effective, termination, update). A user can replicate both the road network and the business data using the desired effective data.

Independent databases, which can be linked to or supported with data extracts, include

- Pavement—Microsoft Access;
- Bridge—PONTIS;
- Traveler information—CARS (data archive been developed);
- Road weather—Oracle;

- Seasonal weight restrictions (temperature data probe)—Oracle; and
- STIP—Oracle.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

More extensive details for pavement and bridges are contained in the PMS and the PONTIS bridge system respectively. HAS uses the NBIS (National Bridge Inventory System) bridge number to reference to the bridges in PONTIS. The HAS CDS (Coordinated Data System) route number with a milepoint from–to range provides the reference to the PMS data files, external tables, and external database files.

ADOT&PF has a data warehouse, the Highway Data Port (HDP), to provide basic road network and roadway characteristics. The HDP provides limited query capabilities for internal ADOT&PF users. The HDP was created to

- Establish a framework for accessing transportation data outside the legacy mainframe menu-driven environment and
- Meet the business needs of frequently requested transportation datasets.

The HDP contains vehicle crash records, basic bridge locations, speed study stations, weigh-in-motion (WIM) data, and in the near future, AADT. Crash records, bridges, and roadway characteristics are retrievable by CDS route or by geographic area (census areas and first class cities). Mainframe Highway Analysis System extracts populate the HDP periodically.

Environmental data, which includes temperature data probe (TDP) data for seasonal weight restrictions and RWIS for maintenance decisions, are stored in an Oracle database. Web applications provide quasi real-time updates: every 30 min for RWIS and daily for TDP.

ADOT&PF has two ongoing initiatives to significantly expand the database integration and establish extensive database linkages:

- HAS–GIS interface and
- Digital imaging for road inventory and asset management.

The GIS geodatabase tables contain foreign keys that provide a link to external tables and databases. The geodatabase tables store only the essential attributes extracted or duplicated from external databases. Access to data in the external databases may be restricted to a portion of their data. The major databases that are linked from the geodatabase are

- HAS,
- MMS,
- PMS, and
- HDP.

The goal for the Digital Imaging for the Road Inventory and Asset Management project is to acquire digital imagery and selected feature locations and attributes along 5,150 centerline roadway miles. Image and feature locations shall be integrated and synchronized with the GIS.

ADOT&PF will also acquire the software for feature extraction from the video so asset location and attributes can be determined for additional transportation assets.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

User confidence in the quality of the transportation feature and network data is critical to the integration. To address this data integration problem, ADOT&PF is developing business processes for

- Data collection procedures for features and road centerline network;
- Data quality assurance (QA);
- Criteria for referencing locations;
- Update cycles for spatial and attribute data;
- Prioritization on updating data fields and non-geometric business data;
- New sections and realignments;
- Time stamping and archiving; and
- Data of differing spatial resolutions.

The most significant data integration problems include:

Geography

ADOT&PF has 33 maintenance stations dispersed throughout the state. Alaska's topography and the great distances to the maintenance stations, many of which are accessible by only by sea or air, increases the cost and time to accomplish road inventory activities quickly. These factors will also be particularly challenging to meet the SAFETEA-LU requirements for safety analysis on all public roads.

Road Centerline Reference Network

Additional, ongoing data collection is critical for a working GIS. Automating, to the greatest extent possible, the processing of centerline and feature data will streamline the addition of new data to the geodatabase. ADOT&PF has an ongoing business process to address the road centerline reference network. A software package has been developed to help automate the centerline and feature data processing.

Synchronization of Databases

Keeping the road centerlines and feature data the same in the geodatabase, the legacy mainframe database, and the data warehouse is necessary to maintain both the GIS and the business application programs. At present, this is completely a manual process.

GIS Layers of Different Scales and Versions

The orthorectified aerial photogrammetry and satellite imagery, which are used as background features to the base map, are gathered from several sources. There have been a few limited database layers developed for Alaska but there is no distribution, update, or validation involved. This is a very significant institutional issue. A statewide GIS committee does exist, but does not have a mandate or funding to improve the datasets.

Question 2*d*: Are the data integrated with GIS technologies?

The HAS–GIS interface objectives are to develop targeted upgrade strategies that will

- Establish HAS as the foundation for linear referenced-based GIS;
- Unify the processing, management, maintenance, and output of transportation spatial data and road centerline network data in an integrated system; and
- Improve data access, display, analysis, and output.

The HAS–GIS interface initiative has very specific goals. It is not intended to meet all the ADOT&PF GIS needs, e.g., right-of-way (ROW) survey grade requirements. ROW might still reference their work area to a route/milepoint within the HAS–GIS interface, then use a detailed GIS application to complete the work. The *HAS–GIS Interface Implementation Plan* (December 2003) provides three phases to the deployment:

- Establishing a geodatabase to integrate the storage and management of road centerline and attribute data in a GIS environment. This phase includes changes to business processes as well as software design and hardware acquisition.
- Deploying an enterprise geodatabase, providing linkage to external systems such as the MMS, and extending the architecture to a web-based service model.
- Migrating applications from the legacy mainframe database to the geodatabase and the data warehouse environment.

ADOT&PF has completed phase 1 and is well on the way to completing phase 2. The *Geodatabase Design Documentation HAS–GIS Interface Phase 1B* report (August 2006) documents the development and testing of the transportation geodatabase. The geodatabase was designed to integrate the storage and management of road centerline spatial data and HAS attribute data in a GIS environment.

All geodatabase objects are organized into six layers that share some similarity of form or function:

- Reference network,
- Routes,
- Events,
- Jurisdictional boundaries,
- Digital orthophotos, and
- External databases.

The reference network provides a common underlying highway geometry of all ADOT&PF users. The reference network is based on these Differential Global Positioning System (DGPS) centerline data, providing a spatially accurate representation of the network with more precise measures for milepoint referencing. Centerlines are represented as links and nodes with traditional link-node topology. The topological structure contains TransportLinks and TransportNodes that define the connections and adjacencies among and between the elements of the network that allow transportation activities to take place.

Subtypes and domains are used to categorize and control the integrity of new data entered into the geodatabase. Subtypes are used to categorize a feature layer into a number of separate types without physically splitting the data into multiple feature classes. For example, the TransportNode feature class has a subtype field to distinguish system intersection anchor points for other anchor points.

The CDS routes for the geodatabase are built from the centerline reference network. The geometry of any CDS route will be coincident with the underlying centerlines, but the CDS routes can have important attributes that may not be applicable to the underlying road segments. It is represented as a polyline M network with measures so that the events can be referenced using a linear measure on any particular route.

Transportation-related objects such as maintenance assets are not part of the network itself, but are related to the reference network or the route feature. There are two types of events: a line event with a route location that describes a portion of the route, or a point event with a discrete location along a route. The CDS route number field is a key field that is used to establish the relationship between event records and the routes they belong to.

A measure location is either one or two values describing the position(s) on the route where the event occurs. A linear route location uses both a from- and a to-measure value to describe a portion of the route, while a point route location uses only a single measure to describe a discrete location along a route.

The jurisdictional boundary feature classes to be included in the geodatabase are listed below:

ADOT&PF Regions
Borough
Census Area
City
Election District
Maintenance Area
Maintenance District
Maintenance Station
Public Safety Detachment Area
State
Town
Town Point
Urban–Rural

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

ADOT&PF identifies each road in the legacy transportation database, HAS, with a CDS route number. Each road number has a route name (CDS route number) and a route description (posted road name). The HAS database contains CDS numbers for all state-maintained roads, most nonstate-maintained roads functionally classified higher than local road, and some nonstate-maintained roads that are classified as a local road.

Roadway

ADOT&PF's legacy database, the HAS, contains all the state-maintained roads, which comprise the State Highway System (SHS). There a few roads in remote areas that have not been inventoried. HAS also contains other non-state–maintained roads:

- National Highway System (NHS) Routes—the NHS is an interconnected system of routes that serve important national functions (security, commerce, and travel). The NHS is comprised of principal arterial routes and routes connecting to intermodal facilities such as airports, ports, and ferry terminals. With a few exceptions, all NHS routes in Alaska are owned by ADOT&PF.
- Alaska Highway System (AHS) Routes—the AHS is comprised of highways that have statewide significance but are not on the NHS. The AHS includes routes that connect communities and routes that link to recreational sites or areas of resource development. Most AHS routes are owned by ADOT&PF.
- Roads functionally classified higher than local roads.
- Roads functionally classified as local roads, especially where there is a significant vehicle crash history.

Over the past 4 years, ADOT&PF has focused on collecting and establishing a reference network through a road inventory program. ADOT&PF purchased a data collection system from NavStar Mapping that incorporates DGPS positioning, digital measurement instrument (dmi), and auxiliary sensors that maintain linear positioning. ADOT&PF contracted for data collection from NavStar Mapping for both centerline and attribute data. ADOT&PF personnel plan to collect both data types in the future.

ADOT&PF has a multiyear highway inventory project to collect additional DGPS centerline coordinates, as well as highway point and linear features for all state-maintained roads, most NHS roads, and a few higher functionally classified roads. An accurate highway feature inventory, particularly department assets, continues to be the goal.

Traffic

The HPMS requires volume estimates on all roads that are functionally classified higher than local roads. To meet that requirement, coverage counts on non state-maintained roads are established at locations based the ADOT&PF Traffic Data Collection Plan.

Crash Information

ADOT&PF receives all law enforcement and driver vehicle crash reports from the Division of Motor Vehicles. Department staff removes crashes that do not occur on public roadways (parking lots, off the ROW, private roads). Almost of all the crash report data fields are then stored in the HAS with a route–milepoint location. For those roads that cannot be located to a CDS route (inadequate location information, route not in the database), the accidents are stored in geographic area roads. The crash data are exported to the data warehouse, the Highway Data Port.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

The traffic and vehicle crash program uses a broad range of roadway features to locate traffic sensors and vehicle crashes. Some of these features have been identified as part of the roadway elements; many of these features are included in the general category of cultural features. The highway inventory also includes support for the MMS and environmental categories. Lastly, the traffic data includes two programs for truck weight. Information for these general categories follows:

- Cultural features (most significant ones):
  - Businesses/lodging,
  - Parks,
  - Government buildings/post offices,
  - Airport facilities,
  - Harbors/ferry terminals,
  - Fire/police/state trooper facilities, and
  - Railroad crossings;
- MMS:
  - Mileposts,
  - DOT maintenance facility,
  - Culverts,
  - Rest areas,
  - Rumble strips,
  - Posted speed limits,
  - Medians, and
  - Turnouts;
- Environmental:
  - Road weather—includes atmospheric, surface, and subsurface data for winter weather maintenance decisions; and
  - TDP—vertical temperature profiles for seasonal weight restriction decisions; and
- Truck weight:
  - WIM data, and
  - Weigh station data.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

The department's legacy transportation database, the HAS, has a route–milepoint LRS. HAS contains the road network, traffic stations and data, and the crash data stored in a hierarchical file structure. Traffic station and crash locations are point features, which are located by a displacement from the beginning of the segment. HAS contains a complete history of the road network and ADOT&PF business data through applicable dates (effective, termination, update). A user can replicate both the road network and the business data using the desired effective data. HAS contains vehicle crash data back to 1977.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

- Vehicle crash timeliness,
- Traffic maps,
- Road network updates,
- Road network coverage for local roads and lower functionally classified roads, and
- Highway asset location (linear and spatial) and attributes.

Generally, not much difference in data quality factors between state and local roads. For the most part, the state does not interface with local agency system data. ADOT&PF desires to include local agency GIS layers with the department's geodatabase, but a there are significant integration issues.

Question 3*d*: What roadway, traffic, and/or crash data do you most need but do not have?

- Missing asset inventory and road centerlines in rural areas and on the non-connected road system;
- Increased real-time operational data; and
- More reliable crash locations on rural highway segments, including GPS coordinates.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

- Road centerline,
- Pavement type,
- Vehicle crash electronic submission,
- Improved orthorectified aerial photogrammetry and satellite imagery, and
- Improved rural highway crash locations (GPS coordinates).

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this has improved agency decisions, such as safety program development, countermeasure selection, and/or changes in policy.

Named Intersections

ADOT&PF has established a STIP project that focuses on cost-effective crash reduction and hazard elimination for the HSIP. The Named Intersection program allows HSIP traffic safety engineers to preidentify intersections by name, parameters, and traffic conflicts for further analysis. The Named Intersection program provides a 5-year look at the accident history and AADT for all roads entering an intersection. Any non-named intersection portion of the roadway is then included in the named segment portion of the analysis.

The program allows AADT adjustment for anticipated growth that the existing AADTs do not reflect or in cases where no traffic count has been taken. Regional yearly reports prioritize the intersection and segment high accident rate locations. The traffic engineers then compare the accident rates with the computed critical accident rate to identify the hazardous roadways for potential remediation action. The HSIP documentation is available at http://dot.alaska.gov/stwddes/dcstraffic/hsip.shtml#.

The Named Intersection program documentation is available from the Program Development Division's Highway Database Management Group.

Statewide Accident Rate and Trend Programs

ADOT&PF, as part of the Named Intersections Program implementation, has created several other crash database queries to aid in the development of the HSIP. They include

1. Intersection Accident Rates: This program uses crash data, AADT data, intersection type, and certain HAS roadway features to generate accident rates for named intersections by intersection control type and number of conflicts.
2. Statewide Accident Rates: This program calculates intersection and highway segment accident rates by intersection type and highway segment functional classification for the entire state or by region, borough, or city and presents average rates for the selected geographic area.
3. Areawide Accident Rates: This program calculates accident rates for named intersections by region, borough, and city for background accident rate comparison between different years.
4. Intersection and Highway Segment Accident Rates by Category: This program uses six different categories of accident data including:
    - First sequence of events,
    - Roadway surface condition,
    - Light conditions,
    - Human circumstances,
    - Alcohol/drug involvement, and
    - Injury severity

Using statewide, region, borough, or city criteria, this program calculates percentages of accidents for the preceding categories for either named intersections or highway segments. These percentages are utilized to compare individual intersections or highway segments to statewide, regionwide, boroughwide, or citywide percentages by category to determine if any of these categories (accident type, roadway surface condition, light condition, alcohol involvement or injury severity) are overrepresented at a given location.

Highway Data Port

The HDP is the department's intranet application for providing easy, efficient access to transportation data. The HDP generates data extracts and reports based on user-defined queries. The HDP accesses an Oracle database populated with road network, bridge, accident, and traffic data extracted from the department['s integrated transportation database, the HAS.

The HDP contains vehicle crash records, basic bridge locations, speed study stations, WIM data, and in the near future, AADT. Crash records, bridges, and roadway characteristics are retrievable by CDS route or by geographic area (census areas and first class cities). Mainframe HAS extracts populate the HDP periodically. The HDP provides a limited query capability. The HDP query capabilities include

- CDS route number—lookup by common road name;
- Route log attribute report—by CDS route number;
- Route lists—by geographic area and route attributes;
- Public road mileage report—by geographic area and route attributes;
- Accident data—by CDS route number;
- Accident data—by geographic area and route attributes; and
- Speed study reports—by CDS route number.

Users can sort the reports by roadway/geographic classifications:

ADOT&PF Region	NHS	Ownership/maintenance responsibility
Borough	AHS	Paved/unpaved/waterway
Census area	Functional classification	Maintenance station
Election district	Rural/urban/urbanized	Maintenance category

Common Referencing System

Building an LRS reference network is fundamental to the HAS–GIS interface deployment. ADOT&PF has a collection and data processing business model in place for road network and transportation features.

An LRS provides the ability to easily and accurately report work activities, inventory assets, and locate vehicle crashes–traffic sensors. The LRS of choice is the route–milepoint system. ADOT&F personnel typically reference activities such as traffic data collection sensors and vehicle crashes using the proximity to established physical features such as historic mileposts, bridge deckings, and intersections. The fully deployed GIS will enable personnel to reference activities by route–milepoint and other reference systems such as bridge or milepost.

Maintenance Management System

ADOT&PF's MMS helps project how asset life-cycle management actions and maintenance changes affect the level of service (LOS) to the public. The QA module planning function supports these life cycle and LOS measurements and reflects the impact of budget changes. The system also tracks the maintenance and operations (M&O) cost for labor, equipment and materials to maintain the state's transportation infrastructure of highways, airports, floats and docks.

The ADOT&PF M&O division has a significant need for data integration for asset management. M&O personnel use the MMS for daily work activities and for managing the department's assets. The Daily Work Report is the core of the MMS. The Daily Work Report generates an electronic time sheet at pay record, personnel hours, and equipment usage to the accounting system.

The GIS Mapping and Highway Data staff spent significant time in establishing a solution to handle different user views for location referencing. This was particularly true for the MMS. ADOT&PF's GIS deployment strategy now includes:

- Establishing route–milepoint as the MMS LRS; and
- Modifying the MMS work report interface (both the user and data interface) to allow users the option to select from reference features (and enter offset distances if appropriate) and have milepoint values assigned by the software

As part of this solution, the highway database staff will provide a road network and reference feature data file for import into the MMS. The MMS asset management program is moving ahead with this solution. This approach will enable MMS data to accurately integrate with other transportation data. The enterprise data integration strategy for road network, feature, and maintenance data, where all data sets are based on the same linear referencing system, will provide a foundation for MMS data spatial location referencing.

Question 4*b*: What additional analysis capabilities would you like to have?

There are two areas where ADOT&PF needs additional analysis capabilities:

- Digital images integrated with a GIS that incorporates
  - Road network and attributes,
  - Statewide accident rates,
  - Named intersection accidents,
  - Vehicle speed/volume/classification,
  - Pavement condition,
  - Bridge condition; and
- Expanded data warehouse (HDP) that incorporates the geodatabase and GIS.

Both of these activities have just started after 3 years of the initial GIS development. Undoubtedly, there will specific data integration projects for highway, traffic, and vehicle crashes developed for the internet via ArcIMS for a PC-based GIS.

ALASKA DATA TABLE

Please indicate with an "**X**" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	**State System**			**Nonstate System**		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths		**X**				**X**
Pavement/shoulder type		**X**				**X**
Capacity			**X**			**X**
Geometrics	**X**				**X**	
Intersection—lanes, signalization		**X**			**X**	
Lighting inventory		**X**				**X**
Guardrail inventory			**X**			**X**
Pavement striping			**X**			**X**
Signage inventory			**X**			**X**
Rail crossing information		**X**				**X**
Pavement friction		**X**				**X**
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	**X**				**X**	
Construction zones		**X**				**X**
Ramp geometrics/characteristics		**X**				**X**
Videologging			**X**			**X**
Other						
Other						
Traffic Data						
AADT	**X**				**X**	
AADT trucks	**X**				**X**	
Congestion		**X**				**X**
Average speed		**X**				**X**
Travel characteristics—hour, day, holiday, month, annual	**X**				**X**	
Intersection turning movements		**X**				**X**
Other: WIM		**X**				**X**
Other: scale house weights		**X**				**X**
Crash Data						
Spatial location			**X**			
Crash record information	**X**			**X**		
Other—Linear reference location		**X**			**X**	
Other—Spatial location–derived		**X**			**X**	

District Department of Transportation Perspective

WILLIAM MCGUIRK
JIANMING MA
District Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Integrating roadway, traffic, and crash data will allow DDOT to set policy and select projects and programs to efficiently, timely, and comprehensively improve the safety of the District's roads. For example, DDOT has been developing annual HSIP reports using historic crash density and frequency. There are many factors contributing to crash occurrence such as roadway geometric design features, pavement surface conditions, human behavior, road use, vehicle characteristics, and weather conditions. Integrating roadway, traffic, and crash data would allow DDOT to better and comprehensively understand traffic crashes and to identify effective countermeasures to improve traffic safety.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection/management activities?

