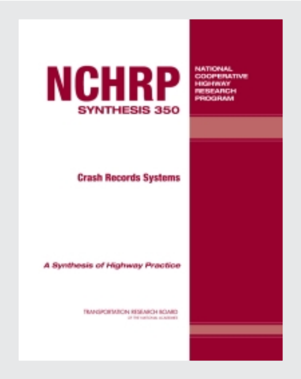

Crash Records Systems

DETAILS

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP SYNTHESIS 350

Crash Records Systems

A Synthesis of Highway Practice

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FOREWORD

By Staff
Transportation Research Board

Highway administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to highway administrators and engineers. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire highway community, the American Association of State Highway and Transportation Officials—through the mechanism of the National Cooperative Highway Research Program—authorized the Transportation Research Board to undertake a continuing study. This study, NCHRP Project 20-5, "Synthesis of Information Related to Highway Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute an NCHRP report series, *Synthesis of Highway Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

This synthesis will be of interest to state transportation agency personnel, as well as to other professionals in both the public and private sectors, who deal with the development of successful crash records systems. The report examined practices and programs in search of current information, as applied to highway and traffic safety. The following topics were addressed: crash data collection, crash processing and management, and data linkages for reporting and analysis. The situation found was characterized as a patchwork of data that ranged widely. Although no single comprehensive system examples were identified, many examples of one or more successful components were found to address the needs of three groups of stakeholders—data collectors, data managers, and data users. This synthesis also contains information about lessons learned from examples of successful systems, addressing the needs and concerns of stakeholders and repeats this information in the context of suggested improvements for future expansion of the use and capabilities of crash records systems.

Survey responses were received from 26 state departments of transportation and follow-up interviews were conducted with selected agencies. This information was combined with a review of pertinent literature.

A panel of experts in the subject area guided the work of organizing and evaluating the collected data and reviewed the final synthesis report. A consultant was engaged to collect and synthesize the information and to write the report. Both the consultant and the members of the oversight panel are acknowledged on the title page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

CRASH RECORDS SYSTEMS

SUMMARY

The need for improved crash records systems arises in part from a growing knowledge that significant improvements in safety have and will come from state actions to control the crash experiences of their road users. To supplement crash data analyses, even more information is needed about both rural and urban roadways. It may not be possible to sustain the gains in traffic safety that have been made in the past, or to achieve further gains, without improvements in the quality and utility of these data.

The impetus to improve the quality and utility of state traffic records systems, in particular motor vehicle crash data, is undertaken against a backdrop of diminished resources and increased demands for those scarce resources. The costs of collecting crash data continue to be a substantial burden to all states. The time required to collect crash data and the costs of doing so compete with demands for other law enforcement work, including more recently, the addition of duties related to homeland security.

Consequently, during the past two decades, some states have eliminated data from their crash report forms rather than adding to existing information to satisfy emerging needs. Other states have altered reporting criteria to reduce the number of crashes that police investigate or implemented "self report" forms for crashes in which no one is injured. At a time when more and better information is needed, these trends can have a substantially adverse effect on the quality and utility of crash data. On the other hand, these trends are also the genesis for attempts to use advanced information collection capabilities in the form of laptop, notebook, and hand-held computers, global positioning system devices, bar code and magnetic stripe readers, and other technologies that have the potential to improve the process of collecting and automating crash and other transportation data.

This synthesis provides information on current practices in crash records systems, as applied to highway and traffic safety. To help identify the current state of the practice, surveys were distributed to transportation agencies in all 50 states and the District of Columbia. More than half (26) responded to the survey, and follow-up interviews were conducted with selected agencies. The discussions focused on administering, collecting, and maintaining crash data; ensuring data quality; accessibility of crash data and how it is integrated and linked to other databases; and the barriers to each of these activities.

The crash records system is of primary concern in this synthesis. However, the utility of crash data to identify safety problems or to evaluate the effect of changes in traffic safety is limited by its ability to be used with other types of data. These other data sources include, at a minimum, driver and vehicle records, traffic and roadway condition inventories, and medical outcome data. This synthesis addresses the ability to link crash data with these other traffic records system components.

Over the years, the U.S. Congress has increasingly viewed traffic crashes as a national problem meriting federal involvement; therefore, the federal goal in this area has been to provide leadership and financial aid to the states as incentives to develop a nationally uniform system. The states, on the other hand, have tried to retain the maximum degree of flexibility and decentralization so that they can respond to their own state needs. Ironically, the states have the same difficulty in maintaining uniform crash records systems statewide, because

their localities also wish to retain the maximum degree of flexibility to meet the needs of their local constituents.

Three areas that can define the success of a crash records system are: (1) data collection, (2) data processing and management, and (3) data linkages for reporting and analysis. No single crash records system was identified that has a "best practice" approach to all three areas simultaneously. There are, however, examples of successful systems that handle one area or another particularly well. Based on these examples, and using the literature and our own experience with traffic records systems, some overall descriptions of systems that are possible with today's technology and could serve the needs of stakeholders at all levels of the traffic safety community were developed. These descriptions are summarized here.

The most promising approach to crash data collection is an automated field data collection tool that is used to capture information as close to the event as possible. Field data collection hardware can include a portable or in-vehicle computer, global positioning system unit, magnetic stripe and/or bar code reader, and other technology as desired. The law enforcement officer using this tool would be able to link with state driver and vehicle data to complete sections of the crash report without having to reenter information that already exists electronically. Officers may also scan information directly from a vehicle identification number and/or registration documents, license plate, or driver's license to obtain information for their reports.

The crash software tool can include edit checks that closely match those in the statewide crash report system and prompt officers to complete all required fields, including supplemental reports. A supervisor could then automatically review the resulting crash report. Once accepted, the report can be sent to the agency's local crash records system, if desired, as well as to the statewide crash records system. This paperless process could also support the generation of a graphic image of the form suitable for printing and archival storage. The primary advantage of automated crash data collection software is a reduction in the time spent by officers in records management and in supervisory review. The improvement in quality and timeliness of the crash data benefits all stakeholders in the traffic safety community.

In regard to crash data processing and management, a pressing need for crash records systems is the capability to accept data electronically. Adding this capability may result in major updates to the structure and processing of a statewide crash database; however, the system must continue to support manual processing of crash reports from a hard copy (paper) format. Some manual post-processing of crash information, especially for quality control of location coding, is advisable even with automation of the field data collection and electronic data transfer. The document management and archival storage of crash reports should accommodate both electronic and paper forms. The savings in reduced data entry, along with improvements in data quality and timeliness, benefits all stakeholders.

Crash data alone do not serve as the sole basis on which to make highway and traffic safety decisions. A comprehensive traffic records system is required with linkable components to support reporting and analyses of all types of data. In most states, a comprehensive traffic records system could not exist in a single agency and have it fit well with the core business of that agency. For example, an agency that is responsible for issuing licenses to drivers and titles to vehicles may not have the resources to support other components of a traffic records system that do not assist them in completing their agency's primary mission. A knowledge base, in the form of a traffic records data clearinghouse or resources dedicated specifically for ad hoc data linkages, is a method for a state to achieve the goal of serving the needs of all highway and traffic safety stakeholders.

A knowledge base supports all or some components of the traffic records system readily available to the users for analysis and reporting. Data sources are linked directly with the crash data or linked indirectly through probabilistic matching. This type of knowledge base is one way to increase the utility of crash data for less experienced users and to help build strong advocates for traffic records improvement throughout the state. The Missouri Department of Transportation is an example of a directly linked data system that primarily supports only that agency's users. The Massachusetts data warehouse is an example of a university-based system, with Internet access for analysis and reporting given to all approved users. Although the number of traffic records data clearinghouses is increasing, most states conduct data linkages on an ad hoc basis, often using university-based staff.

The lessons learned from the examples of successful systems are simple, but worth repeating in the context of improved practices for crash data collection, crash data management, and data linkages for reporting and analysis. To further the practice of implementing successful crash records systems, several actions can be undertaken.

- Establish a statewide traffic records coordinating committee—Data collectors, system managers, information technology staff, safety analysts, and program staff from all the stakeholders can learn to work within the much broader context of a comprehensive traffic records system framework.
- Develop data-for-data partnerships—Data collected for any of the components of a traffic records system are needed by a diverse set of users, agencies, and jurisdictions. The most successful crash records systems provide some form of sharing data, software, and/or hardware resources to local jurisdictions in exchange for improved data collection for their systems.
- Develop a knowledge base for traffic records systems—Examples of successful crash records systems have embraced the concept of a knowledge base to serve the highway and traffic safety community.
- Simplify crash data collection—The most successful crash records systems have resulted from efforts to simplify field data collection.

Coordination, communication, and cooperation are keys to successful development of crash records systems. Successful crash records systems are most often managed within the context of a strategic plan. Agreement from all traffic records system custodial agencies is critical, as is a commitment to sharing data and resources among the collectors and managers of the data. The entire highway and traffic safety community benefits from improvements in data quality and availability.

CHAPTER ONE

INTRODUCTION

> The government are very keen on amassing statistics. They collect them, add them, raise them to the n-th power, take the cube root, and prepare wonderful diagrams. But you must never forget that every one of these figures comes in the first instance from the village watchman, who just puts down what he damn pleases.
>
> —Comment of an English judge quoted by Sir Josiah Stamp in *Some Economic Matters in Modern Life*

BACKGROUND

State traffic records assessments promoted by NHTSA and FHWA, as well as a recent evaluation of states for possible inclusion in FHWA's Highway Safety Information System, have discovered a disturbing trend. The completeness and quality of the safety databases of many states are eroding. With reductions in staff and other resources, a smaller proportion of motor vehicle crashes is reported to state crash databases than ever before. Crash thresholds are increasing to the point that any meaningful analyses are problematic, and data entry backlogs result in information that is outdated by the time the data are available for use. Although states are increasing their use of geographic information systems (GIS) technology, they are not adequately maintaining or linking a record of the roadway characteristics associated with specific locations. Core data elements such as location control, number of lanes, lane widths, shoulder widths, median type, and median width are missing in many systems that define roadway characteristics. Items such as horizontal curve, vertical grade, intersection features, and interchange features are virtually nonexistent.

An increasing emphasis on traffic records is not without justification. It has become apparent over time that appropriate, accurate, and timely information describing various aspects of the transportation system (including its crash experience) are needed to improve traffic safety and mobility. Data on fatalities are not enough. National samples of police-reported crash data are not enough. To manage its safety programs effectively, each state needs to analyze an increasingly wide variety of information about the design characteristics of its road system, the behavior of traffic on that system, and the crash experiences of its users. This need for improved data arises in part from a growing awareness that significant improvements in safety have and will come from state actions to control the crash experience of road users. More than ever states need detailed information about both urban and rural roadways. Without improvements in the quality and utility of these data, it may not be possible to sustain the gains in safety that have been made or to achieve further gains.

As shown in Figure 1, the fatality rate per 100 million vehicle-miles traveled (VMT) essentially has flattened in the United States, after experiencing steady improvement for many years (*1*). In 1990, 44,599 fatalities occurred, for a rate of 2.08 per 100 million VMT. In 2002, 42,815 fatalities occurred, for a rate of 1.51 per 100 million VMT.

The U.S.DOT and other major stakeholder groups have adopted as their goal to reduce fatalities to a rate of 1.0 per 100 million VMT by 2008. To meet this goal, it is more critical than ever to be able to analyze state safety data to make informed decisions on the best methods for reducing fatalities.

The incentive to improve the quality and utility of traffic records systems, in particular motor vehicle crash data, is undertaken against a backdrop of diminished state resources and increased demands for scarce financial resources. The costs of collecting crash data continue to be a substantial burden to all states. In addition, the time required to collect crash data and the costs of doing so compete with demands for other police work, including more recently, homeland security duties.

Consequently, over the past two decades, some states have eliminated some data from their crash report forms rather than adding to the existing information to satisfy emerging needs. Other states have altered reporting criteria to reduce the number of crashes that police investigate or implemented "self report" forms for crashes in which no one is injured. At a time when more and better information is needed, these trends can have a disastrous effect on the quality and utility of crash data. Conversely, these trends are also the genesis for attempts to use advanced information collection capabilities in the form of laptop, notebook, and hand-held computers, global positioning system (GPS) devices, pen-based entry systems, and other technologies that have the potential to improve the process of collecting and automating crash and other transportation data.