DDOT has completed the assessment of the traffic records information systems components: traffic crash, roadway, vehicle, driver, enforcement/adjudication, and injury surveillance. Based on the assessment, DDOT is currently initiating a multi-agency project, the District of Columbia Traffic Records Information Systems, to improve timeliness, completeness, accuracy, and integration in data collection. We use the number of crashes as one of the criteria to identify and prioritize traffic safety improvement projects. Once DDOT has the integrated roadway, traffic, and crash data in place, more advanced criteria could be developed to identify and prioritize safety improvement projects.

Question 1*c*: Do you have a formal SMS? If so, please describe.

DDOT developed a Comprehensive Transportation Safety Plan in FY2001. The goal is to reduce traffic fatalities by 2% each year. This plan requires implementing new strategies and continuing current programs in the areas such as drivers, pedestrian and cyclist, trucks and buses, roadways, work zones, improve neighborhood traffic safety, safety in school zones, incident management, and enforcement. DDOT is currently developing a new SHSP under the SMS. The new plan, if accepted, will reduce traffic fatalities 50% by 2025.

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

DDOT will utilize the integrated information to identify and prioritize roadway pavement rehabilitation and maintenance projects, bridge inspection, safety improvement in high hazard locations, traffic control and surveillance programs, transportation improvement programs, and asset management.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Yes, our agency does. Actually, the DDOT Traffic Services Administration (TSA) is initiating the establishment of a District of Columbia Traffic Records Coordinating Committee which will provide policy and strategic oversight to the establishment, management and maintenance of the District of Columbia Traffic Records Information Systems. This project is part of the District of Columbia SHSP.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

DDOT's Infrastructure Project Management Administration (IPMA) has maintained a Street Inventory System (SIS) that records all roadway related data. IPMA is working on upgrading the SIS using the GIS platform. The new roadway inventory system will be called the Street Spatial Database (SSD), which is a state-of-art Enterprise geodatabase. DDOT's TSA has a Traffic Accident Reporting and Analysis System (TARAS) that has an in place recording of all police-reported crashes on the District's roads. TARAS is maintained by TSA to provide a rational method to determine where safety improvement should be made. Data collection is a cooperative effort between DDOT and the Metropolitan Police District (MPD). The information from this system is used by other agencies and also for HPMS reporting. This system maintains location, location characteristic, crash type, and severity data for each accident as reported on the Traffic Accident Report (PD10). These initial accident data are transferred via scanned documents and entered into the TARAS database. The online portion of TARAS is used to review or correct individual crash records and to generate reports, by various criteria, using separate programs.

In addition, TSA also maintains and operates three WIM stations and numerous short-term coverage traffic count stations. TSA is renovating and expanding 32 permanent traffic count stations.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

No, these databases have not been integrated yet. We currently are improving the integration of these databases through the Traffic Records Information System. We have the TARAS database in place for crash analysis. In the TARAS, we have information on crash, involved persons, vehicles as well as location identifiers.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

One of the major challenges is to merge (or link) different databases which have their unique location identifiers. The TARAS only uses intersections as its unique identifier; this situation makes it difficult to do comprehensive crash analysis since crashes occurring midblock are usually analyzed along with those occurring at intersections. Therefore, this situation gets complicated if all crashes are analyzed using intersection settings. For example, we cannot differentiate crashes that can be corrected by traffic control measures from those that can be reduced using other engineering countermeasures.

Question 2*d*: Are the data integrated with GIS technologies?

The data integration will be finally implemented on a GIS platform. So far, the SIS database is migrated to the GIS environment—the SSD.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

U.S. Park Services collect crash data on the federally owned roadways such as Rock Creek Parkway and George Washington Parkway.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

Besides those listed in the table, DDOT also collects vehicle classification, weight, vehicle occupancy, pedestrian, and bicycle counts.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

Since there have been few new roadway construction projects in the District of Columbia, the information in the roadway inventory database does not change much. DDOT downloads and reports electronic traffic data from WIM stations and permanent traffic count stations monthly. The crash data are usually updated annually. The integrated database will have the capability to store historical data. The linkages between databases are location identifiers such as SIS ID and longitude–latitude coordinates.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

Timeliness and accuracy are two major challenges facing the DDOT at this point.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

Electronic Crash Reporting System is what is needed most. We probably do not have roadway geometric design features, such as degree of curvature and degree of grades, which may play important roles in investigating crash occurrence.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

Timeliness and accuracy would provide the greatest benefit to our agency. Timely and accurate data will allow DDOT to make more informative decisions in identifying, prioritizing, and managing safety improvement projects.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*. What techniques have been particularly useful? Please provide examples of how this has improved agency decisions, such as safety program development, countermeasure selection, or changes in policy.

The GIS-based crash information system should be particularly useful to DDOT to develop safety improvement programs. DDOT currently use 5% highest crash locations as improvement targets. If the integrated GIS-based database were in place, DDOT would have the ability to identify more specific and effective countermeasures to reduce traffic fatalities and improve the driving environment.

Question 4*b*: What additional analysis capabilities would you like to have?

As described above, the GIS-based crash information system should be in place and a single criterion needs to be developed to identify and prioritize high hazard locations. For example, the criterion should consider the number of crashes by severity and should be calculated using different weights for crashes at different severities based on the economic loss (including, property damage, loss of labor, medical, insurance, legal fees, etc.).

DISTRICT OF COLUMBIA DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths		X			X	
Pavement/shoulder type		X			X	
Capacity			X			X
Geometrics			X			X
Intersection—lanes, signalization	X				X	
Lighting inventory		X			X	
Guardrail inventory		X				X
Pavement striping		X			X	
Signage inventory		X			X	
Rail crossing information		X				X
Pavement friction			X			X
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness			X			X
Construction zones		X				X
Ramp geometrics/characteristics			X			X
Videologging			X			X
Other						
Traffic Data						
AADT	X				X	
AADT trucks	X					X
Congestion			X			X
Average speed	X				X	
Travel characteristics—hour, day, holiday, month, annual			X			X
Intersection turning movements		X			X	
Other						
Crash Data						
Spatial location			X			X
Crash record information	X			X		
Other						

Iowa Department of Transportation Perspective

PEGGI KNIGHT
THOMAS M. WELCH
Iowa Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Countermeasure effectiveness study, program development, investment decisions, and determination of countermeasures.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making?

Yes.

Do you have a formal business plan for identifying and prioritizing data collection–management activities?

Informal.

Question 1*c*: Do you have a formal SMS? If so please describe.

Yes. Multiagency, multidisciplinary group.

Question 1*d*. How is integrated information used in your agency's project management and program development activities including your safety improvement program?

For Site selection and countermeasure identification.

Question 1*e*. Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Yes.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

We use Oracle Spatial database for roadway records. Crash data are in shape files.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

Databases are integrated in a decision support environment using key fields and a spatial component. A geodata library was created as a data warehouse.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

None.

Question 2*d*: Is the data integrated with geographic information system technologies?

Yes.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

Yes. Roadway data from local governments, plans, etc. Traffic data are collected by state crews. Crash data are collected by local law enforcement.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

No response.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data?

Roadway data are stored in a flat file on tape. The previous 10 years of crash data are available in a data warehouse.

How far back are data accessible?

Roadway data are available for about 30 years. Crash data are only available for 10 years.

How do you maintain linkages between databases to integrate historical data?

Prior to 1999, the tie was done through spatial proximity; 2000 to current data have a roadway key field tie.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency?

We are working on improving data timeliness and accessibility for roadway and traffic data. For crash data, we are working on consistency and completeness as training issues.

Are there differences between state and local agency system data?

There are none for crash data.

Question 3*d*: What roadway, traffic, and crash data do you most need but do not have?

Intersection inventory features and driveways.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

All of them.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful?

GIS display.

Please provide examples of how this has improved agency decisions, such as safety program development, countermeasure selection, or changes in policy.

- Easier to communicate with agency decision makers and elected officials;
- Site selection for specific countermeasures; and
- Evaluation of countermeasure effectiveness.

Question 4*b*: What additional analysis capabilities would you like to have?

Intersection inventory.

IOWA DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X			X		
Pavement/shoulder type	X			X		
Capacity			X			X
Geometrics			X			X
Intersection—lanes, signalization			X			X
Lighting inventory		X				X
Guardrail inventory		X				X
Pavement striping			X			X
Signage inventory		X				X
Rail crossing information	X			X		
Pavement friction			X			X
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness			X			X
Construction zones			X			X
Ramp geometrics/characteristics			X			X
Videologging	X					X
Other						
Traffic Data						
AADT	X			X		
AADT trucks	X				X	
Congestion			X			X
Average speed		X				
Travel characteristics—hour, day, holiday, month, annual	X			X		
Intersection turning movements		X			X	
Other						
Crash Data						
Spatial location	X			X		
Crash record information	X			X		
Other						

Michigan Department of Transportation Perspective

RONALD L. VIBBERT
Michigan Department of Transportation

JACK BENAC
Michigan Department of Information Technology

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Program Development

Data have been used in the development of emphasis areas for the SHSP. Support the goal to reduce the death rate to 1.0 deaths per 100 million vehicle miles traveled (VMT), manage safety grant programs for seat belt, speed, failed to yield, DUI selective enforcement programs, motorcycle safety, graduated driver license, and the development of the Traffic Records Strategic Plan.

Investment Decisions

Data are used in developing safety programs, design alternatives, etc.

Determination of Countermeasures

Data are used in all aspects of countermeasure development, i.e., improve sight distance, determination of signalization, rumble strips to reduce drift off road crashes, etc.

Overall, the integration of data has allowed Michigan DOT (MDOT) staff to access information they need across our functional silos. This allows us to develop projects with knowledge of assets and performance outside of the functional silos.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection–management activities?

This information has resulted in better decision making in the evaluation and monitoring of safety programs and projects.

MDOT does not have a formal, departmentwide plan for collecting data. Data are collected to support various engineering, project development, and planning needs, or to meet federal requirements. The resulting data, to the extent we can capture it systematically, is made available and shared.

MDOT has started efforts to identify data items–elements where more information is needed to support our activities. Most of these missing elements revolve around non-pavement roadway features, such as guardrails, culverts, etc. Where data might exist, such as in desktop databases, our efforts will focus on making those available.

Michigan's Traffic Records Coordinating Committee (TRCC) recently concluded the Traffic Records Strategic Plan, which includes the assessment of safety data, the prioritization of data-collection initiatives, and the establishment of baseline and projected benefits of improved data.

Question 1*c*: Do you have a formal SMS? If so, please describe.

Yes. Michigan's SMS is one of the six contained in our Transportation Management Systems (TMS). This is built upon a large database–warehouse covering the original six Intermodal Surface Transportation Efficiency Act (ISTEA) management systems. We should note that crash information is referenced from a statewide database, and is not in the TMS database.

The SMS includes intersection, interchange analysis, time of return, many forms of crash reporting peer group analysis, and reports of high crash locations (this functionality is actually performed elsewhere).

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

Integrated information is used throughout the development of individual "silo" projects, as well as in the development of our transportation program. Information supporting individual projects with locations must be referenced using a single LRS or the project will not be funded. Other uses include

- Road audits/project scoping to determine the need for safety considerations;
- Mean crash rates are used for design and location-specific performance measures;
- HSIP; and
- 5% list.

These programs also identify the need for improved and more complete data.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Yes, the Governor's Traffic Safety Advisory Commission (GTSAC) and the state's Traffic Records Coordinating Committee (TRCC) help assure the involvement of safety and planning as well as other state agencies.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

- Oracle database environment;
- Sun servers; and
- Mostly PowerBuilder-based software, including our management systems and crash data processing. There have been recent developments using IBM's WebSphere tools (Java).

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

The databases are formally integrated. Databases are integrated by two LRS (one for state routes and one for all roads). This has allowed us to eliminate duplicative data sources which ease coordination. The databases supporting traffic records processing are shared across departments as well.

Databases are also integrated by latitude–longitude coordinates, which are directly related to the all-roads LRS mentioned above.

A data mart has been developed for crash data.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

Michigan is fortunate to have an enterprisewide map base with conflated LRS. We have no significant data integration problems.

There is a need for more discrete roadway data. This is not an integration problem as much as it is a data assembly/collection/capture problem.

There is a need for standard data collection processes for local roads.

Question 2*d*: Are the data integrated with GIS technologies?

Yes.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

Statewide crash data are available and located spatially and through a LRS on all roads.

Roadway and traffic data off of the state system is generally not available to MDOT, except where it supports HPMS or various systems modeling activities. This is changing, however, as Michigan's Asset Management Council's pavement condition assessment is providing pavement type, number of lanes, and a condition rating for roads on the Federal Aid System.

Other roadway feature data are not available to MDOT; roadway and traffic data are not available to MDOT beyond state roads except in areas where MPOs manage data, i.e., Southeastern Michigan Council of Governments (SEMCOG).

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

No response.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

Online crash data are maintained for 10 years and is updated to the current spatial and LRS. Traffic information is available for 20 years. Roadway data are kept for 10 years. We have several data sources that go back to the 1960s and 1970s.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

Crash data require continuous QC monitoring to maintain timeliness, consistency, completeness, and accuracy. QA/QC programs are in place to monitor and improve crash data quality.

Generalized roadway data are maintained in MDOT's sufficiency file that supports data according to predetermined road segments. The information in this file is designed for reporting and network analysis purposes, not for detailed project identification or engineering analyses. Using information from this file (which for some items is the only source) requires prorating road features over the segment which causes data accuracy problems. Intersection features and freeway interchange features have not been updated since the late 1990s. No systematic process is in place to centrally collect and maintain roadway data on local roads.

There are some significant gaps in our roadway features inventories such as guardrails, various shoulder or drainage features and attributes. Some items exist on desktop or "paper" databases that need to be made available to others.

There is a lack of traffic information for nontrunkline roads. We are expanding our traffic volume data collection efforts to support HPMS.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

- Discrete roadway features, intersection features, and freeway interchange features, and
- Local roadway and traffic data.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

- Crash data;
- Physical transportation assets including their location, attributes, condition, and performance over time;
- Project-based performance measures/predictors;
- Operational roadway, intersection, and freeway interchange features; and
- AADT and commercial vehicle traffic data.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this has improved agency decisions, such as safety program development, countermeasure selection, or changes in policy.

Crash data analysis is available through web-based tools. This includes some mapping and ad hoc query capabilities. This capability has raised the visibility and importance of quality data that supports the HSIP and selective enforcement programs.

Condition and program/project effectiveness are evaluated using various software tools.

GIS is useful in identifying relationships and patterns that are not easily discernable using non-spatial/visual techniques.

Projects are “GISed” to identify actions that could be combined to save costs, such as sharing traffic maintenance costs, minimizing road closures, etc.

Question 4*b*: What additional analysis capabilities would you like to have?

- Improved mapping initiatives and improved local data management projects are under development;
- Improved methods of identifying peer groups for safety analysis and terms of reference studies;
- Ability to generate collision diagrams from underlying roadway and crash data; and
- Ability to produce high crash locations.

MICHIGAN DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X				X	
Pavement/shoulder type	X				X	
Capacity	X				X	
Geometrics		X			X	
Intersection—lanes, signalization		X			X	
Lighting inventory			X			X
Guardrail inventory		X				X
Pavement striping	X					X
Signage inventory		X				X
Rail crossing information	X			X		
Pavement friction		X				X
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness		X			X	
Construction zones						
Ramp geometrics/characteristics		X				X
Videologging			X			X
Other						
Traffic Data						
AADT	X				X	
AADT trucks	X				X	
Congestion	X				X	
Average speed		X			X	
Travel characteristics—hour, day, holiday, month, annual		X			X	
Intersection turning movements		X			X	
Other						
Crash Data						
Spatial location	X			X		
Crash record information	X			X		
Other						

Mississippi Department of Transportation and Public Facilities Perspective

JEFFERY K. ELY
JEFF PIERCE
Mississippi Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

With one of the highest fatality rates in the nation, Mississippi DOT focuses extensively on areas to improve the safety of our roadways. Mississippi DOT contracted with GeoDecisions to build a web-based application that would incorporate the above data sets to assist in improving safety and the decision-making process. This system will be the "backbone" of our HSIP.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection–management activities?

We have not done a formal assessment of the benefits, but we are certain that Mississippi DOT will yield a much higher benefit-to-cost ratio with our HSIP funds.

Question 1*c*: Do you have a formal SMS? If so please describe.

No response.

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

Mississippi DOT currently does not have the capability to regularly utilize all of the available data attributes within the system screening process at this time. Mississippi DOT will have this capability when the Safety Analysis Management System (SAMS) is completed.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

The traffic engineering division has the lead role in the development of the SHSP. Representatives from the planning division have participated in the process. Both divisions do play a role the development of the traffic records plan as well.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

The roadway characteristics database is currently a flat data file housed in Microsoft SQL Server. There are approximately 90 attributes ranging from physical geometries (such as lane and shoulder width) to administrative features (functional class, route designation, etc.). A relational data model has been developed and will be implemented with the collection of statewide data in the next 2 years. All attributes are associated to a county ID, route ID, and begin and end mile points. The traffic database is also a flat file housed in Microsoft FoxPro. All traffic attributes are point features associated to a unique identifier. Roadway characteristics and the traffic database are cross-referenced through the traffic site id.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked?

Currently, all three datasets are in separate environments and are integrated on an as-needed basis for data reporting, etc. For traffic and roadway data, there is a unique identifier associated to each traffic count location that also is stored in the roadway characteristics database.

Have you created a safety data mart or data warehouse? If so, what is included?

Mississippi DOT is in the process of creating a data warehouse for SAMS that will include roadway characteristics, traffic volumes, road and city name alias tables, and crash information. All of the data will be referenced to the LRS.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

With roadway and traffic data, it is ensuring that both correctly reference the same segment of road. This is a concern because the data sets are stored in separate databases and administered by two separate branches within the planning division.

Question 2*d*: Are the data integrated with geographic information system technologies?

Yes. We are in the process of improving our GIS available data daily.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

We collect nonstate roadway and traffic data for HPMS reporting, traffic analysis, etc. Road inventory data are gathered on a 3-year cycle. We utilize a DOS system that enables us to flag features and roadway characteristics using an in-vehicle laptop in conjunction with a DMI. In the next couple of months, we will begin collecting these data using digital video.

Mississippi DOT collects traffic volume and classification on nonstate system using both portable and permanent equipment. Portable volume counts are collected using ACE traffic counters. Classification counts are collected via a consultant that uses MetroCount counters. Permanent volume and classification counts are collected using a system of in-ground loops and sensors and are polled via phone modem on a daily basis to access the data using the Mikros Tel System.

Crash data are available for the local road system; however, we cannot do any type of spatial analysis with the local road crash data.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

Yes.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

We do maintain historical data but it is not linked between databases. Annual backups are made of the tables for historical reference. Roadway data are easily accessible for 20 years back, but more may exist on mainframe backups. Historically published traffic data spans back to the 1970s. Digital files are available for the past 10 to 15 years.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

There are some problems with timeliness for roadway data. The 3-year collection cycle has slipped due to staff shortages. Accessibility is also a problem with roadway data. It is available to most users within Mississippi DOT but must be provided to planning staff by those outside this agency. Integration is not a problem but has been somewhat cumbersome prior to GIS. We are making the data much more accessible as our GIS develops.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

The incorporation of local roads within the LRS would allow off-system analysis. This is very important now with the new FHWA reporting requirements in SAFETEA-LU. Additionally, we are currently working to improve our curve and grade data.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

AADTs, pavement data, and physical characteristics such as lane/shoulder/median widths in conjunction with crash data.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this improved agency decisions, such as safety program development, countermeasure selection and/or changes in policy.

GIS, SAMS.

Question 4*b*: What additional analysis capabilities would you like to have?

Automated traffic and congestion analysis.

MISSISSIPPI DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X			X		
Pavement/shoulder type	X			X		
Capacity		X			X	
Geometrics		X			X	
Intersection—lanes, signalization		X			X	
Lighting inventory			X			X
Guardrail inventory			X			X
Pavement striping			X			X
Signage inventory	X					X
Rail crossing information	X			X		
Pavement friction	X					X
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	X					X
Construction zones			X			X
Ramp geometrics/characteristics			X			X
Videologging	X					X
Other						

MISSISSIPPI DATA TABLE (*continued*)

Traffic Data						
AADT	**X**			**X**		
AADT trucks	**X**			**X**		
Congestion			**X**			**X**
Average speed			**X**			**X**
Travel characteristics—hour, day, holiday, month, annual			**X**			**X**
Intersection turning movements		**X**			**X**	
Other						
Crash Data						
Spatial location		**X**				
Crash record information	**X**			**X**		
Other						

Ohio Department of Transportation Perspective

LEONARD EVANS
Ohio Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Roadway, traffic, and crash data integration is crucial for the transportation planning processes at the Ohio DOT. From a strategic standpoint, the department is committed to building and operating a safe, efficient, and sustainable transportation system. The department uses data-based decision making to manage by fact and to direct resources to meet transportation needs. The great enabler has been the successful integration of basic transportation asset inventories with information describing the adequacy of these assets to meet identified needs.

Integrated data are visible in the Ellis project management system. This system identifies all capital construction projects through the project development process and tracks the project scope, schedule, and budget. Projects programmed in Ellis comply with strict business rules to identify affected roadway segments and bridge structures. Existing inventory data and condition attributes are viewable to the users for pavements, bridges, basic roadway characteristics, and traffic volumes.

Crashes are received weekly from the Ohio Department of Public Safety and are logged to known routes and street names on state highways, typically within 3 months of the event. Annually, high crash locations are identified based upon crash density and crash frequency. These locations are studied along with highly congested roadway segments identified by the statewide congestion analysis to determine appropriate countermeasures. These countermeasures vary from low-cost–short-term fixes to high-cost–long-term fixes. The major capacity-related projects incorporate safety and congestion measures to prioritize the project selection process as defined by the Transportation Review Advisory Council (TRAC) project selection process.

Internally, the funds management process uses integrated data to allocate funding among the various transportation programs and districts. Inventory size and condition data are used in conjunction with performance measures to determine program needs and to monitor implementation.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection–management activities?

The department uses a series of 65 organizational performance index measures to evaluate the outcomes of key transportation responsibilities. These measures leverage the data collected by the various sources for use in decision making and surveillance. Data collection is normally associated with a given program or task, such as HPMS, distribution of gas taxes, pavement management, bridge management, and highway maintenance. The data collection is tied to some form of decision making determined by the transportation function.

System improvements are prioritized through the strategic management process which identifies short-term (2-year) strategic initiatives for areas where improvement is needed. These strategic initiatives are part of the overall management process and drive the development of new or improved data systems and management processes. Past initiatives have included the development of the data integration, project management, performance measurement, and safety systems.

Question 1*c*: Do you have a formal SMS? If so, please describe.

Yes, the department has historically used mainframe applications to locate and analyze crashes to identify high crash locations. These locations are studied annually and are addressed by construction projects, maintenance actions, and dedicated safety projects. GIS, data warehousing, and statistical reporting is used for crash analysis and the identification of hot spots.

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

The project management program, Ellis, uses the Base Transportation Referencing System (BTRS) to identify project locations, display attribute data for assets along these locations and track the resulting actions on bridge and pavement conditions. Before and after crash analysis is performed in areas affected by projects.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Yes, the safety office has had a longstanding relationship with the statewide highway safety efforts and traffic records issues. The formalization of these processes has been a natural evolution of this process.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

The roadway data serves as the basis for the organization of transportation data. This process has been in existence for over 50 years and covers 100% of the state, county, and township systems. Municipal data has been dated but is being significantly improved through a statewide program offered at the county level for local data collection. Traffic data are collected on a 3-year cycle for all state highways. Few counts currently exist off of the state system but some improvement efforts are being initiated at the county level for the local systems. The crash data are updated weekly and lags real-time by about 3 months. All crashes are reported, which include fatalities, injuries, and property damage only claims greater than $400.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

A corporate data warehouse exists to permit cross reporting and to support the GIS systems. This data warehouse uses the BTRS roadway identification number and is segmented into 2 million records to represent every 100th of a mile of state highways. A business practice has been to create a data warehouse model for each corporate data application. Key linkages are the BTRS location, project ID, structural file number, and crash number

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

Currently, the department is attempting to resolve temporal issues with the data. The road inventory is dynamic and affects the integrity of analyses that extend over several years. The problem is more acute when analyzing crashes over multiple years and when performing pavement degradation analysis. Another challenge is to integrate transportation data that is being collected at the local level. There has been unprecedented growth in the accuracy and completeness of local transportation data as a result of an effort to improve 911 emergency response activities.

Question 2*d*: Are the data integrated with geographic information system technologies?

Yes, our GIS systems provided the initial capability to integrate data and still offer tools for more advanced data integration. The GIS tools are used to develop the BTRS identification process.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

Yes, recent efforts have been underway to improve the location of crashes along the county and township networks as well as within municipalities. A process has been developed to better locate crashes identified by street numbers and intersection references. As more counties adopt the standards being used for the 911 emergency response systems, their local networks will be available for further analysis. The 911 data collection process has incorporated the Ohio DOT's BTRS identification process as a standard used by the data collection contractors.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

Bridge and culvert inventories.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

Roadway data are currently brought forward to the present. An effort is underway to recreate historical roadway data over the past 10 years to support pavement analyses. Hard copy road inventory data are available to 1950s. Traffic data goes back to 1992 and includes the last three to four traffic counts taken on a 3-year cycle. Crash data are readily available in a data warehouse back to 1992 and earlier data are archived. The Ohio DOT's data warehouse integrates historical data using the current BTRS roadway network.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

Ohio's basic road inventory process is codified in law and dates back to the 1950s. County engineers are required to report changes in county and township roads annually as part of the state gas tax distribution process. Municipal inventories have been incorporated when available but lack a data maintenance mandate as is applied to the county and township system. State highway data are complete and accurate and is revised as part of an annual perpetuation process. The local data are improving considerably as more counties participate in the 911 emergency response location-based referencing system (LBRS) project http://oit.ohio.gov/SDD/ESS/Ogrip/LBRS.aspx.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

Logging of crashes within municipalities has jumped from 0.33% to 61.51% this year as a process was implemented to log crashes based upon street addresses. Ohio DOT receives all of the 380,000 crashes that occur annually in the state. Crash data would improve considerably if GPS location data were to be provided by local law enforcement. Data timeliness and accuracy improvement efforts have been underway at the state level but have been slow in implementation.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

Improvements to local road inventories and crash data locations will have the most significant impact on safety analyses. The addition of local traffic counts will facilitate the identification of high crash locations and safety hot spots.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this has improved agency decisions such as safety program development, countermeasure selection, or changes in policy.

The state utilizes a process to identify high crash locations and hot spots. This has been very useful in directing resources in areas of greatest benefit. The corporate data warehousing effort has greatly improved the inclusion of transportation data and facts into daily decision making. Coupled with strategic direction and performance measures, positive results are being achieved through coordinated efforts.

Another technique worth mentioning is the Resurfacing Project Accident Analysis. This process has defined business rules for analyzing resurfacing projects for significant crash locations and facilitating exemptions for some standards when crashes are below a threshold and not associated with specific locations. This process limits the need to perform wholesale upgrades when routine resurfacing is needed.

Question 4*b*: What additional analysis capabilities would you like to have?

We are working to improve the process for diagramming crashes. Addressing temporal changes in transportation features and alignments will improve evaluation of safety improvements and asset management degradation predictions.

OHIO DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X				X	
Pavement/shoulder type	X				X	
Capacity	X					X
Geometrics	X					X
Intersection—lanes, signalization		X				X
Lighting inventory			X			X
Guardrail inventory		X				X
Pavement striping		X				X

continued

OHIO DATA TABLE (*continued*)

Data Category	**State System**			**Nonstate System**		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Signage Inventory		**X**				**X**
Rail crossing information	**X**			**X**		
Pavement friction		**X**				**X**
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	**X**				**X**	
Construction zones	**X**					**X**
Ramp geometrics/characteristics		**X**				**X**
Videologging	**X**					**X**
Other—Structures (bridges)	**X**			**X**		
Other—Culverts		**X**				**X**
Traffic Data						
AADT	**X**				**X**	
AADT trucks	**X**				**X**	
Congestion	**X**					**X**
Average speed	**X**					**X**
Travel characteristics—hour, day, holiday, month, annual		**X**				**X**
Intersection turning movements			**X**			**X**
Other						
Crash Data						
Spatial location	**X**				**X**	
Crash record information	**X**			**X**		
Other						

Oregon Department of Transportation Perspective

DAVID RINGEISEN
MARK WILLS
Oregon Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Integration of Oregon's DOT crash, traffic and roadway data merged with other project data has provided better information for identifying the success of past engineering countermeasures. Additionally, the data collected and reported highlights areas that require more decision making for the annual Safety Priority Indexing System (SPIS) traffic investigations, and STIP projects. These decisions on safety program investments and project selection for both state and local focus have been supported with the asset data.

Oregon DOT also provides spatial integration of the state highway definition, roadway, traffic, and crash data (among other information) offering internal and external project managers and other data customers an accessible, flexible, and more comprehensive picture of the conditions of the highways. The flexibility is represented in the querying choices provided the end user. The spatially integrated data allows for cluster analysis when looking for various patterns of occurrence and, in addition, allows the user to look at the history of highway conditions for before and after project analyses.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection–management activities?

Although Oregon DOT has not formally assessed the value of specific data, it has recognized its intrinsic value to all aspects of transportation management and has developed a formal Linear Asset Management Implementation Plan that identifies action items focused on data management. This plan includes standards and polices as well as further integration advocacy and data standard enforcement.

Among other asset plans and communication tools, Oregon DOT's recently developed Asset Management Strategic Plan has identified roadway safety linear assets as a priority. Oregon's Transportation Safety Action Plan (OTSAP) influences and guides safety data and project activities. The OTSAP is an element of the larger Oregon Transportation Plan (OTP). The OTP provides ongoing support via many of its goals, polices, and strategies, including Policy 2.2 Management of Assets.

In context to Traffic Safety, Oregon DOT has participated in a series of National Traffic Records Assessments and works continuously to implement recommendations whenever possible. The new Crash Data System is one result of implementing traffic records recommendations. The Project SMS (PSMS) works closely with Transportation Data Section to evaluate needs and develop tools for use by Regions traffic investigators and other safety advocates. To highlight a few examples; decisions resulting from data have proven themselves in reduced fatality rates, increased access to crash and other data, and the commissioning of successful safety corridors.

Question 1*c*: Do you have a formal SMS? If so, please describe.

Oregon's SMS reflects a long history of effective transportation safety programs and interagency cooperation. The system responds to a federal requirement for a formalized systematic decision-making process and policy direction provided by the Oregon Transportation Commission's (OTC) approval of the Transportation Safety Action Plan.

Oregon has established transportation safety programs that address engineering, education, enforcement, and emergency medical services issues.

The federal requirement to have a SMS, which was established in 1991 through the ISTEA, is now voluntary; however, Oregon, and most other states, proceeded to develop SMSs. These management systems take different forms in each state, but each has the goal of reducing deaths and injuries due to motor vehicle collisions.

With approval of the OTSAP in 1995, the OTC established its expectations regarding transportation safety. The development of a SMS to serve the needs of all state and local agencies and interest groups involved in transportation safety programs is one of 70 actions included in the OTSAP. According to the OTSAP, the PSMS should be based on an adequate traffic records system and should be designed to:

- Establish efficient processes for ongoing cooperative efforts among the various political and technical entities;
- Incorporate analysis tools;
- Provide direct input into the project identification and selection process;
- Guide investment decisions about all types of transportation safety programs; and
- Help decision makers evaluate the effectiveness of individual actions and overall system performance.

The Traffic Engineering and Operations Section is responsible for the PSMS. Other Oregon DOT units that have participated in the development of the PSMS are the Transportation Safety Division, the Policy Section, the Transportation Data Section, Driver and Motor Vehicle Services Division, and Oregon DOT regional staff.

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

One example of how asset information has been used in program funding and project development is the use of data from the bridge and pavement systems that resulted in the Oregon

Legislature ordering a $3.1 billion bond program (OTIA III) in 2003 to repair and replace aging bridges in the state.

Another example is how culvert information, although not complete, has been sufficient to illuminate high risks associated with their condition. This has resulted in the reallocation of $17 million from the Interstate maintenance program specifically to culverts for the current biennium.

In terms of the safety improvement program, the Transportation Data Section works with closely with Transportation Safety Division in the development of annual performance measures, their Annual Traffic Safety Performance Plan and their Oregon Traffic Safety Book. Crash and other traffic data are used to identify past performance and set new performance goals. Additionally, the Transportation Data Section develops several annual publications: State Highway Crash Rate Tables, Traffic Crash Summary, Motor Carrier Crash Rate Tables, Oregon Mileage Report, and the Traffic Volume Tables.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

Yes, both program areas are involved in these processes. There are representatives from the Transportation Data Section, Traffic Operations, Engineering and Roadway Section, Oregon DOT Information Systems, Transportation Safety Division, and Motor Carrier Division on the Traffic Records Coordinating Committee. This committee has oversight of the final assessment and the resulting traffic records project selection.

Additionally, all of these program areas are involved with in the Oregon Transportation Safety Division's annual conference process that guides the setting of the annual safety performance goals for Oregon's Traffic Safety Performance Plan.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

The CDS is an application developed in Visual Basic 6.0 with a MS-SQL 7.0 database, using Crystal Reports 8.5 for report generation. There is a web-based component of the reporting function that provides limited reporting for internal users; however, the majority of the reporting is produced by the CAR Unit. This is a relational database that collects and reports at the crash, participant, and vehicle levels. It employs nearly 300 validations and utilizes tables from the Integrated Transportation Information System (ITIS), Oregon DOT's corporate state highway inventory system, for validating state highway descriptions and definition. Definition data include NHS, functional classification, and other jurisdictional boundaries as well as accurate milepoint information.

The Traffic Monitoring System is in the process of a rewrite whose database is to be developed in MS-SQL. The system will have three components: application server, databases, and graphical user interface. This is a modified-off-the-shelf (MOTS), web-based application and it will provide GIS functionality.

Oregon DOT's corporate state highway inventory system, ITIS, is currently in DB2 with a NOMAD front-end. It also provides web-based reporting for internal and external users. During the next biennium, a major project will begin that will incorporate this database and the road maintenance features inventory database.

Question 2*b*:Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

The databases are not formally linked, but do provide extracts and reporting tables to other asset systems. There is linkage in the use of highway number and milepoint information in many databases. The data that they provide is also included in Oregon DOT's web-based GIS tool, TransGIS. Detailed information is provided including statewide transportation management system data, STIP projects, safety data, and rail, freight, and environmental data. These data are accessible for analysis, planning and research needs.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

- A common LRS;
- The timing of roadway inventory and other annual file closures;
- Common data definitions and database standards; and
- Information technology resources required to develop the required links.

Question 2*d*: Are the data integrated with geographic information system technologies?

Yes, the data are well integrated in GIS technologies and the application of spatial data are expanding daily. TransGIS, as mentioned in question 2*b* above, is a commonly used tool both internally and externally. There is a current GIS framework project that will provide roadway and traffic data for all jurisdiction roads. This will further the ability to collect and report both state and local road crash data with spatial coordinates, utilizing roadway data that is maintained in local agency systems.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

Oregon DOT does collect crash data on all jurisdiction roads. That data includes functional classification, NHS, and a variety of roadway location information. Crash reports filed with the Driver and Motor Vehicle Services Division (DMV), which qualify by state statute, are analyzed, and then the information derived is coded and entered into the CDS.

Oregon DOT's HPMS includes local nonstate system data for traffic volumes. The data are collected from the local agency itself. The Transportation Data Section contacts the city, county, or miscellaneous agency that are known to collect traffic data. The data that corresponds to federal aid roads are then added into our database.

DATA

Oregon DOT's recently developed CDS has implemented national crash data standards, i.e. ANSI D16, ANSI D20 and is compliant with a major percentage of MMUCC-recommended data elements. It has improved the overall management of the data and greatly increased the QA of data by embedding approximately 300 validations within the data entry interface and by utilizing a reporting table from the highway inventory corporate database.

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

Oregon DOT's Transportation Data Section includes three crash data programs; a federal program, the Fatal Accident Reporting System (FARS), CDS, and the Motor Carrier Safety Net, and Statewide Commercial Vehicle Crash Database.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

The CDS currently maintains 20 years of crash data within the database. All the data are accessible for internal reporting purposes. There are linkages to roadway and traffic data delivered within the TransGIS via coordinates. Additionally, the data also provides a linkage for other systems with the inclusion of highway and route number and milepoint.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

Roadway, traffic, and crash data categories are fairly equivalent for most of the factors listed.

Timeliness

Crash data has improved in all data quality factors with the development of a new system but timeliness remains an issue due to the DMV processes leading up to the actual collection or coding of the information. Annual traffic VMT is also slower in completion than is desirable for use in annual files closures, submittals, and publications. However, there is an automation project underway that will improve the timeliness and accessibility of the traffic data.