Crash data are the basis for many decisions regarding traffic safety, highway design, operations, and research. These data are used to help identify specific problems, to develop and prioritize remedial actions, and to establish goals and performance measures to evaluate whether the desired results

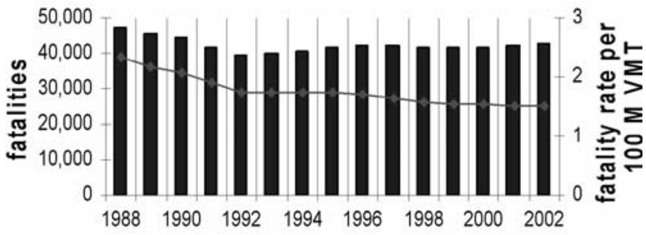

FIGURE 1 Plateau of U.S. fatality rates. (Bars show the frequency of fatalities, the line shows the fatality rate.)

are being achieved. All levels of government use these data to determine how to allocate their scarce resources to address traffic safety issues.

By applying technological advances and overcoming institutional issues, crash record systems can be improved significantly. In addition, there is an initiative by NHTSA, in collaboration with FHWA and the Governor's Highway Safety Association, which resulted in the Model Minimum Uniform Crash Criteria (MMUCC). Many states are making changes in their uniform crash reports based on the MMUCC guidelines.

SYNTHESIS OBJECTIVES

This synthesis provides information on current practices in crash reporting and processing, as applied to highway and traffic safety. To help identify the current practices in crash reporting and processing, surveys were sent to state transportation agencies and follow-up interviews were conducted with selected agencies. The discussions focused on the following issues:

- Who is responsible for administering crash data and how is it collected?
- Who is responsible for maintaining the crash databases?
- How are data quality (e.g., timeliness, accuracy, completeness, and uniformity) ensured?
- How are crash data integrated and linked to other databases?
- How are crash data made accessible to users?
- What barriers exist to the above activities?

ORGANIZATION OF SYNTHESIS

Identification of information for inclusion in this synthesis began with various types of literature identified by the TRB Transportation Research Information System (TRIS) database, copies of recent traffic records assessments provided by NHTSA, and the safety data library maintained at Data Nexus, Inc. Following the review of the existing literature, a screening survey was distributed to all of the states to help identify examples of successful practices in crash records systems. More than half of the state departments of transportation (DOTs) (26) responded to this survey and many were contacted for additional information.

Of primary concern in this synthesis is the crash records system. However, the utility of crash data to identify safety problems or to evaluate the effect of changes in highway and traffic safety is limited by its ability to be used with other types of data. These other data sources include, at a minimum, driver and vehicle records, traffic and roadway condition inventories, and medical outcome data. This synthesis addresses the ability to link crash data with these other traffic records system components.

Chapter two of this report presents background information and a review of the pertinent literature for crash reporting and processing. The review helps to define the characteristics of a good crash records system for use as a benchmark when identifying successful systems.

Because crash records systems are in transition, many current projects that would be of interest to practitioners have yet to be documented in published reports or studies. A brief survey was conducted among agencies involved in crash reporting and processing to get the most up-to-date information on practices and plans. The survey scope and methodology are described later in this chapter and chapter three documents the results.

Chapter four combines the literature review and survey results and highlights the most successful practices that were identified. The following topics are addressed:

- Crash data collection,
- Crash processing and management, and
- Data linkages for reporting and analysis.

Chapter five takes the form of lessons learned in reviewing the current practices in crash records systems. These lessons support future expansion of the use and capabilities of crash records systems.

SURVEY SCOPE AND METHODOLOGY

A survey instrument was designed to gather basic information about current practices in crash records systems (see Appendix A). The survey consisted of 13 questions intended to elicit responses describing how each state collects, manages, and uses crash information. This survey provided an initial screening of agencies to identify potential crash records systems and procedures for further study. The survey asked about timeliness, completeness, and perceived accuracy of the information, as well as how the crash data are used. The overall costs to the state of developing and maintaining the crash records systems were also explored. The survey asked respondents to describe desired improvements to their current system and to identify any other crash records systems they considered to be successfully implemented.

CHAPTER TWO

LITERATURE REVIEW

HISTORY

The first National Conference on Street and Highway Safety in 1924 marked one of the earliest instances of federal interest in motor vehicle traffic crashes. A result of this informal meeting of state representatives was the Uniform Vehicle Code that established a legal basis for investigating and reporting crashes. In 1946, the President's Committee on Traffic Safety asked states to begin developing a database of traffic crashes on which to perform future studies (*2*). At the federal level, interest in crash reporting from 1924 to 1956 was mostly in an advisory role. However, by 1955 there were 75 million registered drivers and 62 million vehicles, and the annual traffic fatality toll that year reached 38,000.

The next 10 years saw an increasing awareness of the national scope of the crash problem and the need for federal leadership and financial aid to assist the states. By the mid-1960s, the National Safety Council (NSC) reported in excess of 49,000 crash fatalities at an estimated annual societal cost of $3.5 billion. The NSC recommended that the federal role expand to include setting uniform standards and providing financial assistance to the states for safety programs. In addition, the NSC recommended that the states collect crash data in more depth and modernize their crash data collection systems (*3*).

The modern era of highway safety began with the passage of the Highway Safety Act of 1966 and continues to evolve today. Section 402 of the Highway Safety Act required, among other things, that states follow uniform standards, establish an effective crash records system, and investigate crashes to determine probable cause. Section 403 of the act included requirements to improve crash investigation procedures and develop comprehensive crash data collection and analysis procedures (*4*). Based on this legislation, the U.S.DOT published standards to promote uniformity in the development of state crash records systems. Highway Safety Program Standard Number 10, Traffic Records, requires each state to establish and maintain a centralized system to collect crash data. It further requires that states keep information concerning drivers, vehicles, and crashes in compatible files for ease in compiling statistics and analyzing crash data. This regulation also lists minimum data requirements, such as the model and make of the vehicle, to be included on the crash report form (*5*).

The American National Standards Institute (ANSI) approved two standards intended to promote national uniformity in crash data. The ANSI D-16 *Manual on Classification of Motor Vehicle Traffic Accidents* (*6*) provides a vehicle damage classification scheme and defines what constitutes a crash. The ANSI D-20 *Data Elements Dictionary* (*7*) provides the definitions of the most commonly used terms in crash reporting. These ANSI standards have been updated routinely throughout the years.

In 1975, NHTSA established the National Accident Sampling System (NASS) and the Fatal Accident Reporting System (FARS) (*8*). NASS is a random sample of nationwide crashes collected by crash investigation teams and FARS is a census of crashes involving fatalities encoded by specially trained analysts in each state. These two national systems have undergone changes over the years, but continue to provide a source of crash data to detect national trends.

Late in the 1980s, FHWA established the Highway Safety Information System to collect crash and roadway inventory data from selected states for research purposes (*9*). The Highway Safety Information System does not represent a statistical sample, but crash and roadway data are added to the system periodically to support various research studies. Generally, state data files are not combined for analysis because there is a lack of similarity in definitions and coding of various elements.

Throughout the 1990s, numerous legislative and programmatic actions reflected heightened interest in traffic records systems, including:

- The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, passed by the U.S. Congress, which decreed that states establish a number of interrelated information management systems to support their decision processes concerning the maintenance of their roadway systems and efforts to improve transportation safety (*10*).
- Several major programs that were undertaken by NHTSA to improve the quality and utility of police-reported crash data including:
  - CADRE, Critical Automated Data Reporting Elements (*11*),
  - CODES, Crash Outcome Data Evaluation System (*12*),
  - MMUCC (*13*),
  - Sponsorship of an annual national conference on the use of traffic records data, and

  - Grants to support the development of strategic plans to improve traffic records systems.
- Grant funds provided to states by FHWA in partnership with NHTSA for the development of strategic plans to improve their traffic records systems and the development by FHWA of guidelines for the management systems required by ISTEA legislation (*14*).
- Initiation of the National Governors Association's project by the Office of Motor Carrier Safety, now the FMCSA, to improve the quality and utility of information concerning crashes involving commercial vehicles (*15*).

As an adjunct to these and other efforts, Congress created a number of incentive mechanisms that provided additional grant funding to support traffic records improvements if a state has not passed certain safety legislation. Individually and collectively, these efforts encouraged states to improve their traffic records systems, in many cases providing both the motivation and funding necessary to do so.

Over the years, Congress has increasingly viewed traffic crashes as a national problem meriting federal involvement; therefore, the federal goal in this area has been to provide leadership and financial aid to the states as incentives to develop a nationally uniform system. One example of federal input was the publication in 1990 of an advisory describing traffic records systems and the recommended components of such systems (*16*). On the other hand, states have tried to retain the maximum degree of flexibility and decentralization so that they can respond to their state needs (*17*). Ironically, the states have the same difficulty in maintaining a uniform crash records system statewide because their local jurisdictions wish to retain the maximum degree of flexibility to meet the needs of their local constituents.

NHTSA conducts a periodic survey to identify the custodians of the various records systems that comprise each state's traffic records system. These results were updated with those obtained from a survey conducted by FMCSA to determine the types of agencies that serve as the custodians for the statewide crash records system (*18*). The most recent results of those combined surveys indicate the categories of crash custodial agencies as:

- Thirty agencies that are roadway oriented (e.g., state DOTs and highway departments).
- Eleven agencies that are primarily law enforcement (e.g., Departments of Public Safety, State Police, and Highway Patrol).
- Seven agencies that are primarily financial in nature (e.g., Departments of Revenue).
- Two agencies that are unknown because of no response to either survey.

The diverse uses and users of these crash systems create an equally large and diverse set of demands. For example, a public safety custodian may place more emphasis and resources on crash data collection, whereas a DOT might be more likely to expend resources to improve data warehousing and linkage. Attempts to balance competing needs can create problems, or the perception of problems, when trying to make changes and improvements to the crash records systems.

By 1994, national costs of crash data collection and management were estimated at $130 million, with data collection being 60% and data management 40% of that total (*19*). The estimated unit cost was $21 per crash. At that rate, even states with a smaller than average number of crashes can expect to spend millions of dollars to collect and manage these data.

The increased reliance on traffic records information by the highway safety community to develop, manage, and evaluate its programs, however, has to be given full consideration in making a decision to improve crash data collection and management procedures. Traffic records data, particularly information contained in the police crash report, are the basis for virtually all safety programs, from roadside hazard removal to the enforcement of traffic safety legislation. Law enforcement, traffic engineers, the judiciary, private citizens, the medical community, and highway safety program specialists use traffic records data to initiate actions that ultimately may reduce the frequency and severity of motor vehicle crashes of all kinds. Understanding and satisfying the information requirements of the traffic safety and public health community is the key to developing usable and accessible crash records systems.

CRASH DATA COLLECTION

In recognition of the need to meet differing local needs with their data collection efforts, the updated NHTSA *Traffic Records Advisory* (*20*) recommends data systems that are flexible enough to receive data from numerous local systems in a consistent format. Figure 2 shows a data flow diagram (DFD) from the Advisory. This DFD illustrates the wide number of data sources needed to complement the crash records system.

The highway safety literature has historically documented the causes of, and problems arising from, poor quality crash data. *NCHRP Synthesis of Highway Practice 192* (*21*) covers this subject well. The causes of poor quality are numerous but can be generally viewed as errors in form design (i.e., the data collection instrument was flawed), reporting errors (i.e., the person completing the form made a mistake), and mismanagement of the records (i.e., the original data were somehow corrupted during processing). As shown in the DFD, there are numerous steps in the data collection process where these errors can occur. The following are some of the issues involved in obtaining quality crash data.

- Uniformity of data—Crash data uniformity is primarily a national problem, because most states mandate the

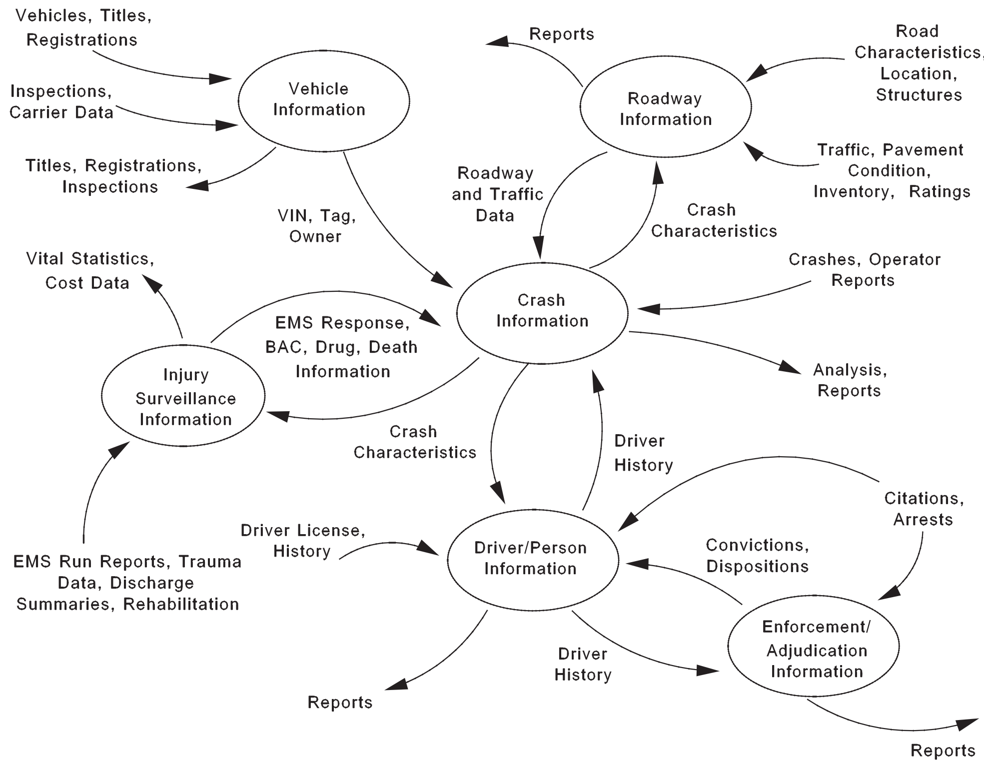

FIGURE 2 Distributed traffic records systems.

use of a uniform crash report form. The federal government has consistently worked toward national standards for crash data reporting for all states. It has only been since the promotion of MMUCC and the National Governors' Association commercial truck and bus data variables, supplemented by federal funding initiatives for traffic records improvement that substantive advances have been made in uniform reporting. As states make periodic changes in their crash report forms, they are beginning to incorporate the guidelines into their crash records systems. In addition, most states follow ANSI standards D-16 and D-20 for crash data reporting. As even more states incorporate MMUCC into their crash reporting standards, the ability to provide meaningful analyses and draw appropriate conclusions on a national level will be significantly improved.

- Accuracy of data—The more times that crash data are interpreted or key entered into a system, the more likely that the accuracy of these data is affected. Although inadequate training for law enforcement officers may have contributed to problems of accuracy in the past, steps have been taken to improve training programs and to provide automated tools for simpler and more accurate crash data entry.
- Level of reporting—The level of reporting was once a serious problem only at the national level, owing to the different reporting thresholds used by each state. Today, with fewer and fewer resources to commit to crash data collection, localities are making their own policies about which crashes they will investigate. This variance among local reporting policies and thresholds has implications for the statewide crash database that were once only a problem for national comparisons and analyses. These include:
  - Many crashes that may go unreported;
  - Driver-only reports, or officer desk reports, which may not be as reliable as a trained officer's report taken at the scene of the crash; and
  - Systematic biases that are introduced into the data if drivers report certain kinds of crashes, whereas officers report others, or if certain types of crashes are consistently missing from the database.

Underreporting or errors in crash reporting affect decisions regarding the selection of crash countermeasures, law enforcement activities, allocation of funding at state and local levels, and numerous other traffic safety and transportation system management activities.

- Timeliness—In the late 1960s, NHTSA found that crash data were often several months to a year old by the time they were available in the crash reporting system. In the early 1980s, as crash records systems matured, timeliness of crash data became less of a problem, with information available often within 2 months of the date of the crash (*22*). In 1993, a review of nine states showed the time from crash to crash file as 25 to 210 days (*23*). According to the survey results for this study, one-quarter of the responding states reported that a crash may be entered into their crash records system up to a year or more after the crash occurred.

CRASH DATA MANAGEMENT

Management of crash records systems also affects the quality of these data by duplication of the data handling, outdated software systems, and a lack of system compatibility with other components of a traffic records system. Many of the older legacy systems for crash management were designed with linkages to other components of a traffic records system (e.g., Roadway, Vehicle, and Driver systems) to edit data as it was entered. In addition, extensive system validation edits were in place to improve the quality of the crash data.

As resources are reduced, fewer coders are available to enter the crash data and the data entry falls further and further behind. To overcome these data entry delays, many states have removed system validation edits, reduced the number of data elements entered, and raised the crash reporting thresholds. In many cases, those variables required to link the crash file to other data components (e.g., vehicle tag or vehicle identification number, driver's license number, and location coding) are also removed. The result is that crash data are processed more quickly, but the ability to use these data for analyses is severely limited.

TECHNOLOGY STRATEGIES

In a study to identify possible improvements in safety information to support highway design, technological strategies with the potential for improving safety information are presented (*24*). The following list is adapted from these technological strategies.

- Data Collection
  - Portable computers
  - Prerecorded data readers
  - Artificial intelligence
  - Location technologies
  - Laser-based measurement
  - Digital photography
  - Aerial imaging
- Data Communications
  - Cellular systems
  - RF (radio frequency) systems
  - Fiber optic systems
- Data Management
  - Optical scanners (optical mark recognition and optical character recognition)
  - Artificial intelligence
  - Error-trapping and correction
- Databases
  - Relational
  - Object-oriented
- User Interfaces
  - Graphical user interface (GUI)
  - GIS
  - Computer-aided dispatch
- Decision Support
  - GUI
  - Context-sensitive help
  - Voice recognition
  - Artificial intelligence
- Analytical Tools
  - Modeling
  - Simulation.

There have been numerous pilot tests and uses of these technological strategies to improve crash records systems, with varying degrees of success. In regard to this report, it was concluded that technologies could address some of the issues of data collection, management, and use. Indeed, a single technology might address numerous issues. However, it was clear that technology would not solve all of the problems of crash records systems.

Beginning in the early 1990s, many technologies were proven useful in the area of crash records systems. These included the following projects:

- Technocar 2000—This project, funded by FHWA, NHTSA, and the Texas DOT, proved the use of innovative technologies in a law enforcement vehicle to improve the ability of the officer to collect data and report locations, and the ability to establish a link with other sources of information. The vehicle contained a mobile videotaping system; GPS; a pen-based computer system with touch screen and in-vehicle docking and keyboard; and the TRASER database software system for crash, citation, and commercial motor vehicle inspection forms. The TC2000 was examined for human factors conditions and withstood crash tests of the installed equipment and mounting systems (*25,26*).
- ALERT—The Advanced Law Enforcement and Response Technology (ALERT) project, funded by FHWA, National Institute of Justice, and International Association of Chiefs of Police, continued the work started in the Technocar 2000 project. A vehicle was outfitted with an integrated network of devices to support the mobile data collection requirements and provide wireless access to local, state, and federal databases, controlled through a single GUI (*27*). Although this study has ended, automotive and other companies continue to identify vehicle-based technologies for data collection.
- Expert systems—This crash data collection program, funded by FHWA, tested the use of expert systems technology to improve the accuracy of police-reported data. Three expert systems were developed, evaluated, and implemented in mobile software programs in use in Iowa: (1) seat belt use, (2) vehicle damage rating, and (3) roadside barrier problem identification (*28*).

- TraCS—Support of the Traffic and Criminal Software (TraCS) is a federal–state partnership, between the U.S.DOT and the state of Iowa, to demonstrate the successful integration of technologies for data collection, management, and communication of safety information. In-vehicle hardware functions as a mobile data computer and for field-based reporting, such as motor carrier safety inspections, citations, Implied Consent [driving under the influence (DUI)] forms, and incident and crash reports. The system uses wireless data communications, mobile video, GPS, GIS, and bar codes (*29,30*). TraCS use has spread from Iowa into several other states.
- Electronic identification—This encompasses a group of technologies that allow storage, retrieval, and comparison of personal identifying data. NHTSA has been involved in the development and testing of new driver license technologies for several years (*27*). These include magnetic strip, bar code, digital photo, digital fingerprinting, and "smart card" technologies. The data can include names, coded numbers (such as a driver's license number), and addresses, along with personal descriptive or biometric information (e.g., digital photo, eye color, height, weight, thumbprint, and iris scan).

As early as 1993, FHWA found numerous examples of technologies already being used for crash data collection. The most prevalent technologies available at that time were various configurations of portable computers for field data collection, GPS for identifying locations, magnetic strips and bar codes for driver identification, and bar codes for vehicle identification (*23*). These technologies, along with digital cameras and scanners for optical mark sensing and/or optical character recognition, were identified in that study as components of a model crash data collection system.

LOCATION REFERENCE

An early NCHRP Synthesis described a location reference method as "a way to identify a specific location with respect to a known point," including three elements: "(a) identification of a known point, (b) a measurement from the known point, and (c) a direction of measurement" (*31*). The two basic location reference methods described in that study are still in use today:

- Sign-oriented methods (milepost, reference post) and
- Document-oriented methods (calculated mile points, route log, straight-line diagrams).

A variation of the sign-oriented method (i.e., locations determined in the field) in practice today is the use of GPS or automatic vehicle locator to identify the coordinates of the location. A variation of the document-oriented method currently in use is a selection of a location using a GIS map. Examples of the more advanced site locator routines are available in the Iowa TraCS software and the Illinois Mobile Crash Reporting System (MCRS) software.

The use of a precise location reference method is a critical aspect of crash data, whether analyzing the location of crash occurrences or using the location reference to link crashes to other data sources. Before the passage of the ISTEA legislation in 1991, complete location reference systems were generally available only for those roadways on the state-maintained highway system. Since 1991, there has been more emphasis on referencing locations for local roadways as well. Illinois, Michigan, and Missouri are examples of the many states that have moved toward a location referencing system that identifies all roadway locations, usually as part of a GIS for mapping those locations.

An NCHRP study of highway crash and roadway systems describes the advantages and disadvantages of using particular location referencing methods (*32*). Of most importance to this discussion is the need to use a second location referencing method when coordinates are the primary location identifiers or a carefully constructed linear referencing system. The use of coordinates alone can create difficulties in trying to merge data files because of the level of precision needed to match the locations. For example, a roadway file may identify a location to a particular point, whereas a crash location code may identify a spot several meters from that roadway point. It can be difficult to identify high crash locations because a particular coordinate identifying a location in a crash file (because of its precision) may match only one or two crash records. Knowledge of the roadway and a well-defined linear referencing system allows the effective correlation between the various coordinate locations to form a meaningful picture of crash experience.

INSTITUTIONAL AND ORGANIZATIONAL BARRIERS

Pfefer et al. (*24*), the authors of an NCHRP study of safety information to support highway design, suggested several organizational and institutional strategies that can affect crash data quality. A few of the issues from that report included:

- Poor communication of changes (e.g., new roadways not identified in crash system),
- Lack of access to other data systems (e.g., files reside in different agencies),
- Inadequate training and feedback for data collectors,
- Lack of linkages with other databases resulting in duplicate data collection,
- Changes in forms and procedures without adequate communication and review, and
- No standardized methods of identifying locations.

There are numerous barriers to using crash or other data that could be considered institutional, organizational, or systematic. There is often inadequate knowledge about the existence of crash data and its availability, a failure to document the conditions of its collection, varying definitions and measuring instruments, and simple reluctance to confront the adverse consequences of misusing or misunderstanding these data. Access to these data can be affected by the ownership of the data, security issues, and the costs to collect and generate the data.

The NSC's National Agenda for improving safety information systems includes the following six goals to address the organizational and institutional barriers that have an impact on crash and other components of traffic records systems (*33*):

- Instill an appreciation for the value of highway safety information systems.
- Establish a means by which collection, management, and the use of safety data can be coordinated among all organizations and jurisdictional levels.
- Integrate the planning of highway safety programs and information systems.
- Provide the resources necessary to select appropriate technology.
- Establish a cadre of professionals trained in appropriate analytical methods.
- Promote technical standards for the characteristics of information systems.

The AASHTO *Strategic Plan for Highway Safety* (*34*) supports these goals with specific recommendations in the management area that deal with gathering and analyzing crash data:

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

States have taken significant initial steps to address some of these barriers by developing new directives, documentation, and instructions; creating statewide traffic records coordinating committees; and promulgating new tools and standards for the crash and other data records systems. Efforts to transform the existing culture have included implementing incentives (usually financial), overcoming disincentives, educating and training the decision makers and the users and providers of data, and implementing new processes to effect change in the crash records systems.

The implementation plan for the international scan for traffic safety information systems (*35*) proposes a number of strategies to update AASHTO's Goal 21. These include activities such as:

- Marketing traffic safety information to increase public and political awareness of its importance.
- Simplifying data collection by law enforcement officers by increasing the automation of data and only gathering data necessary to be collected in the field.
- Supporting electronic data collection of all types of data; for example, crash, roadway, traffic, driver, and medical.