Accuracy

Roadway data suffers the most from accuracy issues. This results from years of varied field collection methods, irregular inventory procedures, varied database construction, and limited QC and QA. Oregon DOT's asset management program has a pilot project in progress that will identify existing gaps in these areas. This information will influence the prioritization of inventory and automation projects. Oregon DOT has also developed a data council that will be looking at these issues and implementing changes for standardizing many of these procedures.

Integration

This factor is advancing through the utilization of GIS tools. New efforts toward data standards and data collection policies will also improve this area.

Local roads data are not equivalent to state data. Crash data reports are available equally from both jurisdictions. However, local roads data will not be easily mapped until there is a common LRS implemented for local roads. The state roadway information is naturally more accurate, and it is updated on a scheduled basis.

Other categories may report less on local jurisdiction roadways because it is not in their control to inventory nor do they share common definitions.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

Local roads data.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

It is difficult to make that distinction, because new construction and preservation projects require the analysis of the crash and traffic conditions within the project areas as part of their scoping, and roadway data are significant to all aspects of operations.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

SPIS, GIS display, safety corridor analysis, top 10% crash sites, and focused roadway–crash site analysis.

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this has improved agency decisions such as safety program development, countermeasure selection or changes in policy.

Focused roadway–crash analysis has been used for illumination studies that resulted changes in policy. The same method has resulted in a countermeasure that was a driver for a major median barrier change and installation project (cable barrier) along Interstate 5.

Question 4*b*: What additional analysis capabilities would you like to have?

Additional spatial analysis capabilities, expanded roadway jurisdiction crash rate analysis, enhanced crash rate methodologies, and integrated Emergency Medical Services (EMS) data.

OREGON DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths		X				X
Pavement/shoulder type	X					X
Capacity		X				X
Geometrics	X					
Intersection—lanes, signalization	X				X	
Lighting inventory		X				X
Guardrail inventory	X					X
Pavement striping		X				X
Signage inventory		X				X
Rail crossing information	X				X	
Pavement friction	X					X
Pavement distress indicators—e.g. rutting, shoulder drop-offs, roughness	X					X
Construction zones		X				X
Ramp geometrics/characteristics	X					X
Videologging	X					
Other						
Traffic Data						
AADT	X				X	
AADT trucks	X				X	
Congestion		X			X	
Average speed	X				X	
Travel characteristics—hour, day, holiday, month, annual	X				X	
Intersection turning movements	X					X
Other						
Crash Data						
Spatial location	X				X	
Crash record information	X			X		
Other						

Pennsylvania Department of Transportation Perspective

LAINE HELTEBRIDLE
BILL HUNTER
Pennsylvania Department of Transportation

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

Roadway and traffic data are stored in the Pennsylvania DOT's (PennDOT) Roadway Management System (RMS). RMS is a legacy computer system that was implemented in 1985. Crash data are stored in PennDOT's crash system. Roadway and traffic data are downloaded on a nightly basis for uses in the crash system. Traffic data are taken into consideration when constructing new roads or in maintenance treatments of existing roads. Crash data led to the determination that the three biggest highway safety problems were aggressive sriving, DUI, and seat belt use. These three areas have had programs developed to address them and receive the largest portion of Federal 402 funds.

Each bureau in PennDOT develops a yearly business plan that is approved by the Secretary of Transportation. The Bureau of Maintenance and Operations (BOMO) has responsibility for RMS. Data collection for RMS and management of maintenance activities is included in BOMO's business plan. The Bureau of Planning and Research (BPR), a bureau within PennDOT's Office of Planning, is responsible for collecting traffic and HPMS data. These activities are included in the Office of Planning's business plan. The Bureau of Highway Safety and Traffic Engineering, which is responsible for collecting crash data, has a traffic records strategic plan and a records coordinating committee.

Pennsylvania has a formal SMS known as the Multi Agency Safety Team (MAST). MAST contains many sub teams that target specific areas. One of these sub teams focuses on data. It looks at the data that is collected and explores ways to improve data quality and collection methods.

Pennsylvania's MPOs and RPOs enter into an annual Unified Planning and Work Program (UPWP). The UPWP is managed by the Center for Program Development and Management, a bureau within PennDOT's Office of Planning, and contains the projects that the MPO or RPO will accomplish that year. These projects include traffic and HPMS data collection for the department as well as participation in Pennsylvania's SHSP. Tasks involved with participating in the SHSP include conducting data collection and analysis; identifying problem location and developing and assessing strategies; and reviewing interim and final plans.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

While state-owned roadway and traffic data are stored in RMS, and crash data are stored in a separate system, these data can be integrated because the data are all stored using the same identification key (county/state route/segment/offset). As a result, the crash system can download needed roadway and traffic data (e.g., pavement type and width, shoulder type and width, median type, etc.) and store these data in the system's database. With the roadway and traffic data, the crash system can normalize the crash data and produce high crash identification, crash clusters, etc.

Pennsylvania has approximately 72,000 mi of non-federal-aid roads owned by 2,564 municipalities. These roads are not included in RMS or in the department's GIS system. Roadway and traffic data are collected on the 3,300 mi of municipal owned roads on the federal-aid system; the crash data on these roads is not being integrated. However, 60% of all crashes take place on PennDOT-owned roads.

PennDOT's GIS contains roadway and traffic data for all state owned roads and municipal owned roads that are on the federal-aid system. Crash data for all state-owned roads is also included in GIS. Roadway data on the nonstate system roads that are on the federal-aid system is collected and stored in RMS. These data are obtained in one of four ways: from PennDOT if the road is being "turned back" to the municipality; from the request to add a municipally owned road to the federal-aid system; HPMS annual data collection or videolog of the road. If a road is on the federal-aid system, it is automatically included in Pennsylvania's traffic collection program. Crashes on nonstate system roads are reported by the police to PennDOT like crashes on state-owned roads.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

No response.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

Historical roadway and traffic data are stored in RMS. Roadway data for state owned roads are kept historically from the time when the road was constructed. Some historical roadway data for the nonstate system are stored in HPMS. HPMS data are easily retrievable back to 1993. Traffic data for state-owned and nonstate-owned roads on the federal-aid system are available back to 1978. Historical crash data are available back to 1977 and the past 10 years of crash data are available online. It is currently difficult to link these databases to obtain historical data.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

PennDOT has 11 district engineering offices. Each district office has an RMS coordinator that is responsible for entering data into RMS. This type of system can have consistency and accuracy issues due to the data quality being dependent on the RMS coordinator. Traffic data are collected by using MPOs, RPOs, PennDOT district offices, and vendors. There normally is not an issue with accuracy, consistency, or completeness. Occasionally there is an issue with timeliness of receiving the data. Pennsylvania has 1,280 police departments of varying size. Training is provided to the police departments on completing the crash form but with this many departments, consistency and accuracy can sometimes be problematic. Completeness of crash data can be a problem in that PennDOT does not have a way to check if all reportable crashes have been reported.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

The data needed the most for the traffic and crash systems are on local roads. BPR recently completed a research project to determine the number of sites where traffic should be collected on the Commonwealth's 72,000 mi of municipally owned roads. Since it is not possible to collect traffic data on all 72,000 mi, it was determined that 7,200 counts could be taken and would be statistically significant. The research project also provided randomly selected sites within each county to take these traffic counts. BPR is working on a system to collect, process, and store these counts.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

The Bureau of Highway Safety and Traffic Engineering (BHSTE) and BPR have developed the Crash Data Analysis and Retrieval Tool (CDART). CDART provides highway safety engineers, traffic engineers, and police departments with the capability to analyze data and prevent fatal crashes. It is a fully integrated system with a direct link between queries and mapping. CDART provides accurate crash location identification and is available on PennDOT's intranet allowing data and reports to be communicated between several departments in various locations within seconds. Previously, a meeting had to be scheduled at PennDOT's headquarters in Harrisburg with a database administrator to obtain data. CDART analyzes crash data that is used for highway safety prioritization but the data are now available for all PennDOT projects and operations.

BHSTE currently has a research project to determine if there are new and better GIS tools to help analyze crash data and to combine these data with other sources of data. The bureau also has projects to better define clustering and to create more data mining tools for CDART.

PENNSYLVANIA DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X				X	
Pavement/shoulder type	X				X	
Capacity		X			X	
Geometrics	X				X	
Intersection—lanes, signalization (PennDOT does not own traffic signals)	X				X	
Lighting inventory			X			X
Guardrail inventory	X					X
Pavement striping			X			X
Signage inventory	X					X
Rail crossing information	X				X	
Pavement friction	X				X	
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	X				X	
Construction zones	X					X
Ramp geometrics/characteristics	X					X
Videologging	X				X	
Other						
Traffic Data						
AADT	X				X	
AADT trucks	X				X	
Congestion		X			X	
Average speed		X				X
Travel characteristics—hour, day, holiday, month, annual	X				X	
Intersection turning movements		X				X
Other						
Crash Data						
Spatial location		X				X
Crash record information	X			X		
Other						

Wisconsin Department of Transportation Perspective

MARTHA FLOREY
SUZIE FORD
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INTRODUCTION

The Wisconsin DOT (WisDOT) is an umbrella agency composed of units responsible for planning, constructing, and operating state roadways and other transportation modes, managing aids to nonstate network roads, managing driver records, vehicle registration and crash data, and WisDOT also houses state highway patrol operations and the state highway safety office. WisDOT has a central office and five regional offices.

WisDOT is the repository of all state crash, citation/–conviction, driver license, vehicle registration, state and local roadway asset, and traffic data. The University of Wisconsin Traffic Operations and Safety (UW-TOPS) lab has assumed an increasing share of WisDOT's Safety analysis responsibilities over the past few years.

VALUE

Question 1: What is the value to your agency of integrating roadway, traffic, and crash data in the context of your asset management and safety management functions?

The integration of multiple layers of data creates new information and identifies relationships between variables. Integrated data permits more sensitive identification and factor analyses of safety issues and normalization to identify at-risk characteristics and locations.

Because crash causation and outcomes are multifactorial, encompassing both sociocultural, and environmental factors, the integration of layered data provides the information upon which valid analyses may be based. This is particularly true in the arena of human behavior, which is the primary (85% to 95%) cause of crashes.

Question 1*a*: In what specific activities does/will this information result in better, more informed, fact-based decisions, e.g., program development, investment decisions, determination of countermeasures?

Integration of these databases permits normalization of crash data to establish rates, using traffic volumes, vehicle mix, length of roadways, etc., on all roadways. It allows linkage of roadway geometrics to crash experience for the selection of more closely tailored countermeasures in resource allocation. For example, geometrics can be used to identify where median barriers, curve radius, sight distance, etc., may be a factor in crash causation. Business areas and functions that will benefit from data integration are:

- Roadway improvement program—development/investment decisions:
  - 6-year program, 3-R program project selection;
  - Determine accurate economic value cost/benefit analyses;

  - Target hot spots, then establish appropriate countermeasures for each; and
  - PMS and BMS.
- HSIP and hazard elimination safety (HES) engineering projects:
  - Targeting highest benefit–cost value of proposed improvements;
  - 5% locations; and
  - HSIP and STIP.
- Behavioral HSP—behavioral activity selection and supporting 1- to 3-year program/project plans (strategies include education, enforcement, emergency response, etc.):
  - Identify high-risk behaviors, groups, locations "targeting";
  - Countermeasure selection;
  - Program and project evaluation; and
  - Section 408 Traffic Safety Information System Improvement Plan.
- SHSP:
  - Nucleus for an SMS to begin integration of data for analyses; and
  - Nucleus for coordination of various safety planning efforts.

Internet access to crash and other safety-related crash data and analytical tools will result in faster and better management decision making. The UW-TOPS lab has worked with WisDOT to develop the Internet WisTransPortal with multiyear plans to build a data warehouse containing crash, traffic, injury, and other data with improved content, functionality, and accessibility. This information and decision tool warehouse will help WisDOT and local planners establish priorities for improvements in safety data collection, management and dissemination.

Question 1*b*: Have you assessed the value of this information in regards to the benefits of better decision making? Do you have a formal business plan for identifying and prioritizing data collection–management activities?

Question 1*c*: Do you have a formal SMS? If so, please describe.

The 2006–2008 SHSP identified more effective decision-making processes/SMS as a top-10 issue area project. However, Wisconsin has not performed a formal assessment of WisDOT safety decision-making or institutional issues. The 2007 HSP has set aside funds for training of data users and safety analysts; needs assessment will be the first task for this project.

Roadway data collection priorities and data management activities are mandated under Wisconsin state statutes and governed by administrative rules. Neither the State of Wisconsin nor WisDOT has a formal business plan that supports integrated transportation safety-related data collection priorities and data management activities.

The 2006–2009 Traffic Safety Information System (TSIS) Strategic Plan was written so as to institutionalize multiagency traffic safety data planning for the state. However, integration with other WisDOT IT planning efforts has been minimal and memorandums of agreement (MOAs) for coordinated planning were not signed within WisDOT. The TSIS strategic plan followed NHTSA's Traffic Records (TR) Guidance and, because of the required benchmarking, concentrated on data collection rather than data management or analysis improvements; although it supports some projects in the latter areas.

Question 1*d*: How is integrated information used in your agency's project management and program development activities including your safety improvement program?

Historically, Wisconsin's HES program was not data-driven; it allotted funds on a first come, first serve basis. It was unable to spend down its set-aside funds. Currently, crash rate per hundred million VMT (HMVMT) and intersection crash rate are used.

The WisDOT Meta-manager system combines safety, traffic, and roadway data in order to assess safety concerns, scope, and program projects to facilitate an accelerated design process where staff use flags raised in "Exception to Standards Reports." This is FHWA approved and is in the WisDOT Facilities Development Manual.

Question 1*e*: Are your safety and planning (or data) offices coordinating on the development of the state's SHSP or traffic records plan?

There is no formal coordination between WisDOT safety and planning staff except through the Traffic Safety Council (TSC) and the Traffic Records Coordinating Committee (TRCC). There is no traffic records position in WisDOT. Traffic records coordination has been performed for many years in a fractured and inconsistent manner. WisDOT planner participation in TRCC strategic planning was informal and not extensive. SHSP development was led by State Highway Safety Office (SHSO) and was episodic rather than institutionalized as an on-going process.

TSC and SHSP

The SHSO is a unit within the Division of State Patrol's large Bureau of Transportation Safety (BOTS). The state safety engineer is in a unit in the Division of Transportation System Development's Bureau of Highway Operations, and the Bureau of Planning (BOP) is in the Division of Transportation Investment Management (DTIM). The BOTS director chairs the TSC, BOTS staffs it, and the state safety engineer and the HES program manager from DTIM/BOP are members. Their major work to date is the development of the 2006–2008 SHSP.

TRCC–TSIS Strategic Plan

A member of the BOTS staff has chaired and convened the TRCC since 1999, and has been responsible for developing of the 2000, 2002, and 2006–2009 Traffic Safety Information Systems Strategic Plans. This plan is developed and updated with input from data collectors, managers and users from many disciplines from all levels of government. Some members of the TSC overlap with the members of the TRCC, but this set of relationships is not institutionalized, and information flow has been minimal.

CURRENT SITUATION

Question 2: Please provide a brief history of the status of the integration of roadway, traffic, and crash data in your agency.

Question 2*a*: Please briefly describe the technical infrastructure of your agency's roadway, traffic, and crash databases.

The State Trunk Network (STN) system is a mainframe DB2 CICS application. Oracle is used to create the centerline and shape files for the network.

For nonstate roadways, the Wisconsin Information Systems for Local Roads (WISLR) is a web-based, GIS, client–server application using Java, Business Objects, VB, ArcObjects, ArcIMS, and Oracle PL/SQL. The On/At with offset linear reference method used in this application is a simple, standardized way to identify the location of roadway data such as pavement ratings and surface type. Most roadway sections are easy to describe using this method.

The traffic database uses Oracle and proprietary software, TRADAS, to process and validate all continuous and short duration volume, speed, classification, and WIM data. The system generates daily, monthly, and annual statistics required by FHWA.

The state accident file is a DB2 relational database. Data from police-reported crashes are extracted into SAS extracts which contain four datasets: accident, occupant, vehicles and objects. Crash reports, both paper and electronic, are imaged and kept for a period of 4 years in the Division of Motor Vehicles/Traffic Accident Section.

The Meta-Manager Management System has integrated corporate STN data (e.g., roadway, safety, traffic, pavement, bridge, function, etc.) for the past 8 years in order to appropriately manage Wisconsin's highway assets.

Question 2*b*: Are these databases formally integrated? If so, how are the files linked? Have you created a safety data mart or data warehouse? If so, what is included?

The state roadway system contains county trunk highways and above with a handful of local roads. The nonstate roadway system, WISLR, has a background layer of the state highways used for spatial and On/At intersection reference

The state and nonstate roadways are spatially integrated in WISLR. State highways in WISLR do not contain roadway attributes or necessarily the same state link-IDs carried in the state system.

Over the past year, traffic data was integrated on state and nonstate roadways. This effort required manual efforts to connect traffic and roadway data. Traffic AADT is linked to the state system using "from and to" reference point (RP). Traffic AADT is linked to the WISLR system using traffic "site IDs". New sites on the local roads will require a manual effort to add the traffic "site IDs" to the local roadway location.

Crashes are currently located on the state system by post-processing crash reports using RP coding to link to the state trunk network. Accuracy and completeness are problems, even with recently adopted processing improvements. A research study by the University of Wisconsin Traffic and Operations Safety Lab (UW-TOPS) has automatically located historic crashes on the nonstate system in one jurisdiction, and will be expanded statewide.

WisDOT has no safety data mart or data warehouse. The WisTransPortal Internet data warehouse at UW-TOPS contains crash data from 1994 to current. It is available to certified users. The main data sources in the WisTransPortal at this time are:

1. DMV crash data, 1994 to present. Includes a complete copy, in Oracle, of the four SAS-based crash tables (accident, vehicles, occupant, objects) plus the RP-LINK information.
2. 5-min traffic detector data from the WisDOT Advanced Transportation Management System (ATMS) for Milwaukee, Madison and Wausau. This is separate from the TRADAS system, although there is some overlap.
3. RWIS weather station data, since the start of 2006, polled and archived every 5 min; although information for many stations are updated less frequently.
4. Milwaukee lane closure data. WisDOT is starting work soon on a project to develop a statewide lane closure permitting system, which will expand the database to include all statewide work zone/lane closure data that pertains to WisDOT operated roadways.
5. Traffic camera streams from Milwaukee. This is not really data in the usual sense, but is part of the intelligent transportation system (ITS) network.
6. There are plans to add Milwaukee county sheriff and state patrol incident data soon.
7. Transportal has shape files for the state and some of the nonstate roadways.

Question 2*c*: What are the major data integration problem areas for roadway, traffic, and crash data in your agency?