These and other strategies are discussed in more detail in a FHWA working document, Scan Technology Implementation Plan, which was developed based on the findings of the scan team.

CHAPTER THREE

SURVEY RESULTS

Twenty-six states responded to the survey for this synthesis. The vast majority of responses (23 of 26) came from DOTs or the equivalent. One response was received from a highway safety office within the state police agency, a second came from an office of highway safety within the department of public safety, and the final response did not specify the agency. The survey responses reflect crash record systems in place and/or under development during the early summer of 2004. Figure 3 shows the geographic distribution of the responding states, which are shaded on the map. Table 1 gives an overview of their crash experience.

As seen in Figure 3 and Table 1, the responding states are from all areas of the country and represent a broad distribution of crash experience. It is of interest to note that the data in Table 1 also came from different years of crash records. The oldest data came from Washington State (which plans to have 1996–2002 data available soon). As of this writing, only 3 of the 26 states had made their 2003 data easily accessible by the public. Because these data are derived from crash summary data available on the Internet at a particular point in time, it is likely that some of the other states either have 2003 data available for internal use or they have a policy against providing crash data on the Internet.

SURVEY RESPONSES

Question 1 of the survey asked respondents whether their responses applied to an existing system, a new system currently under implementation, or to a planned future system. Twenty-one of the 26 respondents reported that their answers described a current system. Four of the remaining five respondents indicated that they were describing a new system that was currently under implementation. One respondent (Colorado) said that its responses describe a planned system for which funding is already in place. Because almost 90% of the respondents were from state DOTs, in some cases (e.g., Mississippi) there is an existing crash database at the custodial agency, but a separate state DOT crash system of linked data is currently under development.

Question 2 of the survey asked respondents how long it takes (from the date of the incident to final data entry) to enter a crash into their central crash database. Figure 4 shows the distribution of answers. As may be seen in the figure, the most frequent responses were "Within 90 Days" (10) and "Within 30 Days" (9). Still, almost 20% of respondents indicated that it could take from 91 to 364 days to be entered into their statewide system ("Less than 1 year"). Two respondents indicated that it takes more than a year to enter a crash into their system. Again, it is likely that some of those respondents that refer to their DOT system as not receiving crash data for more than 90 days (e.g., New York reports more than a year), have crash data readily available from that state's custodial agency at an earlier time.

Question 3 asked respondents whether all crashes meeting the state threshold are collected and entered into the crash records system. Twenty-two of 26 states (85%) responded "Yes." Three states (i.e., California, Connecticut, and Oregon) stated that not all reportable crashes are entered in the system and one did not answer.

Question 4 was a compound question. The first part of the question asked if users are able to obtain reports from the system. The second part asked how this is accomplished. Figure 5 summarizes the answers to these questions.

Because it is possible for a system to support more than one level of reporting, the data in Figure 5 show the cumulative totals for all answers from each respondent. No single respondent reported that users are unable to obtain reports from their crash records system. Twenty of the 26 systems, almost 77%, support ad hoc queries specified by the user and 17 (65%) indicated that their crash systems support predefined "canned" reports. Of the 17, only 3 states indicated that canned reports were the highest level of reporting available; the remaining 14 crash systems supported both predefined and ad hoc reporting. Four states have systems designed to support users by having them submit requests to trained analysts. In three of these four cases, this was the only way for users to obtain a report. At least some of the states that reported having to submit report requests, such as Iowa, have a university-based center that actively supports these requests.

Question 5 asked respondents to indicate whether roadway, vehicle, driver, emergency medical service (EMS), and other sources of data can be linked with the crash data. Because it is possible for a system to include linkage to more than one external data source, Figure 6 shows the cumulative totals for all answers from each respondent. Twenty of the 26 respondents (77%) indicated that their crash database has links to roadway data. This was more than double the number

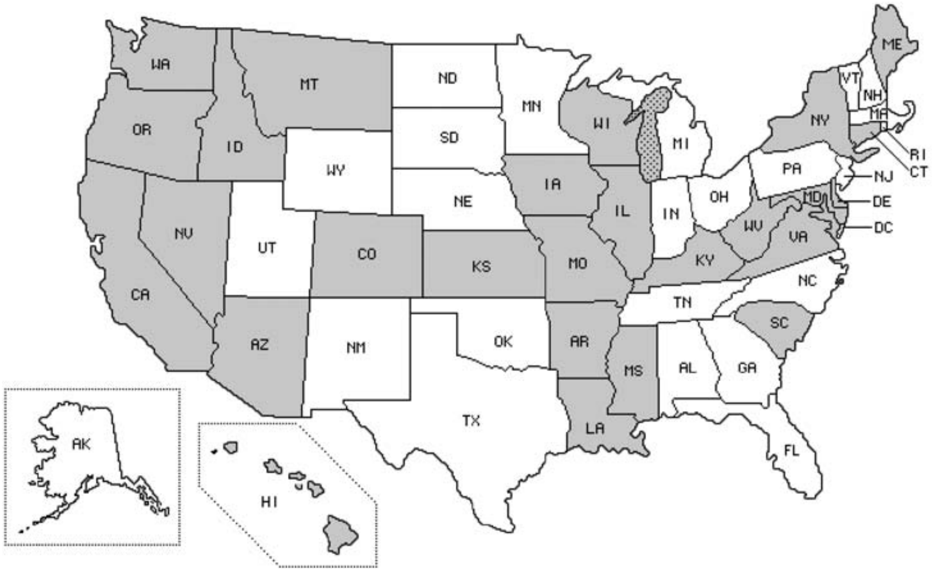

FIGURE 3 Geographic distribution of responding states.

TABLE 1
CRASH DATA FOR STATES RESPONDING TO THE SURVEY

State	Total	Fatal	Injury	PDO	Fatalities	Injuries	Total Casualties	Year of Data
Arizona	134,228	974	46,209	87,045	1,119	74,230	75,349	2002
Arkansas	70,904	557	28,125	42,222	641	52,474	53,115	2002
California	522,562	3,517	201,478	317,567	3,926	305,907	309,833	2001
Colorado	96,990	595	26,208	70,187	655	38,283	38,938	2002
Connecticut	82,787	319	34,448	48,020	343	51,129	51,472	2000
Delaware	20,408	118	6,021	14,269	137	9,967	10,104	2001
Hawaii	10,848	133	6,125	4,590	140	8,620	8,760	2001
Idaho	26,700	261	9,661	16,778	293	14,601	14,894	2003
Illinois	438,990	1,273	87,458	350,259	1,420	127,719	129,139	2002
Iowa	64,361	394	23,763	40,204	445	36,031	36,476	2000
Kansas	78,271	449	18,495	59,327	511	27,059	27,570	2002
Kentucky	130,347	810	32,393	97,144	915	49,329	50,244	2002
Louisiana	160,991	791	48,800	111,400	902	82,800	83,702	2003
Maine	37,251	153	11,538	25,713	165	16,415	16,580	2000
Maryland	104,843	606	38,875	65,362	661	59,517	60,178	2002
Mississippi	91,687	786	24,228	66,673	871	37,174	38,045	2003
Missouri	94,623	822	27,376	66,425	922	42,298	43,220	2002
Montana	23,529	232	6,479	16,818	269	10,083	10,352	2002
New York	306,050	1,431	172,174	132,445	1,554	259,143	260,697	2001
Nevada	62,237	330	20,475	41,432	381	31,522	31,903	2002
Oregon	48,282	388	18,679	29,215	436	27,791	28,227	2002
S. Carolina	108,280	949	32,427	74,904	1,053	52,095	53,148	2002
Virginia	154,848	860	55,041	98,947	942	78,842	79,784	2003
Washington	51,474	318	22,298	28,858	360	34,178	34,538	1996
W. Virginia	49,913	405	16,859	32,649	444	25,788	26,232	2002
Wisconsin	129,072	723	39,634	88,715	805	57,776	58,581	2002

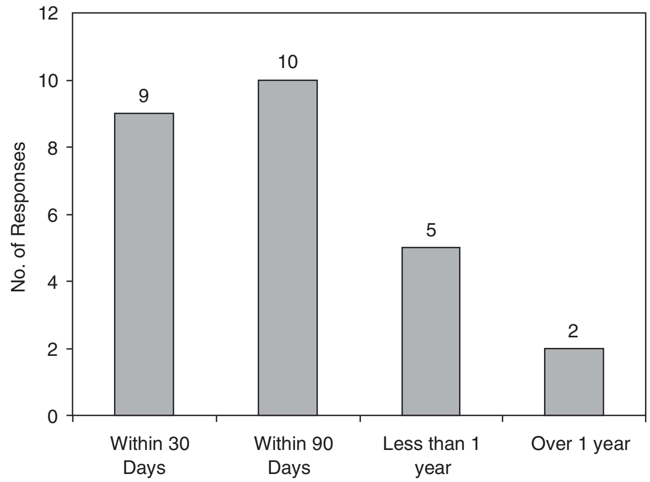

FIGURE 4 How long it takes (from the date of the crash) for a report to be entered into a traffic records system.

of linkages reported for any other data source; however, it is not unexpected because the respondents were predominantly from the state DOTs. The next most frequent linkages cited were to the vehicle and driver data files.

Seven respondents reported linkages to sources of data "other" than those cited in the question. These were identified in the survey responses as:

- Linkages to annual average daily traffic volume data (3),
- A link to citation data (1),
- A link to hospital discharge data (1),
- A link to their bridge inventory (1), and
- No source of linked data identified (1).

The following states reported more than one linkage in their survey response:

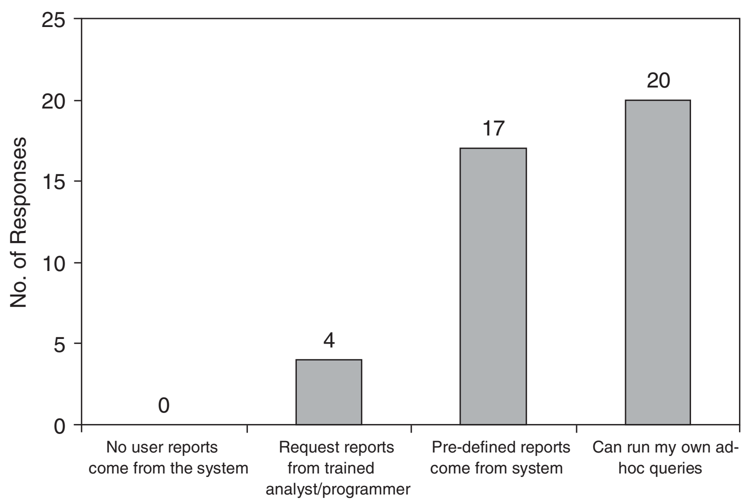

FIGURE 5 How easily can users obtain reports from the system? How does this process work?

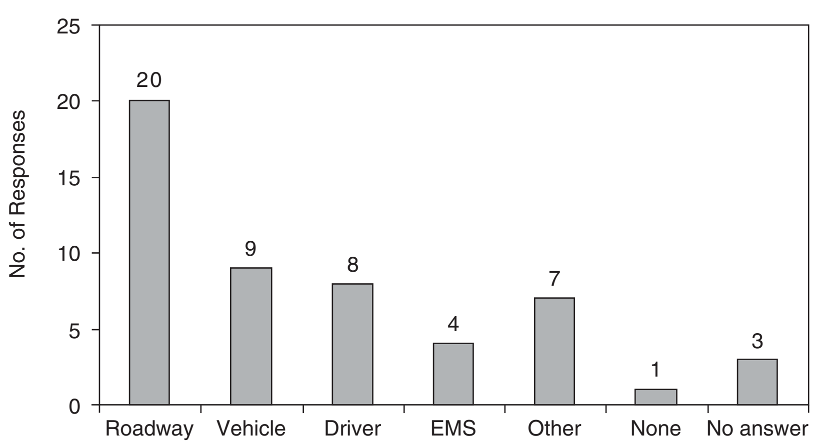

FIGURE 6 Other sources of safety data that are linked to the system. EMS = emergency medical service.

Colorado—Vehicle and driver.
Iowa—Roadway, vehicle, and driver.
Maryland—Roadway, vehicle, driver, and EMS.
Missouri—Roadway and vehicle.
Mississippi—Roadway, vehicle, driver, and EMS.
Nevada—Roadway, vehicle, driver, EMS, and citations.
New York—Roadway, vehicle, and driver.
South Carolina—Roadway, vehicle, driver, EMS, and hospital discharge.
Virginia—Roadway, vehicle, driver, and bridge inventory.

It is interesting to note that there are many more documented linkages of data available in these reporting states (e.g., CODES projects); however, the survey respondents did not report the additional linkages that might be available. Even within the DOTs, for example, Missouri's report of a roadway linkage refers not to a single roadway characteristic file, but rather to their comprehensive transportation management system. This enterprise-wide system is a GIS-based data system supporting their activities with extensive information about traffic, pavement, safety, bridges, and travelways.

Question 6 asked respondents to tell us what location coding methods are used in their systems. The answers are sorted into three basic categories:

1. Locations based on posted locations in the field (e.g., mileposts),
2. Document-based systems that assign a calculated location code (e.g., mile point, log point), and
3. Locations in which a latitude and longitude are collected by GPS or a GIS map is used to pinpoint the location.

Figure 7 summarizes the responses to Question 6. Because it is possible for a system to include more than one location coding method, this figure shows the cumulative totals for all answers from each respondent.

Fourteen of the 26 states that responded to the survey, or almost 54%, are using GIS and/or GPS map-based systems with coordinates. These systems include reading a GPS to obtain coordinates either automatically or manually at a crash site, GIS locator routines to identify a site by pointing to a map, and after-the fact locating of a crash on a map based on the officer's description of the location. Twelve crash record systems use location-coding schemes based on reference posts or mile markers placed on roadsides, and 16 systems are using a document-based mile point and calculated displacement methodology for locating a crash.

Question 7 asked respondents to specify what percentage of crashes is located reliably in their system. The answers ranged from 50% to 100%, with the median response at 94%. The mean response was 88.7%. Two respondents reported that the percentage of crashes reliably located was unknown. In general, the crash records systems that identify locations based on one of the methods of obtaining coordinates are perceived as more accurate and descriptive than the crash systems using traditional field and document-based methods. Being able to conduct spatial analysis with crash and related data with a GIS was cited as a considerable advantage to using the coordinate-based location method.

Question 8 asked respondents for an estimate of the cost to develop their crash records system. Thirteen respondents reported a total cost for developing their statewide crash records system. Although it was not possible to determine the system elements included in the total cost, the mean cost of crash systems reported was just over $861,000. The median cost was $500,000. The difference in these two measures indicates that some outliers likely affected the mean—in this case, one system came in at $3,500,000 and two systems were near $2,000,000. The remaining 10 systems reported much lower costs. Excluding the three multimillion dollar systems, the mean cost of the systems was approximately $390,000. This estimate is much closer to the median value of $400,000 for these 10 systems, indicating that for these

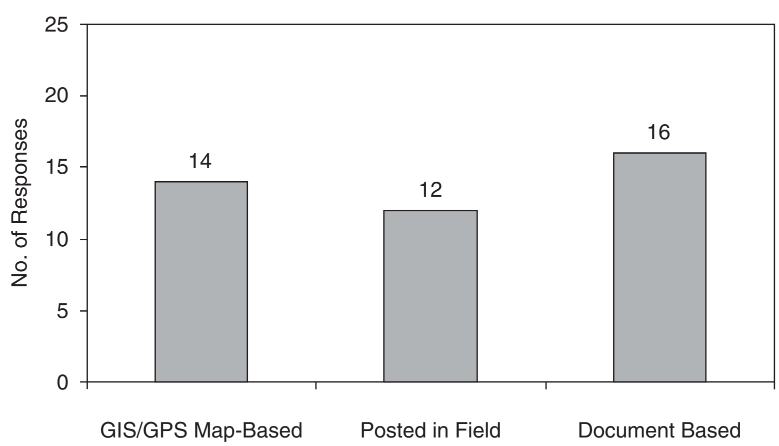

FIGURE 7 Location coding methods used.

lower-priced systems, the measure of central tendency is not overly affected by outliers.

Twelve of the respondents reported that they did not know the cost of developing their systems. Missouri reported a cost for their enterprise-wide system of $24 million, which included numerous data files linked to their crash data. This cost was not included in the averages cited previously, as there was no obvious way to apportion the cost of the crash component of the system. Recent costs for large crash systems that were not reported in this survey include the Texas crash system, which is expected to cost approximately $9 million and the Indiana crash system that has cost approximately $5.5 million.

Question 9 asked respondents for the cost of collecting and entering crash data into their crash records system. Eleven of the 26 states reported this cost, with 3 providing a cost per crash. For the other eight, cost per crash data were calculated using the summary data (annual total cost) of the system and an estimate of the total number of crashes based on the data reported in Table 1. The costs ranged from a low of $1.53 in California to a high of $38.85 in Washington State. Costs for Washington State and Oregon (at $19.88/crash) were by far the highest reported, with the next highest cost per crash reported at $7.61 (estimated for Missouri). It should be noted that the discrepancies in crash costs reported could be the result of many factors, including inconsistencies in the cost components counted as part of the estimate, methods used to compute the component costs, and actual differences in the costs of labor and other items in the various locales. These costs fall within the average of $21.00 per crash calculated in the 1998 crash cost study described in chapter two.

Question 10 asked respondents what features and capabilities they like about their crash records systems. Twenty-four of the states responded to this open-ended question by listing one or more features. Because most respondents indicated that there were several features that they liked about their system, the data in Figure 8 show the cumulative totals for all answers from each respondent when summarized in four broad categories.

- Data collection—Ten of the 24 respondents mentioned data collection as a feature they like about their crash records system. Three of these respondents mentioned electronic transfer of crash data into their system and eight of the respondents were particularly pleased with the data edits and quality control in their system.
- Management—Nine of the 24 respondents favorably mentioned the management and maintenance of their crash records system. Of these, five spoke of the benefits of their document management system and five spoke of the ease with which the crash records system could be managed.
- Linkage—Ten of the 24 respondents were pleased with the ability of their crash records systems to link with other components of the traffic records system. Four of the 10 respondents were particularly pleased with their ability to use location or GIS as a means of linking data with roadway and other inventories. Other data components mentioned as linked to crash records systems included driver, vehicle, EMS, and hospital discharge data.
- Analysis and reporting—Approximately two-thirds of the respondents (15 of 24) believe that the best feature of their crash records system is the ease with which they can do analysis and reporting of the data. The reporting responses include query capability, canned reports, ad hoc reports, and exporting of data to other systems.

Question 11 asked respondents what they would change about their crash records system if they could start over. Twenty-three of the states responded to this open-ended question by listing one or more features. Because most states indicated that there were several features that they would like to change about their systems, the data in Figure 9 show the cumulative totals for all answers from each respondent when summarized in four broad categories.

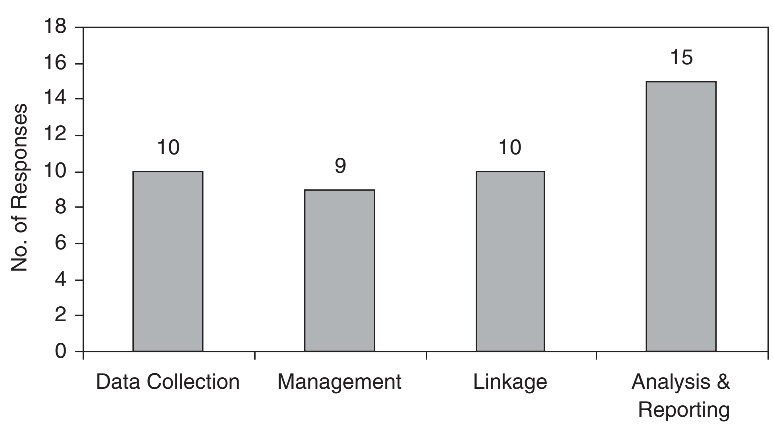

FIGURE 8 What features and capabilities do you like about your crash records system?

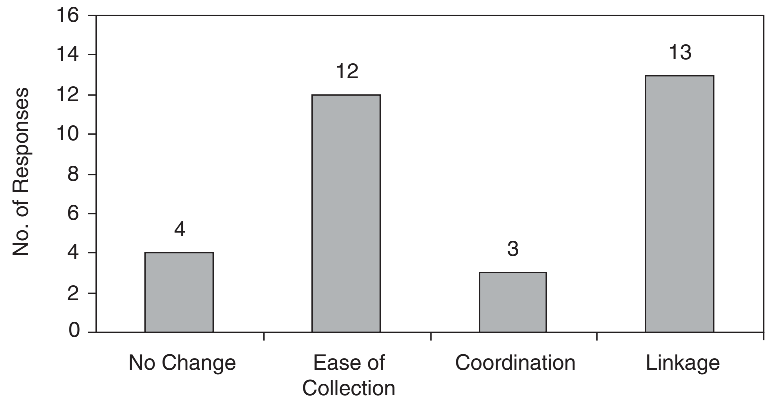

FIGURE 9 What would you change about your crash records system if you could start over?

- No change—Four of the 23 respondents indicated that they would not change anything about their crash records system.
- Easier data collection and access—More than half of the respondents (12 of 23) specified that they would like to automate and streamline data collection procedures with electronic data collection and use of additional technology in the field (e.g., bar code scanning and GPS), user-friendly interfaces, personal computer-based relational databases, simpler ad hoc reporting, and/or Internet-based access.
- Agency coordination—Three of the 23 respondents indicated they would like to have better interagency coordination to ensure that all needs are being met or to effect legal changes that would mandate standards for crash data collection.
- Linkages to other data sources—More than half of the respondents (13 of 23) mentioned that they would like to include better linkages to other data components for both data entry and reporting. Nine of these specifically would have included better linkage with location control data for both data entry and reporting.

Question 12 was an open-ended question asking respondents to indicate if they know of any good crash record systems. Twelve states responded to this question. Half (6) believed their own state has a good crash record system. Two of the respondents indicated they had looked at several systems and had found only components of a good crash records system, and no completely good system(s). Six respondents named other states as having a good crash records system, with four of these responses citing the Iowa TraCS system.

Question 13 was an open-ended question asking respondents to indicate what characteristics they like about the crash systems that they had named in question 12. Ten states responded to this question and half (5) mentioned characteristics of their own crash systems that they provided in their answers to survey question 10. Four of the remaining five discussed characteristics that they like about the Iowa TraCS system, such as the location tool, electronic crash entry on laptop computers in the car, electronic submission with internal edits and sharing of common data. The remaining respondent liked the cluster search program in Colorado that was part of an FHWA research project.

SUMMARY

Overall, the survey response was gratifying. The geographic dispersion of the responses gives some measure of comfort in claiming that the results are representative of the United States. Unfortunately, some large states and some states that are known to be working on new crash records and traffic records systems did not respond to the survey. Where possible, the information on successful practices and initiatives to be presented in the next chapter will be supplemented with information gathered on various crash systems and practices from other sources, such as periodic traffic records assessments.

The survey results show that the data are more timely and complete than might be expected—more than 80% of states claim to have data entry completed within 90 days of a crash, and almost 85% of states claim to have all reportable crashes coded into their systems.

Access to analytic results also appears to be satisfactory, with more than 75% of states giving users the capability to run ad hoc queries on their own. Not surprisingly, linkage of the crash file to other sources of traffic records information is uneven. More than 75% of crash records systems link to roadway data, but this was more than double the percentage of linkages reported to driver and vehicle data.

Most crash systems use more than one location coding method, with traditional document-based and map-based methods being the most prevalent. The ability of states to code locations of crashes is quite good, with almost 90% of crashes located in the crash records system. The use of GPS to locate crashes in the field or GIS maps to pinpoint a crash location is increasing.

All of these capabilities cost money. For the half of the respondents who gave us this information, the average cost to develop a system was just over $850,000. There were 10 systems that cost less than $1 million and 3 systems that cost more than $1 million. The ongoing cost of having data in the crash records system was addressed by 11 of the states and the cost per crash varied widely, from a high of almost $40 to a low of just over $1.50. It is likely that the wide variance is the result of what steps of a crash records system processing were actually included in the costs cited.

The most popular features of the current crash records systems were analysis and reporting, linkage, and data collection; however, only analysis and reporting were cited by a majority of the users. The most frequently requested improvements are linkage to other systems and easier data collection and access. Approximately one-quarter of the respondents mentioned their own crash records system as a model and only a handful mentioned other crash records systems as having all the features they would like to have in their own.

From the survey responses, there was no consensus among practitioners about a crash records system that served all aspects of a successful traffic records system. There are systems that, perhaps, efficiently capture all the needed data in a single area (e.g., crashes). However, that does not translate to the broader traffic records arena and the other systems needed to support users. As might be expected, the situation is characterized best as a patchwork of data ranging from delayed and incomplete to timely and complete.