Every project has several components that are used to provide a framework for understanding the elements of risk that can affect the overall outcome of the project. These components include: time, resources, budget, technical, policies/regulations, and expected benefits. Not unlike our other state DOT partners, these elements are conditions in moving forward with the integration of roadway and crash data.

System stability and data quality are necessary for successful integration. WisDOT recently deployed a local road web-based GIS client–server system (WISLR) in 2002. Any considerations between state and nonstate roadway integration were dependent on the stability of WISLR. WISLR is on its fifth production year certifying local road mileage and has established a good reputation with our local government partners.

Relating accident data collection and crash coding processes will be critical factors in ensuring success for data integration with the crash system.

Question 2*d*: Are the data integrated with geographic information system technologies?

WisDOT state and nonstate roadway data and traffic data are integrated with ESRI GIS. ArcMap, ArcSDE, ArcObjects, ArcIMS and ArcInfo are GIS tools used to maintain, display, and edit the state and nonstate centerlines. WISLR, the nonstate roadway system, has the ability to draw Public Land Survey System (PLSS), hydrography, bridge, traffic site, and rail layer files.

The nonstate roadway data system, WISLR, combines the power of a statewide local roadway data system information with the flexibility of GIS to give the first comprehensive picture of local roadways in Wisconsin. WISLR serves as a gateway to data, maps, analytic tools and automated reporting functions to assist some 1,900 units of local governments with the management of the 100,000 local roads, streets, and highways under their jurisdiction. By incorporating GIS technology and graphing capabilities, local officials now have the ability to view trends in data that might otherwise go unnoticed.

Geocoded crash locations may be captured on the paper MV4000 police accident report or in the Traffic and Criminal Software (TraCS) electronic reporting software for inclusion in the state crash file. Law enforcement agencies are just beginning to use the GPS technology, so only a small percent of crashes come to WisDOT already geocoded. Crashes that occurred on the STN are manually coded with RPs.

Question 2*e*: In broad terms, do you have roadway, traffic, and crash information on the nonstate system? If so, how do you collect it?

WisDOT's WISLR application contains physical and administrative roadway attributes, traffic, and crash location (pilot).

Physical and roadway attributes are reconciled annually through the inventory and certification of local roads. Local governments report any mileage changes to WisDOT using subdivision plats, certified survey maps, or other legal documents.

Traffic AADT from the traffic program is linked to the nonstate system via traffic "site IDs". The collection cycle of traffic data varies based on AADT and functional classification.

A research study is currently underway by UW-TOPS that automatically locates crashes on the nonstate system. In its pilot year it obtained over 80% accuracy and will be expanded statewide as funding permits; but will only geocode the last 5 years of data.

Crashes that meet the reporting criteria are reported in the same manner and included in the state crash file for all public roads, regardless of whether they occurred on a local road or the STN.

DATA

Question 3*a*: Aside from the completed summary data table, are there any additional roadway, traffic, or crash data categories where your agency collects and uses data?

Wisconsin is a CODES (Crash Outcome Data Evaluation System) data linkage state. We have linked all Wisconsin hospital discharge records with all Wisconsin crash records since 1993, and also linked all emergency department records with all Wisconsin crash records since 2002. In the next couple of months 2005 linkage will be completed. We also link Wisconsin crashes to Minnesota hospitalizations. These data can be used to compare with law enforcement severity assessments and to provide a more accurate economic cost forecast for various crash types; the UW-TOPS lab has used them for a study locating median crossover crash improvements.

Question 3*b*: How do you maintain historical roadway, traffic, and crash data? How far back are data accessible? How do you maintain linkages between databases to integrate historical data?

The state system has yearly extracts dating going back from 1993 to present.

The nonstate system has yearly extracts from 1980 to 2002 that uses road segment numbers to link the yearly extracts. From 2002 forward, yearly extracts use route names to join the files.

Traffic data has historical annual statistical data back to 1992. The traffic data utilizes TRADAS software. Some detail hourly data gaps exist due to software system upgrades.

Crashes are maintained in the DB2 relational database for 4 years unless they involve a safety responsibility in which case they are kept longer. SAS extracts are kept back to 1987; some pre-1987 Mark IV crash data files are available. There is linkage between old to current (10 years of RP data are kept) but could also use On/At.

Question 3*c*: Data quality includes factors such as timeliness, consistency, completeness, accuracy, accessibility, and understandability. What data categories have significant data quality problems in your agency? Are there differences between state and local agency system data?

Based on the Characteristics of Data Quality definitions, there are no quality concerns for state, nonstate, or traffic data programs. These programs conduct annual meetings that include the program coordinator and field collectors. The focus of these meetings is on process improvements, uniform data collection practices and policy.

Accessibility has been identified in both the 1999 and 2005 TR assessments as a major problem for WisDOT. For law enforcement or public health users, timeliness of crash and traffic data is an issue. Local traffic data are not as complete as STN traffic data. For local planners, precision is a problem when relating to a generally more precise local GIS. Consistency may also be a problem. NHTSA provided Wisconsin with a MMUCC (2003 edition) evaluation of the Wisconsin Motor Vehicle Accident Report in June 2006. Preliminary numbers show that the current form contains 35 of the 43 open field elements (81.3% compliant). With the advent of MMIRE, Wisconsin may not be consistent with the model roadway elements. The new (2006) EMS run data are National Emergency Medical Services Information System- (NEMSIS) compliant.

State System

There are two types of data that are collected and input into the database. The two types of data are length data and point data**.** Length data are data that are measured. Point data are data that occur at a point.

Examples of length data include

- County,
- Municipality,
- Divided/one-way determination,
- Median type,
- Median width,
- Shoulder type,
- Auxiliary lane type,
- Traveled way,
- Maintenance jurisdiction (municipal extension and connecting highway),
- Access control,
- Access control log,
- Surveillance systems,
- Federal urban area,
- Functional class,

- NHS,
- NHS route segment number,
- Corridors 2020, and
- Long truck route.

Length items have distances that vary. As a rule, length items must be measured for segments of 0.03 mi or longer. Staff does have the ability to record changes to segments as short as 0.01 mi if they wish.

Examples of point data are

- Intersections,
- Structures,
- Railroad crossings,
- Milepost, and
- Lightpole.

STN inventory data collection includes

- County,
- Municipal code,
- Divided/one-way/undivided,
- Median type,
- Median width,
- Average lane width,
- Number of lanes,
- Left shoulder type,
- Left shoulder width,
- Right shoulder type,
- Right shoulder width,
- Right shoulder paved width,
- Right shoulder total width,
- Left auxiliary lane type,
- Left auxiliary lane width,
- Right auxiliary lane type,
- Right auxiliary lane width,
- Traveled way,
- Intersections,
- Structures,
- Railroad crossing,
- Milepost,
- Light pole,
- Municipal–extension/connecting highway,
- Access control,
- Access control log,

- Surveillance system,
- Federal urban area,
- Functional class,
- NHS,
- NHS route segment number,
- Corridor's 2020,
- Long truck route, and
- Strategic Highway Network (STRAHNET).

Nonstate (WISLR)

WISLR provides local governments and WisDOT convenient access to data that help to enhance local transportation and-related planning decision making. Physical and administrative roadway attributes are collected and maintained to certify local road mileage. The primary purpose of the data is to assist in the distribution of approximately $390 million in General Transportation Aids (GTA) to local governments.

WISLR offers local government access to key data and tools for improved decision making. Local governments can control the quality of their local road information by updating data in real time and correcting errors as they are discovered. Data accuracy has improved; local officials are more familiar with local conditions. Graphing capabilities give local officials the ability to view data trends that might otherwise go unnoticed and provide them with graphics to enhance presentations.

In the past year, implementing crash process improvements have addressed known timeliness concerns.

Improve Crash Location Data and Processes—Move RP Assignment to WisDOT

Improving crash location data and the timeliness of assigning location data have been identified as keys to improving both quality and utility of crash data. This shift in responsibility is expected to provide a two-fold (two times) decrease in turn-around time for geocoded (RP-coded) STN crashes.

Improve Data Availability and Processes—Create Working Crash Extracts with Cumulative and Up-to-Date Data

Run the monthly data extracts, so that the extracts are cumulative (incomplete crash data for more recent months) which will decrease the time between incident and crash data availability to the data user.

Promote Electronic Crash Report Data Collection

Promote the use of automation for data collection in the field to improve the accuracy, timeliness and reliability of crash data. A new data entry system, TraCS, collects the data electronically and allows the data to be uploaded to the mainframe DB2 accident database, eliminating the need for manual data entry and reduces handwritten errors by the officers or misinterpretations by DOT data entry staff.

Conduct Law Enforcement Training

Training of law enforcement and other data collectors on how to correctly fill in the location data, so that needed information would not be omitted and abbreviations would not be used. The training would also cover how accurate and complete information would be an added benefit to the reporting agency.

Question 3*d*: What roadway, traffic, or crash data do you most need but do not have?

- Ability to link geometric attributes to roadway crash data.
- Availability of better vertical/horizontal curve data.
- Expanded classification/truck volume data (do not have because technology has not been available to collect the data non-intrusively for urban areas). It has only been in the last couple of years that FHWA will accept length-based class in lieu of axle base. There is more acceptance today with collecting and classing with more generalized bins, e.g., passenger vehicle, small truck, large truck.
- Means to automatically link crash location to state and nonstate databases.
- Establish and implement crash location reference standards:
  - Establish a finite set of location reference methods that support all roadways which can be easily translated to other forms to allow programmatic solutions and/or reduce data sharing efforts, thus, reducing the user's need to reenter data. The process should at least establish one key linear location method (recommendation: On/At-Towards) and one two-dimensional location method (recommendation: latitude/longitude).
- Feasibility of using the On/AT-Towards method with the MV4000:
  - Conduct a pilot program to assess the feasibility of capturing sufficient On/AT-Towards data with the MV4000 (accident report). The changes are expected to reduce crash location errors and reduce the time to provide quality location data to end users. This improvement would involve training and testing with law enforcement at both the state and local level.

Question 3*e*: What data categories do you believe provide the greatest benefit to your agency?

The majority of WisDOT respondents felt this would depend on the analysis needed.

ANALYSIS

Question 4: These data can be used for project planning, program development purposes, but also for statewide business policy evaluation and strategic planning activities. What tools and processes do you employ in your analysis of integrated roadway, traffic, and crash data (e.g., high accident identification, cluster analysis, data mining, GIS display)?

Question 4*a*: What techniques have been particularly useful? Please provide examples of how this has improved agency decisions, such as safety program development, countermeasure selection, and/or changes in policy.

Wisconsin Meta-Manager Safety Information System

This system consists of a three-part systems-level analysis using crash, roadway, and traffic data. Initially, every mile of the STN is placed into one of 10 functional peer groups so that baseline crash statistics (e.g., mean, standard deviation) can be generated for "like" roadways using statistical process control techniques to calculate baseline and standard deviation methods of grouping similar roadways to compare apples to apples.

Based on before/after analysis of prior year safety projects, program of counter-measures will be selected using current year meta-manager analysis.

Traffic and Criminal Software (TraCS)

Wisconsin has adopted the TraCS data collection software application developed by the state of Iowa in partnership with the FHWA and has incorporated this automated data collection into its citation tracking system and its crash data entry system. TraCS licensing is available to enforcement agencies at no cost. Funds for hardware and IT costs are included in Wisconsin's HSP and the TSIS Strategic Plan for the roll-out of TraCS and integration with the Citation Tracking Project and the Wisconsin Justice Information System Project through 2009.

The current Badger TraCS suite of forms includes the Wisconsin Motor Vehicle Accident Report, the Abbreviated Car/Deer Report, Amended Accident Report, Driver Information Exchange, Warning Citation, Uniform Traffic Citation, and Municipal Citation, Alcohol, and Attachment forms. Common data can be shared among these forms and TraCS is capable of incorporating other technologies such as bar code scanners, digital cameras, wireless communications, GPS, mobile printers, and pen-based computers. It also permits external search capacities and export of data from TraCS to the agency's Records Management System (RMS), and to the Wisconsin Courts and the Division of Motor Vehicles.

Examples of Behavioral Programming Analyses

- 12-year trend analyses of crash, KA (Killed or Incapacitated) law enforcement flags and driver characteristics used for objective and program development;
- Annual targeting using 5 years of crash data and roadway and traffic data; and
- Crash trend and factor analysis for policy and project development.

Question 4*b*: What additional analysis capabilities would you like to have?

- Dynamic segmentation for locating crashes; to provide a more sensitive tool for crash location analysis, not restricted to predefined segments of roadway.
- Categorization of "preferred" engineering countermeasures would allow standardized implementation of types of safety improvements.
- A statewide roadway network that includes both state and nonstate highways would enable more timely, accurate, and consistent data collection that can be used for crash analysis.

- One of the key hurdles in identifying unsafe intersections and roadways in Wisconsin is the lack of a complete crash location map, especially for crashes that occurred on local streets whose locations are normally coded by on- or at-street names. UW-TOPS lab developed a system to automate the mapping of Wisconsin local road crash locations. The location mapping algorithm involves the integration of two separate WisDOT databases: the Wisconsin crash database of police traffic accident reports and WISLR. The application of WISLR, which includes an inventory of local roads such as traffic information, pavement condition, and roadway geometry, provides invaluable access to more comprehensive safety analysis. Although the methodology introduced is specific to the two above-mentioned databases, the general ideas can be applied to any similar sets of crash and GIS databases.
- The final result is a pinpoint map of all the intersection and segment crashes that occurred on local roads in Wisconsin, along with the complete crash information associated with each mapped crash. The algorithm developed with this methodology is able to map approximately 79% of the intended pool of available crashes. Quality evaluations indicate that the mapping is almost 98% accurate.

- Push-button tools deployed to local engineers and planners to access the data and complete crash analysis.

Additional WisDOT Safety Analysts positions and training to perform analysis

ADDITIONAL WisDOT CONTRIBUTORS

- John Corbin, State Traffic Engineer, Bureau of Highway Operations;
- Phil DeCabooter, Chief ITS Engineer, Bureau of Planning;
- Terry Woodman, Engineering Technician, UW-TOPS;
- Xiao Qin, Associate Researcher, UW-TOPS;
- Brad Javenkoski, Program and Planning Analyst, Program Development and Analysis Section;
- Mike Schumacher, Program and Planning Analyst, Program Development and Analysis Section;
- Scott Erdman, Statewide STN/HPMS/Deficiency File Coordinator, Bureau of State Highway Programs;
- Kelly Schieldt, Statewide Local Road Coordinator, Bureau of State Highway Programs;
- Paul Stein, Manager of TDS, Bureau of State Highway Programs; and
- Mary McFarlane, Business Automation IS Support, DMV–Traffic Accident Section.

WISCONSIN DATA TABLE

Please indicate with an "X" the degree to which your agency has complete data for specific roadway, traffic, and crash data categories. Please indicate if there are other data categories that apply.

Data Category	State System			Nonstate System		
	Full	Partial	None	Full	Partial	None
Roadway Data						
Lane/shoulder widths	X			X		
Pavement/shoulder type	X			X		
Capacity	X					X
Geometrics (HPMS SAMPLES ONLY)		X				X
Intersection—lanes, signalization	X			X		
Lighting inventory	X					X
Guardrail inventory	X					X
Pavement striping						X
Signage inventory						X
Rail crossing information	X					X
Pavement friction						X
Pavement distress indicators—e.g., rutting, shoulder drop-offs, roughness	X					X
Construction zones	X					X
Ramp geometrics/characteristics	X					X
Videologging	X					X
Other—functional class, ROW,				X		
Other—pavement rating, pavement year, sidewalk, curb parking					X	
Traffic Data						
AADT	X				X	
AADT trucks		X			X	
Congestion		X				X
Average speed (speeds 55 and higher)		X				X
Travel characteristics—hour, day, holiday, month, annual	X				X	
Intersection turning movements						
Crash Data						
Spatial location		X				X
Crash record information	X			X		
Other—codes linkage crash/hosp/ED	X			X		

BREAKOUT GROUP 1

Plans and Decisions to Improve Data Systems for Performance Measurement

SUE MCNEIL
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Federal Highway Administration, Group Leader

PARTICIPANTS

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- Robert Pollack, FHWA, Group Leader;
- Jack Benac, Michigan DOT;
- Peggi Knight, Iowa DOT;
- Jianming Ma, DDOT;
- William McGuirk, District DOT;
- Francine Shaw-Whitson, FHWA; and
- Ronald Vibbert, Michigan DOT

The group was assigned the following themes to discuss: Data Integration – Existing Situation and Data Management Challenges. The discussion is presented in terms of observation and action items, which are documented below. Two NCHRP research statements were developed along with a proposed synthesis project and a proposed peer exchange.

DATA INTEGRATION: EXISTING SITUATION

Observations

Based on the presentations and documentation provided by nine individual states, our group discussion identified concerns and themes as follows.

- How do we generalize? The strategies and experiences presented draw on business models and organizational structures specific to individual states. Given this high degree of situation specific information, how can we develop general concepts with applicability to all states?
- What are the questions that states should be asking to better understand the different opportunities for data integration? These questions will vary depending on what technology the state is using, where the state is in the integration process and the type of systems in place. One frame of reference that could potentially assist states in determining the benefits of integration would be to address the question: What business practice will data integration allow me to implement or improve?

- What are the requirements that we are satisfying by integrating data? Many in the group believed that it was important to determine what the problem that integration is trying to solve is.
- Interest in the group identified a strong need to develop common definitions for terms. For example, what do we mean by integration? Do we need to distinguish between integration and interfacing data? Integration is the ability to link different data sources. If a state is able to satisfy their business needs, it does not matter if you integrate your data or simply interface your data. In other words, it is not important for the user to understand if the data they are working with is a primary or secondary source. Similarly, we need to make sure we clearly define terminology such as warehousing and legacy systems. Are we using the terms as a concept or a process?

Many in the group felt that it was important to document experiences with data integration through migration, providing examples of data warehousing practices and strategies for dealing with scale issues (such as dynamic segmentation). It was also pointed out that describing best practices may be counterproductive as constraints or context are important elements in solving a specific problems including the need to define objectives/desired results/business needs.

It was proposed to describe this process as documenting "design choices" and "viable options" rather than best practices.

Action Items

Based on the discussion, two specific action items were identified:

1. Update and promote FHWA's Data Integration Glossary (See http://isddc.dot.gov/OLPFiles/ FHWA/010394.pdf. Accessed 10/4/06.). This glossary provides common definitions and terminology. The glossary should be reviewed and updated as needed and circulated as appropriate. Many members of the group were unaware that the glossary existed.
2. Document experiences of different agencies with the following topics. The documentation would be in the form of a synthesis of "design choices" covering the following topics:
   - Scale issues: Dynamic segmentation lets you determine the presence or absence of features at a particular location based on definitions of the beginning and ending locations of the feature. Such features include line marking, guardrail, pavement treatments, number of the lanes and treatments such as rumble strips. These features are required to do safety analysis.
   - Temporal issues: Matching the roadway features and weather conditions to the specific time of a crash requires time stamping the data. Most agencies maintain snapshots of conditions and historical analysis requires extracting data from these snapshots. This design decision is related to tradeoffs between processing time versus storage.
   - Capturing data on highway features – much of the data on highway features is lost with the original plans. In addition, new types of data and safety features such as

pedestrian countdown signals, rumble strips and active animal crossing warning systems need to be captured both temporally and spatially.