CHAPTER FOUR

SUCCESSFUL CRASH RECORDS SYSTEMS AND INITIATIVES

Although no comprehensive crash records system was identified as a model or "best practice," many examples of one or more components of a successful crash records system were found. It is often the case that the agency that serves as the custodian for the crash records system determines which component of the system is considered most important in terms of new funding and development initiatives. For example, if the crash records system is under the purview of a state law enforcement agency, then often the crash data collection component is emphasized. If the crash records system is under the control of the state DOT, the emphasis is often on the ability to locate crashes well and to link to other data sources for analysis. If a regulatory agency such as a department of revenue manages the crash records system, the agency often designs a system that allows easy access to a single crash record for sales. To the extent that these agencies work together, especially through a forum such as a traffic records coordinating committee, the strengths and weaknesses in a crash records system can be balanced to serve the needs of all of the stakeholders.

With a growing understanding of the needs of diverse users of crash data, there is more attention than ever paid to the timeliness, completeness, accuracy, and accessibility of these data. This awareness has led to a deeper appreciation for the costs of achieving excellence in a traffic records system. To meet the needs of multiple users, the system must be flexible and its quality must be monitored. Cost savings in one part of the system can have disastrous consequences for other parts of the system. Unfortunately, this is where the breakdowns in the system can still occur. Local law enforcement agencies, pressed for resources, sometimes conclude that they can no longer afford to respond to property-damage-only crashes. Statewide crash custodians, pressed to cut the cost of data entry or to catch up on a backlog of crash reports, skip edit checks or even stop performing procedures such as location coding or text-field data entry. Sometimes new software is installed without adequate testing and suddenly a crash records system that was previously known for having high-quality data is left with no data at all. It can take an agency years to recover from such missteps.

It appears that there still exist some major sources of conflict in supporting crash records systems. The tensions that practitioners most often cite are those among the needs of data collectors, data managers, and data users. A successful approach would be one that addresses the needs and concerns of all three groups and identifies solutions to problems at one level that may make things better at other levels of the reporting process. Because it is not possible to identify an existing system that satisfies this multilevel definition, it is important to examine the successes at each level to see how their application might be adapted to meet the needs of all stakeholders.

For purposes of discussing successful crash records systems, it is necessary to identify successful practices in the three major components of such a system:

- Crash data collection,
- Crash processing and management, and
- Data linkages for reporting and analysis.

CRASH DATA COLLECTION

Law enforcement agencies task sworn officers and other designated report writers to respond to crashes in their jurisdictions. In addition to arranging for appropriate emergency services, securing the scene, gathering evidence, and clearing the roadway as soon as practical, investigators must create the basic record of the circumstances involved in the crash. Even when officers fully understand the importance of high-quality crash data, their ability to perform this task is challenged by competing priorities, specific gaps in training or expertise, and often a simple lack of access to the source of required information. A successful example of addressing this problem is the use of civilian crash investigators for all crashes that do not require a sworn officer's presence. There are cities in Florida and other states that have successfully used trained crash investigators for many years.

A successful system for crash data collection would incorporate the technologies needed by crash investigators to ensure accurate data, ease of completion of the form, as well as seamless transfer of the data to the supervisor, the local crash records system (if desired), and the statewide crash records system. In this respect, the choice of software and hardware tools should meet their needs and be a good fit with the existing and planned information technology initiatives at both the local and state agencies. In that respect, "one size fits all" may not be possible, as we have seen when large cities within a state may be unwilling to use software developed or purchased by the state. A recent example of this phenomenon is the city of Chicago, which does not believe that the Illinois crash data collection tool meets their needs. To facilitate the receipt of suitable electronic crash records from Chicago, the state of Illinois has initiated a data-for-data partnership as an incentive, providing Chicago with the state data they could not have accessed by themselves in exchange for crash data that meets the state criteria. Conversely, some states such as Iowa are able to support all of the local agencies with the same state-provided crash data collection tool.

It is important to recognize that crash records systems are not static. No matter how effective a data collection tool may be today, these systems must be maintained and upgraded to take advantage of newer technologies. A system that works well today may suddenly become untenable when a local department upgrades its dispatch and records management systems. Software written in one language may be costly to change when the main providers of the development tools no longer support that language. At present, this is the case for systems written in Visual Basic, because Microsoft has announced it will no longer support the language. Just as with legacy applications written in COBOL a generation ago, the cost of maintaining Visual Basic programs will gradually increase and the ability to update the software with new functionality will diminish over time. At a minimum, systems need to be updated when the crash report form changes. To meet reporting requirements, the electronic report may need to be modified to meet the new standard. Changes may be required to the data entry screens, the underlying database, the report image (printed or electronically generated graphic), and other features of the software. Planning for these updates is the responsibility of the state or local agencies that purchased them. The lead times for many governmental agencies are such that planning more than one year out is crucial to timely implementation of any change. A sign of a successful system is one supported by an agency that has built the cost of maintenance into the annual budget and begun funding updates and improvements right from the start. The Indiana and Illinois crash records systems were developed in part using more current .Net technology. Systems such as those in Kentucky and Iowa are already planning upgrades to the newer technology as well.

What Are Crash Data Collection Tools?

There are many examples of automated crash data collection tools. The simplest of these tools are designed to allow completion of a form in a word processing application that allows for printing out a completed hard copy crash form to send to the state reporting agency. Except for solving the problem of illegible handwriting, these low-end systems really do little to improve the crash reporting process. The information on the form is not captured as data and there are few edit checks or other built-in tools to assist the officer in completing the form accurately according to departmental standards.

On the high-end of automated crash data collection tools are systems such as TraCS, used in Iowa and other states, and MCRS used in Illinois. These systems allow crash data entry in the field with validation edits, use of maps to pinpoint locations, and electronic transfer of data to other systems. More importantly, these data collection systems either allow access through the state telecommunications network for verifying driver and vehicle data or provide the tools to scan information from the vehicle identification number, registration papers, vehicle plate, and driver's license. This ability to communicate with other systems while in the field reduces data entry by automatically filling data fields and better ensures linkage to these data files in the future for analysis and reporting.

At this level of sophistication, examples of tools that should be included are those that:

- Read bar codes or magnetic strips from the driver's license and the vehicle identification number and/or vehicle plate,
- Collect coordinates of the crash location using GPS or GIS locator routines,
- Automatically populate data fields whenever possible, and
- Share information among the various reports that the officer has to complete.

As mentioned previously, sometimes even the best of crash data collection tools are not sufficient to convince a large city to give up its own local systems. For example, Chicago and its surrounding counties generate approximately 50% of the crashes in Illinois. To obtain these crash records in electronic form, the Illinois DOT is promoting the data-for-data partnership. They plan to provide web services that include access to data that Chicago cannot get on its own, in exchange for receiving the city's crash data in the appropriate electronic format. One web service will serve as an Internet-based conduit from the local agency (in this case Chicago) to access statewide driver and vehicle files to verify data. A second web service will serve as the GIS for all localities to use to pinpoint the crash location, thus ensuring consistency in location coding. The Illinois DOT is committed to adding other services as identified and sharing these services with localities in exchange for the electronic submission of their crash records in the required format.

Why Implement Crash Data Collection Tools?

Implementation of the proper crash data collection tools can reduce the overall time spent processing crashes. The savings may not always be realized in the field (by the officer completing the forms), because it may take just as long to collect the information as it would with a paper form. For example, it may take just as long to gather witness statements and to complete other time-consuming tasks. Overall, agencies that use crash data collection tools will realize significant cost savings by reducing paper handling and duplication of data entry tasks, while improving the data accuracy. When supervisors review crash reports, for example, if the collection tool incorporates sufficiently robust error trapping and field validation, the reports are more complete and meet the department's standards for consistency. The supervisor can thus concentrate on the sufficiency of the information and not spend time checking to see that every required field is completed. Once reports are accepted, they can be stored directly in the department's crash records system, if desired, thus avoiding data entry at the local agency. In addition, if the state crash records system is capable of accepting reports electronically, the local agency can send data directly to that system without having the data printed and mailed. This saves time and resources at both the local law enforcement agency and the state crash custodial agency.

That these quality improvements and time savings also accrue to the state crash records operation means that the best solution for local law enforcement can also be the best solution for central data managers as well. Higher quality data are available faster and without the need for intervening data entry steps. This also helps users who need better data faster. In short, the implementation of high-end crash reporting tools in law enforcement agencies is a way to benefit all crash records stakeholders.

How a Crash Data Collection System Works

There are many ways to implement a successful crash data collection system. The following is one example that incorporates currently available technology and yields the desired benefits in terms of improved quality, timeliness, and reduced data entry and printing later in the process. Other variations can yield similar successful results.

The reporting function begins on a portable computer or, at a minimum, a vehicle-based computer, when an officer, or civilian crash investigator, arrives at the crash scene. When the officer begins to complete the crash report form, the software provides guidance through the process by highlighting required fields and providing pick lists, common definitions, and built-in help files as needed. A swipe of the driver's license initiates a check against state driver records for the individual involved in the crash and returns with name, address, and vehicle information, along with any alerts associated with that person (e.g., outstanding warrants and license status). The officer can accept the name and address and the software will automatically populate the form. Entry of a license plate number for the vehicle initiates another check with state motor vehicle records and information about that vehicle comes back to populate fields as needed or alert the officer to problems (e.g., this is a stolen vehicle or other alerts). The pertinent information is also stored in a contact record so that the system uses it to automatically complete name, address, vehicle, and license information on any of the many types of reports completed. For states without the necessary telecommunications capabilities, an investigator may also collect much of this information by scanning a driver's license, registration papers, vehicle identification number, or vehicle license plate.

Meanwhile, the linked GPS unit gathers the geographic coordinates of the crash location. This assists the officer in determining the exact location of the crash at a later time. A record can be created of the county, road name, distance to and from the nearest point or intersection, and may correct the GPS coordinates to snap to the location referencing system used by the state DOT. The location information is now available to be used on any other types of reports as needed. In the Illinois example, roadway and traffic characteristics are automatically attached to the crash at the time the location is identified to create a single linked record with both crash and roadway variables.

The officer then completes the form, making a drawing of the scene, recording a narrative description of the crash, and entering witness statements as needed. Many of the fields use a pop-up pick list from which the officer selects from the possible responses. The software reminds the officer to fill in the required fields and automatically activates any required supplemental data fields and forms based on the information the officer has entered so far. As the form is completed, additional edit checks alert the officer to mistakes or inconsistencies that may cause the departmental or state crash records system to reject the report.

The officer can then electronically forward the completed report to the supervisor's computer for review. The report can be transferred through the state telecommunications, or by means of a wireless network, by docking a portable computer at the end of the shift. The supervisor checks the report and adds comments for corrections before sending it back to the officer, or forwards it to the official crash database if the report is acceptable. At that point, the crash report may be processed through another set of edits and quality control measures. Additional edits may be needed, particularly in a case where the data collection is not occurring while directly connected into the state system. In some cases, the system is a local crash system that then forwards the crash data electronically to the state system and in some instances, the crash report is moved directly into the official state crash records system.

Ancillary Benefits to a Crash Data User

Because an automated tool can collect crash data with a robust set of edit checking features, the quality of the data can be improved significantly. This also improves the timeliness of data in the crash records system because there is little or no delay for data entry and forms management at the crash custodial agency.

Edit checks in a crash collection tool can serve as a training tool by providing feedback to the law enforcement department and the officer immediately on receipt. Instead of finding out about errors months after the event, officers and supervisors can get immediate feedback while the information is still fresh and the people involved in the crash can easily be contacted. This continuous training and feedback improves the overall quality of the crash data.

CRASH PROCESSING AND MANAGEMENT

The official crash records custodian typically resides in a DOT, department of revenue (DOR), or department of public safety. In any case, the responsibility for collecting and managing crash data may not be a central mission of the custodial agency and it may, at best, be responsible for the field data collection of only a portion of the data they manage. For example, the primary operational missions of a DOR are to title vehicles, license drivers, and collect fees. If a DOR is the custodial agency for crashes, and yet it is rarely a user of those data, there may not be an understanding or emphasis on expending resources to develop a successful crash records system. Likewise, when another agency is the custodian of the crash records system, but would like to link to driver and vehicle files, the DOR may not have their operational data in a form that is conducive to combining with crash data.

Traditionally, agency staff works from a paper forms process and enters data manually to create a crash records system. Typically, specially trained staff has completed required tasks, such as adding location codes and pre-processing coding forms before data entry. The information is entered as recorded on the form (or as annotated by the location coders and others). In some cases, such as in the Arkansas system, off-site contractors do the data entry. In Tennessee's state crash records system, a batch transaction file is run through a series of edit checks before the crash is added to the official database and error reports are printed from the overnight data run. Until recently, an entire batch of 25 to 50 crash reports had to all pass the edit checks before any single crash could be accepted into the system. Either the errors that would block acceptance of the crash report are corrected or, as is still the case in many states, the form is returned to the officer who wrote the original report. For states using this traditional procedure, the data entry lag is such that there is little expectation that a returned crash report will ever make it back for entry into the system.

In most states, a separate process of document management is accomplished either through microfilm, paper storage, or, more recently, digital imaging. This process creates an archive of the original crash report forms for later use and is used to route the crash record to the appropriate staff for entry into the crash records system. The most successful examples of document management include a digital imaging component that allows paper crash forms and supplemental documentation to be accessed easily during data entry or later during analyses of the data. The document management system can easily be modified to adjust routing of documents to various stations to be handled, such as to the FARS analyst.

What Is Crash Processing and Management?

A successful crash records system accepts electronic data from law enforcement agencies throughout the state, either directly or from local crash records systems. The hope of collecting all crash reports electronically may never be realized; however, most states are able to significantly reduce their manual data entry process by working with state police and large local law enforcement agencies. Through a combination of an automated crash data collection tool and web-based crash report forms for use by departments that lack field automation, the majority of the crash reports could be delivered to the state crash database in electronic form. This has the advantage of creating a centralized record that includes all fields on the crash report form, already checked for accuracy and completeness, and available in the database in a timely fashion following completion by the crash investigator.

Examples of successful systems include those where the state encourages electronic data by

- Defining standards for acceptance of crashes into their system (e.g., Maryland and Michigan).
- Making data collection software free to the local agencies (e.g., Iowa and Kentucky).
- Allowing officers to work directly on-line to the state system (e.g., Illinois and Indiana).

The most successful systems accommodate both electronic and paper crash forms. With the view that there will always be some level of manual data entry required, changes to the state's processing of paper documents is usually required when it moves to accept electronic data. These process changes typically result from the need to retain an image archive. The reason for this process change is that managing paper documents is not the same as processing electronic forms when it comes time to generate an image. The electronic form exists as data in a database. It contains the narrative and diagram and many other fields that are not typically entered manually into a crash records system. In other words, it is possible to generate the image of a crash report form from data created electronically, but it may not be possible to do so with a crash record entered manually without a diagram or narrative. If all paper crashes are digitally imaged in a document management system, however, it is much easier for users to locate all of the crash forms when needed.

Why Create a Crash Records System?

There are numerous benefits of creating a successful crash records system. Two examples are the reduced cost of data entry and the reduction in duplicate data entry into multiple crash records systems. The data entry staff will only have to deal directly with those reports that are submitted on paper. The state may still need specialized post-processing staff to handle location codes (or at least verification of locations), as well as any other post-processing that cannot be automated. However, the overall data entry requirements will be much more focused toward quality control issues once a sizable portion of the crashes is submitted electronically. This has the immediate effect of reducing the backlog of crash reports awaiting data entry. Because the reports are checked for errors sooner (even paper reports get attention sooner than before), it is much more likely that errors can be corrected. Crash reports received electronically will have already gone through error checking and validation before acceptance into the statewide system; therefore, overall quality of the crash data will be improved.

Another benefit of a successful crash records system is its ability to deal with image archiving in a more reliable and less space-intensive fashion. For crash reports that arrive in electronic form, the image can be generated by the system as needed and need not be stored as a graphic file. If the storage of graphic files is desired to maintain a record of changes to the crash report, the storage media are smaller and less prone to damage or image degradation than are microfilm or hard copy storage. Thus, the cost of maintaining the archive is reduced. Staff time required to create the image archive will diminish as more crash reports are received electronically. Most states using state-of-the-art document management systems are able to image their crash report forms and all supplemental documentation well within 24 h of receipt (e.g., Illinois, Indiana, and Iowa).

Aside from the technical benefits, however, the primary reason to create a successful crash records system is the advantage that all users can access the same crash data that is complete, timely, and accurate. The time and financial resources currently expended on crash data collection, management and use, and multiple agencies and jurisdictions can be reduced significantly through coordinating these efforts. A successful crash records system will allow access to images as well as data, will be linkable to other data sources for safety analyses, and will provide a stable and reliable source of information for decision making.

How Crash Processing and Management Work

When a crash report is completed using a crash data collection tool, the resulting data can be forwarded to the crash records system through a secure connection (e.g., TCP/IP, secure ftp, or other transfer protocol). At the receiving end, the data are run through any additional edit checks that may be needed and added to a pending file of the crash records system. At the same time, the image of the crash can be generated using a graphic form processing tool and the image is stored in an image archive database. This image is never changed, but newly received updates to the crash report data may result in a new image that can be added to the historical image archive. The image archive stores all versions of the crash report required by state law and the policies of the custodial agency.

The web-based crash data entry form can also be used by agencies that lack the resources to implement field data recording. This system would have the same edit checks and transfer procedures as the crash data collection tool. A crash report that passes the edit checks on the web-based form is forwarded to the crash records system where it can be processed just like any other electronically submitted crash report. The newly developed Texas crash records system includes just such a web-based tool for use by smaller law enforcement agencies that do not believe that they have a need for a complete crash data collection tool or do not have the equipment to support automation in the field.

Some local agencies may still submit a paper crash report form. The processing of these forms can be imaged with a digital scanning process and the data entry operation can consist of a heads-up display for processing of the form's content and for review. The new Illinois and Indiana crash records systems use digital document management systems and heads-up data entry in this manner. The data entry employee still has to key in much of the form; however, it is now entered more quickly and there is no handling of paper once the imaging process is completed. When data entry is completed, the data for this crash are stored in the same manner as if it had been submitted electronically.

The reason for the pending file in the crash records system is to allow for any necessary post-processing, including location verification and supervisory review. For example, the crash data collection tool in Illinois allows an officer to pinpoint a location on a map; however, because of the importance of location coding to the Illinois DOT, a post-process location unit verifies the coordinates based on the description of that location from their roadway characteristics database. Once the location has been verified, the roadway and traffic characteristics are automatically linked to the crash record. Once this post-processing is complete, the data are added to the official crash database, often within 24 h of receipt at the custodial agency. The image archive is updated nightly so that it too is available within 24 h of receipt. As much as possible, the post-processing is automated so that most crash reports need minimal intervention to be added to database and image archives.

Ancillary Benefits of Crash Processing and Management

A successful crash records system has data that are timely, complete, and more accurate than ever before. Edit checks in the data collection tools virtually eliminate the most common forms of mistakes so the data are more accurate and more consistent. Crash data are available much sooner than in the past and are more reliable, whether for interim reports or multiyear analyses. Decision makers can use current crash data and adjust to changes much more rapidly than in the past.

In many cases, local agencies (e.g., law enforcement and engineering) can reduce the need to store data locally, dramatically reducing the cost of maintaining a local crash records system and creating multiple copies of the same data. In addition, agencies that previously did not have automated systems can use the statewide data as their source for information on crashes in their jurisdictions. The pressure to create redundant data systems is lessened and the agencies that contribute data to the statewide system can realize some cost savings, whereas others like county and city engineers and planning organizations may avoid those costs altogether. For agencies that wish to continue with their local systems, exports from the statewide crash database can be made readily available for their use. Conversely, if data are entered into their local system, crash records can be electronically transferred to the state crash records system.

DATA LINKAGES FOR REPORTING AND ANALYSIS

Ultimately, to be worth the effort and expense of its creation and maintenance, a crash records system must support analyses for highway and traffic safety. Furthermore, the decisions based on these analyses must yield better solutions than other less expensive ways of making decisions. The underlying realization that environment, vehicles, and human factors all play a role in crash frequency and severity points directly to a need for data systems that can link these information sources. The current reality in most states is that no single agency has control of all the necessary data to make up a complete traffic records system. Most components of a traffic records system serve a primary operational purpose that may be far removed from highway and traffic safety analysis. It is through the work of practitioners and the cooperation of the stakeholders that anything approximating a comprehensive traffic records system can be created. It is critical that data collectors and managers understand that the information in crash records systems must be of sufficient completeness, accuracy, and timeliness to be useful for highway and traffic safety decision making.

As the capabilities of computer systems and software have grown in recent years, the ability to support large-scale integrated databases at a reasonable cost has become a reality. At the same time, states have worked to overcome institutional barriers to sharing data with authorized users both within and outside of government agencies. At the time of this synthesis, there existed successful examples of linkage of traffic records system components. Whether establishing a crash data clearinghouse or assigning trained staff and resources to conduct ad hoc linkages, the important result is a knowledge base that can support ongoing safety data analyses. The basics of what constitutes a knowledge base for traffic records are sound no matter what means is used to establish it. More important is the potential for focusing on serving users needs efficiently with knowledgeable staff that makes this concept appealing for decision makers, data system managers, and budget-minded agency heads alike. For these reasons, this section of the synthesis focuses on supporting the linkage of the crash records system to other data sources for reporting and analysis.

What Is a Knowledge Base?

A knowledge base, whether established physically as a data clearinghouse or as a staff that performs ad hoc linkages and analyses, is a one-stop-shopping place to get the needed data and assistance to support highway and traffic safety analysis. Any potential user of any component of the traffic records system should be able to access the knowledge base and retrieve

- The data they need (including multiple years of data) from available sources, such as crash, roadway, driver/vehicle, medical, enforcement, and court records;
- Reliable databases that link records from the various data sources;
- Expert advice on the contents and limitations of these data and how to use them reliably in combination;
- Assistance and advice on conducting analyses and interpreting the results; and
- Access to other traffic safety stakeholders, including data collectors, managers, and other users.

Many states are moving toward an actual data clearinghouse that meets the definition of a knowledge base. Colorado, Delaware, Kentucky, and Massachusetts all have various pieces of this type of system built and available for use. Many states make multiple years of linked roadway and crash data available to highway safety professionals. Some states, such as Missouri, have a data clearinghouse that includes not just crash and roadway data, but multiple other roadway-related databases as well. Thus, linkage of at least part of the components of a traffic records system is within the reach of practically every state. Creation and staff support of a crash data clearinghouse is not a one-time effort and it requires ongoing resource commitments. What may be less obvious is that a knowledge base of professionals that can support ad hoc linkages of data also requires continuous resource commitments to be successful, and most states continue to support ad hoc linkages of the various data sources for safety analyses. The most successful of these states invest in training and knowledgeable support staff to support these efforts.

Why Create a Knowledge Base?

The best argument in favor of a select group of professionals to support linkages and analyses is that it will provide consistent and trained service for decision makers by delivering data and analytic support. This type of argument would require that multiple agencies compare the cost of their analytic support and data sharing efforts at this time and estimate what they could relinquish if a single knowledge-based staff took on selected tasks.

A likely impetus for creation of such a knowledge base comes from the inability of agencies to meet the rising demand for access to data and requests for assistance in using the data. In an era of budget constraints and contraction of agency services to only the "core" business missions, a centralized knowledge base is one way to gain efficiency and provide a necessary service that normally would be outside of any single agency's purview. It is also a way to eliminate the nonconstructive arguments between agencies about the "official" numbers on traffic-related injuries, deaths, and costs because everyone would be working from the same set of numbers. Communication about the data and how to use the data correctly is also simplified when there is a single source.

How a Knowledge Base Works

On a periodic basis agreed to by each agency that acts as custodian of a component of the traffic records system, a copy of their data is forwarded to the data clearinghouse or the staff resources assigned to be the knowledge base for safety linkage and analysis. The agency will also provide current documentation, a data dictionary, and contact information. Ideally, the data submitted are as complete as possible in that personal identifiers are left in the file at this point to assist in linkages. However, the staff would be responsible for removing any identifiers based on the custodial agency's requirements before releasing any information. Because files may contain information that cannot be released to the public, archival copies are generally not made available to anyone except those authorized by the custodial agency and only for limited purposes.

The staff will generate an extract for general release that has all personal identifying information redacted in accordance with applicable privacy laws. At that point, the data will be available for general release to authorized users. The staff can then use the original data again to create one or more linked databases as needed. Because linkages among traffic records components often are most reliable when using personal identifiers as linking variables, the personal information is left in the files until the linkage is performed. When this is not possible, or where that linkage fails, a probabilistic matching process may be needed. The resulting linked datasets can then be purged of personal identifiers and made available to authorized users.

This knowledge base staff can perform other important duties in conjunction with the release or analysis of data. These duties include calculating quality control measures, processing data dictionaries and coding manuals, creating basic standardized reports, updating contact information, and documenting the availability of the data. All of these products support the authorized users, including the custodial agencies.