A proposed synthesis topic was developed and is included on page 124.

DATA MANAGEMENT CHALLENGES: INSTITUTIONAL ISSUES

Observations

All agencies have to deal with legacy systems. This is a particularly important institutional issue as agencies are unable to hire staff to work with these systems. The real challenge is developing a migration plan to move from the legacy systems. An effective plan recognizes that migration is part of the cost of doing business, is responsive to the business needs of the organization, integrates appropriate new technology, and assigns priorities to action items. There are many different viable options for dealing with legacy systems. As numerous agencies still have to face this issue, documenting these options would be of value.

Similarly, all agencies have to deal with data quality. It is important to differentiate between good data that agencies do not have access to (due to their inability or to ownership issues) and data that is accessible but does not reflect the actual situation, or is out of date.

Timeliness is also an issue. Good data quality is derived from a process: define what you need, develop performance specifications, implement and monitor. Examples include

- Technology also plays an important role in data quality. Data collection tools have great potential to assure quality and automate as much of the data collection as possible. For example, data capture using the ubiquitous cell phone rather than paper and pencil data collection is one mechanism for avoiding errors and making the process seamless. However, data capture mechanisms needs to be a conscious design decision.
- Built-in edit checks and validations can be used to automate the checking process. For example, one city was found to have seven data entry errors per crash record but when each field was automatically checked at the time of data entry the number of errors went down to 0.4 errors per crash

The AASHTO Data Collection Guide for Roadway Data (Asset Management Data Collection Guide, AASHTO-AGC-ARTBA Task Force 45 Document, AASHTO, Washington D.C., 2006) serves as a good starting point for exploring mechanisms to improve data quality.

Members of our discussion group had all successfully integrated maps with their data. Various members made the following observations:

- To a limited extent, other media such as video and photos was perceived not to be a difficult problem.
- All business data should have a location reference since the location reference serves as the principal mechanism for combining or linking the different types of data.
- One of the more important challenges is maintaining these data.

- Some consideration should be given to standards for data depending on the purpose and use of the data. For instance, data used to design construction projects usually need to be more precise than data to determine when guardrail inspections should be conducted.
- Standards would also provide benefits in the interchange of data from diverse sources and the management of the volume and quantity of data.

Historical data are typically maintained for retrospective analysis and developing deterioration and prediction models. In determining how much data to archive and how much data to store, a plan for storing and accessing the data must clearly identify objectives and business needs. Historical data are generated because of temporal changes in the assets, new versions of software, and new data collection procedures. Maintaining access to historical data is again part of the cost of doing business.

Much of the discussions centered on the need to clearly define objectives, and develop a plan for data integration that reflects the legacy systems in the organization, new and evolving technologies, opportunities to build on past experiences, the need for ongoing training, and frequent institutional change. The following observations were made:

- A technology plan needs to link to applications, business process and business requirements. The plan should recognize that many of the barriers are not technological but institutional.
- Training is a key component of integration and comes in many different forms including training by vendors, scanning tours, and workshops. Training may target a particular group (for example, law enforcement officials), or a particular technology (for example, global positioning systems).
- In the context of ongoing institutional change, plans need to focus on the gains from involvement and commitment to the process of data integration. Finding champions, getting buy in, and enlisting stakeholders are important elements of the process.
- Interoperability can be a significant issue when different vendors do not release file formats and individual data owners do not understand the value of data sharing.

Action Items

Based on the discussion, members of the group listed four specific action items:

1. Promote the AASHTO Asset Management data collection guide. *FHWA, AASHTO and TRB Committees.*
2. Develop a synthesis of
   - Viable options for dealing with legacy systems including concepts of integration and interfacing, and running parallel systems;
   - Technologies for data capture;
   - Strategies for automated edit checks; and
   - Examples of integrating different types of media documenting the configuration and condition of the assets to support SMSs. This would include the design decisions to support these alternative media and the limits on quality and quantity (for example, what is the appropriate resolution for storing digital photos.) Note: A proposed synthesis topic

and a proposed peer exchange were developed and are included on pages 124 and following.

3. Develop guidelines for conducting business process reviews including the role of technical assistance teams to help conduct reviews. Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled Guidelines for Conducting Business Process Reviews for Successful Data Integration Projects to Support Asset Management and SMSs which is included on page 108.

4. Propose recommendations for developing IT projects to function in an open architecture. This includes dealing with issues of ownership of data, open architecture and interoperability. The project will also address the role of different jurisdictions including locals. Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled Open Architectures to Support Data Integration Projects which is included on page 111.

BREAKOUT GROUP 2

Integrated Systems for Accessing, Analyzing, Displaying, and Reporting Data for Measures

JACK STICKEL
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VICKI MILLER
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PARTICIPANTS

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- Vicki Miller, FHWA, Group Leader;
- Kenneth Campbell, TRB;
- Ralph Craft, FMCSA;
- Jeffery Ely, Mississippi DOT;
- Laine Heltebridle, PennDOT;
- Bill Hunter, PennDOT;
- Ron Martindale, ADOT&PF; and
- Jeff Pierce, Mississippi DOT.

SUMMARY OF THEME DISCUSSIONS

Data Integration: Existing Situation

Methods to Integrate Roadway, Traffic, and Crash Data

- Location reference translated to a common location key
- Multiple location referencing methods are viable

Major Impediments to Achieving Enterprise Data Integration

- Getting local agencies to participate;
- Perceived different business needs among stakeholders, especially between state and local government;
- Lack of governance models
- Inconsistent/incomplete metadata;
- Data collection plan incomplete or non-existent;
- Training and skilled technicians/programmers, especially with mainframe systems; and
- Data collection on all local roads.

Extent Data Are Integrated with Geographic Information Systems

- Most agencies making some progress in moving forward on GIS and data integration, and
- Varying degrees of success due to issues: institutional, technology, inventory program, and funding.

Data Categories Experiencing the Most Problems

- Crash locations, especially for local roads.
- Effective dates: road network changes, business data, inventory dates.
- Business processes for data collection.
- Road network segmentation.
- Agency business rules to cover road network changes.

Integrated Data Accessibility Across Organization

- Governance—who determines which groups have access to data/which types?
- Lack of intranet mapping capability.
- Broadband communication, especially rural areas.
- Technology availability.

Challenges from Partnerships with Local and Regional Governments

- Different inventory processes, i.e., right-of-way versus roadway centerlines.
- Different business needs for integrated data—may not keep all fields.
- Partnership agreement that spells out responsibilities, data transfer, quality checking, metadata, and other data stewardship issues.
- Frequency of data—real-time operational data versus periodic data collection.
- Location referencing.
- Completeness of data sets—some agencies may use summaries.

Value and Benefits of Data Integration

Decision-Making Scenarios with Greatest Payback in Using Integrated Data

- 511—small successes to these data, but enormous potential.
- Geodatabase design—build in linkages to external tables and files.
- Vehicle infrastructure integration (VII).

Effective Use of Shared Data

- Established governance model,
- Privacy safeguards,
- Access business rules, and

- Tailoring output to user needs—can bring user buy-in.

Effective Use of Integrated Data in Developing Highway Safety Countermeasures

- Data systems to support the before and after.
- Good handling of historical data, both road network and business data.

Additional Desired Analysis Capabilities

- Automated data linkages.
- Analysis that considers human elements, i.e., driver contributing factors.

Observations

- Everyone is making some progress in moving forward on GIS and data integration. Technological and institutional issues slow down progress, but a major inhibiting factor is a lack of data collection, including road centerlines, on local roads
- Increased data means there is a need to use smarter analysis tools or visualization techniques. Agencies may need additional players (technology, skilled analysts) and different/higher level analytical tools to help. There may be some useful tools out there that could be used if there was some technology/knowledge transfer, i.e., IHDSM.
- Agencies may have gone as far as they can in some areas, i.e., countermeasures without looking at areas such as driver behavior (listed as the contributing factor on the majority of vehicle crash reports).

Research Topics: Value and Benefits of Data Integration

- Jack Stickel (ADOT&PF): Synthesis of analytical approaches to visualizing roadway, traffic, and crash data integration. Inventory the types of questions agencies would like answered through visualization. Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled Synthesis for Visualizing Roadway, Traffic, and Crash Data Integration, included on page 113.
- Bill Hunter (PennDOT): Work with the local counterparts on why we need to do integration. How do we convince the locals to participate in statewide data programs? Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled How Do We Convince the Locals to Participate in Statewide Highway Safety Data Programs? included on page 115.
- Ralph Craft (FMCSA): Integrating driver behavior problems, especially pedestrian accidents, with roadway characteristics and crash data. Need to access other data sources such as citations. Note: A tentative research problem statement follows, titled Integrating Driver Behavior Factors into Roadway Safety Data. This research problem statement was identified as needing further definition and clarification before moving forward.
- Jack Stickel (ADOT&PF) and Ken Campbell (TRB): Look at institutional issues and approaches to dealing with barriers to access. How do we sell the value to agencies so they will buy in as a stakeholder? What is the potential value of increasing access to driver and vehicle records? Note: A tentative research problem statement follows, titled Approaches for Dealing

with Institutional Barriers to Data Access. This research problem statement was identified as needing further definition and clarification before moving forward.

PROPOSED RESEARCH PROBLEM STATEMENT: INTEGRATING DRIVER BEHAVIOR FACTORS INTO ROADWAY SAFETY DATA

Ralph Craft, FMCSA, USDOT

Problem

States use crash location data to help determine where highways and streets should be modified to prevent crashes in the future. In this type of analysis there is the unstated assumption the highways cause crashes. Crashes may be caused by poorly designed curves, confusing signage, dysfunctional traffic signals, lack of median barriers, deteriorated pavement, misplaced light poles, or many other problems.

However, we know that poor driver behavior can be a critical factor in causing crashes. Before deciding to make highway safety improvements, the crash data examined should include driver behavior data. It is important to know the percentage of drivers in crashes in any particular location that were fatigued, legally drunk, going 20 mph over the speed limit, etc. Highway engineers would want to prioritize their highway improvement safety projects not just on total crashes at specific locations, but by the number of crashes where highway safety problems played a role in the crash.

Thus, it is important that driver condition entering the crash envelope and driver behavior with the crash envelope be integrated with other data about the locations where crashes take place.

Objective

The objectives of the proposal are to assess

1. How many states integrate driver behavior crash factors with the location of crashes, and how this is accomplished; and
2. The impact of integrating driver behavior crash factors with crash location on the choices of highway safety projects to pursue.

The final product of the research would be a paper addressing these two objectives.

Key Words

- Driver crash facts,
- Crash location, and
- Highway safety projects.

Urgency/Priority

Driver behavior is a crucial element in a large majority of crashes. Ignoring driver behavior, when deciding which highway safety improvement projects to undertake, can lead to wasting critical highway safety funds.

Cost

Approximately $100,000

User Community

- State DOTs,
- AASHTO, and
- FHWA.

Implementation

The research should uncover good examples of integrating driver behavior into crash location information, and encourage more States to insure that driver behavior is a factor in allocating scarce highway improvement projects.

Effectiveness

Effectiveness would be determined by changes in highway safety projects undertaken that focused more on highway design, construction, and maintenance problems as opposed to crash locations where driver behaviors were the key factors. Effectiveness would be measured by (*a*) whether states shifted priorities as a result of adding driver behavior to the mix and, (*b*) whether highway safety improvement projects became more effective in cutting down on crashes.

PROPOSED RESEARCH PROBLEM STATEMENT: APPROACHES FOR DEALING WITH INSTITUTIONAL BARRIERS TO DATA ACCESS

Jack Stickel, ADOT&PF

Problem

Data availability and data access issues limit highway safety improvement analysis. This is particularly true for driver and vehicle records. Although some data types are protected by state statutes or confidentiality policies, most of the data should be accessible. There are multiple reasons for not allowing data access. Agencies may view data as confidential or protected when it is not. Agencies may view that information technology requirements to make the data accessible will cost too much in resources (time, funding). Agencies may feel there are no benefits for them to provide access to the data. Still other agencies may view their data source as the only correct view and are not interested in sharing or opening access to the data. Having open data access can reduce cost, increase analysis capabilities, and improve recommended solutions to transportation alternatives.

Objective

The objective of this proposal is to develop strategies that can be used to get agencies to open database access for transportation data and in particular, driver and vehicle records.

Key Words

Data access, data integration, confidentiality policies, value of data sharing.

Related Work

The research would look at effective state transportation agency programs for opening up data access and data sharing.

Urgency/Priority

Access to driver and vehicle records is an important consideration in determining crash causal factors and proposing remediation options. Having a toolbox of benefit scenarios would be very helpful in selling the value of data integration and in opening up data access in transportation agencies.

Cost

$75,000

User Community

- HSIP,
- AASHTO,
- FHWA,
- NHTSA,
- Highway Safety Offices,
- EMS, and
- Injury Prevention Centers.

Implementation

A published document that (*a*) provides recommendations on selling the value of sharing data, and (*b*) includes specific scenarios that cover a variety of data areas: vehicle and driver records, crash records, and road network centerline coordinates are a few examples.

Effectiveness

Effectiveness would be determined by the success state transportation agencies have in improving data access and developing data partnerships for data sharing.

BREAKOUT GROUP 3

Advanced Technologies for Data Collection in Operations

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PARTICIPANTS

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- Leonard Evans, Ohio DOT;
- Martha Florey, WisDOT;
- Suzie Ford, WisDOT;
- David Ringeisen, Oregon DOT;
- Keith Sinclair, FHWA;
- Tom Welch, Iowa DOT;
- Mark Wills, Oregon DOT; and
- Anita Vandervalk, Cambridge Systematics, Inc.

Safety management has generally focused on the allocation of resources based on past performance while other physical asset management systems forecast performance into the future. For example, SMSs have largely focused on crash performance. The following questions were provided to the group to seed discussion:

- What types of processes does your agency use to allocate resources across safety, asset condition, and capacity considerations?
- Do you feel that current financial allocation processes make efficient resource allocation decisions between safety investments and other investment?
- In programming of resources for future roadway design improvements, does your agency typically make decisions on future traffic operations (congestion) or does future safety performance enter into decision making?
- What additional analysis capabilities or tools would you like to have available in your agency to better integrate safety resource allocation decisions with programming decisions based on results of physical asset management systems?
- What are common themes?

BREAKOUT GROUP DISCUSSION

The breakout group discussed the issues identified above and then went immediately into identifying research issues to support the integration of safety issues into the resource allocation process.

Methods for Integration of Data

The group discussed the technology needs for integration of physical assets and crash data. The group divided the collection and integration of data into two key components: field data collection and the office systems used to integrate management systems. On the field data collection side, the most problematic issue identified was locating crashes and recording crash information. Although some members suggested that GPS is the most desirable technology to assist in the locating crashes, there remain problems with the use of the technology. There are also good alternatives for recording and processing locations with respect to a referencing database. The group thought that a good synthesis of the state of the art along with documenting the benefits and costs of various technology solutions and locating approaches would be useful in helping to identify a cost effective approach for automating crash record data and location data collection. It was also noted that *NCHRP Synthesis of Highway Practice 350: Crash Records System* has limited information on the subject.

With respect to the office integration of management systems, there was a very lengthy discuss of business practices related to synchronizing crash and roadway databases. Many in the group felt that most agencies are moving toward a GIS environment for the integration of databases and a map-based interface is the most common and effective means of presenting and interpreting data. Inventory systems are often continually updated but are generally only annually verified and updated for physical changes to the highway system. Cycle times may be different for the updating of the system on the state highway system and of the roadway operated by local jurisdictions. Business rules for updating databases and synchronizing and verifying databases at specific times have implications on the ability to use the data to perform safety analysis. The rules have largely evolved through time at each agency and the group suggested that there is a need to identify best practices for these business rules.

Action Item: Two syntheses are needed. One is a state of the art of technology used to locate crashes and documentation of benefits and best practices. This should include an analysis framework to allow agencies to evaluate the financial and economic viability of various solutions. The second synthesis should document business rules used by transportation agencies to update and verify databases. Because each agency has developed these processes on their own, it is likely there will be best practices found at one or more agencies that can be adapted by others.

Integration of Safety Databases with Other Databases

Although many in the group tend to think in terms of integration of crash data with data on the physical roadway, there are several other databases that could be integrated. These include citation data, driver data, vehicle data, and data with respect to EMS. Information from each of these databases is required for comprehensive highway safety planning and analysis. For example, quality and timeliness of EMS is likely to impact the relative severity of crash when life-threatening injuries are involved. Driver state of health, driving experience and training, and other driver attributes are also likely to determine the outcome and even likelihood of a crash. A challenge is to determine which of these databases should be integrated with crash and roadway data and how to design the integration. For example, it may be more cost effective from a safety perspective to invest in a statewide driver education program or a campaign to arrest drunk drivers rather than building an interchange at a congested intersection. Integration of these disparate databases allows comparison across functional areas.

Research is needed to identify which category or categories of data is the most important and which offers the largest return to investment. Once the return is understood, priorities may be assigned.

Action Item: Conduct research to identify database integration that offers the greatest opportunity for improving safety performance. Once the most important integration challenges are identified, direction should be developed to integrate these databases and some guidance is required regarding the analysis that the integration provides.

Examples of Improvement Through Integration Across Silos and Across Jurisdictions

There are several examples of how integration across functional silos and organizational boundaries has resulted in better services and systems. These can be used as examples for benefits that are possible through integration of safety systems with other databases. Some of the examples that the group identified were

- Efforts across private and public agencies to create 911 information services;
- Several states including Michigan, Ohio, Iowa, and Oregon were thought to be examples of states that have made data integration a priority—the issue is then to determine what makes these states stand above and provides them with the direction to make integration possible; and
- Examples of cooperation across the lines between state and local government.

Action Item: Much of the information required to develop case study examples of the agency culture, management direction, and benefits of integration across functional silos and across agencies already exists. What does not exist is the summarization of this literature into brief examples that can be distributed to transportation agency managers. A literature review and summary of benefits of integration could be taken on by one of the University Transportation Centers or as a faculty directed graduate student research project.

How Is Asset Management Already Helping to Improve Safety?

Asset management practices are already enabling a number of improvements to the transportation system that in turn improve safety. For example, Ohio DOT uses its asset management systems to understand current conditions and forecast future conditions of the roadway. It also benchmarks the expected safety performance of roadways and intersections of common designs. Starting with current safety performance, Ohio DOT develops safety performance goals for highway segments and intersections categorized by various geometric designs. Ohio DOT is then able to compare safety performance goals with the actual safety performance and identify safety deficiencies for target funding. Through the asset management process, transportation agencies are also better able to coordinate their project plans, making them more efficient and removing conflicts that may result when project scheduling is decentralized.

Action Item: Conduct a synthesis of practice to document how agencies that have embraced asset management have also achieved safety benefits on their roadway system.

How Can Safety Compete on a More Level Playing Field with Investments in Other Physical Assets?

At the project level, planning and programming staff commonly takes into account the benefits and costs of making capacity improvements for congestion relief, improvements that encourage and promote economic development, and improvements that renew worn-out infrastructure. What is more difficult to take into account at the project level is future safety performance. Many in the group did not feel that this is due to a lack of analytical tools. Unfortunately, to many, the analysis tools seem to be shrouded by complex statistical procedures and methodologies. These methodologies should be made more transparent. There needs to be more awareness in the transportation planning community of the availability of methods to forecast future traffic safety performance and how to use results in planning decision making.

As an example, Chapter 4 of the AASHTO *User Benefit Analysis for Highway* manual (the red book) includes guidance on the incorporation of future highway safety benefits for project benefit–cost analysis. It also requires that the applying agency conduct its own safety analysis to adapt the methods outline to local jurisdictions. Although methods to forecast future highway safety performance exist, they are largely unused by the transportation planning community.

Action Item: A research project is required to understand what tools are being used by transportation planners to include safety in transportation improvement programming and planning and then to document the best practices. Then, existing methods used to forecast future safety need to be incorporated into an easy to use manual with numerous examples. The manual also needs to address how future safety performance can be integrated with other performance measure and goals. This manual can then become the focus of a training program for transportation planning staff members.

Determine Where You Are with Respect to Integration of Safety into the Transportation Programming Process

In the mid 1990s, as the AASHTO asset management task force developed its first business plan. One of the action items in the business plan was to have a general guide developed for the implementation of asset management at transportation agencies [NCHRP Project 20-24(11)]. Incorporated into the guide is a self-assessment tool which helps an agency understand where they are with respect to use of asset management. All agencies practice some form of asset management but some are more advanced than others. A similar self-assessment tool could assist an agency in understanding how well it has incorporated safety into the planning and programming process alongside other assets.

Action Item: Conduct a small workshop with knowledgeable safety experts from operating agencies, academia, and private sector advisors to identify criteria that define the progress an agency has made with respect to integrations of asset management into the resource program and planning process. The results of the workshop would be used to develop a self-assessment tool for transportation agencies to determine how advanced they are with respect to incorporating safety into resource decision making.

Building on an Existing Model—Evaluate and Modify PLANSAF for Statewide Application

New tools and processes are being explored as part of a rising interest in safety-conscious planning. One implementation is the NCHRP PLANSAF project. Fundamentally, PLANSAF is a program (procedure and software) that allows planning at the metropolitan or regional level through the incorporation of safety in transportation infrastructure development decisions. It uses aggregate system input measures to predict safety performance of several crash types. Prime drivers are demographics, road extent, and road class fractions. While not specifically intended for statewide application, measures for its application are potentially available at the state level. While the PLANSAF model is not likely to be directly implemented, the concepts appear extensible. PLANSAF utilizes regression models to forecast safety performance. Conventional asset management methods also apply categorical analysis and Markov Chain Processes, among others, to forecast system performance. Models are sensitive to policy options—this project should develop a procedure for systems safety planning that is also sensitive to these options, and be readily implemented in a number of states.

Action Item: Develop an NCHRP problem statement for the development of a PLANSAF-like tool for safety planning at the state level.

Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled Highway Safety as an Asset: Incorporating Safety Performance Metrics in State Level Planning and Programming, which is included on page 105.

Risk Management as a Systematic Approach to Assist in Resource Allocation

Risk management is the practice of identifying potential losses, estimating their impact and probability of occurrence, mitigating or minimizing the highest risks, and working toward addressing lower risks. Jurisdictions that have thoroughly embraced transportation asset management (e.g., Canada, New Zealand, Australia, the United Kingdom and selected U.S. states) have included risk in their management systems (see proceedings of the 2006 International Asset Management Scanning Tour). However, current methodologies are largely a function of the economic or social risk associated with the failure of the transportation system.

Risk management represents a very attractive approach to assessing the importance of making or not making investments in safety improvements. What is required is a framework for assessing risk and then a methodology to lay safety side-by-side with performance measure for other investments and then make resource allocation decisions across investment categories.

Action Item: Develop an NCHRP problem statement for the development of traffic safety risk management tool. The methodology and approach should be consistent with the methodology developed for risk assessment in NCHRP 20-74: Developing an Asset-Management Framework for the Interstate Highway System.

Note: This was identified as priority research area and a proposed research problem statement was developed for this topic, titled Incorporating Traffic Safety Risk Management into the Asset Management Process, which is included on page 118.

Safety Planning for the Life Cycle of a Facility

Throughout the life of an intersection or a highway segment, the safety performance is impacted by traffic volumes and patterns, by adjacent land use, access control, etc. For example, intersections of rural median divided multilane highways with two-lane roadways with two-way stop control have a very good safety performance when the minor road traffic volume is low. However, as minor roadway volume increases, safety performance declines meaning that geometric improvements need to be made to the intersection or intersection traffic control needs to be improved. Safety performance functions for intersections and roadway segments can be used to determine when the safety performance of the roadway element warrants an improvement throughout its lifecycle.

The problem is to identify when critical points in the life cycle of a roadway element occur to determine crash countermeasures that can and should be applied at these critical points. Critical points in safety performance could be defined by traffic volumes, traffic patterns, lane use, roadway access, etc.

Action Item: Develop an NCHRP problem statement for the development of a framework for life-cycle analysis for safety purposes and provide a number of realistic examples to promote implementation by transportation agencies.

Note: This was identified as priority research area and a proposed research problem Statement was developed for this topic, titled Life-Cycle Analysis of Designing Highways for Safety, which is included on page 121.

Exposure Measures: Local Road ADT Availability and Quality and Relation to Safety Programs

Generally, what drives a safety improvement program are crash rates or expected numbers of crashes. However, on the local road system counting traffic can be a very low priority activity for local agencies. If traffic counts are not performed, then reliable traffic information is not available and data-driven programming decisions of safety funds cannot be made. Because traffic counting programs may be deficient, traffic safety resource may be inefficiently allocated.

Action Item: Develop an NCHRP problem statement to conduct research to determine the magnitude of misallocation made due to inaccurate or missing traffic count information on the local roadways. Assuming that significant inefficiencies are found, the project should identify best practices for cooperation between the state and local governments to obtain accurate and timely traffic count information or to find suitable surrogate measures.

Documenting Lessons and Successes from Past Efforts to Incorporate Safety into Planning

Safety conscious planning has been a concept promoted by AASHTO and FHWA over the last 5 years. More recently, SAFETEA-LU promulgated a requirement that all states have a Comprehensive Highway Safety Plan. These two activities have helped to promote safety in the transportation planning and resource allocation process at state transportation agencies. There have been many examples of how these two efforts have resulted in safety being included in agency goals and in financial decision making. Some agencies have done a better job of incorporating safety then other and there is, therefore, a need to document the best practices.

Action Item: Conduct a survey of agencies to identify best practices. This could be conducted by a University Transportation Center or as a TRB synthesis.

RESEARCH PROBLEM STATEMENT 1

Highway Safety as an Asset

Incorporating Safety Performance Metrics in State-Level Planning and Programming

REGINALD R. SOULEYRETTE
Iowa State University

NCHRP PROPOSAL

This proposal was generated and identified as a priority by the Integrating Roadway, Traffic, and Crash Data Peer Exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Tom Maze and Reginald R. Souleyrette of the Center for Transportation Research and Education at Iowa State University.

Problem Statement

While safety is a principal goal of nearly every transportation agency, it is treated reactively. Classical approaches include before and after studies and other project-level analysis. High crash locations are identified and mitigated. Safety audits look for low-cost opportunities to improve safety along with reconstruction and maintenance. However, there is no direct and predictable linkage between the deployment of all of these approaches and the attainment of system safety performance goals.

The study of this linkage is better understood in the management of physical assets. Pavement and bridge conditions may be reliably forecast as a function of past and current conditions and future allocation of resources using asset management systems and techniques.

Research Objective

The objective of this research is to investigate the extensibility of conventional asset management approaches to the highway safety arena at the state planning level. New tools and processes are being explored as part of a rising interest in safety conscious planning. One implementation is the NCHRP PLANSAF project. Fundamentally, PLANSAF is a program (procedure and software) that allows planning level (regional) incorporation of safety in transportation infrastructure development decisions. It uses aggregate system input measures to predict safety performance of several crash types. Prime drivers are demographics, road extent and road class fractions. While not specifically intended for statewide application, measures for its application are potentially available at the state level. While the PLANSAF model is not likely to be directly implemented, the concepts appear extensible. PLANSAF utilizes regression models to forecast safety performance. Conventional asset management methods also apply categorical analysis and Markov Chain Processes, among others, to forecast system performance. Models are sensitive to policy options—this project should develop a procedure for systems safety planning that is also sensitive to these options, and be readily implemented in a number of states. Evaluation of the procedure(s) and models developed could include

- Data requirements,
- Logic of structure and conceptual appeal,
- Ease of calibration,
- Effectiveness of the model,
- Flexibility in application,
- Types of available outputs,
- Operational costs, and
- Compatibility with other models and model types.

Key Words

Asset management, system safety, safety planning, performance measures, transportation system performance data

Related Work

NCHRP 8-44: Incorporating Safety into Long-Range Transportation Planning.

Urgency/Priority

This proposal reflects the impetus of the Integrating Roadway, Traffic, and Crash Data peer exchange held November 1–2, 2006. Given safety is a top priority for FHWA and many states, and given the aggressive safety goals of the U.S. DOT—national highway safety goal of reducing the roadway fatality rate from 1.5 per 100 million VMT to 1.0 by 2008—this proposal is of urgent priority.

User Community

State agencies, FHWA, AASHTO

Implementation

Incorporating safety performance metrics in state-level planning and programming requires implementation by state DOTs and the leadership of AASHTO. Changes in STIP are the logical manifestations of project outcomes. The deliverables of this project would be guidance to states and a model program. Implementation is state choice and responsibility.

Effectiveness

Engineering is one of four key areas—along with education, enforcement, and emergency response—for improving highway safety performance. The effectiveness of this program will be closely linked to the effectiveness of projects and programs in each of these other three areas. Model inputs need to reflect these exogenous factors. Effectiveness of the regional PLANSAF program concept can be used to benchmark.

Estimated Cost

$350,000

RESEARCH PROBLEM STATEMENT 2

Guidelines for Conducting Business Process Reviews for Successful Data Integration Projects to Support Asset Management and Safety Management Systems

SUE MCNEIL
University of Delaware

This proposal was generated and identified as a priority by the Integrating Roadway, traffic, and crash data peer exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Sue McNeil of the University of Delaware and Robert Pollack of the Federal Highway Administration.

PROBLEM STATEMENT

Data integration is critical to the successful development of asset management and SMSs as both are data-driven processes using data not necessarily owned or controlled by the organization or unit developing or using the system, and requires continuous improvement due to emerging and evolving technology. Successful data integration projects have conducted a business process review. A business process review is the analysis and design of workflows and processes with and between organizations. The review helps to understand what kind of data is needed, who the stakeholders are in the process, the need to cross organizational boundaries, and how the data will be used. This includes data to support model development, decision making, and reporting.

Transportation organizations are generally not familiar with business process reviews. Nor have they historically viewed activities such as data integration as part of the cost of doing business. Providing guidelines to agencies for conducting business process reviews will help to provide a context for this process and focus attention on the outcomes, thus helping to ensure that the needs of stakeholders are reflected in the plan for action.

OBJECTIVE

The objective of this project is to develop guidelines for transportation agencies to conduct business process reviews to support data integration projects for asset management and other management systems, particularly SMSs. The guidelines will also include strategies for using technical assistance teams to help conduct the business process review.

KEY WORDS

Asset management, safety management

RELATED WORK

The recently completely peer exchange Integrating Roadway, traffic, and crash data peer exchange (November 2006) serves as a resource for the proposed project. Other resources to be reviewed include:

- Environmental Spatial Information for Transportation: A Peer Exchange on Partnerships, a summary of Workshop held in 2003 (http://onlinepubs.trb.org/onlinepubs/conf/reports/cpw_1.pdf. Accessed November 4, 2006.).
- "Developing Business Plans to Support Transportation Decision Making," TRB Statewide Transportation Data Committee Peer Exchange, June 27, 2004, Draft 9/19/04. (http://webservices.camsys.com/trbcomm/peerex06-27-2004.htm. Accessed November 29, 2006.)
- "Challenges of Data for Performance Measures" Workshop, held July 8, 2006. Research Needs Statements were also generated. (http://www.trb.org/conferences/jointsummer/2006/NCHRP%20proposal.pdf. Accessed November 29, 2006.)

URGENCY/PRIORITY

SAFETEA-LU requirements for SMSs and increasing interest in asset management mean that this project is high priority. Organizations are overwhelmed by data issues and need help developing a systematic process by which to develop and manage a data integration plan.

ESTIMATED COST

$100,000

USER COMMUNITY

AASHTO, FHWA, state DOTs

IMPLEMENTATION

Individual state DOTs will implement the guidelines. Data integration is an ongoing process and even states that have implanted enterprisewide GIS systems and have largely integrated much of their data must undergo a continuous improvement process in response to new and evolving technology.

The proposed project should include a task for an agency to pilot the use of the guidelines to conduct a business process review.

EFFECTIVENESS

Data integration is intended to enhance decision making by supporting tools that evaluate the impacts of decisions based on data. While it is difficult to evaluate the impacts of better decisions, the benefits of better data, easier access to data and more informed decision making as they related to management systems have been discussed in the Asset Management Guide and various conferences and presentation. More importantly, data integration will have positive impacts beyond safety and asset management. Public sector agencies are facing pressures to be more accountable, and more transparent. Easier access to data supports these functions.

RESEARCH PROBLEM STATEMENT 3

Open Architectures to Support Data Integration Projects

SUE MCNEIL
University of Delaware

This proposal was generated and identified as a priority by the Integrating Roadway, traffic, and crash data peer exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Sue McNeil of the University of Delaware and Robert Pollack of the Federal Highway Administration.

PROBLEM STATEMENT

Ownership of data, proprietary file formats and the lack of interoperability present significant challenges to transportation data integration projects. At the same time, the need to migrate away from mainframe legacy systems, the data needs of initiatives in asset management and safety management, and the promise of information transparency in enterprisewide GIS systems are putting increasing pressure on agencies to address data integration. The challenge is how to develop projects, specifications, and products that support an open architecture that serves both our current and future needs.

OBJECTIVE

The objective is to develop open architecture concepts to support data integration projects. The project will involve identifying relevant stakeholders and progress to date. The project will also produce a primer on open architecture concepts including a checklist of issues to consider. It is intended that these concepts will lead to subsequent projects that will develop standards and specifications to support this process.

KEY WORDS

Interoperability, asset management, safety management, information technology

RELATED WORK

Other industries have addressed these issues. For example, the Building Information Model (BIM) (See http://en.wikipedia.org/wiki/Building_Information_Modeling; accessed November 14, 2006. Or http://www.aia.org/tap_a_0903bim; accessed November 14, 2006) is evolving as the standard in CAD for the architectural industry to ensure that architects, engineers and fabricators can communicate. Similarly, work by the Open Geospatial Consortium, Inc. provides a rich source on standards for GIS and location referencing that should be addressed.

URGENCY/PRIORITY

As more agencies move to enterprise wide GIS, it is important that agencies do not get locked into a technology or a single vendors solution to a problem. Addressing this issue soon is important.

ESTIMATED COST

Suggest $75,000 or $100,000

USER COMMUNITY

AASHTO, FHWA

IMPLEMENTATION

Individual agencies will use the results of this project to develop their own standards and specification. FHWA and AASHTO will use the results of this project to determine how they want to be involved in standard setting.

EFFECTIVENESS

While this project is intended to improve the delivery of IT projects, it will also extend the life cycle of IT projects as it will build in flexibility and focus projects on delivering solutions that are transferable. It will also reduce the need for custom interfaces that require specialized knowledge to develop and an ongoing commitment to maintain.

RESEARCH PROBLEM STATEMENT 4

Synthesis for Visualizing Roadway, Traffic, and Crash Data Integration

JACK STICKEL
Alaska Department of Transportation and Public Facilities

This proposal was generated and identified as a priority by the Integrating Roadway, traffic, and crash data peer exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Jack Stickel of the ADOT&PF and Vicki Miller of FHWA.

PROBLEM STATEMENT

State transportation agencies are at various stages for inventorying road centerlines and transportation features, developing an integrated database, and deploying a geographic information system for their highway safety improvement programs. A significant increase in data availability comes with these advances in capabilities. Visualizing crash trends, patterns, and other value-added crash analyses can serve both the highway safety staff and management level proactive safety analyses. Effective visualization of roadway, traffic, and crash data integration at the enterprise level can also assist in funding allocation for transportation projects and highway safety improvement evaluation. Many state transportation agencies have developed excellent techniques for visualizing roadway, traffic, and crash data integration for the Internet/intranet. Other state agencies could benefit from these web applications.

OBJECTIVE

The objective of this proposal is to perform a synthesis of successful visualization techniques that state transportation agencies have used to integrate roadway, traffic, and crash data for making resource allocations and countermeasure decisions.

KEY WORDS

Countermeasure decisions, data integration, decision support, resource allocation, visualization

RELATED WORK

The first work effort would be to survey state transportation agencies to identify highly effective visualization techniques for both internal and public dissemination. The next step would be to define what questions the agencies are trying to answer with their visualization.

URGENCY/PRIORITY

Peer reviews and workshops can bring together several state transportation agencies to share innovative visualization techniques. This process, although quite effective, is costly and will not work for most states. Surveying a wide number of transportation agencies could provide a starting point for a highly effective synthesis of state transportation agency visualization practices.

ESTIMATED COST

$175,000

USER COMMUNITY

- State transportation agencies,
- AASHTO,
- FHWA,
- NHTSA,
- Highway safety offices,
- EMS, and
- Injury prevention centers.

IMPLEMENTATION

- A detailed synthesis report of innovative visualization techniques which includes detailed examples, hardware/software requirements, and transportation agency contact information and
- Selected web presentations on selected topics.

EFFECTIVENESS

Real-time collection, highway effectiveness quality checking processes, and increased data collection presents transportation agencies with ever-increasing datasets with which to perform safety analyses. The objective then is to provide decision makers with better analysis tools, which includes visualization techniques. Providing transportation agencies with a toolbox of innovative and effective visualization techniques can significantly benefit the resource allocation and project decisions for other state transportation agencies.

RESEARCH PROBLEM STATEMENT 5

How Do We Convince the Locals to Participate in Statewide Highway Safety Data Programs?

WILLIAM G. HUNTER
Pennsylvania Department of Transportation

This proposal was generated and identified as a priority by the Integrating Roadway, Traffic, and Crash Data peer exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Jack Stickel of the ADOT&PF and Vicki Miller of FHWA.

PROBLEM STATEMENT

Over the years, it has been fairly well documented that states having good crash, roadway, and traffic data can make major inroads in reducing the number and severity of vehicular crashes. To make highway safety improvements, having good integrated information allows for better problem identification, countermeasure development, and evaluation of implemented actions. However, most states only maintain roadway–traffic data for state-owned roadways such as AADT, roadway width, number of lanes, urban/rural, access control, type of surface, surface condition, etc. The lack of this type of data for local roads hampers the state's overall ability to define problems and improve safety. Not fully analyzing crashes that occur on local roads leaves a major part of the puzzle missing.

With advancements in information technology, and in particular, GIS techniques, the collection and integration of roadway/traffic data for local roads can be reasonably accomplished from the technical standpoint. However, having the locals capture and maintain that road information may prove to be a greater problem than amassing all the necessary hardware and software. With the increased emphasis on homeland security and severely constrained budgets, local governments face many challenges in finding resources to do what is needed. Everyone should understand that capturing these data is no small task. Are there techniques or equipment that can make this job easier? Are there ways municipalities can band together to get the job done? Are there alternatives? In conclusion, the question that needs to be answered is "How do the states convince the locals to participate in statewide highway safety programs by providing that necessary data? How is it shown "what's in it for them?"

OBJECTIVE

To develop strategies to help states convince local governments to participate in the collection and maintenance of roadway–traffic data on their roads and forward it to the states for use in developing highway safety programs.

Typically, studies of this kind include surveys, telephone interviews, focus groups, etc., of state highway safety officials to define the problem and its scope. A literature search is then conducted to find potential solutions. These are then confirmed with more surveys and/or focus groups with local officials.

KEY WORDS

Local roadways, traffic data, roadway data, highway safety

RELATED WORK

Unknown

URGENCY/PRIORITY

A major portion of the information needed for state highway safety professionals to assess crash problems and develop countermeasures is missing. While development may take some time, the sooner it is started, the better chance there is to meet state and federal fatality reduction and safety goals.

COST

Since this effort will undoubtedly require surveys, focus group activities, and travel, it is estimated that this project will cost approximately $500,000.

USER COMMUNITY

State governments and all levels of local governments—in addition the following should be included: FHWA, NHTSA, FMCSA, and Highway Safety Offices.

IMPLEMENTATION

Preliminary report should be submitted for review and comment to the project managers within 6 months of the beginning and the entire effort should be completed within 1 year of inception.

EFFECTIVENESS

Each year thousands of lives are lost on our nation's highways. Efforts to curb that loss by using effective data and techniques to address the consequences of that loss should be undertaken. Integrated crash, roadway, and traffic data from all types of roads will allow a more complete analysis of the problem and permit actions to be implemented that consider all aspects of highway safety and traffic management.

RESEARCH PROBLEM STATEMENT 6

Incorporating Traffic Safety Risk Management into the Asset Management Process

TOM MAZE
REGINALD R. SOULEYRETTE
Iowa State University

This proposal was generated and identified as a priority by the Integrating Roadway, Traffic, and Crash Data Peer Exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Tom Maze and Reginald R. Souleyrette of the Center for Transportation Research and Education at Iowa State University.

PROBLEM STATEMENT

Risk management is the practice of identifying potential losses, estimating their impact and probability of occurrence, mitigating or minimizing the highest risks, and working toward addressing lower risks. Jurisdictions that have thoroughly embraced transportation asset management (e.g., Canada, New Zealand, Australia, the United Kingdom, and selected U.S. states) have included risk in their management systems (see proceedings of the 2006 International Asset Management Scanning Tour). However, current methodologies are largely a function of the economic or social risk associated with the failure of the transportation system.

This problem statement addresses the need to include safety in the risk management process. For example, when a highway segment fails to perform as planned or its performance is degraded by congestion, not only will the failure increase travel time cost and reduce economic opportunity, it will also reduce the safety performance of the facility. The congestion may also divert traffic to facilities with inferior safety performance (e.g., from a congested freeway to a local street or two lane highway). The framework and tools for assessing the traffic safety risk in the transportation asset management process do not exist.

RESEARCH OBJECTIVE

The objective of this research is to generate a framework for assessment of risk in the asset management process, identify an analytical tool (or tools) for incorporating risk into the asset management process practiced by state transportations agencies and by local transportation agencies, and provide examples of their use. Specific tasks include:

- Review the state of the practice of safety risk management in other industries and the international experience within transportation.
- Develop a theoretic framework for a methodology to incorporate safety risk management into asset management.
- Develop a practical framework for a methodology to incorporate safety risk management into asset management.
- Conduct a workshop with interested stakeholders from agencies across the United States. This could be held in conjunction with another meeting that involves state safety engineers. With input from the workshop, appropriately modify the methodology for safety risk management.
- Develop a case study of the implementation of the methodology for a realistic but fictitious jurisdiction or a limited application to a jurisdiction.
- Provide examples of how risk management should be taken into account in resource allocation along side other performance measurement systems and system goals.
- Estimate the costs of full application of the methodology to a state.
- Provide step-by-step instructions for the application of the methodology.
- Conduct a small workshop for a likely implementer of the system. Use comments received in the workshop to fine tune the methodology.
- Recommend further improvements and research required to make the methodology more robust.

KEY WORDS

Risk management, asset management, safety management, safety performance, traffic safety

RELATED WORK

NCHRP 20-74 is a project to develop an asset management system for the Interstate highway system. Part of that project involves the incorporation of risk management into the interstate highway system asset management system. Methods developed in 20-74 and the project described here must be compatible and consistent.

URGENCY/PRIORITY

This should be initiated following the partial completion of 20-74. This project should be started by the beginning of the calendar year 2008.

USER COMMUNITY

State agencies, MPOs, local governments, FHWA, AASHTO

IMPLEMENTATION

Provides a realistic case study, a cost assessment for a full-scale implementation, and step-by-step instructions on implementation.

EFFECTIVENESS

Results allow the inclusion of traffic safety risk in asset management decisions.

ESTIMATED COST

$500,000

RESEARCH PROBLEM STATEMENT 7

Life-Cycle Analysis of Designing Highways for Safety

TOM MAZE
REGINALD R. SOULEYRETTE
Iowa State University

This proposal was generated and identified as a priority by the Integrating Roadway, traffic, and crash data peer exchange held on November 1–2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion group led by Tom Maze and Reginald R. Souleyrette of the Center for Transportation Research and Education at Iowa State University.

PROBLEM STATEMENT

Facilities may become less safe as traffic volumes and other conditions change. For example, for at-grade intersections on multilane, median divided, minor road stop controlled highways, safety performance decreases with increasing minor road volumes. When minor roadway volume is low [say less than 1,000 vehicles per day (vpd)], such a two-way, stop-controlled intersection generally operates very safely. As minor traffic volume rises to above 2,000 vpd, the intersection should be examined for improvement to grade separation or other less conventional improved geometry. At 4,000 vpd minor road volume, the safety benefits of building an interchange almost always exceed its cost of construction. In addition, there are number of design improvements that can be made throughout this type of intersection's life cycle to improve safety (see NCHRP 15-30). Understanding how traffic volumes, mix, traffic patterns (percentage trucks, turning movement volumes, etc.) and adjacent land use impact the safety of an intersection or highway segment can facilitate the provision of guidance for improvements across the facility's life cycle. Improvements can be pro-active in anticipation rather than reactive after poor safety performance occurs. In other words, by considering the relationship between geometry, operations, control and safety performance throughout a facility's life cycle, safety problems can be prevented.

This project will structure an approach for planning facility improvement throughout the lifecycle of highway links and intersections. In conjunction with a project panel, three types of common intersection geometry and two types of highway segment geometry will be selected for framing a safety lifecycle analysis. Once the five typical geometries have been identified, Safety Performance Functions (SPFs) will be identified for each from the literature. The SPFs and example costs of typical countermeasure (taken from such sources as the NCHRP 500 series) will be used to define thresholds for when countermeasure may become cost beneficial. For example, along a five-lane arterial street with continuous two-way, left-turn lane, at what driveway density, speed, and volume do driveway consolidation, frontage roads, or backage roads become cost effective from a safety standpoint? Because each "real-world" situation is unique, this analysis can only result in general thresholds. However, the analysis can provide corridor managers and highway planners with a structure for planning for the safety lifecycle of a facility as well as thresholds to use for guidance.

RESEARCH OBJECTIVES

Principally, the objective of this research is to develop a structure for planning for the lifecycle of a facility. While focusing on five common types of intersection and roadway segment geometries, a secondary objective of the research is to provide guidance on when geometric improvement for safety should be considered. The structure developed should be flexible such that individual agencies can use the research as guidance to develop their own lifecycle planning guidelines which fit their own unique characteristics. Specific tasks to support this objective include:

- Review the literature to identify several roadway segment and intersection types with common geometry that have sufficient prior safety statistical analysis to support the research identified in future tasks.
- Identify several common geometries for roadway segments and intersections and present the pros and cons of each for further analysis. Support the panel's selection of the final five common types.
- Develop a list of design, access management, traffic control, etc. strategies that can be used at each of the five typical geometries over their lifecycle and develop a typical cost estimate for each (see http://www.oregon.gov/ODOT/HWY/TRAFFIC/PDF/Counter_Measures.pdf for example costs of counter measures).
- For each of the five selected geometries, use the SPFs from the literature to identify thresholds for when safety performance has decreased enough to make selected crash counter measures cost effective. Within each analysis, perform sensitivity analysis so that the report can identify to what extent local conditions will change the timing of when each improvement is justified.
- Develop guidelines for transportation agencies to adopt and modify the lifecycle thresholds and lifecycle planning their own unique applications.
- Conduct a daylong workshop with transportation agency corridor managers and systems planners to introduce concepts, train in their use, and to obtain feedback for the final manual/report.
- Draft the final manual/report.

KEY WORDS

Safety analysis, countermeasure, life-cycle planning, corridor planning

RELATED WORK

NCHRP 15-30 is a project that has identified several safety improvements to intersections of rural median divided highways that may be applied throughout the life cycle of this type of intersection. While the NCHRP 500 series has developed guidance on countermeasures at intersections and highway segments, it does not provide guidance for planning and programming these improvements throughout the lifecycle of the facility.

URGENCY/PRIORITY

This project should be started as early as possible as NCHRP 500 is complete and 15-30 is nearing completion.

USER COMMUNITY

State agencies, MPOs, local government, FHWA, AASHTO

IMPLEMENTATION

Provide instruction for the implementation and adaptation of lifecycle planning guidelines for immediate application by agencies.

EFFECTIVENESS

Results will allow corridor managers and highway planners to take into account the safety needs of roadway segments and intersections throughout the life of the facility and facilitate aggressive national safety goals.

ESTIMATED COST

$300,000, 18 months

PROPOSED SYNTHESIS TOPIC

Viable Options and Design Choices for Data Integration Strategies to Support Asset Management and Safety Management Systems

SUE MCNEIL
University of Delaware

JACK STICKEL
Alaska Department of Transportation and Public Facilities

This proposal was generated and identified as a priority by the Integrating Roadway, traffic, and crash data peer exchange held on November 1-2, 2006. The concept was to bring both data and highway safety professionals together to share experiences and identify key issues relating to integrating data sources used to support safety management and introducing asset management concepts into the highway safety management arena.

A total of 17 state agency representatives and 12 other federal, university, and private agency representatives participated in active discussion groups. This proposal was identified as a priority by the discussion groups led by Sue McNeil of the University of Delaware and Robert Pollack of the Federal Highway Administration and by Jack Stickel of the ADOT&PF and Public Facilities and Vicki Miller of FHWA.

PROJECT SCOPE

This synthesis would document state transportation agency experiences with data integration including migration from legacy systems, and provide examples of data warehousing practices and strategies for dealing with specific elements of data integration. This includes recognizing the constraints imposed by various organizational and institutional structures, and technology and the context in which they are applied, specifically the objectives of the project. The context includes the desired results and the business needs. Specific topics include:

- Dealing with legacy systems including concepts of integration and interfacing, and running parallel systems.
- Implementation issues:
  - Scale issues: Dynamic segmentation lets you determine the presence or absence of features at a particularly location based on definitions of the beginning and ending locations of the feature. Such features include line marking, guardrail, pavement treatments, number of lanes, and treatments such as rumble stripes. These features are required to do safety analysis.
  - Temporal issues: Matching the roadway features and weather conditions to the specific time of a crash requires time stamping the data. Most agencies maintain snapshots of conditions and historical analysis requires extracting data from these snapshots. This design decision is related to tradeoffs between processing time versus storage.

– Capturing data on highway features: Much of the data on highway features is lost with the original plans. In addition, new types of data and safety features such as pedestrian countdown signals, rumble strips and active animal crossing warning systems need to be captured.

- Strategies for automated edit checks.
- Integrating different types of media documenting the configuration and condition of the assets to support SMSs. This would include the design decisions to support these alternative media and the limits on quality and quantity (for example, what is the appropriate resolution for storing digital photos.)

INFORMATION SOURCES

Several sources of information are available

- The e-circular from this peer exchange; and
- FHWA case studies on data integration.

However, the richest sources of information are the experiences of the states. This will require interviews with states that have a broad base of experience in this area or those who are currently engaged in this process.

PROPOSED PEER EXCHANGE

Best Practices on Migration from Mainframe Systems

SUE MCNEIL
University of Delaware

JACK STICKEL
Alaska Department of Transportation and Public Facilities

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BACKGROUND

Transportation agencies still have to deal with legacy systems as they move into modern geographic information systems and data marts. Two particularly important institutional issues are that agencies are unable to hire staff to work with these systems and keeping the legacy systems synchronized with the new applications. The real challenge is developing a migration plan to move from the legacy systems to the new environment. An effective plan recognizes that migration is part of the cost of doing business, is responsive to the business needs of the organization, integrates appropriate new technology, and assigns priorities to action items. Documenting and sharing these options would be valuable to state transportation agencies in considering the different viable options for dealing with legacy systems.

OBJECTIVE

Provide a workshop/peer review for transportation agencies to share successful approaches to migrating transportation databases to this new environment. Data managers and information technology specialists will cover their existing transportation database infrastructure and current migration initiatives. Each organization will prepare an advance report describing their current experience and common problems. These reports will form the basis for discussions on specific processes and technologies for migrating to new transportation databases.

APPENDIX

List of Acronyms

AADT	Annual average daily traffic
AASHTO	American Association of State Highway and Transportation Officials
ADOT&PF	Alaska Department of Transportation and Public Facilities
AHS	Alaska Highway System
ATMS	Advanced Transportation Management System
BHSTE	Bureau of Highway Safety and Traffic Engineering
BMS	Bridge Management System
BOMO	Bureau of Maintenance and Operations
BOP	Bureau of Planning
BOTS	Bureau of Transportation Safety
BPR	Bureau of Planning and Research
BTRS	Base Transportation Referencing System
CARS	Condition Acquisition and Reporting System
CDART	Crash Data Analysis and Retrieval Tool
CDS	ADOT&PF Coordinated Data System
CDS	Crash Data System
CODES	Crash Outcome Data Evaluation System
DDOT	District Department of Transportation (Washington, D.C.)
DGPS	Differential Global Positioning System
DMI	Digital Measurement Instrument
DMV	Driver and Motor Vehicle Services Division (Oregon)
DOT	Department of Transportation
DTIM	Division of Transportation Investment Management (WisDOT)
DUI	Driving Under the Influence
EMS	Emergency Medical Services
FARS	Fatal Accident Reporting System
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
GIS	Geographic Information System
GPS	Global Positioning System
GTA	General Transportation Aids (WisDOT)
GTSAC	Governor's Traffic Safety Advisory Commission (Michigan)
HAS	Highway Analysis System (ADOT&PF)
HDP	Highway Data Port (ADOT&PF)
HES	Hazard Elimination Safety Program
HMVMT	Hundred Million Vehicle Miles of Travel
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Plan
IHSDM	Interactive Highway Safety Design Model
IPMA	Infrastructure Project Management Administration (DDOT)
IRI	International Roughness Index

ISTEA	Intermodal Surface Transportation Efficiency Act
IT	Information Technology
ITIS	Integrated Transportation Information System (Oregon DOT)
ITS	Intelligent Transportation Systems
KA	Killed or Incapacitated
LRS	Linear Referencing System
M&O	Maintenance and Operations (ADOT&PF)
MAST	Pennsylvania Multi Agency Safety Team
MMIRE	Model Minimum Inventory of Roadway Elements
MMS	Maintenance Management System
MMUCC	Model Minimum Uniform Crash Criteria
MOA	Memorandum of Agreement
MOTS	Modified-off-the-Shelf
MPD	Metropolitan Police District (District of Columbia)
MPO	Metropolitan Planning Organization
NCHRP	National Cooperative Highway Research Program
NEMSIS	National Emergency Medical Services Information System
NHS	National Highway System
OTC	Oregon Transportation Commission
OTP	Oregon Transportation Plan
OTSAP	Oregon's Transportation Safety Action Plan
PennDOT	Pennsylvania Department of Transportation
PLSS	Public Land Survey System
PMS	Pavement Management System
PSMS	Project Safety Management System (Oregon DOT)
QA	Quality Assurance
QC	Quality Control
RFP	Request for Proposal
ROW	Right-of-Way
RMS	Roadway Management System (PennDOT)
RMS	Records Management System (WisDOT)
RP	Reference Point
RPO	Rural Planning Organization
RWIS	Road Weather Information System
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SAMS	Safety Analysis Management System (Mississippi DOT)
SEMCOG	Southeastern Michigan Council of Governments
SHSO	State Highway Safety Office (WisDOT)
SHSP	Strategic Highway Safety Plan
SIS	Street Inventory System (DDOT)
SMS	Safety Management System
SPIS	Safety Priority Indexing System (Oregon DOT)
SPF	Safety Performance Functions
SSD	Street Spatial Database (DDOT)
STIP	State Transportation Improvement Program

STN	State Trunk Network (WisDOT)
STRAHNET	Strategic Highway Network
TARAS	Traffic Accident Reporting and Analysis System (DDOT)
TDP	Temperature Data Probe
TDS	Traffic Data Systems (ADOT&PF)
TMS	Transportation Management Systems (Michigan DOT)
TR	Traffic Record
TRB	Transportation Research Board
TRAC	Transportation Review Advisory Council (Ohio DOT)
TraCS	Traffic and Criminal Software System
TSA	Traffic Services Administration (DDOT)
TSC	Traffic Safety Council (WisDOT)
TSIS	Traffic Safety Information System (WisDOT)
UPWP	Unified Planning and Work Program
UTC	University Transportation Center
UW-TOPS	University of Wisconsin Traffic Operations and Safety Lab
VII	Vehicle Infrastructure Integration
WIM	Weigh in Motion
WisDOT	Wisconsin Department of Transportation
WISLR	Wisconsin Information Systems for Local Roads

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