By virtue of their experience working with each of the data sources, the staff acquires knowledge of the contents and limitations of each database. They become ideally suited to serve as an analytic resource to assist other users, and they can communicate the caveats about each database and help users formulate questions in a manner that can be reliably answered using the data. When users need help conducting an analysis, the staff can explain the coding and structure of each file or they can conduct analyses for the users.

Ancillary Benefits of a Knowledge Base

A knowledge base, whether through a data clearinghouse method or through a specialized staff method, brings the possibility of meeting users' needs in a highly visible manner. It is assumed that better customer service will support expanded use of the data by a larger number of people drawn from a broader spectrum of users. To the extent that these new users see themselves as stakeholders in the traffic records system, they can in turn support improvements to all the components of the traffic records system. One important possible benefit of a traffic records knowledge base is the building of a coalition that will help to support expansion and improvement of the system that supports them. With this in mind, it is suggested that the knowledge base include customer service measurements and that the staff maintain a customer contact database.

SUMMARY

Data collection, data management, and data usage are the three areas that define the success of a crash records system. There is currently no single system in the United States that would meet any reasonable definition of a best practice approach to all three areas simultaneously. There are, however, examples of systems that are successful in one area or another. Based on these examples, and using the literature and consultant experience with traffic records systems, some overall descriptions of systems that are possible with today's technology and could serve the needs of stakeholders at all levels of the traffic safety community were developed. These descriptions are summarized here.

Crash Data Collection

The most promising approach to crash data collection is an automated field data collection tool that is used to capture information as close to the event as possible. Field data collection hardware can include a portable or in-vehicle computer, GPS unit, magnetic strip and/or bar code reader, and other technology as desired. The officer using this tool would be able to link with the state driver and vehicle data to complete sections of the crash report without having to reenter information that already exists electronically. Officers may also scan information directly from vehicle identification numbers and/or registration documents, license plates, or driver's licenses to obtain information for their reports.

The field software tool can include edit checks that match those in the statewide crash report system and prompt officers to complete all required fields, including supplemental reports. A supervisor could then automatically review the resulting crash report. Once accepted, the report can be sent to the agency's local records management system, if desired, as well as to the statewide crash records system. This paperless process would also support generation of a graphic image of the form suitable for printing and archival storage. The primary advantage of automated field data collection software is a reduction in the time spent in records management and supervisory review. The improvement in quality and timeliness of the crash data benefits all stakeholders in the traffic safety community.

Crash Data Management

Crash records systems must have the capability to accept data electronically. Adding this capability often results in major updates to the structure and processing of a statewide crash database. However, the document management and archival storage of crash reports must accommodate both electronic and paper forms if the system does not create an electronic image of the crash report form. Some manual post-processing of crash information, especially for quality control of location coding, is advisable even with automation of the field data collection and electronic data transfer. The savings in reduced data entry, along with improvements in data quality and timeliness, will benefit all stakeholders.

Data Linkages for Reporting and Analysis

Crash data alone do not serve as the sole basis upon which to make highway and traffic safety decisions. A comprehensive traffic records system is required with linkable components to support analyses of all types of data. In most states, a full traffic records system could not exist in a single agency and have it fit well with the core business of that agency. For example, an agency that is responsible for issuing licenses to drivers and titles to vehicles may not have the resources to support other components of a traffic records system that do not assist them in completing their agency's primary mission. A traffic records knowledge base, either through a data clearinghouse or through resources dedicated specifically for ad hoc data linkages and analyses, is a method for a state to achieve the goal of serving the needs of all highway and traffic safety stakeholders.

A knowledge base supports all or most components of the traffic records system readily available to the users for analysis and reporting. Data sources are linked directly with the crash data or linked indirectly through probabilistic matching. This type of knowledge base is one way to increase the utility of crash data for less experienced users and to help build strong advocates for traffic records improvement throughout the state. The Missouri DOT is an example of a directly linked data system that primarily supports only that agency's users. The Massachusetts data warehouse is an example of a university-based system with Internet access for analysis and reporting given to all approved users. Although the number of traffic records data clearinghouses is increasing, most states conduct data linkages on an ad hoc basis, often using university-based staff.

CHAPTER FIVE

CONCLUSIONS

The most successful examples of crash records systems reported here were those developed in an environment of multidisciplinary and multijurisdiction coordination, communication, and cooperation. The lessons learned from these examples of successful systems are simple, but worth repeating in the context of improved practices for crash data collection, crash data management, and data linkages for reporting and analysis. Several items are suggested.

- An established state traffic records coordinating committee—This is a committee charged by the executives of stakeholder agencies throughout the state, ideally staffed by the office of highway safety, whose members are drawn from every facet of the traffic safety community. The committee's strategic mission includes coordination, communication, and interagency cooperation on improvements to any component of the traffic records system. This committee can serve as a forum for communicating plans and needs among the agencies responsible for the crash, roadway, driver, vehicle, emergency medical service/trauma, law enforcement, and court records systems. Data collectors, system managers, information technology staff, safety analysts, and program staff from all the stakeholders can learn to work within the much broader context of a comprehensive traffic records system framework.
- A strategic plan for traffic records improvements—The strategic planning efforts will arise with a meaningful process that begins with custodial agency buy-in to ensure that the plan will serve as a blue print for change. As part of the strategic plan, a detailed implementation or action plan guidelines provides specific actions and assigns responsibility for completing those actions, outlines the completion schedules, and lists the antecedent tasks so that schedule slippage can be anticipated and accommodated.

  A strategic plan that is flexible and keeps in mind the broader objectives of collecting high-quality data in a timely fashion and making those data accessible for analysis and reporting has been noted to be desirable. Examples of successful crash records systems have come from committees and agencies that keep in mind the strategic missions and, as a result, do not end up with a crash records system that is technically sound, but does not meet the needs of the highway and traffic safety community.
- Budgeting for the entire life cycle of the system—Successful crash records systems have often been reported to cost millions of dollars to develop and maintain. Although it is rarely possible to plan for all contingencies, it is critical to incorporate a sensible life cycle and financial commitment into all phases of the system planning life cycle.
- Data-for-data partnerships—Data collected for any of the components of a traffic records system are needed by a diverse set of users, agencies, and jurisdictions. Those agencies that bear the greatest costs for data collection may not be the ones that benefit most from their use. There may be little incentive for a municipal law enforcement agency to invest in collecting complete, accurate, and timely crash data, for example, if scarce local resources must be assigned to combat crime. However, it is often the case that there are resources at state agencies that would benefit local agencies. The most successful crash records systems provide some form of sharing data, software, and/or hardware resources to local jurisdictions in exchange for improved data collection for their systems. Examples of incentives have included access to detailed department of transportation mapping software, free crash data collection tools, and distribution of global positioning system readers to obtain locations that are more accurate. In many respects, public agencies are the customers of other public agencies. In serving one another with better access and resources, everyone benefits.
- A knowledge base for traffic records systems—Successful crash records systems have embraced the concept of a knowledge base to serve the highway and traffic safety community. Whether as a data clearinghouse or as a staff specifically assigned to conduct ad hoc linkages, having trained resources for data access affords an improved coordination and communication between users and the collectors and managers of the data. The expertise developed for this knowledge base becomes a resource for every stakeholder and gains support for more traffic records system improvements.
- Simplified crash data collection—The most successful crash records systems have resulted from efforts to simplify field data collection. Examples of such efforts have included providing software and hardware tools for data collection, training and support, linkages to other data sources to reduce the number of data elements collected, and the use of non-sworn officers for crash investigation.

Based on these observations, the following are suggested for future considerations:

- Coordination, communication, and cooperation are keys to successful development of crash records systems. States and the federal government have long recognized the importance of a *forum at the state level* to bring together the diverse stakeholders and foster an awareness of the needs of data collectors, managers, and users. With the large amounts money involved, and the potential for failure even in the best-designed systems, the traffic records community has developed an awareness of the need for long-term planning and life-cycle budgeting.
- Successful crash records systems have most often been managed within the context of a strategic plan. Strategic plans should be flexible and should incorporate a detailed implementation plan, including action item lists and task assignments. Buy-in from all traffic records system custodial agencies is critical, as is a commitment to sharing data and resources among the collectors and managers of the data. The entire highway and traffic safety community benefits from improvements in data quality and availability. Only by working together and committing shared resources will it be possible to justify the necessary spending. *Establishing a knowledge base* is one way to ensure that high-quality data for use in decision making is available to the highway and traffic safety community.

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APPENDIX A

Survey Questionnaire

NCHRP Project 20-5, Synthesis Topic 35-03
Crash Reporting and Processing

This survey is part of the NCHRP Synthesis on Crash Reporting and Processing. We are hoping to collect detailed information on innovations in crash reporting specifically, and highway and traffic records information in general. In order to identify interesting projects for the synthesis, we are asking a short set of questions in the following pages. Based on your responses, we will determine who we will need to telephone for additional information.

Please take a few minutes to complete the survey. If you do not know the answer to a question or it cannot be answered effectively for your situation, please indicate that in the space provided so that we know that you intended to leave that question unanswered.

At the end of the survey there is a space for you to give us contact information. We would like to be able to follow up via phone and/or e-mail with you and any other key contact people you suggest to us.

Thank you for your interest and assistance in completing this survey.

1. Please indicate whether your answers apply to:

   ___ an existing system already in place and functioning as described

   ___ a brand new system still being implemented

   ___ a vision for a planned system that will be implemented in the future

2. How long does it take (from the date of the crash) for a report to be entered into your crash records system?

   ___ Within 30 days

   ___ Within 90 days

   ___ Less than a year

   ___ Over a year

3. Are all crashes that meet the statewide reporting threshold entered into the system?

   ___Yes

   ___ No

4. How do you obtain data reports from the crash records system? How easy is this to do?

   ___ No user reports come out of the system itself

   ___ I have to submit requests to a trained data analyst or programmer

   ___ I can run my own canned (pre-defined) reports from the system

   ___ I can run my own ad hoc reports using the system's analytic tools

5. What other sources of safety data are linked to the system?

   ___ Roadway

   ___ Vehicle records

   ___ Driver records

   ___ Emergency medical services

   ___ Other: ____

6. What location coding method(s) are used to pinpoint a crash?

____

____

____

7. What percentage of all crashes is located reliably? ________%

8. How much did it cost to develop the crash records system? $__________

9. How much does it cost to collect crash data and enter it into your system?

   ______________ don't know

   $______________ per crash, or

   $______________ total per year

10. What are some features and capabilities that you like about your system?

____

____

____

11. If you could start your crash system over, what would you change about it?

____

____

____

12. Do you know of anyone (statewide, regional, or local) that you think has a particularly good crash records system? If yes, who?

____

____

____

13. What are the characteristics of the system in Question 12 that you particularly like?

____

____

____

Contact Information:

Please tell us about yourself:

Name: ____

Title: ____

Agency/office: ____

Address: ____

____

Phone: ____

Fax: ____

e-mail: ____

Is there anyone else we should follow up with?

Name: ______________________________

Title: ______________________________

Agency/office: ______________________________

Address: ______________________________

____

Phone: ______________________________

Fax: ______________________________

e-mail: ______________________________

Name: ______________________________

Title: ______________________________

Agency/office: ______________________________

Address: ______________________________

____

Phone: ______________________________

Fax: ______________________________

e-mail: ______________________________

Thank you for your help. If you have any questions, please contact

Barbara DeLucia at 979.696.3400 or bdelucia@data-nexus.com

Fax (979.696.3404) or mail completed responses to:

Data Nexus, Inc.
P.O. Box 11770
College Station, TX
77842-1770

APPENDIX B
Survey Respondents

Arizona Department of Transportation
Arkansas State Police, Highway Safety Office
California Department of Transportation, Division of Traffic Operations
Colorado Department of Transportation
Connecticut Department of Transportation
Delaware Department of Transportation, Planning Division
Hawaii Department of Transportation, Highways Division
Idaho Office of Highway Safety
Illinois Department of Transportation, Division of Traffic Safety
Iowa Department of Transportation, Office of Driver Services
Kansas Department of Transportation
Kentucky Transportation Cabinet
Louisiana Department of Transportation and Development
Maine Department of Transportation, M&O, Traffic Division
Maryland State Highway Administration, Office of Traffic and Safety
Mississippi Department of Transportation, Traffic Engineering Division
Missouri Department of Transportation, Transportation Planning
Montana Department of Transportation
Nevada Department of Transportation, Office of Traffic Safety
New York State Department of Transportation
Oregon Department of Transportation, Transportation Data Section
South Carolina Department of Transportation, Safety Office
Virginia Department of Transportation, Mobility Management Division
Washington State Department of Transportation, Transportation Data Office
Wisconsin Department of Transportation, Division of Motor Vehicles
Wyoming Department of Transportation, Highway Safety

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation