National Cooperative Highway Research Program

NCHRP Synthesis 192

Accident Data Quality

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

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Synthesis of Highway Practice 192

Accident Data Quality

JAMES O'DAY
Salem, South Carolina

Topic Panel

THOMAS E. BRYER, *Pennsylvania Department of Transportation*
FORREST M. COUNCIL, *University of North Carolina*
BARBARA H. DELUCIA, *DeLucia & Associates*
DENNIS UTTER, *National Highway Traffic Safety Administration*
ROGER HATTON, *Arizona Department of Transportation (Retired)*
PATRICIA S. MARRIOTT, *Illinois Department of Transportation*
RICHARD F. PAIN, *Transportation Research Board*
JEFFREY F. PANIATI, *Turner-Fairbank Highway Research Center, Federal Highway Administration*
BONNIE POWELL, *Lansing, Michigan*
PHYLLIS YOUNG, *Federal Highway Administration*

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series reports on various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which these reports are useful will be tempered by the user's knowledge and experience in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to highway department administrators, accident records personnel, information systems and data processing management personnel, highway traffic and safety engineers, drivers' licensing officials, state and local police, as well as federal agencies, industries, traffic safety associations, and others responsible for the collection, analysis, and use of accident data. Information is provided on national accident data banks in addition to state and local practice associated with accident data collection, analysis, and evaluation.

Administrators, engineers, and researchers are continually faced with highway problems on which much information exists, either in the form of reports or in terms of undocumented experience and practice. Unfortunately, this information often is scattered and unevaluated, and, as a consequence, in seeking solutions, full information on what has been learned about a problem frequently is not assembled. Costly research findings may go unused, valuable experience may be overlooked, and full consideration may not be given to available practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of reporting on common highway problems and synthesizing available information. The synthesis reports from this endeavor constitute an NCHRP publication series in which various forms of relevant information are assembled into single, concise documents pertaining to specific highway problems or sets of closely related problems.

This synthesis describes current practice with respect to the characteristics and importance of accident data quality, including the reporting and data collection procedures, the analysis and quality control measures employed, and the communications systems used.

This report of the Transportation Research Board discusses accident records systems, including data sources and users, considers the effects of inadequate data on analyses, and reviews data acquisition and processing programs that have had good results in the states using them. Recommendations for improving operating systems and for additional research are included.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

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Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

ACCIDENT DATA QUALITY

SUMMARY

Accident data represent a sort of window on the world of the untoward things that happen in the traffic system. The interpretation of those data may lead us to a better understanding of operational problems, should enable us to devise countermeasures for those problems, and in many cases allow us to evaluate the effectiveness of countermeasure programs.

The quality, that is the accuracy, precision, timeliness, and completeness of the data used to address these problems is important to the solutions. Practical problems that may rely on analyses of accident data include: a state highway department choosing one site over another for reconstruction because of a higher apparent injury rate, a legislature choosing to fund an alcohol enforcement program over, for example, a vehicle inspection program because of greater expectations for the former, or the federal highway safety agency publishing a standard for occupant protection. Certainly not all such decisions are based solely on accident data, but good quality data can make an important contribution.

In the United States, traffic accidents are usually investigated by police officers who complete a standard form designed and promulgated by a state agency. In recent years these forms have subsequently been translated to computer form and aggregated at the state level where they become a record of a year's accidents. Such data are placed into files where they can be accessed and analyzed statistically. Quality of the data depends at least on the performance of the police investigators and of those reviewing the data and entering them into computers. There is also an obligation on the part of those accessing and using the data to recognize and provide feedback on data quality problems.

Although the most immediate users of these data are the police and roadway agencies, many others use them, too. The list includes health departments, education departments, manufacturers, the insurance industry, academics, lawyers, private associations, newspapers, legislators, the federal government, and other data programs such as the National Highway Traffic Safety Administration's Fatal Accident Reporting System and the National Accident Sampling System. Almost all of these use data to generate policy and to effect the expenditure of (sometimes large amounts of) money. It is important to all that the collections of accident data truly represent the real world.

Differences in organizational arrangements among the states may affect the quality of traffic records. When all participants in the accident collection and processing work are in a single department it is usually easy to communicate among both the people and the computer files. Communication among computers and people in separate departments is typically more difficult, sometimes to the extent that it is just not done.

While those states with separate departments for the various functions may be challenged to develop the communications network necessary to improve data quality, many states have done so and serve as models for others with these needs.

Two American National Standards Institute (ANSI) documents have been promulgated to help states develop consistent reporting methods. These are the ANSI D-16.1 and the

ANSI D-20.1. The National Highway Traffic Safety Administration, in conjunction with the Federal Highway Administration (FHWA), has initiated the CADRE (Critical Automated Data Reporting Elements for Highway Safety Analysis) program. A parallel effort performed for FHWA by the National Governors' Association (NGA) led to the development of a standardized set of variables for reporting accidents involving large commercial vehicles. This is expected to lead to an enhanced capability to identify safety problems associated with trucks.

Most states continue to refer to the ANSI standards in modifying report forms. Many are adopting elements of the CADRE and NGA plans as they update their accident reporting procedures.

The accident reporting process can be compared with a scientific survey in which the interviewers are usually informed about the importance of collecting complete and accurate information. There is evidence that most accident investigation personnel are poorly informed about the variety of users of their data. In many cases, neither the data preparer nor the user has a good understanding of the effects of such limitations. The literature suggests that accident data are biased with respect to injury and many other factors, yet estimates of missing data are not routinely made by state agencies. Wrong or misleading conclusions can result from erroneous data. Although there is no simple solution to the data quality problem, attention to training, supervision, data processing, and communications can help.

Several important system studies have been published over the past ten years, pointing the direction toward improved data acquisition and data processing systems. Many states have followed the guidelines provided in these documents, and this synthesis reviews some of the resulting progress.

A review of the literature leads to the conclusion that a model accident records system should include:

- Competent accident investigation, supported by training and supervision,
- A report form attuned to users' needs,
- Attention to detail in preparation of reports,
- Accurate data entry and processing,
- Free-flowing output to interested users, and
- Feedback of user comments to induce system improvement.

It is incumbent on the people who generate and process the data to make all possible corrections, as well as to qualify the resultant data by describing data problems to subsequent users. A circular flow of information between the data providers and the users is most effective. The better the quality and availability of the accident data the more they will be used. Good users are intelligent and vocal; the more the data are used, the more they will be criticized and discussed. Critiques will lead to further improvement in the data quality. It is important to establish communications channels to foster this interchange of information.

Federal transportation agencies and many accident researchers would be pleased if data from the various states could be more usefully combined into larger groups for study. Two or more accident data sets may be combined for analysis if:

- The thresholds for reporting are equivalent,
- The thresholds are applied in the same manner,
- The scales on which comparisons are to be made are the same,
- The scales are interpreted and applied in the same manner, and
- There are few missing data.

At the federal level only the Fatal Accident Reporting System (FARS) comes close to satisfying these requirements, and even in this case some of the variable scales are not

interpreted in the same way. Since the combined files of other programs such as the National Accident Sampling System (NASS) are based on police-reported accidents they are affected by variable reporting thresholds and missing data. Attempts to adjust data being combined from disparate sources analytically have generally been suspect.

There are similar inconsistency problems within individual states as reporting performance varies in local jurisdictions. Comparison among cities and counties within a state will be more defensible and useful if the five conditions above are met.

Many current programs are progressing toward the ideal system discussed above. Examples of novel data acquisition work include training activities in Utah, New Jersey, Florida, and Idaho; a scannable accident report form in Michigan; and trials in many states of laptop computers or other devices for direct field entry of digital information.

The interpreting, coding, and entry of accident data into a computerized data base provides opportunities for correcting errors and adding to the completeness of the file. Computer editing ranges from a simple semantic edit (no 30th day of February), to cross checks between variables (no snow in the summer in Florida), to table lookups (reported route must be in the jurisdiction). Nearly every state has some type of semantic editing, and many have added more sophisticated methods. The Pennsylvania Department of Transportation and FARS have extensive edit checking manuals that serve as examples of how this function may be accomplished.

One of the conditions necessary for quality in traffic data is for the people with various responsibilities to communicate with each other. Various methods are in place, including newsletters (distributed to transportation and police agencies), formal committee structures to plan and evaluate the use of data, and (in Wisconsin) a commendation program for officers who do an exemplary job of accident reporting.

Presently, in one or more places in the United States, there are or have been pilot hardware programs involving the following developments:

Global Positioning System (GPS)
Loran-C (a low-frequency hyperbolic radio navigation system)
scannable accident report forms
pen-based computers
PCs
laptop computers in police cars
laser disk storage and video display
barcodes and barcode readers
magnetic strips

Nearly all the above hardware programs must be viewed as experimental at present, but these are necessary steps to fuller implementation. Many believe that there will be widespread use of many of these techniques within a few years.

Users of accident data should understand the limitations of the information with which they are working. This does not mean that the data have to be complete and free of error. It does mean that the users should consider the effect of uncertainty in the data on their conclusions. Although many researchers have estimated the extent of under-reporting or of inconsistencies in reporting of accident information, there have been operational measurements of this kind only in a few federal programs (FARS and NASS). Expansion of such efforts to states would certainly lead to a better understanding of the data limitations, and ultimately to more useful analyses.

Successful data processing systems develop a profile of each user, and notify that person or organization if information pertinent to his or her needs arrives. For example, several states download subsets of the state data to PCs at the local level—either by forwarding a disk or by modem from the state facility. In other states, monthly summaries that are tailored to local interests are forwarded to local jurisdictions. More states are

advertising their wares, and doing computer searches on request for local jurisdictions or others.

Most states have not estimated the completeness and accuracy of their accident data. There is a need for easier methods to make such measurements. It would be helpful if the federal transportation agencies would sponsor some pilot programs in this area. Ultimately it would be helpful to have an ongoing estimate of the quality of each state's accident data.

Many of the novel accident data collection and processing changes currently being pursued deserve to be evaluated by carefully designed experiments. Of the many trials of new hardware most have been evaluated only subjectively. Before committing to statewide or nationwide implementation of a program, it is important to be able to predict success with some certainty. Carefully designed and implemented evaluations can help. The results of such evaluations should be shared with other states by contributing reports and papers discussing the measurement of data quality to such forums as the National Safety Council's Traffic Records Committee (TRC) summer meeting or the TRB annual meeting. Such reports should be encouraged by the concerned federal agencies, the National Safety Council, TRB's Traffic Records and Accident Data Analysis Committee, and the American Statistical Association's Transportation Statistics Committee.

Although the ANSI standards, and the CADRE, and NGA documents provide brief definitions of such variables as injury, accident cause, and vehicle description, they stop short of providing training documents to assure that all responses are comparable. The police injury scale (KABC0) seems to be interpreted differently in different parts of the country, and, to some extent, in different parts of individual states. The effect of this variation is to confuse the results when data are aggregated over more than one jurisdiction. This is a serious limitation to data quality, and police-based injury statistics will be of limited value until this problem is addressed and solved. The National Safety Council's Traffic Records Committee has (as of 1992) appointed a working subcommittee to consider such a task. At the very least, new training materials should be considered to promote consistency in injury reporting.

There are other data elements with reporting inconsistencies. The coding of vehicle defects demonstrates that states are far from identical in their reporting of this factor. Factual data such as driver age, vehicle identification number, date and time of the crash are often consistently and accurately reported. Many other variables—road classification, drinking in the accident, number of persons present, vehicle damage, and causation factors—need to be reviewed for consistency.

Any of several groups could lead the effort to make reporting variables more consistent. NHTSA might pursue this problem as an add-on to the CADRE effort. Other agencies might continue to review appropriate parts of the accident report—FHWA (for road-related variables), the International Association of Chiefs of Police (for accident causation variables), and the American Association of Motor Vehicle Administrators (for factors related to registration). The National Safety Council's TRC has had success in the past in encouraging states to adopt standards voluntarily. The TRC might furnish the environment for continued studies and agreements regarding data quality. It has the advantages of broad representation as well as a history of fostering standardization. The members of this committee are active participants in the quest for quality in accident data. They have proposed a national agenda with quality as a leading topic and have also initiated an informative newsletter titled *EXCHANGE* that is widely distributed in the traffic records community.

CHAPTER ONE

INTRODUCTION

The National Safety Council (NSC) notes that the number of U. S. traffic fatalities in 1912 was 3,100, suggesting that there was some national aggregation of accident data by that year (*1*). At the local level, early accumulations of data were likely to be pin-maps in the office of the traffic engineer or police chief, with colored pins identifying different accident events. Judgments about where to make engineering improvements or where to boost law enforcement efforts were based on the concentrations of pins. This kind of presentation had the advantage of being easily interpreted. Further, the data were typically accurate, complete, and detailed because the people who developed it were directly involved with its application.

At the national and state level early statistics were gathered mostly to count failures in the traffic system. Early computers for handling such data were card sorters. Analysis was limited mostly to tabulations of the numbers of persons injured or killed in particular groups in the population. Annual statistics were produced and published for the United States by the NSC in its annual *Accident Facts* booklets. Similar reports were (and still are) produced in nearly every state. These have been useful in documenting the size of the traffic safety problem, but they have allowed only simplistic problem identification.

DATA QUALITY

What is Quality?

For accident data, components of quality include:

- Ascertainment (or completeness of coverage)—the degree to which the data collection system contains all the cases defined by the data collection threshold.
- Consistency of coverage—whether the degree of ascertainment varies by jurisdiction, time, personal characteristics, weather, or other factors.
- Missing data—in addition to the problem of missing cases (underascertainment), there may be missing data elements for cases that are reported.
- Consistency of interpretation—whether the report elements (injury level, degree of damage, fault, accident type) are reported in the same manner in different states or local jurisdictions, or by different reporting officers.
- The right data—Another aspect of quality is having the right data elements. For the accident data to be most useful to the National Highway Traffic Safety Administration (NHTSA) it is important to identify the vehicle characteristics; for the Federal Highway Administration (FHWA) the roadway details are important; for a psychologist it may be important to have details about the driver's age, sex, licensing history. Each state may have a list of data items important to its own needs.
- Appropriate level of detail—this depends on the variable and on the questions asked. For vehicle identification the level of detail may vary from a vehicle identification number (VIN) to the reporting officer's estimate of vehicle size, make, and model. Degree of injury varies from the common KABC0 code in most states to more sophisticated schemes that identify individual body regions and types of injury. Geo-coding varies from a precision of a few feet to large fractions of a mile. There is usually a trade-off between the level of detail and the effort required to produce it. Choices in this area depend on the local need.
- Correct entry procedures—all of the above factors may be compromised or enhanced by the treatment of the data at the point of entering it into a computer. It is important to control the quality of the data by manual and automatic edit checks at that stage. In addition, analyses that identify shortcomings in the data should be fed back to the data collectors and the data entry personnel so that the system will improve.
- Freedom from response error—when something was measured, was it measured correctly?

Importance of Data Quality

Accident data (and other traffic records information) are used for many purposes. At the federal level these include rule making (such as NHTSA's vehicle standards), legislative decisions (perhaps funding tied to alcohol intervention programs), operational decisions (such as limiting the types of roadways on which certain vehicle types are permitted), and design and policy decisions (geometric standards, roadside hardware specifications).

At the state and local level, accident data may be used to decide which of two roadways to repair first, where to place a stronger enforcement effort, or whether to introduce a sanction aimed at teenagers.

Suppose the police investigate only a small fraction of the accidents that occur on rainy days because they are saturated with calls. As a result, the reported data will underestimate the number of rainy day accidents. Without a knowledge of such a bias, the analyst may miss the identification of slippery spots on the road network. If all the cases had been reported, however, these locations might have been identified as the most serious problem areas. Missing cases in the accident data set are often biased in a way that will affect problem identification.

The most usable combination of data from several jurisdictions results when collection rules and practices are identical. Failing this, the analyst must understand and account for the variation. In a 1965 analysis of truck accidents in several states, the authors concluded that injuries were much over-represented in accidents involving double tractor trailers (*2*). At that time most of the doubles in the country were in California, and California's state accident files were mostly limited to injury accidents. Other states

that reported a higher proportion of property-damage-only accidents had very few doubles. This interaction of two variables (the high presence of doubles and the restriction to injury-only accidents) led to the unfounded conclusion that doubles had higher injury rates. The authors corrected this conclusion later as they reanalyzed the data with a better understanding of the differences in data collection rules.

In a laboratory experiment, scientists usually collect data under highly controlled conditions. They ordinarily have few missing data, and they plan to achieve precision and accuracy necessary for the problem they are trying to solve. This doesn't always work as planned, but the scientific method dictates that the measurement scales and instrumentation be considered at the outset. Traffic accident data are not collected under laboratory conditions, but rather in a real world, usually with considerable missing and even erroneous data. The purpose of this synthesis is to provide information about the quality of traffic accident data by reviewing pertinent work from the past, and by presenting examples of current efforts toward higher quality traffic system data.

The Computer Revolution

Several events came together in the 1960s to change the way accident data were used. Computers, once used primarily for business and academic research purposes, became plentiful, cheaper, more powerful, and they were applied to new fields. Computer software that had been developed mostly for researchers analyzing social survey data became available for the analysis of accident data.

The National Safety Council had long accepted the responsibility for compiling national traffic accident statistics. Much of the structure of state accident tabulations came directly from the form that the Safety Council used for its annual reports, and in many ways this structure was appropriate for the more sophisticated analysis techniques becoming available.

In 1966, the U. S. Congress created two new federal agencies (the National Highway Safety Bureau and the National Traffic Safety Bureau—later merged as the National Highway Traffic Safety Administration) dedicated to improving highway safety (*3*). The computerization and standardization of reporting methods were then supported by the energies and monetary resources of the federal government. A supporting document to the 1966 bill, U. S. House of Representatives Report No. 1700, argued that accident investigation efforts would be useless unless the results could be fed into a record system (*4*). The authors pointed out that

> . . . the accident record system is the one aspect of the total State program that the committee believes can and should be developed and at work by the end of 1967.

In the early period of federal support the emphasis was on training for data collection, and on the acquisition of hardware to process the data. Perhaps the need for quality was implied, but it is more likely that this subject was simply neglected in the process of getting the hardware in place. In retrospect it would have been appropriate to add another paragraph:

> The best data collectors and the best computers are limited by the care with which the data are collected, processed and analyzed. The acquisition of computers, the collection of data, and the entry of data into the computer system are all necessary steps. The conclusions drawn from such an operation should be tempered by an understanding of the quality of the data and the process.

The Computer Evolution

Accident reporting and data processing systems of the states have improved continually. Computer hardware sales dominated the field for more than ten years after the 1966 act. The result was that nearly every state developed computing power adequate to the tasks of processing and analyzing accident data within a short time, but it is only recently that the software has caught up. Since about 1980, computer programs originally developed for analyzing social survey data have become more user friendly. Many have been adapted to microcomputers. This has permitted a variety of analyses and, coupled with an ever-increasing cadre of people trained in computer analysis, has encouraged exploratory study. The accident (and related driver, vehicle, and roadway) data sets provide insight into the errors occurring in highway travel. Many people are now able to take advantage of this combination of data and computer capability.

Why Now?

Despite the guidance provided by standards and training, and the leadership of the federal agencies and the National Safety Council, there has been a growing concern that the quality of traffic records data is not well understood. Many who use the accident data process, plot, and publish without awareness that some of the data may be missing or in error.

Since there is much evidence that such data are incomplete, users announcing conclusions that may be affected by shortcomings of the data should be concerned. In most scientific fields people who fail to do this will hear from their peers. The readers of accident analyses are more competent than ever before. Statements based on unqualified data are ever more likely to be criticized.

The Role of Management and Organization

Differences in organizational arrangements among the states may affect the quality of traffic records. Some states have a single department of transportation, with essentially all components of the traffic records system under a single manager. This might include the state police, driver and vehicle licensing and records processing, highway construction and maintenance, as well as accident data processing and analysis. Other states have separate agencies for nearly every component, with licensing being in a taxation department, state police reporting directly to the governor's office (sometimes with a relatively minor connection with local police departments), and the highway department being separate from either of these. The accident data processing function may be in any one of these agencies, or even divided among several of them.

When all participants in the accident collection and processing work are in a single department it is usually easy to communicate among both the people and the computer files. Uncertainties in vehicle or driver identification can be resolved at the data input stage. Communication among computers in separate departments is typically more difficult, sometimes to the extent that it is just not done.

There is a great variety of state organizational arrangements. While those states with separate departments for the various functions may be challenged to develop the communications network

necessary to improve data quality, many states have done so and serve as models for others with these needs.

Standardization

The National Highway Traffic Safety Administration, in conjunction with the Federal Highway Administration, published a notice in the *Federal Register* announcing the CADRE (Critical Automated Data Reporting Elements for Highway Safety Analysis) program. The original notice was published in May 1990, with the final list published on January 13, 1992 (*5*).

A redefined list of data elements was published in the report of the National Safety Council's CADRE Task Force in May 1991 (*6*). The authors state:

> The CADRE elements are those elements that are considered essential for analysis, but are either not routinely collected by some states, are not of sufficient quality for analysis, or are not available for analysis on the automated file.

Eighteen variables are then listed, along with recommended coding schemes consistent with the American National Standards Institute (ANSI) D-16.1 manual and The States' Model Motorist Data Base Data Element Dictionary for Traffic Records Systems (ANSI D-20.1) (*7,8*). In part, the CADRE notice says:

> Highway safety program professionals are dependent on accurate and complete data to:
>
> • Identify problems, and evaluate the effectiveness of highway safety efforts and program activities.
> • Assess the relationship between the vehicle and roadway characteristics, crash propensity and injury severity to support the development or evaluation of highway safety programs.
>
> The purpose of CADRE is threefold:
>
> • Improve the analytic utility of states' police-reported accident and related data files.
> • Provide consistent and uniform data definitions/terminology.
> • Facilitate the exchange of information about highway safety technology among states.

The final version of CADRE resulted from consideration of the many comments from the states and others, and from the deliberations of a broadly representative (states, federal agencies, industry, universities, associations) advisory committee that met several times to review these comments. One of the values of the CADRE program will be to generate the kind of discussion among states that will lead to higher quality data both at the state and national level. Many states have already begun to adopt elements of the CADRE plan as they periodically make changes to their accident reports.

A somewhat parallel effort initiated by the Federal Highway Administration led to the development of a specialized set of variables for reporting accidents involving large commercial vehicles. The study leading to this list was performed for FHWA by the National Governors' Association (NGA) (*9*). This program also made use of a broadly representative advisory committee. These variables are often referred to as the "NGA" variables. Many of these have also been added to state accident report forms within the past two years. This is expected to lead to an enhanced capability to identify safety problems associated with trucks.

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 encourages states to improve many of their accident reporting activities (*10*). In particular, ISTEA authorizes the Secretary of Transportation to make grants to states that agree to adopt or have adopted the recommendations of the National Governors' Association with respect to police accident reports for truck and bus accidents.

Organization of This Synthesis

The search for information for this synthesis began with a variety of literature identified by queries of the Transportation Research Information Service (TRIS) data base at the Transportation Research Board (TRB) and the Highway Safety Library at the University of Michigan's Transportation Research Institute (UMTRI). This was followed by visits to offices concerned with accident data collection and processing in Pennsylvania, New Mexico, Utah, Illinois, Indiana, Wisconsin, Michigan, South Carolina, and North Carolina. These states were selected in part because their data were considered important and useful by federal transportation agencies, in part to represent various geographic regions, and in part to represent states of varying size. To supplement the state visits, telephone conversations were conducted with personnel in most of the remaining states.

Of primary concern in this synthesis is the accident record system. Many other kinds of traffic records are combined with accident records to discover safety problems or to evaluate the effect of changes to the traffic system. Other data sources include driver records, vehicle records, roadway and roadway condition inventories, and medical records. In this report there is only limited discussion of areas other than the accident records.

Chapter Two of this report presents background information and a review of the pertinent literature. The effect of data shortcomings on analyses is considered. Much of this literature illuminates the extent of missing and inaccurate data.

In Chapter Three the characteristics of a generic designed-for-quality traffic records system are discussed. Also in Chapter Three a variety of users of traffic safety information is listed, and the importance of users in providing feedback regarding the usefulness of the data is discussed.

Chapter Four addresses some important characteristics of accident data systems, and reviews current data acquisition and data processing practices in areas of the United States as examples of useful programs that may be emulated by others. This discussion is followed by consideration of communication and evaluation within the accident data system, and by a discussion of the role of management in such programs.

Chapter Five provides a brief summary of the earlier chapters, restates a number of conclusions, and makes recommendations for further action and research toward higher quality in accident data.

CHAPTER TWO

BACKGROUND AND LITERATURE REVIEW

Many authors have discussed the various aspects of data quality identified in the introduction. This chapter presents a discussion of some of the problems of consistent reporting methods, then compares the accident investigation process with a scientific survey, and sets an analytical foundation for considering the effects of error in a data processing system. An annotated review of the pertinent literature, divided into four sections, is presented.

CONSISTENCY OF REPORTING

Within each state the collections of accident data today are mostly:

- In a common form,
- Collected by officers with similar training,
- Stored in readily accessible computer files,
- Collected according to nominal threshold criteria, and
- Based on national standards.

Although there has been useful guidance from the national standards, state and local jurisdictions are responsible for their own accident data system designs. Each jurisdiction faces its own problems, and emphasis varies from state to state. One state may group pickup trucks and small vans in a single category in the accident data—probably a holdover from the time when both were primarily commercial vehicles. Another state has always had separate categories for such vehicles. Such variation makes it difficult to combine data from several jurisdictions for analysis.

Some states are evidently concerned about defective vehicles as causes of accidents, and they have provided specific variables on their report form for identifying defective tires, brakes, steering, lights, or other factors. Other states record such information only in the narrative of the report. In the Fatal Accident Reporting System (FARS) program, NHTSA asks that any notation of a vehicle defect in the state report be coded into their "Related Factors-Vehicle Level" variable.

Figure 1 shows the distribution of the number of defects cited per hundred vehicles involved in accidents as listed in the FARS data for 1990. Note that this ranges from nearly eleven defects per hundred vehicles in Wyoming to about 0.5 in Michigan. It seems unlikely that vehicle condition would vary this much across the states. Such variation may result from the emphasis placed on vehicle condition in police training or from the use of report forms that make it convenient to list vehicle defects. Until this reporting phenomenon is better understood it would seem inappropriate to conclude that vehicle defects are related to (for example) mountainous terrain.

Perhaps of more concern is the consistency in reporting of injury severity in state accident data. While there are a few states using more complex codes, the majority records injury severity on a five-point scale often referred to as the KABC0 scale. The definitions of these injury levels in the American National Standards Institute (ANSI) D-16.1 manual are:

K = person with fatal injury.
A = person with incapacitating injury.
B = person with non-incapacitating evident injury.
C = person with possible injury.
0 = No Injury.

The D-16.1 manual further defines incapacitating injury as including severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconsciousness at or when taken from the accident scene, unable to leave the accident scene without assistance, and others.

Non-incapacitating evident ("B") injuries are defined to include lump on the head, abrasions, bruises, minor lacerations, and others.

Possible injuries ("C") are defined in D-16.1 to include momentary unconsciousness, claim of injuries not evident, limping, complaint of pain, nausea, hysteria, and others.

FARS uses this scheme for coding other-than-fatal injuries (*11*). In addition, both the FHWA and NHTSA have devised translation systems for data from the few states that have adopted a different (usually more detailed) police injury scale (*12,13*). Most state files also provide codes for "unknown injury" and/or "unknown if injured."

The States' Model Motorist Data Base Data Element Dictionary for Traffic Records Systems (ANSI D-20.1) includes these slightly modified definitions:

> Possible Injury is any reported or claimed injury which is not included below, e.g., momentary unconsciousness.
>
> Non-Incapacitating Injury is any evident injury that is not fatal or incapacitating, e.g., abrasions, bruises, minor lacerations.
>
> Incapacitating Injury is any non-fatal injury which prevents the victim from walking, driving, or other normal activity, e.g., severe lacerations, broken bones.

In both the D-16.1 and D-20.1 these definitions were intended to provide a scale of injury degree that could be assigned by a police officer attending the accident. These could then be used as measures of injury severity for tabulations or evaluation studies. All states have been encouraged to follow these ANSI standards so that injury data aggregated over several states would have a common basis.

Figure 2 shows the distribution of injuries on this police reporting scale for 23 states. All of these states report that they collect and automate data for all accidents with any injury. Yet the percentage of injuries in each severity category varies widely by state. California reports only 4.89 percent incapacitating ("A") injuries while Illinois reports 23.83 percent—nearly five times as high. Alabama, which reports more than 55 percent "A" injuries, admittedly uses a somewhat different definition of this category, including many injuries placed in the "B" category by police in other states.

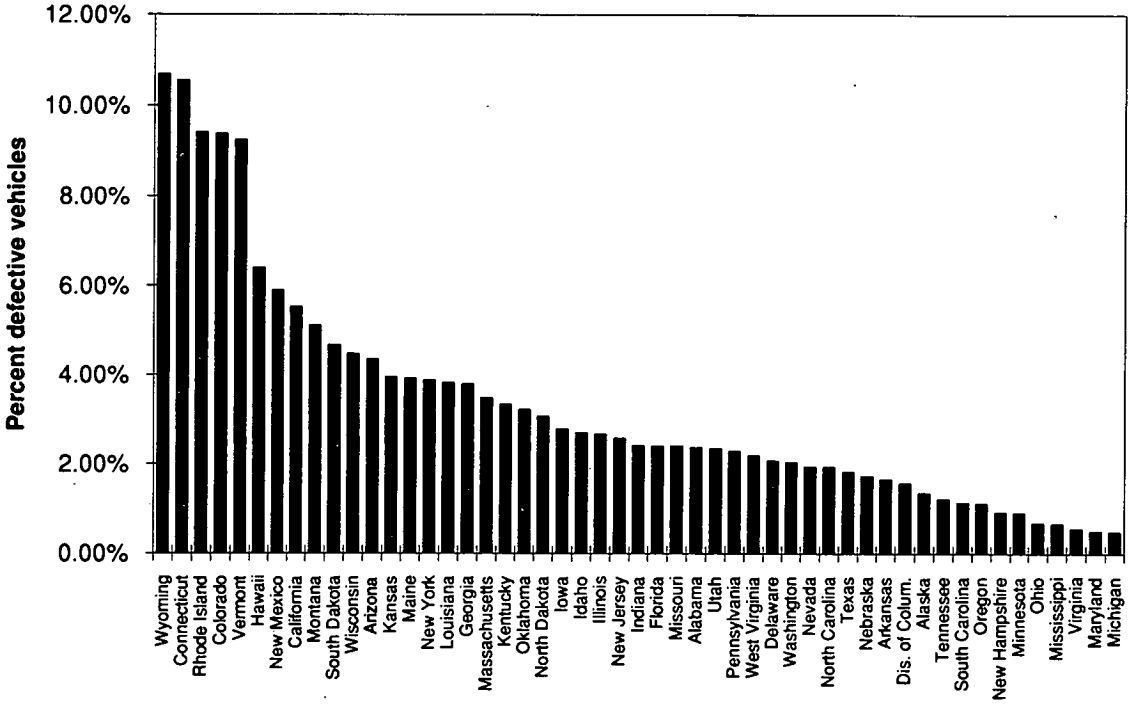

FIGURE 1 The percent of defective vehicles in fatal crashes by state. (Source: FARS 1990)

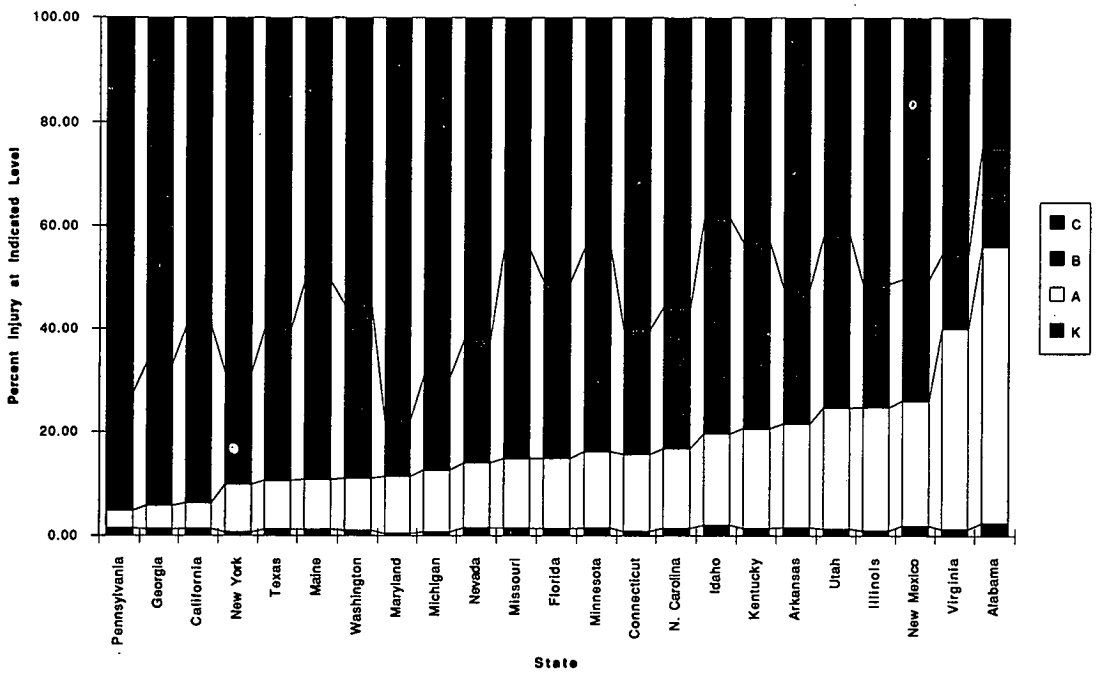

FIGURE 2 Distribution of police reported injuries on the KABCO scale for several states. (Source: Various state accident data files from the 1988-1990 period)

Both the vehicle defect and injury plots suggest that states continue to interpret standard definitions in different ways.

Parallel with Survey Methods in the Sciences

In the sciences, researchers plan surveys carefully. Interviewers are trained to be accurate and complete in their reporting. Ordinarily the quantity of data collected is planned in advance to be adequate to produce statistical significance for the problem addressed.

The process of attending traffic accidents and completing a standard accident report form is in many ways analogous to the sampling survey as conducted by many research organizations. A strong branch of statistics, usually called sampling theory or survey sampling, has developed over the past 50 years. This branch of statistics permits researchers to draw conclusions with specified certainty from the sampled populations. For further study of survey sampling methods see the texts by Kish or Cochran (*14,15*).

In survey sampling there are several kinds of possible errors, and each of these has a counterpart in the traffic accident reporting process. Cochran says (*16*):

> In census and in almost all sample surveys, a number of different variables are measured on all selected units. The incomplete or missing data with which this report deals are generally of two types. Sometimes, none of the variables is measured for a unit or subunit—the mail questionnaire was not returned, the interviewer could not find anyone at home, and so on. This type of miss will be called a unit non-response. Alternatively, most of the questions for a unit are answered, but for certain questions either no answer is given or the answer is judged to contain a gross error and is deleted during editing. Usually, such questions are ones that are sensitive, e.g., questions that concern income, or ones for which the respondent does not have the information. This type of miss is called an item non-response.
>
> Another kind of error is the recording of the wrong value for an item. This is (in survey sampling) called a response error, and, of course, the inclusion of such information introduces a bias into the data. There are occasions in which the response error is so gross that it can be discarded, and then that incident may be treated as a non-response error. On the other hand, if the response is reasonable but wrong it may not be detected and leads to a greater bias in the result.

The analogies to the accident report should be clear: Unit non-response is the failure to get an accident report for a case that satisfies the definition for inclusion, that is, one that meets the defined threshold level.

Item non-response is simply the failure to record any value for a variable—like failing to write down the driver's sex or age.

Response error is the recording of a wrong value for any variable, e.g., listing a person's age as 20 instead of 30, or recording a car's size as small when it was really large.

Scientific surveyors try very hard to keep these errors to a minimum. Unit non-response is controlled by spending time and money to get every interview that was supposed to be in the sample. Sometimes cases are missed (say a household that was selected but for which the owners had gone on a six-month safari—and the project had to be completed in four months). Statistical methods for adjusting for such errors exist, but it is always better to get the interview.

Item non-response is minimized by careful training of interviewers, sometimes by separate follow-up interviews, and sometimes by inclusion of redundant questions that permit an item to be estimated from information contained in another response.

Response error is also controlled by careful training, and to some extent by subsequent testing or comparison with other responses. NHTSA's FARS program, for example, receives some vehicle identification numbers (VINs) that can not be decoded by the computerized look-up tables. In such cases, it is sometimes possible to refer to another variable that identifies the make or model of the vehicle, or to go back to the report source for a better value.

There is no simple rule about the percentage of unit or item non-response that is acceptable; it depends on the problem at hand. In social survey practice, unit non-response of a few percent is commonly accepted; for larger values there is often an attempt to determine the magnitude and to make some statistical adjustment.

It is quite improper to simply assume that the missing data set is not biased with respect to the acquired data. It is probably better to assume the opposite. Typically there is a reason for data being missing. For example:

- During periods of inclement weather it is often not possible for the available police to attend all accidents, so that underreporting is associated with weather.
- It may be easy to get occupant ages for minor collisions where all of the participants are available for interview, but difficult for serious crashes in which all occupants have been transported to a hospital. The likelihood of injury increases with age, so that age information might be more likely to be missing for older persons.

There are cases in which a small nonresponse would be very important—for example, the unavailability of an estimate of drinking-driving (such as an alcohol test for drivers who died in crashes).

Table 1 compares some characteristics of the accident data system with those of a scientific survey.

The Error Equation

Accident data are often used to estimate the frequency of some event of interest. For example, a planner may wish to estimate the likelihood of injury given a particular type of accident. This may be computed by dividing the number of injuries by the total number of accidents that occurred over some time period.

When an estimate of such a proportion is based on data that have been acquired by people completing report forms, there is typically some uncertainty about the true value of that estimate. If every possible case had been investigated and the reports completed without error, there would be no uncertainty at all. However, if there are some missing cases (accidents that should have been investigated but for which no data were collected, or accidents that were investigated but no report sent to the state), the measure of interest may be biased because the proportion in the missing data is different from that in the obtained data.

Texts on sampling statistics define the error in such an estimate as consisting of two parts (*14,15*). The first term in equation (1) is inversely proportional to the number of cases in the sample, but tends toward zero as the number of cases approaches the number in the population (often the case for police-reported accidents). The second term is a function of the proportion of missing cases (accidents that were supposed to be included in the file but were not) and to the bias (the difference between the true value of the measure of interest and the value in the missing data). The value of the estimate of interest in the missing data is usually not known, but it is often biased with respect to the obtained data. The root

TABLE 1
COMPARISON OF ACCIDENT DATA COLLECTION WITH A SCIENTIFIC SURVEY

Accident Data Collection	Scientific Survey
Census (nominally all cases above a certain threshold are included), making many statistical tests inappropriate or unnecessary.	A small proportion of the total population is randomly selected for interview. Careful sampling permits estimates to be made of the whole population.
Usually there are many missing cases, and the missing data are typically, if not always, biased relative to the obtained data set.	Percentages of missing data vary, but in a good survey they are kept to a few percent. In analysis, biases in the missing data are often determined and used in drawing conclusions from the analysis.
Many questions are not planned in advance; data may be used for a variety of studies.	Many questions are planned in advance, although the resulting data may be used for new studies.
There is modest effort to get complete and accurate data; reporting completeness often varies with time or location.	There is substantial effort to get complete and accurate data; interviewers' activities are monitored carefully; sometimes interviews are duplicated to insure accuracy.
Investigators have many duties other than completing the accident report.	Investigators (interviewers) are usually dedicated to one task.

mean square (rms) error (the true value has about a 2/3 chance of being within ± this amount) is defined as the square root of the sum of two terms as shown in the equation below. Usually there is a reason for cases being missing, and the reason is often related to the measurement of interest.

$$\text{rms error in estimate} = \sqrt[2]{(\text{sampling error})^2 + (\text{bias error})^2} \qquad (1)$$

Suppose that we wish to compare the average severity of crashes in two cities. Assume that, in the first city, the police have a dedicated traffic squad that investigates almost all crashes. They may even complete reports for some crashes that are of lower severity than the state-defined threshold, providing a service to motorists who wish to have a police report. In the second city, the police have adopted a practice of not investigating an accident unless there is an injury requiring their presence or unless the vehicles cannot be moved without assistance.

Using the collected data, the probability of injury (the number of injuries divided by the number of accidents) may be computed for each of the two cities. The first city will exhibit a relatively low injury rate (because there were many non-injury accidents reported). The second city will have a relatively high injury rate because, although there were many non-injury accidents, they were not reported and thus did not appear in the data to be analyzed.

For the first city, the missing data term in equation (1) is essentially zero, since there are few missing cases. For the second city, there are many missing cases and, although it seems likely that many of these are non-injury cases, we may not know enough about them to be sure of this. Thus there will be a large uncertainty regarding the true value of the proportion of injury accidents for the second city.

Observations of Coverage

In a scientific survey under direct control of those who will use the data, it is usual to make an effort to acquire data for every case in the planned sample, and to hold item nonresponse to a low value. The extent of these factors in accident data sets has been studied by several authors and their works are reviewed here.

Scott and Carroll provided a good picture of the state of completeness and accuracy of accident data in various states in the early 1970s (*17*). Their review of studies indicated that underreporting is a serious problem. A 1966 report they reviewed found that reporting completeness (in that era) was 48 percent in Washington D.C., 32 percent in Maryland, and 30 percent in Virginia (*18*).

Zylman, on the staff at the Center for Alcohol Studies at Rutgers, observed accident reporting policies in many areas of the United States (*19*). He observed wide differences in both the reporting

rules (threshold levels) and in the actual reporting. These were related to the diligence of the police and to local command options in several jurisdictions within both New York and California. His studies led to this thesis:

> Data gathered by any police agency can only be used to describe conditions in that jurisdiction. It cannot be assumed that data gathered from two or more agencies are either valid or representative unless it has first been determined that each agency is using the same rules of measurement, the same interpretations and the same terminology and that they are enforcing similar laws and ordinances with similar diligence.

Although this paper was written in the early 1970s, it is not clear that there has been substantial improvement. Indeed, in many states and cities (and in some federal agencies) there is a continual discussion about limiting the extent of accident investigation to save money.

Chipman tested the accuracy of reports on fatal motor vehicle crashes by comparing vital statistics for Canadian provinces and territories with police-reported traffic fatalities (*20*). This study covered a period of about 10 years, although the period varied slightly by province. Counts of police-reported deaths were higher than the vital statistics source indicated—in one year as large as 7 percent different for the entire country (434 deaths). Chipman could not resolve the differences, but suggested further research into underreporting or misclassification on the part of all parties. She noted that a 7 percent error in such a statistic was unacceptable for many research applications.

Maas and Harris compared Netherlands hospital discharge data (believed to be 95 percent complete) with police accident reports of hospital inpatients (*21*). They concluded that the police record accounted for about 83 percent of the total inpatients, and that there were various biases in the police data. For example, young pedestrians and bicyclists were underreported. However, the police data were stable from year to year. The authors concluded that it would be possible to estimate the change in injury rates over time using the police data alone.

This is an interesting study because it shows initiative in comparing the police data with some external source to validate it. Cross-checking of such files using names is not permitted in the Netherlands because of their experience with the Nazis in tracking their residents during World War II. This analysis was based solely on numbers of patients in each file. Their conclusion:

> It seems advisable to carry out, from time to time, detailed investigations into the reliability and representativity of the police records of hospitalized persons injured in a traffic accident.

Hauer and Hakkert cite the term *partial ascertainment* as coming from the statistical literature (*22*). They state that a high percentage of reporting of all accidents "is much to be desired." They note that the actual threshold for reporting varies (at least) with driver age, location, severity, and time of day. They argue that users should understand the degree of underascertainment and correct for it.

The authors discuss 14 studies of underreporting of accidents published from 1971 to 1985. A general conclusion (taken from these 14 studies) is that fatalities are probably correct within 5 percent, but 20 percent of injuries requiring hospitalization are not reported, nor are 50 percent of injuries that do not require hospitalization.

One of the reports reviewed by Hauer and Hakkert was that of Greenblatt et al. done in connection with the NASS program (*23*). This study estimated that 79 percent of injury accidents were reported in NASS, and 54 percent of property-damage-only accidents. The telephone part of the survey, which asked respondents to recall accidents over the past four months, was followed up by a prospective study (with a mailed return) for the following four months. The authors considered many possible bias effects, and tested for some. They concluded that, because of the high response rate, the biases in the refusal group were not of great importance. Other biases in the respondents were identified and discussed. The authors conclude that some type of occasional or continuing survey (telephone + checking accident reports) should lead to a capability to adjust the NASS estimates for a truer picture of the numbers of accidents and injuries in the United States.

Hauer and Hakkart argue that it is very important to know the proportion of missing cases (which varies with accident type, driver age, and other factors) to make a realistic estimate of a problem. They suggest strongly that every jurisdiction should make such a determination (although they do not propose a method for doing so).

Fife reports on a study matching FARS fatalities with those recorded in the National Center for Health Statistics (*24*). He found an 85 percent match (based on a 2-day sample). He suggests that a modest effort could result in the addition of cause of death information to FARS. Fife's paper has the further advantage of confirming that FARS is indeed a rather complete record of traffic fatalities for the United States. NHTSA has recently added the death certificate number to the FARS data.

Fife and Cadigan conclude there is substantial variation in the quality of accident data from state to state, "suggesting a need for caution" in comparing state performance based on non-fatal crashes (*25*). In this paper, the researchers look at city-to-city variation within a state (Massachusetts). They suggest that data on local reporting performance be obtained and used to adjust jurisdictional comparisons.

Barancik and Fife compared hospital records of treatment in hospital emergency rooms in northeastern Ohio with police-reported motor vehicle traffic collision injuries (stored in the Ohio Department of Public Safety files) (*26*). They reported that matched police reports were found for only 442 of 882 cases (50 percent). The reporting rate was higher for drivers (74 percent), persons arriving by emergency vehicle (69 percent), and people admitted to the hospital (74 percent). They were lower for passengers under 16 years of age (27 percent), and bus passengers (only 1 of 10 reported). Fifteen percent of the police reports specified that the crash involved no injuries. Of 46 injured people transported to the hospital by police, eight (17 percent) had no matched police reports. These data are not claimed to be representative of the country as a whole, although the authors refer to similar reports that suggest that the problem is universal. Many believe that underreporting is more serious in large cities where the police are overloaded and are not able to take the time required for full reporting. Detroit police officials announced in the early 1970s that they would investigate accidents only when they were needed at the site. Cleveland is included in the area covered by the Barancik and Fife study, and a part of the underreporting may be related to the urban nature of the region. Nevertheless, this report supports the general contention that underreporting is not a minor problem. The authors' conclusion:

> Until complete and accurate population-representative injury data become available, the limitation of official police reported motor vehicle injury data should be considered whenever those data are used.

McGuire reported the results of an interview study done in about 1970 in Mississippi (*27*). The intent was to get an estimate of underascertainment of cases. The conclusions:

> It seems appropriate to conclude that most states have difficulty in maintaining complete records, which makes interstate comparison difficult. Not only do such records underrepresent actual frequency, but they probably contain definite age, sex, and occupational biases. As with all such data, findings of the present study cannot be generalized without care, but they do underline the fact that the nature of biases existing in official records should first be established before they are used for research or used to form the basis for action programs.

While the paper was based largely on an interview series in Mississippi, some comparisons were made with earlier studies in California and Illinois. This is, of course, only one of many reports with a similar conclusion—in this case that perhaps half of the cases are missing.

By comparing hospital and police data on traffic accident victims, Laberge-Nadeau et al. report that although Quebec's police estimated 55,961 road accident victims, the true number was somewhere between 70,093 and 79,600 (*28*). They reviewed other similar studies that had much larger underestimation, but felt that the 22 percent underestimate for Quebec was certainly a problem. This was based on a sample of 1008 persons.

O'Day et al., in a National Crash Severity Study (NCSS) interim report, found that the NCSS data file, which was supposed to include every fatal accident in each of 40 counties in the United States, missed about 20 percent of the fatalities (when compared with FARS) (*29*). The mechanics of case identification (picking up forms at police stations, etc.) contributed to the problem of missing cases.

Pendleton et al. reported that alcohol involvement in Texas driver fatalities was estimated at 20 percent (from the police report) (*30*). Autopsy reports showed that 51 percent were above 0.10 blood alcohol level. Their conclusion:

> The findings emphasize the need for better quality data on alcohol involvement in traffic accidents.

Partyka, as a part of an analysis of NASS data to estimate the frequency of head injury in light vehicles, compared the NASS-estimated number of fatalities with those reported by FARS from 1982 through 1989 (*31*). She estimates that NASS underestimated fatalities by about 16 percent from 1982 through 1986, and then averaged an underestimation of 37 percent for the years 1988-89. (NASS design changed substantially in 1987.) She speculates on possible causes for such underestimation:

> (1) The national inflation factors are too small, in which case non-fatal injuries might be underestimated by similar amounts;
> (2) NASS produces good injury estimates but does not accurately separate fatalities from seriously injured survivors, considered unlikely because most fatalities occur long before the NASS investigation is begun; and
> (3) NASS produces good injury estimates, but some police reports for fatal accidents are missed.

For purposes of her study, she assumed that (1) was the correct explanation. One conclusion:

> The reason for these consistent underestimates is not known, but the source of the differences has important implications for non-fatal injury estimation.

Accuracy and Precision of Reporting

Location

Zegeer discusses accuracy (particularly location accuracy), cost (of data acquisition and processing), and the quality of the output for solving certain problems (*32*). Most of the attention is directed toward the problems of designing and reconstructing highways. He visited Alabama, California, Michigan, and Illinois, and presents some cost estimates for those states. Location accuracy figures for various states, based on a questionnaire, were reported. The FHWA recommended in 1977 that all states should be able to identify accident locations to the nearest 0.1 mile in rural areas, and 100 feet in urban areas (*33*). Zegeer states, however, that some state agencies indicate that

> . . . a sizable portion (10 to 30 percent) of accidents cannot be located due to obvious locational coding errors or omission of location referencing information . . . accuracy or completeness of the locational description as recorded by the police officer is largely a function of the importance placed on the accuracy of this particular item of data and an awareness of this importance by the police agency/officer. . . . problems may arise because many police agencies are understaffed and must attend to other police duties, and thus accident report accuracy may not have a high priority.

The effect of errors in location reporting on operations is discussed, but the dollar cost of failing to identify locations that need safety upgrading is difficult to estimate.

Other Factors

Crash severity is frequently reported on a three-point scale such as minor, moderate, and severe damage. North Carolina, Texas, and Michigan have used a 7-point vehicle damage scale (the TAD Scale) for a number of years to record vehicle damage (*34*). More recently Putnam County in New York State has begun to record vehicle damage using the TAD scale. In the severity part of this scale, officers estimate damage level on a scale of 1 to 7. The reference manual for the TAD shows pictures only for levels 2, 4 and 6. Griffin suggested that this was the reason that TAD values 2, 4 and 6 were more likely to be reported than would have been expected (*35*).

Variability in reporting vehicle defects (by state) in the FARS data was reported by O'Day et al. in a study done for NHTSA seeking sources of vehicle defect information (*36*). A plot of more recent data for this factor is shown as Figure 1. This suggests that at least this factor is interpreted and used in different ways in various parts of the country.

Douglass and Filkins studied alcohol related accidents in many states. Each of the seven states' accident data included in the quasi-experimental design contained a measure of alcohol involvement (*37,38*). The operational forms and meanings of the official data, however, were characterized by a wide range of definitions which by no means could be taken to refer to the same category of event. Some states would not record alcohol involvement unless there had been a citation; others reported alcohol involvement with much less evidence. This led Douglass to define a three-factor surrogate

for drinking driver accidents: *nighttime*, *single-vehicle crash*, and *male driver* so that he could compare data from several states.

Taylor and Malik reported on several shortcomings of the police accident data file in Michigan that limited the usefulness of the data for some of their research applications (*39*). In a study of the relationship between vehicle characteristics, highway geometry, and accidents they found that over 25 percent of the VIN codes did not decode. Further, in Michigan the commonly accepted practice has been to list vehicle #1 as the "at fault" vehicle and vehicle #2 as "not at fault." It was determined by further examination of the records that these designations were incorrect 16 percent of the time. In yet another study, it was determined that 30 percent of the single trailer accidents were being recorded in the "tractors without trailers" category.

Taylor and Malik defined four types of data, reporting on the errors in their sample of cases in each type:

1. Factual data such as time and date.
   No errors were found.
2. Data entry requiring interpretation by the investigating officer such as route class, accident type, or road alignment. Specific errors were:
   11 percent in vehicle #1 identification,
   10.4 percent in route class (mostly omissions)
   0.0 percent in road alignment
   2.8 percent in accident type
   0.6 percent in object hit by vehicle #1
3. Data generated from other coded fields such as vehicle type.
   Smaller groups were frequently in error. For example about 20 percent of the vehicle identifications for pickup trucks with a utility trailer contain an error.
4. Data entered in more than one field in the accident file.
   Truck type and *intersection versus non-intersection* occasionally showed conflicts between variables.

The authors reported that the data encoders (at the state level) were doing a relatively good job of interpreting the reports and correcting some errors, but that they could do more. Further, they recommended stronger training of the police on such items as Vehicle #1 identification (this was apparently not even covered in the training course) and truck descriptions (including full details on the report).

In a study in Monroe County, Indiana, Shinar, Treat, and McDonald compared police-reported information with that obtained from in-depth accident investigations (*40*). Police were judged most accurate in reporting location, date, day of week, and number of drivers, passengers, and vehicles in each accident. At the other extreme, the least reliable police data concerned vertical road character (30.6 percent misidentified), accident severity (in 30 percent of the injury accidents police classified them as non-injury), and road surface composition.

Campbell and McLean had reported (in a North Carolina study) that injury was often underreported because the people themselves did not realize they were injured (*41*). The day after the crash an accident victim might discover a sore neck or muscle (much as an athletic injury shows up the morning after the game). McLean noted that such injuries did not appear in the data file because they were not reported to the investigating officer. However, these injuries would be reported to an in-depth investigation team conducting a post-accident interview.

In 1964 Hutchison and Kennedy presented a paper sponsored by the TRB committee on highway safety research (*42*). Although the conclusions are based on the results of a study concerning the widths and cross-sections for Illinois divided highway medians, the authors suggest that the findings can guide the use of accident records in other studies.

Studying encroachments on the median, the authors state that the police reported encroachment in only about 20 percent of the cases in which it occurred (not all of these cases were accidents). This was often because the police viewed the damage as minimal (although the highway department would have liked to be able to bill repairs to the driver or his insurance company). The authors suggested that the police needed further training about the interests of the highway department. Some quotations from their report:

> An accident record is not only a function of the safety of the highway, but also a function of the amount of police surveillance provided, the discipline and policies of the particular police personnel having jurisdiction, the extent to which accident reports from the various participating police agencies have been consolidated, the policies and methods involved in analyzing the reports and classifying the extracted material to be included in the accident record, and many other variables. Much effort should therefore be devoted to the control of variables affecting the reliability of highway safety data and to testing the reliability of existing sources of such data. This work should be an integral part of any investigation based on accident records.

and

> The responsibilities for maintaining the necessary understanding and cooperation of police agencies in providing accurate routine highway safety data should be given more active attention by the users of the data. One way of doing this is to see that the results of frequent tests of the suitability of accident reporting are made available to police supervisors for use in directing police activities. The need for this feedback of information to the police was illustrated by the great number of inaccurate statements of accident locations and inaccurate or missing accident diagrams on the accident reports involved in this study. Findings such as these, accompanied by an explanation of their significance must be supplied by other agencies because the police are usually not in a position to make such studies or to judge the significance of a given level of accuracy or detail in accident reporting. . . .

and the last line:

> Better liaison is needed in developing and maintaining accident reporting policies and methods commensurate with both the resources of the police and the needs of the users of highway safety data.

Relationship to Users

Many users of police-reported accident data have limited knowledge about the completeness and accuracy of the data they are using. A reported increase in the number of fatal accidents involving tractor trailers in the late 1970s was ultimately attributed largely to errors in truck identification in the early FARS data. A substantial reduction in the proportion of C-level (complaint of pain) injuries in Detroit at about the same time was later attributed to a change to no-fault insurance, making it less profitable for crash victims to report such injuries. In South Carolina a procedural change requiring officers to write down the names and ages of persons injured at the C-level (rather than to simply record their number) had the effect of reducing the number of reported C-level injuries.

In a recent issue of a safety journal there are several papers in which the conclusions may depend on the quality of the police accident data used. In one paper concerned with a change in drinking patterns in accidents, only the state law ("Accidents must be

reported if there is injury or death, or more than $200 in property damage") is quoted to qualify the data. In another paper, the effect of weather on accident frequency is studied without an observation that bad weather accidents are frequently underreported because of the difficulty of handling the large number of accidents occasioned by the weather.

Figgers and Nash wrote about the importance of accurate police-reporting of restraint system usage (*43*). They state that present reporting is often inaccurate because occupants don't want to admit fault or police don't know how to observe. The authors suggest that further training would make the reporting more accurate and thus more useful. For example, police could be trained to look for strained seat belt components as an indication that the belt had been worn, or pristine belts as an indication of non-wearing. The authors argue that accurate determination is necessary to be able to evaluate the effect of belt usage.

Partyka estimated fatality rate as a function of car size (*44*). She used the NHTSA's FARS data in conjunction with vehicle registration data from the R. L. Polk and Co. National Vehicle Population Profile files. She determined that systematic differences existed in weight coding between the two sources.

> Overall, the registration data appear to describe a car (of a particular make, model, and model year) as about one hundred pounds heavier than that car is described in the fatality data. The effect is to bias the comparison of fatalities per registered vehicle against lighter cars. Failure to consider this difference can lead to very misleading results.

She reports that the unadjusted data led to the conclusion that small cars have five times the occupant fatality rate of large cars, although the adjusted data yields a factor of less than two. This is an excellent example of how a misleading conclusion can be drawn by using data without understanding limitations.

Sivak and O'Day surveyed 50 traffic safety professionals in 13 countries regarding the potential value of a disaggregated (individual records as opposed to summary data) international file of fatal accidents (*45*). They also commented on the value of a disaggregated non-fatal file. Of interest to the present study is ordering of variables by value to the respondents. The ten most useful variables in the non-fatal file were: *accident type, traffic unit type, driver age, date and time of day, road class, extent of injury, number of injured persons, age of involved persons, number of involved persons,* and *seat location.* For a fatal file there were slight departures from this, but the first four were the same and in the same order. The other reports reviewed in this chapter suggest that all of these variables except age and date and time should be treated carefully when used to draw conclusions.

SYSTEM DESIGN

There is a dearth of open literature about computer editing for entry of data into traffic accident files. Early edit checking was limited to verification of keypunch operations by keying the data a second time. With the appearance of computer terminal input of accident data, nearly all agencies have developed tests to assure that the data entered are at least within a defined range, and many have developed quite sophisticated checks to be applied either at the time of data entry or subsequently.

One public document of interest is NHTSA's FARS Coding and Validation Manual (*11*). This represents an accumulation of edit checking procedures developed over a long period of time, and these insure that the FARS data files are self-consistent. For example, if the Accident Type is coded as Railway Train, then the Intersection type must be "Railroad Grade Crossing." Flags are displayed to the entry person for unusual reports, and this provides an opportunity to recheck the source. There are literally thousands of such tests in the present FARS operation, and a recent FARS coding manual is recommended reading to those with less sophisticated checking systems. A similar manual has been prepared for the NASS/CDS program.

Many state systems incorporate both range checking and inter-variable tests, but for the most part the documentation is not as public as the FARS coding manual. The coding manual used in Pennsylvania is one of the more complete guides (*46*). It is specific to the Pennsylvania coding structure, but contains many examples of inter-variable tests intended to make the data files accurate and complete.

In *NCHRP Synthesis 133: Integrated Highway Information Systems* (*4*), Briggs and Chatfield note that the terms Integrated Highway Information Systems (IHIS), Comprehensive Computerized Safety Record-keeping System (CCSRS), and Statewide Integrated Traffic Records System (SWITRS) all describe the same entity. Which term one uses depends on where one resides in a state organization. Highway oriented people favor the term IHIS. Driver and vehicle accident analysis people are more likely to use SWITRS or CCSRS.

Briggs and Chatfield describe a list of obstacles to integration of traffic records, including competition among state departments, managers not realizing that there is a problem, development and use by compartmented groups of their own data files, and a desire for independence from the failures of other departments. Utah is used as an example of a department of transportation that coordinated an integrated system by having a working committee with all of the appropriate people on it. The Michigan Accident Location Index (MALI) was cited as a product of coordination between the state police department and the transportation department. The Washington (state) highway department codes location onto all the accident reports before the state police computerize them, thus ensuring that their needs will be taken care of in the common file. Briggs and Chatfield recommend easy access to data files by all kinds of users, suggesting that there are few valid reasons for secrecy. An advantage of wider access is that wider use leads to detection of problems, making the files better for all. File managers can limit misuse of data by making detailed information available to users, rather than restricting the distribution of the files.

In 1977, Pennsylvania changed the threshold for reporting accidents from a dollar limit to a towaway limit (plus any accidents with injuries). The result was a sudden drop in the number of reported accidents per year (which led to reduced processing costs and other benefits). Loukissas and Mace considered the problem of comparing older data with the post towaway-only data for evaluation of road safety modification (*47*). They reviewed a sample of about 12,000 accidents (8,000 of which involved property-damage only (PDOs)), determining which of these would have been reported under the new rule. They found that the percentage of PDO towaways varied considerably by accident type (55 percent of the fixed object accidents versus only 23 percent of the rear-end accidents).

In a review of the 1981 system in place in Virginia, Hargroves and Hargroves considered the completeness and the quality of coding (*48*). They include a list of seven deficiencies (of the existing Virginia system) from an earlier report:

1. Absence of centralization in the handling of traffic records.
2. Inaccurate and incomplete recording of accident locations.
3. Nonuniform accident reporting procedures.
4. No uniform procedures for detecting and correcting accident reports that are incomplete, inaccurate, or improper.
5. Untimely and inefficient collection, processing, and dissemination of accident data.
6. No direct data inquiry mechanism for the Highway Safety Division.
7. No regular feedback of accident data to localities.

This report was one predecessor to the redesign of the Virginia accident data handling system.

Truck travel and accidents concern many state officials, and truck related data acquisition has been encouraged. Abkowitz provided a lengthy review of many sources of truck accident and exposure data (*49*). Among other sources, he reviewed the FHWA's Office of Motor Carrier Safety's Motor Carrier Management Information System (MCMIS). This collection of truck accident reports has had a varying threshold through the years ($2,000 before 1986, $4,200 in January 1986, $4,400 in March 1987). Today the threshold is adjusted by the Gross National Product (GNP) deflator index. This is no doubt a better method for having the file represent the same accident severities each year. The author says that the FHWA acknowledges underreporting (reports to this file are made by vehicle owners or operators) may be as high as 40 percent.

The TRB Traffic Records and Accident Analysis Committee chaired by Chatfield produced a paper during a workshop held at Airlie, Virginia on May 6-8, 1985 (*50*). In that year, Public Law 98-363 provided for grants to states for the improvement of Comprehensive Computerized Safety Recordkeeping Systems (CCSRS).

Safety recordkeeping systems are defined rather broadly in this paper to include such files as driver licensing, vehicle registration, law enforcement management, public health programs, highway planning and construction, roadway maintenance, and traffic operations.

The minimum set for a real "CCSRS" was defined as including the driver file, motor vehicle file, accident file, traffic volume file, and highway inventory file, with appropriate links (license numbers, locations) to each other. While on-line linkage was recommended, occasional development of linked files for specific problems was allowed. Many examples of the uses of such linked files were given, including:

1. Identification of high-accident locations (Identification of roadway sections where unusually high numbers of accidents occur, or where accidents are unusually severe).
2. Identification of hazardous roadway elements.
3. Using the data to identify high-risk locations before they manifest themselves in high-accident occurrence.
4. Selective traffic law enforcement.
5. Traffic enforcement planning.
6. Driver improvement programs.
7. Court monitoring.
8. Monitoring designated truck routes.
9. Evaluation of highway safety projects and programs.

No cost figures are given in this document, but some factors to be taken into account in determining the cost of such a system are discussed. These include the required size of the system (number of drivers, accidents, etc.), the cost of personnel, the cost of a computer, the cost of acquisition of input data, and the cost of managing the system. The authors suggest there may be a large initial cost (if nothing is in place at the outset), but that operating costs should not be excessive.

Stated benefits of CCSRS include: A real reduction in operating costs, because the data-keeping system can be made much more efficient; and quicker identification and solution of problems, leading to cost savings for various agencies and the public.

Five obstacles to the development of a useful CCSRS are discussed, including: incompatible location reference systems; lack of property-damage-only accidents; obsolete or incomplete data; incompatible data files; and rapidly changing technology.

Methods for overcoming institutional barriers are discussed, including management recognition of the need, cooperation among competing state activities, and proper staffing and funding. An interagency advisory council within the state is recommended.

Keith Smith and others at the University of New Mexico designed an implementation of the CCSRS program to operate in that state (*51*). Using TRB *Circular 293* (*50*) as a guide, they laid out a system that included the accident data, the mapping data base, and other files. For analysis they recommended the Statistical Analysis System (SAS) software that was already available at the university (*52*). It was preferred in part because it had great capability and was relatively easy to learn. The present integrated data processing system in New Mexico is a descendant of this initial design effort.

In 1987, the Transportation Research Board formed a steering committee to consider how the application of state traffic records might be improved (*53*). Five benchmark questions were defined to test the capabilities of various state data processing systems to solve problems that would involve multiple files (and links). These were checked by having the various task force members discuss the problems with people in several states. No single state could solve all the problems (as of 1987). An example of a question is:

> In order to relate roadway geometrics to accident rates for certain vehicle types, you need to investigate related data for the past two or three years. Can you provide accident rates for the past three years for homogeneous roadway geometrics (e.g., degree of curvature, road width) by type of vehicle (passenger cars, straight trucks, and tractor-trailers by number of trailers)?

Answering such a question would involve a roadway characteristics file, an accident file, and probably a vehicle registration file (for more detail on vehicle types).

The remainder of that report discusses the capabilities of the surveyed states to answer the test questions, and then discusses the need for institutional support of change (and problems in achieving this).

Chapter Summary

This chapter has reviewed the analytical problems that result from inconsistent or inaccurate data. A mathematical representation of reporting error has been discussed as a framework for further review of the literature

A review of documentation regarding missing data (both for missing cases, and for missing items of information on reports) suggests that accident investigation is far from complete, and that the missing cases are biased with respect to injury and many other factors.

Considerable variation in the accuracy of reporting such items

as geographic location, injury, vehicle defects, and alcohol usage was noted in the literature.

The effect of uncertainty in estimates made from accident data on the analyses conducted by data users was discussed, indicating that users should consider data inadequacies as possible explanations to their findings and conclusions.

Finally, some literature on systems approaches to traffic accident record systems was reviewed. Several important guideline papers have been written over the past ten years, and many system changes have proceeded from these guides.

CHAPTER THREE

THE ACCIDENT RECORDS SYSTEM AND ITS USERS

In this chapter the major elements in a model accident records system are described. These include:

- Competent accident investigation,
- A report form attuned to users' needs,
- Attention to detail in preparation of reports,
- Accurate data entry and processing,
- Free-flowing output to interested users, and
- Feedback of user comments to induce system improvement.

In the last part of this chapter a variety of users of the traffic data are identified, and their needs discussed.

ORGANIZATION OF RECORDKEEPING SYSTEMS

While this report is concerned mainly with quality control of accident data, these data exist in a larger traffic records system. To be helpful to many users, these data must be used in conjunction with other files such as driver, vehicle, or highway volume or inventory records. The recommended minimum comprehensive traffic records system, adapted from TRB *Circular 293*, is shown in Figure 3 (*50*).

Several states permanently link all of these files (accident reports, vehicle and driver registrations, and roadway characteristics) so that users can draw on the combined files for analysis. Other states link the data only occasionally to study a particular problem, and some states have not linked the files at all.

A state administrative structure in which all agencies concerned with traffic records are in a single department seems to make it easier to develop an integrated safety data system. Wisconsin DOT, for example, encompasses the state police, the highway department, and the motor vehicle registration and driver licensing agencies. Accident data, vehicle and driver records, and state roadway records are all in a single computer, making the sharing of data relatively straightforward. Users may interrogate the central integrated records system as shown in Figure 4.

The system in Pennsylvania is similar, although the state police are not included in the Pennsylvania Department of Transportation (PENNDOT). However, the accident data processing is done within PENNDOT, and the driver, vehicle, and roadway files are also maintained there.

Other states divide these responsibilities into quite separate departments. In Illinois and Michigan, the state police, the highway department, and the Secretary of State's office (which handles vehicle registration and driver licensing) are distinct. In such an arrangement, data can be shared among departments with communication interfaces, although this requires both appropriate software and cooperation among the participants. In some cases, because of reluctance to share information, cost, or other reasons such communication is minimal. In Connecticut, for example, VINs are acquired for FARS cases (about 400 per year) by a letter of request between the accident coding section and the motor vehicle registration section.

The state of Washington maintains the several kinds of data (accident, driver, roadway, medical) in separate departments, and generally on different kinds of computers. They have solved the

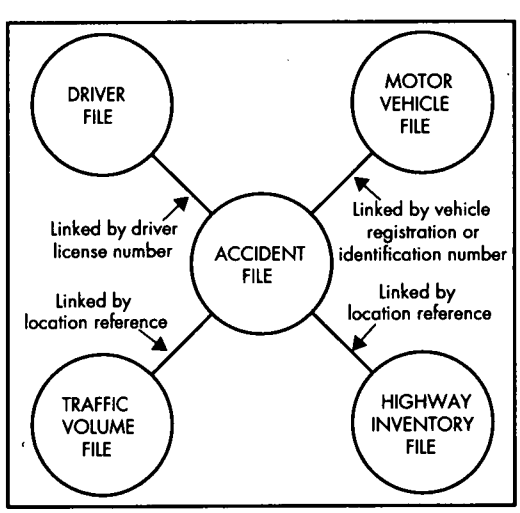

FIGURE 3 The minimum comprehensive traffic records system. (adapted from TRB Circular 293)

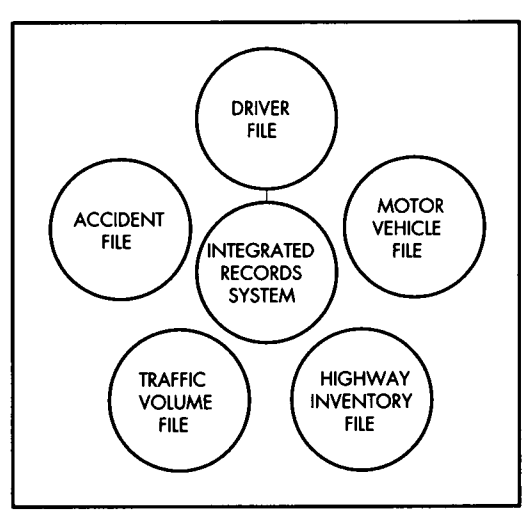

FIGURE 4 The central integrated records system. (adapted from TRB Circular 293)

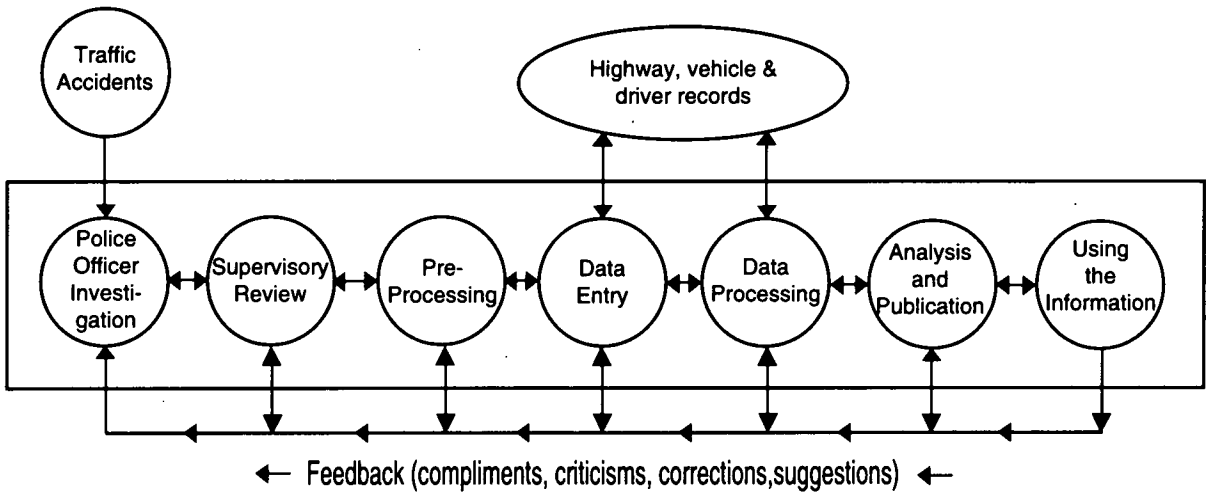

FIGURE 5 The sequence of activities in the accident data system.

problem by creating a separate agency that obtains all of the data quarterly, converts them into a common form, and makes them available for their own analyses as well as those of others.

A Generic System

Figure 5 shows the sequence of activities in acquiring and using data about traffic accidents. At the upper left is the accident. It is usually attended by one or more police officers who observe, interview, and complete a written report form. In most cases this completed form is delivered to a police post or station where it is reviewed by a supervisor. From time to time, bundles of these reports are sent to an agency that enters these data into a computer, first checking the reports (interpreting) for gross errors or to add information (coding) necessary to further processing. In the next step, data are usually entered into a computer, and then added to previous input to form working files. These are sometimes aggregated over a period of a month or a quarter, but ultimately over a one-year period. These files then may be processed, and routine publications distributed. The agency should be ready for requests for special analyses.

Case Selection and Investigation

In all cases there is a state law defining the threshold severity of accidents that are to be included in this data collection system. This has typically been defined to include all accidents with personal injury or a fatality, plus all accidents with property damage exceeding a certain level, either in dollars or some other measure. These definitions vary from state to state and from time to time, often increasing the dollar damage limit to keep pace with inflation.

The choice of a threshold is usually a compromise. The highway department engineers usually would like to have a complete list of accidents of all severities to permit easier identification of locations with road design or traffic problems. Police agencies would usually be happier with a high threshold to minimize their paper work. Others would like to have all injuries reported. The legal threshold is typically set by legislative action after the judgments of the various concerned agencies have been heard.

To be most helpful to the various users, an ideal system would achieve complete coverage of the population defined by the threshold law. In order to compare data from different jurisdictions, this achievement should be consistent across all areas of the state. Also, in an ideal system the police reports should record the appropriate information for each variable, that is, there should be no missing data.

The reviewed literature suggests that most systems are not achieving these accident data collection ideals. Performance in this area depends on training, incentives provided by management of the system, and good communication that informs the individual reporting officer of the importance of his input. Many states provide training similar to that of the state police academy for local police, and this might be expected to keep reporting quality high. Most states stipulate a supervisory review of accident reports, often with a second signature on the accident report. Keeping everyone in the reporting chain informed as to the ultimate uses of these reports should help to maintain data quality.

Processing, Analysis, and Publication

The preprocessing, data entry, and preliminary analysis activities often take place in a single department, augmented by reference to other related traffic information (driver, vehicle, and highway data) as shown in Figure 3. Typically, the preprocessing stage involves adding or supplementing location information as well as checking the report forms for completeness, sometimes requesting further input to achieve this. At the data entry stage, the ideal system will have a variety of computer edit checks to ensure that codes are within range and not in conflict with other information. Accuracy can be enhanced if the system allows timely reference to active driver and vehicle files (for checking such items as vehicle identification numbers and driver names and addresses). Reference to roadway files can permit immediate correction of deviant location codes or highway descriptions. While such tests can be made after the accident report has been entered into a computer, on-line

reference to relevant information at the time of data entry can improve the data quality.

Accident data are usually entered on a case-by-case basis, with the working files being updated daily, weekly, or monthly. Some police agencies would like to have data in a usable form within a few days of the event, but timeliness does not seem to be critical for most other users. However, data quality can be enhanced by completing the processing of a case within a reasonable time period, while participants in the accident (and its investigation) were still available to answer questions. A few states require that police reports be forwarded to the processing office within 10 days, and in some states processing is completed within an additional 10 to 15 days. In other states, the processing is delayed by many months. In at least one state, many accident reports from the last half of one year were not processed at all because of time and budget limitations. From a quality point of view (and considering the needs of most state users), accuracy and completeness are probably more important than timeliness, but excessive processing time should be avoided. With appropriate system design, size does not seem to be an obstacle. Texas, with more than 250 counties and a half million accident reports per year, usually has accidents coded and into a working computer file within 30 days.

When a reasonable number (perhaps a month's worth) of accidents have been entered into a computer, the data processing group has an opportunity to inspect the data for consistency. Testing of the data at this point in the process can be largely automatic, comparing distributions of many variables with the same distributions for the previous month or year. Differences that exceed some defined level can raise a flag, and the source of a problem can often be identified. This is frequently described as a post-processing test as opposed to the edit checks used for data entry. Many tests can be run without finding any problems, but such events as one jurisdiction failing to report minor injuries consistently could be detected quickly. Appropriate corrective measures could then be taken.

The staff at the University of North Carolina has studied variable distributions for the state files they have prepared for FHWA, and they have prepared extensive comments about the completeness and accuracy of the data. Their comments on a variable related to occupant ejection in one state's files provide an example of the kind of information provided to users:

> Here, 19.99 [sic] percent of the occupant cases were not coded. Our assumption is that this variable is simply not coded as often as it should be for the non-driver positions. In addition, we found that the coding for this variable had been modified on the accident report form in 1985, but the basic computer codes in the raw data documentation had not been changed, leading to errors in category labeling. We have corrected this in the SAS files, but the raw documentation codes remain in error.

In the accident file for the state of Texas, many listed variables are accompanied by comments regarding limitations. For example, in the listing of the variable ROAD CURVATURE the following comment is made: "Coded only for accidents in rural areas and cities not participating in the Texas Urban Project." The entry for the variable RESTRAINING DEVICE USED, is accompanied by this comment: "Coded only for passenger car, truck, or bus occupants who were killed or injured, or those who were passengers of a vehicle with a damage scale of 5 or more." Users of such data are thus forewarned about problems of interpretation.

Concerned data providers should welcome feedback that may improve the quality of the system. The University of Michigan's Transportation Research Institute ends the introduction to each accident file codebook with this statement:

> While every effort has been made to provide accurate, reliable data, inconsistencies may arise from the source data or from the reformatting procedures used. Consequently, we cannot guarantee the accuracy of the data, but will try to correct any discrepancies that are found. Any comments or suggestions concerning the data or the codebook may be made by calling [name and phone number].

Whether such an offer is made formally or informally, the willingness to try to correct faulty data is very important.

If consistency analyses can be done (and corrections made) within the state data processing facility, the higher quality data will be appreciated by all potential users. Whether or not such tests are done automatically, new data should at least be tested by visual inspection against a previous period by listing one-way distributions and comparing them. The data processing staff should try to understand any discrepancies, and attempt to repair them. After the data have been placed in working computer files, they are likely to be used by people who do not have the insights of the data processing group. It is incumbent on that group to make all possible corrections as well as to qualify the resultant data by describing data problems to the users.

THE USERS

The working files should be easily manipulated to provide a variety of outputs. Many standard reports may be distributed periodically to local police and roadway agencies, as well as to state agencies. It has been said that the value of a library is indicated by the number of people who use it more than once; solid evidence of the usefulness of an accident data processing system would be many repeated requests from individual users who found the information useful. Interested users may communicate observed deficiencies, enabling processing system management to improve the value of the data.

The variety of users of accident data files is shown in the rectangular boxes of Figure 6. At the center of this figure is the record-keeping agency, and users have been grouped for discussion purposes into state agencies, U.S. government agencies, industries, associations, local (city or county) agencies, and a miscellaneous group.

Highway and police departments are the most visible state government users of accident and related data. Analyses are distributed privately within the appropriate departments, and they seldom become a part of the referenced journal literature. Such private documents, however, lead to many operational decisions within the state.

In each state, the highway agency uses these data to identify locations needing safety improvement or other funding decisions. When changes are introduced to improve highways, the effects of such changes are measured by a change in accident frequency and severity. In some states, the district engineers have direct access to accident computer files, while in others the data are analyzed in a state office and distributed to the districts. Many state highway agencies conduct research activities that include analysis of accidents as a function of roadway characteristics. In addition, many highway departments work closely with academics and students at their state universities in researching accident problems.

State police agencies analyze accident data to develop operations plans, to evaluate Selective Traffic Enforcement Programs (STEP),

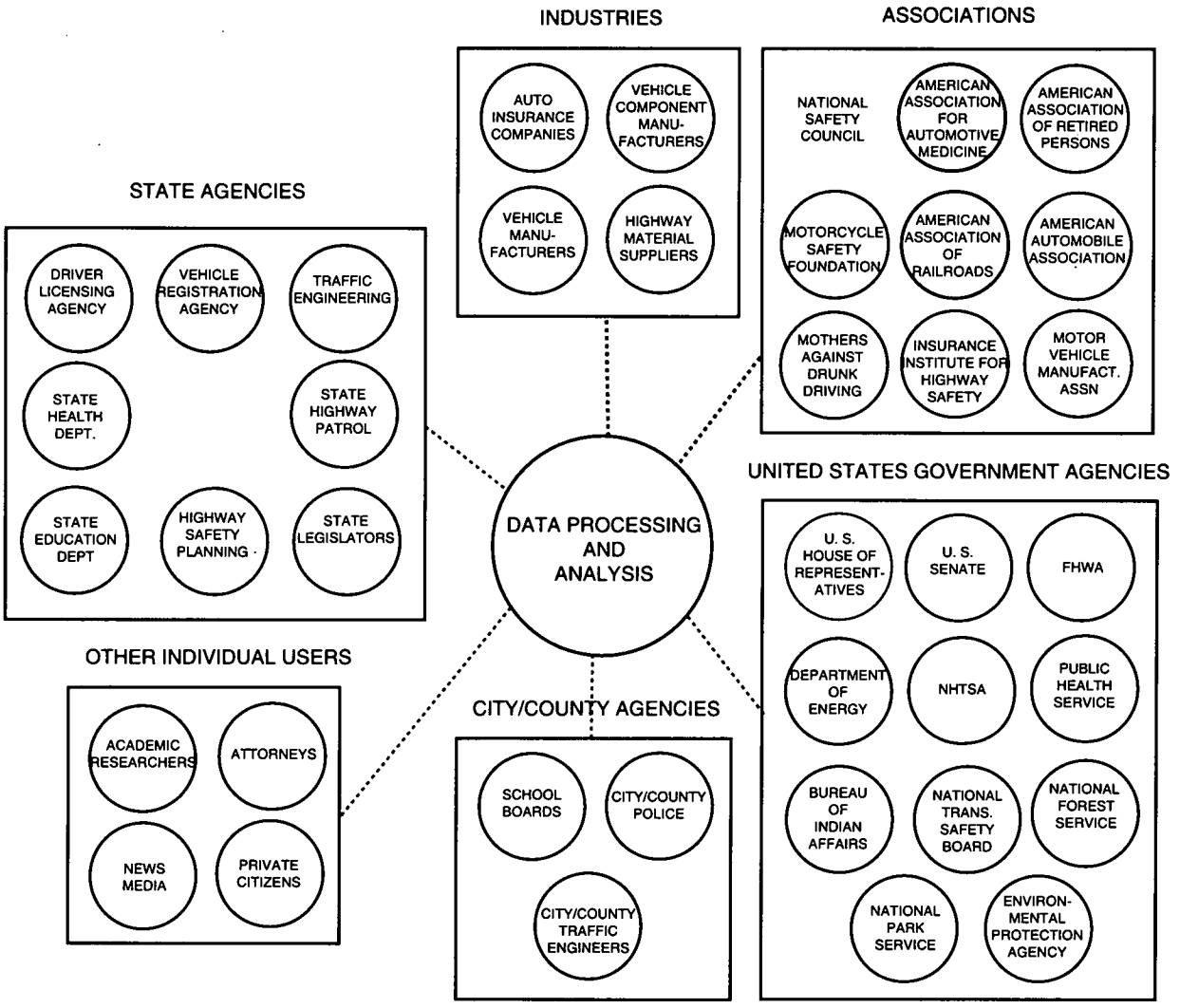

FIGURE 6 The users of accident data files.

or to support budget requests. An example of the type of internal (not widely published) report in this category is a California Highway Patrol study of tank truck accidents written in 1981 (*54*).

Driver licensing agencies routinely associate accident data with their driver record file, and most maintain some kind of point system to identify problem drivers. In some states the data about accidents are put into the driver files as a part of the accident processing; in others it is done after the fact. In either case, it is an important part of the driver control process. Many driver licensing agencies conduct research about driver improvement methods, and the accident data are a major input to that research.

At least one state health department has used highway accident data to discover cases of state-supported hospital treatment that should have been paid for by federal funds or other non-state funds. Many health departments have developed trauma registers, and wish to link the police accident information with their data. State education departments have studied the incidence of school bus accidents. State legislators occasionally request data about the number and types of accidents in their own districts. Finally, highway safety planning agencies (most of which are in one of the above departments) need access to accident data to plan and justify safety programs proposed for the upcoming year.

In addition to the normal state traffic safety functions, special projects are occasionally defined, and these make use of the accident data both for planning and evaluation. Within the past several years New Mexico conducted eight traffic safety projects, each directed by a committee made up of persons representing public and private agencies. The appropriate agencies are identified by letters in Figure 7, and the legend at the lower right corner of the figures indicates the constitution of the various committees. All of these are interested users of the traffic accident and related data in that state.

Similarly in Utah, although the Department of Public Safety and the Department of Transportation are separate agencies, there are many joint committees and good communication exists among the participants. There are quarterly committee meetings, and topics include Utah Department of Transportation (UDOT) repair plans and police planning. A typical meeting has representatives from the governor's highway safety office, UDOT, and the Highway Patrol. Idaho convenes an annual conference for law enforce-

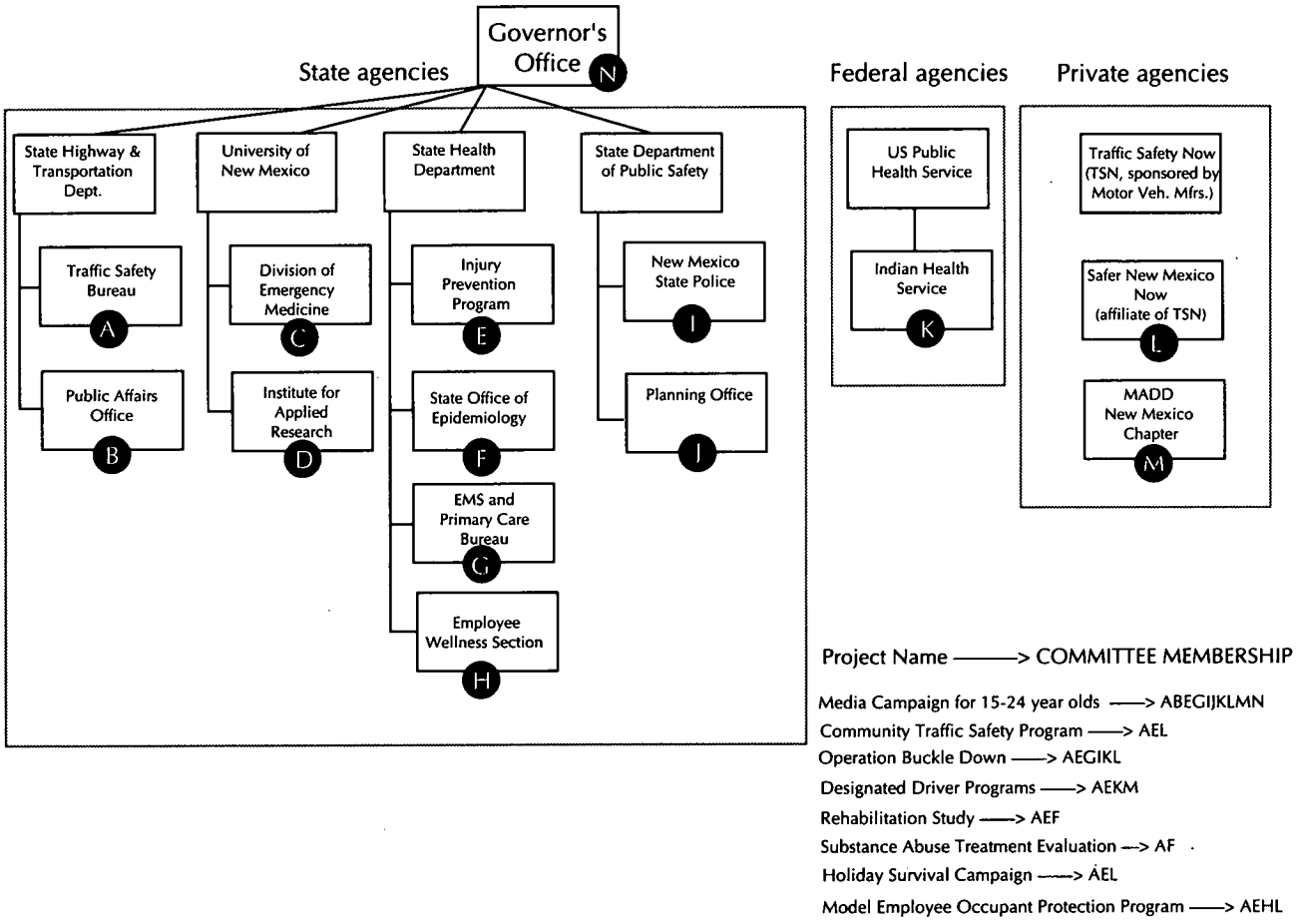

FIGURE 7 Traffic safety project coordination in New Mexico (planning and steering committee structures).

ment personnel and local road authorities hosted by the Office of Highway Safety to let everyone know what is happening to the data being sent in by the police.

United States Government Agencies

The Federal Highway Administration (FHWA) needs accident data for its research programs, but this agency has a limited capability for direct data collection. FHWA uses information obtained from the states to develop travel and accident trends, to identify safety problems, and to evaluate programs by assessing the effectiveness of safety resource investments. In this connection the FHWA has developed a Highway Safety Information System (HSIS) (*55*). In this program, accident and related data files have been acquired from five states that have a combination of useful accident data and computerized files of complementary roadway information. At present (1992) these files (for U.S. and state road systems only) are in place with data from Illinois, Michigan, Utah, Maine, and Minnesota (*56*).

In addition, the FHWA annually acquires and compiles data on accidents and mileage by road class from all of the states. The accident counts come directly from the various state accident files. The Highway Performance Monitoring System (HPMS) also permits estimates of vehicle miles of travel as well as accident, fatality, and injury data—all tabulated by road class and state. These are summarized and published annually.

The National Highway Traffic Safety Administration has several programs of its own for accident data acquisition—the National Accident Sampling System (NASS), and the Fatal Accident Reporting System. NASS depends rather directly on the police-reported accidents in each of the states in which it collects data. There are two parts of the NASS program today, one of which (the General Estimates System) uses the police-reported information directly. The other part is the Crashworthiness Data System in which the police data are augmented by reports of specialist investigators. Both of these depend on the coverage and, to some extent, the accuracy and completeness of the police reporting in the states.

NHTSA also acquires and maintains accident data files from many states so as to have a source for queries of importance to that agency. Analyses of these data contribute to the development and evaluation of vehicle standards, the identification of problem vehicles, the evaluation of restraint systems, and the evaluation of social programs (anti-drunk driving or restraint usage campaigns).

As of 1991 there were 28 states for which working Statistical Analysis System (SAS) files of accident data were available to the NHTSA staff. Codebooks have been prepared for each state, and an instruction manual guides the users in SAS operations (*57*).

The most used state files at NHTSA are those from Michigan, Texas, Pennsylvania, Maryland, Georgia, Illinois, Indiana, Florida,

Ohio, and Missouri. Of these, Michigan, Maryland, Georgia, Illinois, Florida, and Missouri have VINs reported. Recently, Pennsylvania was added to the list of states recording the VIN.

Data from New Mexico (with VIN) and Utah (also with VIN) are thought to be reliable, but not used so much because of their small number of cases per year. Michigan and North Carolina do not code ejections, and this is considered a serious omission for NHTSA purposes.

Since much of NHTSA's work involves regulation of vehicle manufacturers, VIN numbers are clearly of great importance to users there. There are exceptions to this because of particular data elements, but, other things being equal, they will seek the state with good VIN reporting. New Mexico is rated very high on VIN accuracy and completeness (although New Mexico produces only about 40,000 accidents per year).

NHTSA has provided a grant to the National Association of Governor's Highway Safety Representatives (NAGHSR) to demonstrate the acquisition of data and the computations involved in developing a Sensitivity Index (*58*). This index is intended to serve as a measure of the responsiveness of emergency medical services (EMS) to the medical care needs of highway crash victims statewide. In the pilot program, data were acquired so that this index could be computed for several states, linking computerized crash injury data to EMS, hospital, and census data. The pilot program assessed the quality of data and points out some of the problems of linking such data. The intent is to extend this program to other states, and all states are being encouraged to provide linkages between crash data files and medical files so that this index may be computed.

Many other U. S. government agencies are considered in the category of occasional users. These include, for example, the Department of Energy studying the incidence of traffic accidents involving hazardous materials, and the Department of Health and Human Services' National Center for Environmental Health and Injury Control in Atlanta, which conducts a research program in conjunction with NHTSA. With the recognition that some 40 percent of workplace fatalities are now the result of traffic accidents, the Occupational Health and Safety Administration has acquired an interest in accident data as well.

Industry Users

Industrial users include domestic and foreign automobile manufacturers, the insurance industry, vehicle component manufacturers, and highway equipment manufacturers. Auto manufacturers conduct research to prevent accidents or reduce injury severity. Insurers may use accident data in developing rate structures. Component manufacturers often believe that their products can improve safety on the highway, and they may analyze the data to support their claims. In the highway supplier field, components such as guardrails, anti-skid treatment for pavements, signing, and signaling are typical candidates for evaluation by analysis of accident data.

Associations

Of the many associations in the transportation field, several have been major users of accident data. Local automobile clubs frequently use tabulated accident data obtained from the state in their periodicals. Frequently, associations use data in support of legislative action, and it is important that the data represent the truth. Of the several associations shown in Figure 6, Mothers Against Drunk Driving (MADD) deserves special mention because many state chapters are active users of the available accident data.

Local Agencies

Traffic engineers and police at the city and county level often maintain their own accident records. There are some economies of scale in computerizing the data at the state level. In addition, the statewide standardized data format makes it possible to compare distributions with other jurisdictions. Many state accident data processing groups tailor reports for local agencies, and some have experimented with computer connections or downloading of subsets of the state data.

Others

News media use accident data in a variety of ways. Most usage is of published tabulated data, but for in-depth treatments reporters may seek the results of special analyses. In at least one state, newspaper reporters have learned to access accident data files by computer, and have argued successfully that these files are public under the freedom of information laws.

Academic researchers—specialists in psychology, engineering, medicine, public health, sociology, and economics—all make use of accident data in their studies. Published results of academic research are typically referenced by journal editors, and this adds some credence to their reports. The analysis of less-than-perfect data in the usual accident collection sometimes leads to academic disputes.

Lawyers often make use of accident data to support an argument, but many courts receive accident data as hearsay testimony, giving it much less weight than the testimony of actual witnesses. Quality of data will be questioned in litigation, and such users will find the more defensible data important.

The media, the academics, and the lawyers (as well as the other users mentioned) are often using data in ways that may lead to large expenditures or to major policy changes. In such applications, it certainly behooves the producers of the data to strive to make the files truthful and complete.

Chapter Summary

Desirable characteristics for an accident data acquisition and processing system have been described. These can be achieved by careful attention to detail in collecting the data, sophisticated edit checking, retrieval of information from other sources, and making the information freely available.

There is a variety of users of traffic accident data, many of whom are outside the state transportation related agencies. As the availability of data becomes more widely known, the number of users may continue to increase. A useful circular process between the data providers and the users exists. The better the quality and availability of accident data, the more they will be used, criticized, and discussed. Feeding back such criticism will then lead to further improvement in the data quality. Although many decisions are made without benefit of any data or analysis, it seems likely that good decisions are more likely to proceed from good data.

CHAPTER FOUR

REVIEW OF CURRENT PROGRAMS THAT CAN ENHANCE DATA QUALITY

INTRODUCTION

Federal transportation agencies and many accident researchers would be pleased if data from the various states could be more usefully combined into larger groups for study. Two or more accident data sets may be combined for analysis if:

- The thresholds for reporting are equivalent,
- The thresholds are applied in the same manner,
- The scales on which comparisons are to be made are the same,
- The scales are interpreted and applied in the same manner, and if
- There are few missing data.

At the federal level only the FARS comes close to satisfying these requirements, and even in this case some of the variable scales are not interpreted in the same way. Since the combined files of other programs such as the NASS are based on police-reported accidents, they are affected by variable reporting thresholds and missing data. Attempts to adjust data being combined from disparate sources analytically have generally been inadequate.

There are similar inconsistency problems within individual states as reporting performance varies in local jurisdictions. Comparison among cities and counties within a state will be more defensible and useful if the five conditions listed above are met.

Nearly all states now have traffic records systems that are far advanced from those in place just a few years ago. Personnel working in this area are dedicated and new skills are being developed. More consistent interpretation of the D-16.1 and D-20.1 standards, the addition of the CADRE and NGA variables in more states, and more complete data accompanied by an understanding of the actual thresholds achieved all provide an opportunity for more useful aggregation.

In this chapter, examples of current programs proceeding in the direction of the five conditions listed above are identified and discussed.

Timeliness

Several police agencies have indicated that the data files compiled at the state level are less useful because they are so far removed in time from the present. Most other users (some highway departments, accountants, academics, manufacturers, NHTSA, or FHWA) seem satisfied with aggregations of data from, say, the previous year.

Promptness in the accident file-building process is important, however, because it contributes to quality. Systems in which many months pass between the crash and the file building lose forever the opportunity to recover missing volatile information.

Modern hardware may help to get the correct information the first time. It is not hard to conceive of an accident data system comparable to a store checkout counter. Much of the data could be derived from barcodes or magnetic strips on driver's licenses, vehicle registration cards, car doors, or license plates. With today's communications capability, all of these data could be in the state capitol within hours or minutes, and downloaded to local police the same day.

In 1992 these techniques are not universally used, and full implementation would be costly. Most of them are, however, the subject of experimental efforts. The rapid lowering of computer equipment costs in recent years suggests that these techniques may be affordable soon. Whether the increased speed of file building, increased accuracy, and the availability of timely information to other users will be of great value is still open to discussion.

Thresholds and Coverage

Most states have established some nominal severity threshold, and the expected practice is to investigate all accidents with a severity exceeding that level. The choice of a threshold has typically been a compromise between those who would like to have large amounts of data and those who have to collect the data. Actual thresholds differ from the legally defined thresholds for several reasons.

Overburdened police agencies cannot always keep up with the number of accidents that occur in severe weather. Some drivers do not want their accident involvements known to their insurance companies (because their premium costs may rise), to the state (because they may incur license restrictions), or to law enforcement agencies (because they do not have insurance when it is required). An unpublished survey in Michigan in the 1970s indicated that about 10 percent of those who were required to have insurance did not have it.

Particularly in large cities, the police are often busy with other matters. Detroit police officials were quoted in about 1971 as saying that they would send police only to those accident scenes where they were needed to assist injured or to move vehicles. Chicago has adopted a similar policy. The Barancik and Fife study in northeastern Ohio suggests that some areas in that state may have a similar policy (recall that in that study no accident reports could be located for 8 people who were brought to the hospital by police cars) (*26*).

Many states are rethinking their legal threshold definitions, and officials in several states believe their thresholds will increase to $1,500 or more in the future. The Motor Carrier Safety accident reporting system (operated by the FHWA) has now adopted a

TABLE 2
ACCIDENT REPORTING THRESHOLDS

Alabama	Both citizens and police report; $250
Alaska	$500 property damage
Arizona	Both police and citizens report; $500 property damage
Arkansas	Police report if damage exceeds $50; citizens report when damage exceeds $250
California	Both police and citizens must report accidents with injury or death; citizens also report damage over $500
Colorado	Police and citizens report; $1,000 property damage to any individual
Connecticut	Both police and citizens report; $1,000 property damage to an individual and any accident involving a school bus
Delaware	Both police and citizens report; $500 per vehicle, injury or death
Florida	Both police and citizens report; recently changed to require reporting only of injury/fatality accidents plus those involving alcohol, drugs, stolen vehicles, or hit and run. Previous requirement (1988) was towaways. However, any completed report will be entered into the computer file.
Georgia	Only police reports are used for files; $250 per accident. Citizens must report when damage exceeds $250 per vehicle
Hawaii	$300 property damage
Idaho	Only police report; $250 per accident
Illinois	$250 property damage
Indiana	$200 property damage
Iowa	Both police and citizens report; $500 per accident
Kansas	Only police report; $500 per accident
Kentucky	$200 property damage
Louisiana	Police report injury/fatality; citizens report $500 damage per vehicle
Maine	Only citizens report; $500 per vehicle
Maryland	Citizens report accidents involving injury or death; police required to report in cases of death only
Massachussetts	$500 property damage
Michigan	Both police and citizens report; $200 damage per vehicle, death or injury
Minnesota	Injury, death, $500 property damage; police must report injury and death; drivers must report damage over $500
Mississippi	$250 property damage
Missouri	Only citizens report; $500 damage per vehicle
Montana	Both police and citizens report; police report all; citizens report damage over $400
Nebraska	Both police and citizens report; police report damage over $500; citizens report any damage
Nevada	$500 property damage
New Hampshire	Both police and citizens report damage over $500 per vehicle
New Jersey	Both police and citizens report damage over $500 per vehicle
New Mexico	Both police and citizens report damage over $100 per vehicle
New York	Both police and citizens report damage over $600 per vehicle
North Carolina	Only police report; $750 per accident
North Dakota	$1,000 property damage
Ohio	$400 property damage
Oklahoma	Only police report; $300 per accident
Oregon	Both police and citizens report; $400 damage per vehicle or other property damage
Pennsylvania	Only police report/ injury, death or if vehicle is towed from scene
Rhode Island	Both police and citizens report; $500 per vehicle
South Carolina	Both police and citizens report; $400 per vehicle
South Dakota	Only police report; $500 individual's property or $1,000 per accident
Tennessee	Only police reports are used for MVRs; $400 per vehicle; citizens asked to report when damage exceeds $400 per vehicle
Texas	Only police report if present; citizens report only if police are not present with fatality, injury, or $500 property damage
Utah	Only police report; $400 vehicle damage
Vermont	Both police and citizens report; $500 per accident
Virginia	Only police report; $750 per accident
Washington	Only citizens report; $400 per vehicle
West Virginia	$250 property damage
Wisconsin	Either police or citizens report; $500 per vehicle, $200 for state property damage
Wyoming	Both police and citizens report; $500 per vehicle
District of Columbia	Both police and citizens report; $50 per vehicle

sliding threshold that depends on a national inflation statistic in an attempt to maintain similar coverage from year to year. The 1991 accident reporting thresholds for the states are shown in Table 2, which was derived from a number of sources, including insurance industry and state reports, as well as interviews with state officials. Threshold definitions vary widely among states and factors other than dollar amounts enter into the definition. The most common value is $500, but current standards range from $50 to $1,000. Pennsylvania requires reporting for towaways without regard for dollar damage. Texas requires reporting of certain data elements only when the TAD severity measure is 5 or greater.

It is becoming increasingly difficult for reporting officers to judge repair costs. A recent Insurance Institute for Highway Safety (IIHS) study compared the repair costs of a number of small cars damaged by 5 mph test impacts (*59*). For a 5 mph impact into a pole with the rear of the car, repair costs ranged from $600 to $1,732, with much of the higher figure being attributed to invisible damage. This suggests that the actual threshold for reported crashes may be driven by something other than the dollar limit.

While there would clearly be an advantage to the federal agencies in having accident data collected to a common standard in all the states, progress toward this end has been painfully slow. Each state has its own peculiar problems, sometimes because of unique terrain, severe winter weather, flooding, or special trucking regulations. The accident data forms reflect these state characteristics. Budgets vary from state to state, and the attention that can be devoted to accident data collection and processing depends on both the transportation system management's mandate and the legislature's generosity. California (at the state level) requires reporting of injury accidents, but accepts others, so that the threshold in the resulting file is uncertain.

One important highway application of accident data is to find "black spots," locations on the roadway with more than the expected number of accidents. For this purpose it would be appropriate to have

not only property-damage-only accidents, but even incidents such as sliding off a roadway and recovering. Colorado, for example, maintains a file of instances in which a truck used a runaway ramp even though there was no accident damage. While such data are not added to the general accident file, they are made available so that the highway department can evaluate the effectiveness of the ramp program. An increasing reporting threshold weakens the capability to identify black spots.

People in many state data processing offices believe their missing data are negligible, and that the officers in their state are doing an excellent job of complying with the threshold rules. The literature review suggests that this is an area that requires more than a casual observation to support such a belief.

SELECTED PROGRAMS REVIEWED

The following sections of this chapter provide examples of data acquisition and processing practices that are in use in one or more states. It is difficult to characterize most of these as proven practices, since there has been relatively little formal evaluation of innovations in the accident data field. There has, however, been much experimentation, and the experimenters often are pleased with the changes.

Current Data Acquisition Practices

Investigator Training and Accident Reporting

Nearly all police officers complete traffic accident reports at least occasionally, and their ability to do this well depends on training and experience. A few officers have specialized training in accident investigation, and may often be called to assist with the reporting of serious crashes. The majority of the traffic accidents do not get such attention, and the computer files are filled with reports completed by concerned officers who take accident investigation seriously but do not regard it as their only duty. It is important that such officers continue to recognize the fact that many people are dependent on what they report.

There seems to be a trade-off between completeness of reporting and the difficulty of completing the report. The experience in South Carolina has been cited where reporting of C-level injuries dropped off when complete name and age information were required. One state had the experience of going from a one-page report form to a four-page form, the result being a sharp drop in the number of reported accidents. Conversely, a short one-page form may produce more accident reports, but less detailed information. The choice among these factors is usually made at the state level to satisfy the needs of the highway department or the state patrol, but the implementation often depends on local police commanders and their policies.

Most states use a common accident report form for all police agencies within the state, and typically there has been a manual and training curriculum developed at the state level. In many states there is either a single police academy providing training for both state and local law enforcement personnel, or several satellite academies that are sponsored by the state police. In some states with large cities, such training is done at a city police academy. In any case, consistent training is a prerequisite to consistent data. It is important that the reporting officers understand and follow the reporting conventions. Specific examples of police training activities that assure data quality follow.

Officers attending the police academy in Salt Lake City, Utah are brought into the accident data processing area during one afternoon session to get an understanding of what happens to their reports when they arrive at the state office. They observe the data processing steps, and are introduced to clerks in the financial responsibility section where they learn what is needed in accident reports so that the laws in this area can be enforced.

In New Jersey all police training is centrally supervised by a police training commission (part of the state's Department of Criminal Justice). This agency is responsible for training at the State Police Academy, at 17 county academies and at one other that serves those counties not able to support their own.

All states have a signature block on the accident report form to be signed by the officer who prepares the report. Most states have a second signature block to be signed by a supervisor who has checked the completeness of the report.

In some cases the reporting officers record the location in terms not easily understood by coders at the state data processing office. Data users who identify a problem and who are willing to express themselves can participate in the solution. In Florida, highway department engineers have participated in the police academy training regarding accident report preparation. In addition, they are currently preparing a training video showing just what is done with the location information and describing how they would like to see it recorded. This video will be made available for training sessions at both state and local police levels.

Another video training aid is used by the Idaho state safety office, which also has plans for participating in regional police training activities at least every two years. The data processing people in the Nevada highway department try to make personal visits to each of the larger rural jurisdictions about once every two years, discussing their needs for location data and encouraging conscientious reporting.

How are Accident Locations Reported?

Various schemes for reporting and recording the geographic location of accident sites have been developed. In some cases the accident data were not easily transformed into the coordinate system for other road-related data. For example, when the accidents were listed by milepost but the roadside signs or guardrails were listed by latitude and longitude. In recent years there has been a trend toward systems with common coordinates, such developments being generally referred to as a Geographic Information System (GIS).

Also recently there have been a number of experimental efforts using a satellite navigation system, the Global Positioning System (GPS), for determining position information for the GIS. There are several limitations to fuller use of GPS as of 1992. The number of satellites for complete full-time coverage has not yet been achieved. The cost of the receivers is judged by many to be too high (hand-held receivers are advertised for $895 in 1992) to permit having them in all police cars. While the intrinsic accuracy of the GPS is in the order of a few feet, in a system practical for civilian applications such as accident location recording it is expected to exhibit errors of a few hundred feet. There is much promise for electronic navigation to increase the quality and value

of accident data, and there is an urgent need for experimentation to find the best way to make use of such data.

Over the next few years we can expect the GPS satellites to be fully operational, the cost of receiver equipment to continue to come down, and the number of accident-location experiments to increase.

Accident Report Design

New York State officials believe that the format of that state's accident report (developed in about 1974) induces accurate and complete reporting. In this report there is a cover sheet with detailed codes listed. The reporting officer selects a number from each list and records it in the appropriate box at the edge of the report. Many other states (South Carolina, Maine, Minnesota, Mississippi, and others) have adopted a similar format.

Many states are presently incorporating the National Governors' Association truck variables and CADRE variables into their report forms. Conflicting with this effort, however, is a tendency to reduce the size and complexity of the police accident report to induce complete reporting. Compliance with the D-16.1 and D-20.1 standards is largely voluntary and is likely to remain so. Incorporation of the CADRE variables into state files is encouraged by possible federal funding. There are occasional reports of inconsistencies between states' reporting methods, but no general program for such evaluation.

New Hardware and Methods for Accident Investigators

The Irvine, California police department has employed civilian accident investigators since about 1979. These investigators work in the traffic division, and are supplied with well-equipped vans. They receive the same training in accident investigation as does a sworn officer, but, as specialists, they quickly get above average experience in reporting. These investigators work mostly during daylight hours (6:00 a.m. to 8:00 p.m.), and they report on about 40 percent of the accidents occurring in Irvine, the remaining accidents being attended solely by sworn police officers.

As civilian employees, these specialists do not have the arrest powers of sworn officers, but they can make citizen's arrests. They are often called on to testify in court. When not investigating accidents they may be assigned to such duties as parking meter monitoring.

Figure 8 shows an investigator conducting a post-accident interview. Figure 9 shows the control panel in the right front, which includes siren and light controls, and a computer keyboard (called a Mobile Data Terminal), which connects by radio to all of the police communication computers. This includes the Department of Motor Vehicles (DMV) files, the National Law Enforcement Telecommunications System, and the stolen vehicles reporting system. Dispatch messages are received on the terminal screen. The accident report is entered on the keyboard, and subsequently printed out in the conventional accident report form for transmission to the state.

Other cities in California and elsewhere are using civilians in place of uniformed officers for special service such as accident investigation. The Irvine Police Department believes that creating specialists for accident investigation leads to consistent and accurate reporting at a lower cost than a system using only sworn officers. Further, the availability of a complete communications system with access to stolen car and warrant records make this a cost-efficient operation. An Irvine spokesman suggests that such a system may be attractive to other jurisdictions.

The Putnam County Sheriff in New York State is using an experimental computer input of accident data. The resulting accident reports are then printed out by computer and forwarded to the state for coding into the state file. It is anticipated that a next step in this experiment would be to transmit the Putnam County cases to the state by digital means.

Many states and cities are experimenting with computerizing the accident data at the scene of the accident. This has the potential of performing the kind of computer edit-checks usually done at the state data processing office at the accident scene. The officer can be forced to respond to each query before proceeding to the next variable, and computer tests (such as checking the format for a VIN code) can prompt for a correction if needed. California drivers' licenses now have magnetic strip coding that is used in writing citations for traffic violations. While this is not currently being used to read driver information into the accident reports, it may be in the future.

The Colorado highway patrol is considering a program with laptops or clipboard computers that would prepare accident data for their processing system. These data would then go to the Department of Revenue for file building, but the patrol would also have early information in digital form for its own use.

In Clearwater, Florida, the accident report can be keyed into a computer in the accident investigation car, then transferred to a PC at the station, and finally put on tape for transfer to the state. This program was instituted in February 1991, but the first tape was delivered in February 1992. A number of other Florida jurisdictions enter accident data into computers at the city or county level.

In Mankato, Minnesota, an experiment is underway using a pen-based computer for recording the accident data. This device allows the officer to write with a stylus in normal fashion, but the data are digitized and thus can be transmitted to another computer. Similar pen-based computer experiments are in progress in Mobile, Huntsville, and Tuscaloosa, Alabama and in many other places.

One of the advantages of computer input at the scene is that an edit-check program can be written to ensure complete data entry before the reporter can proceed to the next item. Although this technique has worked well for many applications, it has been little tested for police accident reporting. A rigorous evaluation in this area would be desirable.

Current Practices in Data Processing

Entering Data into the Computer System

The interpreting, coding, and inputting of accident data into a computerized data base provides opportunities for correcting errors and adding to the completeness of the file. If these steps are poorly done, there are opportunities to add to the problem. Most states now enter data at computer stations with edit-checking programs.

The simplest editing program consists of a semantic edit for unallowable codes, such as an eighth day of the week, a 30th day of February, etc. In most such systems the computer will simply refuse to accept the entered value, and will repeat a request for a proper response.

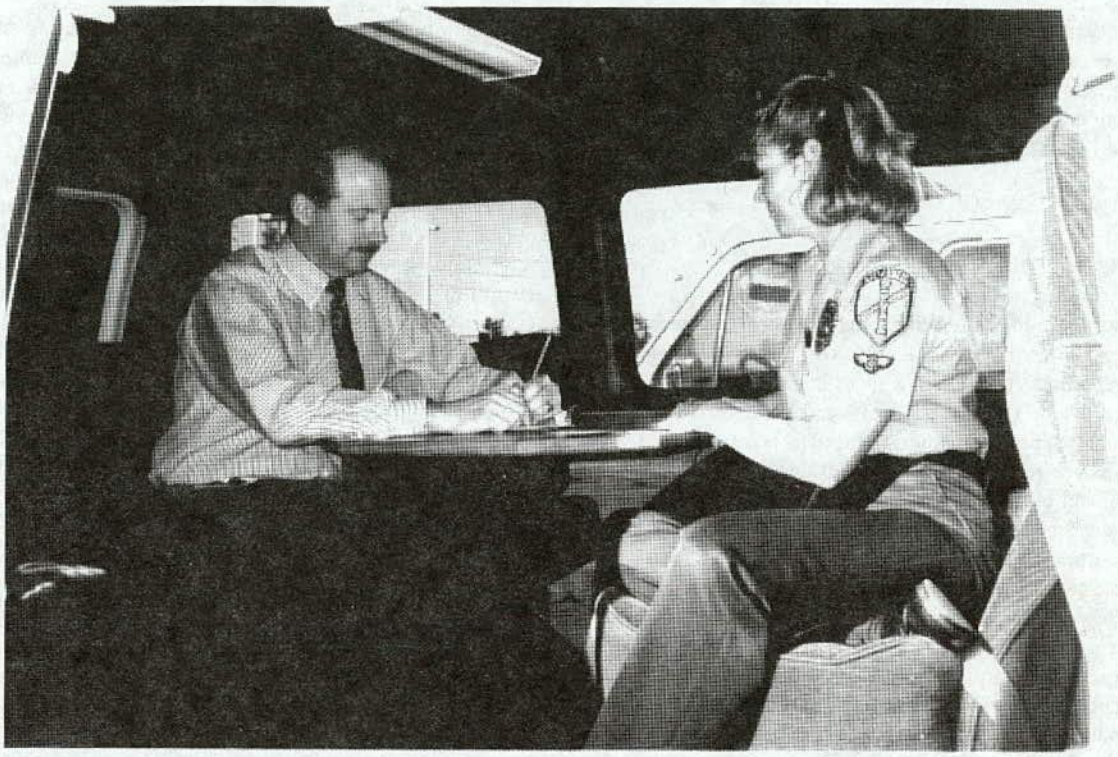

FIGURE 8 The Irvine, California accident investigation van.

A second level of edit checks for internal consistency. This could ensure that daylight would not be reported if the time were listed as midnight (except possibly in Alaska). Tests in this category usually develop from experience, and, although their development may seem slow, modern computers make their application very rapid and nearly transparent to the data entry process.

A third kind of edit typically cross-checks data in an external file. Many states are successfully using this kind of check today. If the entry station has computer access to a driver license and motor vehicle registration file, the entry of a name or number will bring the remaining data to the screen or insert them into the file. This affords an opportunity for the entry clerk to compare the accident report information (driver age, license numbers, vehicle make and model) with the retrieved information, and to make corrections as appropriate. Similarly, location entries can be checked against roadway files to ensure that the location is in the right county or city.

In several states the accident data entry, the vehicle registration and driver licensing, and the highway engineering activities are all within a single department of transportation. When all of these groups use the same computer system it is easier to communicate among them for edit-checking. Pennsylvania's entry terminals have immediate access to detailed driver, vehicle, and roadway data. New Mexico has police, roadway, and motor vehicle files in different organizations within the state, but that state has developed an excellent digital communication system that allows the addition of vehicle and driver information to the accident data file. The license plate number may be entered at the terminal, and the VIN is retrieved from the registration file. Access for driver records is accomplished similarly.

In New York, the VIN is also retrieved from the motor vehicle registration file, keyed by the license plate number entered by the coding clerk. However, this retrieval is done in batch after a day's entries have been made. Consistency checks are made during the batch run, and discrepancies referred to another clerk for correction.

Michigan has recently adopted precoded mark-sense forms so that 80 percent of the coding is complete when the report is run through the mark-sense reader (similar to those used in educational testing programs). The remaining variables are then entered at a data entry station. A copy of an early draft of the Michigan form is shown in Figure 10. Michigan has operated this system throughout the state for more than a year, has modified it as needed based on experience, and has reported their findings through the National Safety Council's Traffic Records Forum. The impetus for this program was a need to save on data entry costs, and those operating the system are pleased with the results. On the other hand, some users observe that the rates of missing and incorrect entries have increased after the change, and argue that this has weakened their analytical capabilities considerably.

California is testing computerized input of data at four California Highway Patrol offices, and in several local agencies (Tustin in Orange County, and the sheriff's departments in Orange and Santa Clara counties). Florida has been testing digital data input by the reporting officers.

Two Ohio cities (Akron and Columbus), as well as several county sheriff's departments, now enter their accident data directly into the state's computer system. The Ohio State Police key their data into a separate system and then forward a tape to the Department of Highway Safety for addition to the general file. Altogether this external activity takes care of about 50 percent of the coding workload of the state office in Ohio. There is a similar activity in

FIGURE 9 The Irvine, California Communications Console.

Idaho (direct coding by Boise and Coeur D'Alene accounts for more than 25 percent of the state's data entry workload) and in Louisiana (where Shreveport, New Orleans, Monroe, and Lafayette forward tapes to the state).

Budget limitations in New Jersey have resulted in delays of several years in getting data entered into working files. The Office of Highway Traffic Safety has embarked on an ambitious program to clear up the backlog. This includes contracting with the state prison system to code several years' data, and laying long-range plans for a decentralized data input system.

Eighty local jurisdictions in Virginia enter accident data into PCs using programs developed by personnel at the Virginia Highway and Transportation Research Council at Charlottesville. This began with a single installation at Staunton about 10 years ago, and is now widely used. The data are not, however, presently organized for direct input to the state computer system.

Connecticut reports that they have planned (but not yet implemented) a program that would have local jurisdictions input data at PCs, sending the results to the state in digital form. Such automation is increasing, but some manual operation remains. Arkansas

AUTHORITY: 1949 PA 300, Sec. 257.622
COMPLIANCE: Compulsion Required
PENALTY: $100 and/or 90 Days

DO NOT USE

UD-10 (1-92)

COMPLAINT #

FORM ____ OF ____

ORI: MI

State of Michigan
TRAFFIC CRASH REPORT

DEPT. NAME:

DATE: MON | DAY | YEAR
TIME: MILITARY
NO. OF VEHIC.

HOW
- HEAD ON
- HEAD ON-LEFT
- ANGLE
- REAR END
- REAR END-LEFT
- REAR END-RIGHT
- SIDESWIPE-SAME
- SIDESWIPE-OPPOSITE
- OTHER

SPECIAL CIRCUMSTANCES
- DEER INVOLVED
- DEER ASSOCIATED
- SCHOOL BUS INVOLVED
- SCHOOL BUS ASSOCIATED
- HIT AND RUN
- FLEEING POLICE PURSUIT
- ____

TOTAL LANES

- FATAL (send FARS information)
- TRUCK/BUS
- CORRECT COPY
- NON-TRAFFIC EXCEPT SNOWMOBILE

WEATHER
- CLEAR
- CLOUDY
- FOG/SMOKE
- RAIN
- SNOW/BLOWING SNOW
- SEVERE WIND
- SLEET/HAIL
- OTHER/UNKNOWN

LIGHT
- DAYLIGHT
- DAWN
- DUSK
- DARK-LIGHTED
- DARK-UNLIGHTED
- OTHER/UNKNOWN

ROAD CONDITION
- DRY
- WET
- ICY
- SNOWY
- MUDDY
- SLUSHY
- DEBRIS
- OTHER

COUNTY | CITY/TOWNSHIP

IF IN CONSTRUCTION ZONE Mark one from each column
- CONST.
- MAINT.
- UTILITY
- LANE CLOSED
- OFF-ROAD
- OTHER
- ACTIVITY YES
- ACTIVITY NO

LOCATION ON
NAME: ____
____ FT MI
N S E W
NEAREST INTERSECTION: ____

RELATION TO ROADWAY
- ON ROAD
- MEDIAN
- SHOULDER
- OUTSIDE OF SHOULDER/CURB
- GORE
- UNKNOWN

AREA

SPEED LIMIT

POSTED
- YES
- NO

DRIVER OF VEHICLE 1 2 3 4 5 6 7 8 9

LICENSE NUMBER | STATE

FIRST NAME | MIDDLE | LAST

STREET:
CITY: ST: ZIP:

D.O.B. M / D / Y | SEX | LIC. TYPE O C M CY F R

C.D.L. TYPE A B C H N P T X

AMBULANCE/HOSPITAL | POS. | REST. | AIRBAG 1 2 3

EJECT | TRAP | INJURY K A B C O | CITATION Haz. Other

C.D.L. EXEMPT. FARM OTHER | MED. CARD

VEHICLE DIRECTION N S E W

C.D.L. RESTRICTIONS 28 29 30 35 36

ALCOHOL HBD YES NO

DRUGS SUSPECTED YES NO

PBT RESULTS REFUSED

HAZARD. ACTION

ACTION PRIOR TO CRASH

INS. CO.:

DRIVER OF VEHICLE 2 4 6 8 NO TRUCK/BUS

LICENSE NUMBER | STATE

FIRST NAME | MIDDLE | LAST

STREET:
CITY: ST: ZIP:

D.O.B. M / D / Y | SEX | LIC. TYPE O C M CY F R

AMBULANCE/HOSPITAL | POS. | REST. | AIRBAG 1 2 3

EJECT | TRAP | INJURY K A B C O | CITATION Haz. Other

VEHICLE DIRECTION N S E W

ALCOHOL HBD YES NO

DRUGS SUSPECTED YES NO

PBT RESULTS REFUSED

HAZARD. ACTION

ACTION PRIOR TO CRASH

INS. CO.:

COMPLAINT #

UD-10 FORM NUMBER

OVERRIDE:

INVESTIGATOR'S NAME(S)

PLEASE DO NOT WRITE OUTSIDE THIS BOX

Printed in U.S.A. More Forms by HCS 800-873-3321 A4100

FIGURE 10 The Michigan scannable accident report form.

has established a modem communication between the driver and vehicle records (in the Department of Revenue) and the accident data processing group (in the Highway and Transportation Department) but presently retrieves data only for fatal accidents because not all terminals will perform this function.

The editing procedures are well developed in NHTSA's Fatal Accident Reporting System (FARS). There is presently an effort to check VINs with software installed on the PCs used in the field—a good idea, because miscodes can be corrected more easily if caught early in the process.

Such things are getting easier to do, and it would be laudable if the NHTSA FARS developments could be made widely available to states and local jurisdictions. Consistency checks are made for location, time, and many other factors. Most of these things are learned through long experience, and it helps to be able to adjust the program as problems are detected. The present FARS coding manual is a document more than 400 pages long that provides rules for inclusion as well as inter-variable comparison checks. Figure 11 is a reproduction of one page in the FARS coding manual detailing the computer checks of light condition reports entered in connection with an accident.

Pennsylvania also has a polished edit-checking system. Figure 12 displays several excerpts from the Pennsylvania coding manual, also several hundred pages long, showing the structure of inter-variable tests that prompt the entry clerk for a better value.

As in many other tasks, training and experience are important in the data entry area. Illinois has adopted an elegant on-line training and evaluation software package for their data entry personnel. New operators are trained and scored on both the speed of entry and the number of errors. Remedial routines can be run if particular errors are noted. All operators are scored periodically to maintain their skills.

Analyzing and Tabulating the Data

Many agencies review the data for accuracy and completeness after the computer files are developed but before accident data files are released for general use. At this stage comparisons can be made with distributions from the previous month or year, and the data inspected for outliers (values outside an expected range).

Most simple distributions, such as the number of accidents by day of the week, the age and gender of involved drivers, or the road class, can be expected to remain rather stable over time. Some distributions will change with time, with rain in the summer, snow in the winter, etc. In the early days of NHTSA's FARS, one state reported no tractor-trailers in accidents for an entire year. Evidently a new coding clerk had misread the instructions, and coded them all as straight trucks. Such an error could have been discovered within a month or two if vehicle type distributions had been printed and compared from month to month.

Printing out such distributions and visually inspecting them can detect errors in the processing system. FARS has since developed a number of automatic tests, comparing such distributions from month to month and from year to year. It is possible, of course, for these distributions to change substantially, but changes like these are worth checking. The Wisconsin Department of Transportation uses a similar set of procedures, checking both manually and automatically each month and from year to year to detect discrepancies. Both of these agencies recognize that their data will be used by many to make decisions, and they do their best to ensure that they are correct.

Hardware

In the traffic accident data field there are plenty of new technologies, and more on the way. Many are too expensive to adopt for general use, and it will cost something just to experiment. Fortunately there are many trials underway. The potential for improving accuracy, coverage, timeliness, and consistency is enormous. The potential for reduced overall cost is also high.

Many of these experiments are not accompanied by research designs. While subjective evaluation is appropriate for early trials of a new device, it is important to measure effectiveness more formally so that future users can benefit.

California has used the magnetic strip drivers license to enter driver identification into a citation-writing machine. The University of Michigan is using a computerized parking violations record-keeping system (*60*). The hand-held parking computer, which has its own printer, prompts parking violations officers to type in the area or parking lot in which the violation occurred, as well as the vehicle's license plate number and expiration date. The system also enables the issuing officer to scroll through and choose the appropriate violation, automatically establishing the fine. When the data are subsequently transferred to the central computer, license plates are automatically checked against a list of persons with six or more default judgments whose cars may then be impounded.

Automation is easier to justify in the more obviously profit-making activities, but the potential for improving the accident records is real. Ultimately, these advances may be cheaper than the present manual operation, easing the officer's task and reducing the time spent in preparing reports. Many of the elements are in place already.

While there may be some failures, experimentation with pilot hardware programs should be encouraged. Presently, in one or more places in the United States there are or have been pilot programs involving the following developments:

- Global Positioning System (GPS)
- Loran-C (a low-frequency hyperbolic radio navigation system)
- Scannable accident report forms
- Pen-based computers
- PCs
- Laptop computers in the police car
- Laser disk storage and video display
- Barcodes and barcode readers
- Magnetic strips

Experimental efforts have been sponsored by federal and state agencies. In at least one jurisdiction contacted as a part of this study, confiscated drug money paid for experimental work.

Standardization

The D-16.1 and D-20.1 standards provide a basis for common data structures that states can use when revising their accident data systems. Some follow-up to study inconsistencies in applying these standards and to develop training literature is desirable.

The federal government is promoting further standardization with the CADRE and NGA data elements. Where possible, both of these are consistent with the D-16.1 and D-20.1 documents. In addition, the FARS coding methods are used (for the fatal accident file development) in all states, and the interstate sharing of FARS

A75

LIGHT CONDITION

Format: 1 numeric

Element values:

Blank
1 Daylight
2 Dark
3 Dark but Lighted
4 Dawn
5 Dusk
9 Unknown

Consistency Checks:

(A050)	1. TIME equals 0900-1600, 1699,	LIGHT CONDITION should not equal 2-5.
(A060)	2. TIME equals 2300-0400, 1699,	LIGHT CONDITION should not equal 1,4,5,9.
(220P)	3. LIGHT CONDITION equals 4 and STATE is not equal to 02,	TIME must equal 0300-0900, 0999, 9999
(220P)	4 LIGHT CONDITION equals 5 and STATE is not equal to 02,	TIME must equal 1600-2200, 2299, 9999
	or LIGHT CONDITION equals 5 and STATE equals 02,	TIME must equal 1600-2300, 2399, 9999
(A010)	5. STATE equals 02 and LIGHT CONDITION equals 4,	TIME should equal 0300-0900, 0999, 9999
(A020)	6. STATE equals 02 and LIGHT CONDITION equals 5,	TIME should equal 1600-2200, 2299, 9999

FIGURE 11 Excerpt from the FARS coding manual.

methods could be instructive to those responsible for coding all accidents.

Communication

One of the conditions necessary for quality in traffic data is for the people with various responsibilities to talk to each other. Newsletters, committees, and various informal communication forms can help.

A mechanism used within the federal government as well as within industry, to facilitate communication is the quality action team (*61,62*). Quality action teams are created to propose, implement, and monitor the steps necessary to solve long-term problems. They are expected to begin with a vision statement telling how their system should be once the problems are resolved. The team members meet periodically to (1) plan a change or test, (2) carry out a test, (3) check and study the results, and (4) act by adopting the change, abandoning the change, or by running through the cycle again under different environmental conditions. What differentiates quality action teams from most committees is that the team is composed of the people who will do the work. This structure would be useful in the accident data area that requires cooperation among many different agencies to succeed.

ERROR MESSAGE ON SCREEN:

9699 IF ACCIDENT DESCRIPTION EQUALS '0', THEN THE FIRST HARMFUL

9700 EVENT MUST BE '01' THRU '08'

EXPLANATION

• If the accident was a "rear end", or a "head on" or a "backing" or an "angle" or a "sideswipe" then there must be at least two vehicles involved in the accident and the first harmful event must b e "struck another vehicle".

ERROR MESSAGE ON SCREEN:

9701 IF ACCIDENT DESCRIPTION EQUALS '6', THEN FIRST HARMFUL

9702 EVENT MUST BE '22' THRU '49'

EXPLANATION

• If the accident was a "hit fixed object", then the first harmful event must be a fixed object.

ERROR MESSAGE ON SCREEN:

9684 IF FIRST HARMFUL EVENT IS EQUAL TO '26' OR '37', THEN

9685 LOCATION TYPE MUST EQUAL '3' OR '8'

EXPLANATION

• If the first harmful event is 26 (struck a bridge wall) or 37 (struck an overhead structure) then location type must be a 3 (bridge) or 8 (bridge and ramp).

ERROR MESSAGE ON SCREEN:

9701 IF I/I EQUALS '06', THEN PRINCIPAL AND INTERSECTING ROAD

9702 TYPES CANNOT BE 6 OR 7

EXPLANATION

• You cannot have railroad grade crossings on the Turnpike.

FIGURE 12 Excerpts from the Pennsylvania coding manual.

Feedback of compliments to the information providers may be helpful. Wisconsin has developed a sort of reward system for police officers who do a superlative job of completing the accident report forms. The group that does the coding and data entry identifies reports that are particularly well done, and provides several positive incentives to the officers involved:

(1) A commendation letter written to the officer's supervisor (Figure 13),
(2) A good-quality ball point pen with the state logo on it, which may be used to fill in the reports, and
(3) A handsome coffee cup with the Wisconsin accident report form reproduced on one side of the cup, a logo on the other (Figure 14).

The Wisconsin Department of Transportation staff believes that the recipients of these awards are proud of them, and that this award system has contributed to improved performance throughout the state.

Wisconsin Department of Transportation

DIVISION OF MOTOR VEHICLES
Traffic Accident Section
P. O. Box 7919
Madison, WI 53707-7919

FAX (608) 267-0606

DIRECT ANY INQUIRY TO:
(608) 266-1077
File No.

March 29, 1992

Chief --- ----
----- Police Department
----------, WI

Dear Chief -----:

We are writing to commend nine (9) of your officers for their fine work with investigating and reporting traffic accidents.

Last week we had the opportunity to enter some accident reports we recently received from the xxx Police Department. We were impressed with the clarity, neatness and attention to detail shown by these Officers:

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The block-style lettered or typed reports, their clear diagrams and narratives, and the care these Officers took to complete all fields on the accident report form are all products of a substantial investigative effort. In fact, their reports rank among the finest in the state.

We want you to know, too, that their devotion to duty will make significantly easier any follow-up action we will need to take in terms of data entry, accident analysis, safety responsibility and responding to public inquiries.

Please thank these nine (9) Officers for a job "well done"! If we may ever be of service to you or your Officers, please don't hesitate to call or write us.

Sincerely,

-------, Accident Entry
Traffic Accident Section
Bureau of Driver Services

FIGURE 13 The Wisconsin commendation letter.

FIGURE 14 The Wisconsin coffee cup.

It is important to keep police officers informed about the kinds of problems their data support. Several states have used or are still using newsletters, documents that are widely circulated to police agencies in the state. Several years ago, North Carolina had such a publication prepared by the Highway Safety Research Center at the University of North Carolina. Funding for this has evidently disappeared, but the Pennsylvania Department of Transportation currently distributes a quarterly newsletter, *Safety Beat*, and the New Mexico Highway Department distributes its *Traffic Safety Newsletter* six times a year.

Both of these newsletters contain a variety of news and information items. An issue of the *Pennsylvania Safety Beat* displayed in Figure 15 provides information about vehicle code updates, statistics on alcohol related accidents, a description of the program for organization vehicle license plates, letters to the editor, and more in its six-page format.

New Mexico's *Newsletter* is published cooperatively by the Highway Department and the University of New Mexico's Institute for Public Law. The issue displayed in Figure 16 contains articles discussing suits against the state, an evaluation of the effect of safety belts, and a continuing discussion of juveniles, alcohol, driving, and the law.

SafetyBeat

OCTOBER-DECEMBER 1990

Published Quarterly
by
The Center For Highway Safety

Commonwealth of Pennsylvania
Robert P. Casey — Governor
Howard Yorusalim — Secretary of Transportation

PA VEHICLE CODE UPDATES

These are some recent changes to the PA Vehicle Code.

TITLE 75

Section 1. The definition of "emergency vehicle" in section 102 of Title 75 of the Pennsylvania Consolidated Statutes is amended to read:

SS 102. Definitions.

Subject to additional definitions contained in subsequent provisions of this title which are applicable to specific provisions of this title, the following words and phrases when used in this title shall have, unless the context clearly indicates otherwise, the meanings given to them in this section:

•••

"Emergency Vehicle" – A fire department vehicle, police vehicle, sheriff vehicle, ambulance, blood-delivery vehicle, armed forces emergency vehicle, one vehicle operated by a coroner or chief county medical examiner and one vehicle operated by a chief deputy coroner or deputy chief county medical examiner used for answering emergency calls, (one private vehicle of a fire or police chief or assistant chief or, when a fire company has three or more fire vehicles, a second assistant chief, or fire police captain and fire police lieutenant or ambulance corps commander or assistant commander or of a river rescue commander or assistant commander or emergency management coordinator or fire marshal used by answering emergency calls) or any other vehicle designated by the State Police under section 6106 (relating to designation of emergency vehicles by Pennsylvania State Police) [.], or privately owned vehicle used in answering an emergency call when used by any of the following:

(1) A police chief and assistant chief.

(2). A fire chief, assistant chief and, when a fire company has three or more fire vehicles, a second or third assistant chief.

(3) A fire police captain and fire police lieutenant.

(4) An ambulance corps commander and assistant commander.

(5) A river rescue commander and assistant commander.

(6) A county emergency management coordinator.

(7) A fire marshal.

•••

Section 2. Section 4552(a) of Title 75 is amended to read:

SS 4552. General requirements for school buses.

(a) Color and identification – Every school bus shall be of a uniform color scheme and labeled "School Bus" on both front and rear as provided by regulation. Exterior labels and markings other than those specifically required or permitted by law or regulation shall be prohibited. This subsection shall not be construed to prohibit the affixation of exterior labels or stickers of a temporary nature which have been approved by the school district as having educational value and which do not obscure the "School Bus" labels.

•••

Section 3. Section 4571(d) of Title 75 is amended to read:

SS 4571. Visual and audible signals on emergency vehicles.

(d) Vehicles prohibited from using signals – Except as otherwise specifically provided in this part, no vehicle other than an emergency vehicle may be equipped with revolving or flashing lights or audible warning systems identical or similar to those specified in subsections (a) and (b).

•••

Approved – March 13, 1990

FIGURE 15 The Pennsylvania newsletter.

Traffic Safety NEWSLETTER

September/October, 1991

Published by the New Mexico Traffic Safety Bureau and the Institute of Public Law

When Refusal is a Crime

A repeat DWI offender who refuses to take a chemical BAC test at the direction of an officer is guilty of a crime in several states in the U.S.[1] In these states, the act of refusing the test carries a jail sentence and other criminal penalties. In New Mexico, refusal carries the administrative penalty of license revocation only.

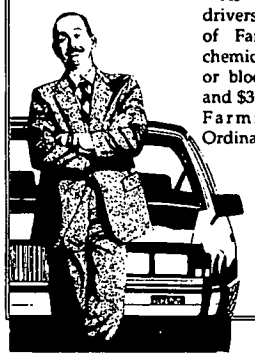
Most recently, Minnesota's Supreme Court upheld the constitutionality of that state's criminal refusal law, rejecting a driver's claim that it violated his privilege against compelled self-incrimination. This result agrees with the conclusions of other courts on this question.[2]

In *State v. Driver*,[3] the defendant challenged the constitutionality of Minnesota's refusal statute, which imposes criminal penalties on a person who refuses to submit to a BAC test if the person's license has been revoked once within the last five years, or twice or more within the past ten years. The law applied to Driver because his license had been revoked once in the past five years. Driver

(Continued on page 6)

Farmington Passes First Criminal Refusal Ordinance in New Mexico

Farmington is the first city in New Mexico to make it a crime for drivers to refuse a breath test when requested to do so by an officer who has reasonable grounds to believe they had been driving under the influence.



As of October 4, 1991, drivers stopped within the city of Farmington who refuse chemical testing of their breath or blood face 90 days in jail and $300 fine for a violation of Farmington Municipal Ordinance No. 99-962.

Elsewhere in the state the penalty for refusal is license revocation for a year, under the state Implied Consent Law.

FIGURE 16 The New Mexico newsletter.

Some states have chosen to place all of the activities associated with traffic accident data (driver and vehicle registration, roadway inventories) within a single department of transportation. Other states have these functions in separate agencies, but their systems can work just as well if they develop good communications links. There may be computer communication where appropriate, but personal communication between departments is even more important. Changes in the system should be planned by committees with all departments represented. Getting several of the principal actors (say the head of accident data processing, the analyst in the highway department who plans maintenance schedules, and the state police executive responsible for training) all in the same car pool might be unrealistic, but perhaps a quality action team composed of those individuals would be feasible.

If the data are used by people outside the state data processing agency, wider distribution of newsletters or periodical publications can be helpful. Systems that can cross-check vehicle and driver information when the accident record is made have demonstrably complete files. Many states have accomplished direct on-line communication among different computer records.

Many state data processing offices return incomplete or unreadable forms to the local police agency for interpretation. In Ohio one jurisdiction reported back to the state inquirer that the officer who put the carbon copy page in the wrong place had been duly flogged. In South Carolina, when the accident coding section had a problem getting a prompt response on returned reports, the administrator wrote a friendly letter letting the city administrators know that insurance companies would be referred directly to the city rather than being taken care of at the state level. This suggestion induced the desired improvement in reporting.

Occasionally, a local jurisdiction simply declines to participate in state data collection activities. For the most part, this is solved by communicating the needs of the state to the local jurisdiction, but in at least one case, the state has threatened to sue the local jurisdiction to force compliance.

Reporting of fatal accident cases is believed to be nearly complete, although the special handling given to fatal accidents sometimes interferes. Sometimes reports are held out of the processing chain waiting for a decision on possible prosecution, and this occasionally leads to their being omitted from the state data file (and subsequently from FARS). Several FARS analysts use clipping services or review coroners' reports to ensure that all fatal traffic accidents are included.

Promoting Use and Feedback from Users

After the accident data have been entered into computer files (and they have been carefully checked), it is important to make use of the information. Nearly all states produce annual reports that tabulate the number of accidents by type and jurisdiction. Many are doing much more than this.

California is arranging for downloads of local data sets to PCs at the local level—either by sending a disk or by downloading electronically from the state facility. Idaho has a similar program, and state personnel are providing training on a PC version of a statistical analysis program to ensure good use of their data. Many states publish reports specific to county and city government agencies and distribute them on a monthly basis. In Washington, subsets of the state data can be sent back to the counties (through a county road advisory board) so that the counties that are capable of doing so can process from floppy disks. New Mexico has provided copies of their accident data tapes to newspaper reporters who then conduct analyses using their own computers. More states are advertising their wares, and doing computer searches on request for local jurisdictions or others. Newsletters advertise the fact that the computer files are available to answer questions.

The Wisconsin state law requires that each county have a traffic safety commission that includes the county highway commissioner (or a representative), a chief county traffic law enforcement officer, the county highway safety coordinator and a representative designated by the county board from each of the disciplines of education, medicine, and law, and three representatives involved in law enforcement, highways, and highway safety designated by the secretary of transportation (*63*). This commission must meet at least quarterly to review traffic accident data from the county and other traffic safety matters. The state is required by this law to furnish each commission with traffic accident data and uniform traffic citation data for the rural, federal, state, and county highways in the jurisdiction(s) represented by each commission, which shall identify the accident rates and arrest rates on their highways, in the form prescribed by the council on traffic law enforcement, and shall also furnish a suitable map for use in spotting accidents.

Some states have developed their own processing packages, and these work well for producing standard reports. Flexible commercial statistical analysis packages have become friendlier over the years, and there are now many different programs available for PCs or Macintosh computers. Most of these provide excellent graphical output, very readable tabular information, and high-level statistics for those who know how to use them. It is not really important which analysis package is used, but it is important to have one that is flexible and permits rapid retrieval and analysis of the data.

Data problems often become apparent only to the users. The more people depend on the data, the more likely they are to complain if they find a deficiency; this is the way the system improves. In Michigan some years ago, an analyst tried to determine the number of car fires by reading narratives. Codes for fires and fuel leakage were subsequently added to the report form, but they have been deleted in the 1992 revision. Death certificate numbers were added to the FARS files because a user "complained." If the data were never used, none of these improvements would have come about.

South Carolina and other states have employees at least partly dedicated to the task of responding to queries from many users. For political subdivisions they prepare and mail monthly summaries. For academics and for industry, they will answer reasonable questions freely.

The users can help, too, by checking the data to make sure they are correct, and feeding back comments or questions when they are not. They can publish, too, and will be told by their peers when they are wrong. While such feedback may seem embarrassing, fixing the problem will be better than letting the data feed bad decisions.

Measuring the Quality of Accident Data

It is important that users of accident data be able to qualify the information with which they are working. This does not mean that the data have to be complete and free of errors. It does mean that the users should understand any limitations that the data may have.

A number of researchers, as discussed in Chapter Two, have tried to measure underreporting or consistency of reporting of

accidents. Few operational agencies have done so. NHTSA has sponsored a survey as a part of the NASS program (*23*). NHTSA also presently has several contracts to study data quality in both FARS and NASS. Some of this has been done by telephone interview, some by reviewing and reentering original accident reports (to detect problems in the coding process).

Comparing police records with subsequent interviews is difficult because people do not recall all events over moderate time periods; some people forget accident involvements within a few months. Further, respondents do not always tell the truth. A pedestrian may recall being struck by a car, but the car driver may not be able (or may not wish) to recall the incident. Respondents sometimes fabricate data, and interview designers try to build in methods to detect such aberrations.

How does a state determine completeness of coverage and accuracy? Much could be done without great cost. First, one can simply look at data from different jurisdictions to determine whether their distributions are different from what would be expected. Are injury distributions from cities of about the same population and density similar, or are they much different? Are there changes in injury distribution from year to year? Perhaps there has been a change in legislation—such as the introduction of no-fault insurance in Detroit or a requirement to have more detailed data on the accident report form in South Carolina (both discussed more fully in Chapter Two).

New Mexico is planning, although they have not yet implemented, a scoring system rating the quality of the police reports (from the coders' point of view) regarding (1) location codes, (2) readability and legibility and (3) the narrative description of the accident. The tentative plan is to add this as a field in the accident report file, and the data could be used to measure improvement over time.

Some measures of the completeness and quality are based on other existing data, such as in the northeastern Ohio study or the Netherlands study, both of which measured the correspondence between hospital records and police reports. Other possible comparisons could be made between police reports and records of tow truck operators, ambulance operators, or tape recordings of 911 calls. Such surveys would permit some estimate of the actual coverage, and thus allow the data to be qualified to the users. The present efforts in connection with the Sensitivity Index project may offer many opportunities to test the completeness of the accident data files (*58*).

The U.S. Forest Service recorded about twice as many deer-car accidents in Utah as did the traffic accident file. While it was not clear that all of the forest service accidents were reportable under state law, a follow-up with case matching could provide some measure of completeness of reporting in the police system.

Mississippi maintains a statewide record of ambulance runs created from a scannable form. The resulting computer file could be compared with the accident data file to measure the completeness of either one. This capability will be used by a Centers for Disease Control project now underway in Mississippi. More states are developing files of injury records from emergency vehicle trips or emergency departments, and comparisons may be made between these and the accident data.

Many states require driver reports in addition to the police accident report. The former are used mostly for enforcement of financial responsibility laws. In Illinois a comparison has been made of the driver and police reports by jurisdiction, and locations where police reports are fewer than 90 percent of driver reports used to be deemed ineligible for funding through NHTSA grants. This is another instance in which existing data might be used to determine completeness of coverage.

Extensive or expensive surveying to measure completeness of reporting is probably not in order. Careful planning and limited surveying is in order. A first step would be to find out whether the previous researchers, who suggest that perhaps 50 percent of the accidents satisfying the threshold are not reported, are correct in any particular jurisdiction. The producers of the data, the state authorities responsible for generating the accident files, should help their users in gaining an understanding of this aspect of the data.

How Management Can Help

Management support is the key to improvement, and management must take an interest in quality. Public use of the data should expose deficiencies, and management is likely to respond to criticism. Dedicated federal support in this area has helped in the past (in the mid 80s the CCSRS program mandated that 10 percent of the 402 funds be spent in this area) but ultimately the system has to sell itself.

Visibly successful data processing systems develop user profiles and notify interested parties when information arrives. Monthly summaries are forwarded to lower jurisdictions, tailored to their interests. Alcohol-centered reports are being generated for the general public and the media. Maryland prints out and distributes lists of locations with 10 or more alcohol-related accidents for the state police department. Local jurisdictions found out about these and asked for similar lists. Repeat users such as MADD or the local automobile club could receive updated information almost without asking. These users would have a strong voice when seeking support for funding traffic safety information.

There has been a budget squeeze in many areas. Several of the states have reported that they are unable to replace workers who leave, and must simply make do with a smaller staff. Automation seems to have the potential to reduce costs over the long run. Connecticut has recently moved from a largely manual system to a modern one; with the new system, using a computer terminal with range and logic checks, about 50 percent of the labor costs are being saved. Kansas has adopted a more modern computer system, and costs have been reduced in that state partly by using inmates at a state correctional institution for the key entry process.

Other states have a part of their data entry done by local jurisdictions, relieving the load at the state data processing office. There are mixed reports about the effect of local data entry on quality, some believing that case information can be corrected more easily if edit-checking is done there, and some believing that a better job can be done at a central processing station. There is general agreement, however, that distributed data entry, avoiding duplication of the keystroking, is more economical.

Chapter Summary

In this chapter the importance of timeliness, compliance with threshold definitions, and coverage to the quality of the accident data have been discussed. Examples of accident investigation, data processing, and communications programs in various states are provided as models for others to consider. Methods of measuring data quality and the role of management in fostering improvements were discussed.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

GENERAL CONCLUSIONS

The people working in the accident data processing field are invariably enthusiastic about their work. Many participate in the National Safety Council's Traffic Records Committee and in its forums; some have an opportunity to attend NHTSA's FARS training programs. Most continue to increase their capabilities by training, adding new equipment and software, and conducting analyses. Many of the changes have been in the direction of increased sharing of accident, driver, vehicle, and roadway data files.

In some states major upgrades in hardware and software have been the result of specialist contractor efforts. Other states have accomplished most of the change using their own personnel. The former method has the advantage of experience gained from contractor programs in other states; the latter method has the advantage that the people doing the work will stay on in their jobs when the change is introduced. Both methods have worked well.

In spite of their enthusiasm, many people in the data processing agencies who were interviewed had an inadequate understanding of the completeness and accuracy of their accident data files. Although each state has a legally defined severity threshold for reporting crashes—ranging from $50 to $1,000 in estimated repair costs, or, in at least one instance, requiring that a vehicle be towed from the scene—there is evidence of many departures from the defined standards. In most states there is little enforcement or monitoring of the coverage. Some data processing personnel interviewed were not sure of the required reporting threshold in their state. Almost no operating agencies have measured the coverage being achieved.

When data files are incomplete or inaccurate, and with the wide range of threshold values, the results of analyses of those data can lead to wrong conclusions—particularly in making comparisons between states, but also between jurisdictions within a single state. Since many of the decisions based on analysis of accident data lead to large expenditures of money, it is important to work toward higher quality data.

Police Accident Reporting

Given a properly designed accident report form, performance of the accident investigators is the next critical step. Consistent training is important, and many states provide training for local jurisdictions by giving courses at the state capital or by teaching the same material in satellite academies. Refresher training has been used profitably, as in Florida where a video tape was being prepared to instruct officers in location recording techniques. Many officers are poorly informed about the variety of users of the data they are producing; many believe they are filling out reports primarily as a service to insurance companies. States with informative newsletters or other enhanced communications help to educate the reporting officers about the value and wide usage of their data. An alternative program used in a few places hires civilian accident investigators to accomplish much of the accident reporting. By training investigators specifically for this task they have achieved excellent reporting performance; at the same time they are able to relieve the higher-salaried sworn officers for other police duties.

For national data and for statewide data, it is important to have consistent structures for accident report variables. The ANSI D-16.1 and D-20.1 standards, and the more recent CADRE and NGA variables lists provide a reference for accident report design. State report forms change infrequently, but periodically there are opportunities to modify them to conform with the standards.

Paper forms are used by all states, and modifications of the New York form, with code values and instructions around the periphery of the report pad, have been used in many other states. A new application of a development from another field is the Michigan report, using mark-sense coding to digitize the information as it is first recorded. In many other applications it has been shown that digitizing data early in the sequence minimizes subsequent transcription errors, and usually leads to higher quality data. Although no state has gone entirely to a computerized input at the field level, there are many experiments underway with laptop computers, pen-based computers, or computer consoles in the police vehicle. Generally, the experimenters view these developments favorably.

Although there have been few formal experimental evaluations, one should expect accuracy and completeness to be improved when the data are computerized close to the source—either at the scene of the crash or at the police station. Communication and computer capabilities continue to improve rapidly. The technical capability exists to enter accident data into the system directly from a police car, and to interact by radio with vehicle registration, driver records, highway files, and others.

In some states the actual reporting threshold varies from one jurisdiction to another. Although there may be a state requirement to report all crashes above a given dollar damage level, some large cities have argued that they have insufficient personnel to comply, and accident reports are completed only for the more serious crashes. The effect of this practice is to bias the state data file in many ways, and thus to weaken or distort conclusions that result from analysis of the file.

Data Processing

The CCSRS concept, discussed in detail in TRB *Circular 293* (*50*), aspires to higher quality accident data files, and to more useful analyses using those and related data. Recall that in this concept motor vehicle registration, driver licensing, road characteristic, and accident data files would be shared on-line for file-building and analysis purposes. In states where the CCSRS idea

has been pursued the data are regarded (as evidenced by use by federal and other outside agencies) as consistently more accurate and complete.

Computerized edit-checking has become much more sophisticated as computer capabilities have increased and costs decreased. Twenty or so years ago there were still many data sets being built from card decks punched with no verification. Almost without exception, today data entry involves at least range checks, and in most cases much more than that. In many states computer table look-up tests guarantee that a listed location is in the assigned jurisdiction; in other cases references to highway department records assure that reported roadside furniture exists at the locations specified in the accident report. Such checks certainly improve the quality of the file for highway department use.

There has been a trend toward data entry at the local (as opposed to the state) level. Modern digital communications systems now allow this, and there seem to be some advantages to the reporting jurisdiction coding the data. The local jurisdiction certainly has quicker access to the data, and there is a capability to recheck vehicles and scenes while entering the data. Many states have pushed this task to the local jurisdiction to save costs at the state office, and most seem to be pleased with the results. Some of the advantages of central processing are a smaller number of data entry people requiring training, and easier supervision of the process. Most states continue to use centralized data entry.

Communications and System Design

The most successful state accident data programs foster communication among all the participants in the system. Data entry clerks or data processing supervisors are encouraged to communicate with the reporting officers when they are unable to understand the reported information. Police are instructed as to how their data are used by the state. Data users, in many cases, communicate with the data producers if they recognize a problem.

Data centers need to develop a clientele. Successful state accident data processing systems provide data automatically to counties, cities, and other clients whose interest in particular data has been identified.

The communication of data required for input editing of the accident cases is important to quality. Even though computers are of different types, it is often possible to develop interfaces that will permit data to be shared on line. In other cases the checks are made after the fact by passing batch information from one computer to another by tape. In one case (Washington) the data are all converted from their original form into a common form in a separate agency. Capabilities provided by such digital communication include correction of vehicle identification, recording of VINs in the accident file, immediate updating of driver records, and a check of vehicle ownership and road characteristics as the accident data are being entered.

Location systems for accident reporting have been developed in different ways in various states. Recently the combination of a satellite-based navigation system (GPS) and an emphasis on rectilinear coordinate recording (GIS) offers hope for more standardization in this area. Many states are using these techniques experimentally, and hardware developers are bringing the production cost of equipment down.

Analysis and Publication

Computerized accident data files are similar to files resulting from scientific interviews. The accident event corresponds to a respondent, and the items on the accident report correspond to the answers given to interview questions. There are many suitable statistical analysis packages available for such data, both for PCs and mainframe applications.

There is a wide range of publication methods. Some states do nothing except to print an annual report; a few states have occasionally failed to do that when other activities take priority. Others publish tailored reports monthly and distribute them to local jurisdictions, safety organizations and news media. California has a strong research group in the Department of Motor Vehicles that makes use of the accident data and publishes widely.

Many states have working arrangements with state universities or other local academic groups, and the combination of research talent and data of good quality leads to many analyses and publications. The University of New Mexico's Institute for Public Law works closely with the state office responsible for compiling the accident data. In North Carolina, the Highway Safety Research Center at the University of North Carolina has provided analytical and design support to the Department of Motor Vehicles and others. Transportation engineering faculty and staff members at the University of California have worked closely with the California Highway Department in analyzing and interpreting accident data. Many university civil engineering departments have formal or informal relationships with the corresponding state agencies. These interactions are important because they lead to usage of the data, and, through feedback, higher quality data.

RECOMMENDATIONS

Operating Systems

Those responsible for state accident data files should develop an understanding of their coverage and compliance with threshold, including information about the kinds of biases that result from any deficiencies. Evidence from those who have done research in this area indicates many biases: underreporting of certain age groups, variation in threshold from one jurisdiction to another, and inconsistencies in reporting injury information. Users need to understand such limitations so they may properly interpret the data.

There seem to be no standard methods for testing for coverage, compliance, and bias, and this may not be easy. Nevertheless, the value of understanding the quality of the data is worth some effort. The methods used in the northeastern Ohio hospital study might be emulated (*26*). Alternatively, it may be possible to review records external to the state system (such as towing company files) to count accidents that should have been reported but were not. In some jurisdictions it may be possible to compare insurance claims against reported accidents. Trauma registries are being developed in many states, and the completeness of the accident files may be tested by comparing the accident data with such registries.

This knowledge (of coverage and threshold) is important to those who use the data. If it is determined that the coverage varies with jurisdiction, driver characteristics, or other factors it may not be practical to change the system rules to make jurisdictions more alike. Nevertheless, those using the data should be informed as to what the data truly represent. Analysts should consider what the

effects of such variation are, and should discuss the effects on their results.

Some who make the data publicly available by publishing tabulations, providing tapes to NHTSA, FHWA, or others, append comments regarding the quality of the files. At least one state has declined to release its accident data files without knowing how the recipient plans to use them, and is prepared to point out shortcomings of the data to the prospective users. This is commendable. For those who release their data for general use, it is even more important that the users be informed.

The data are typically more complex than they appear, and the indiscriminate application of sophisticated statistical programs can lead to unwarranted conclusions. This is particularly true when the effect of a change is being evaluated. Examples of the use and misuse of statistics—a too-small sample size, regression to the mean, lack of a control group, random significance in multiple comparisons, interference by other variables—are discussed in a paper by O'Day et al. (*64*). While this report was mainly concerned with seat belt use, the statistical principles have wide application.

RESEARCH NEEDS

Introductory Statement

Chapter Two cites examples of efforts to determine coverage, and to determine the accuracy with which reporting officers complete their reports. Pilot or demonstration studies in this area might be sponsored by federal agencies (NHTSA or FHWA), or by state governments.

Many of the novel accident data collection and processing changes currently being pursued deserve to be evaluated by carefully designed experiments. A hoped-for output of this synthesis was a tabulation of "proven" techniques for improving accident data quality. Of the many trials of new hardware, most have been evaluated only subjectively. There are potential measures of increase in quality that result from new hardware or software—such as how well the data collection system matches the intended threshold, what percentages of accidents have geographic location information, or how the accident file compares with a hospital-based injury file. Before committing to statewide or nationwide implementation of a program, it is important to be able to predict success with a high degree of probability. Carefully designed and implemented evaluations would be helpful.

The results of such evaluations should be shared with other states by contributing reports and papers discussing the measurement of data quality to such forums as the NSC's Traffic Records Committee summer meeting or the TRB annual meeting. Such reports should be encouraged by the concerned federal agencies, the NSC, TRB's Traffic Records and Accident Data Analysis Committee, and the American Statistical Association's Transportation Statistics Committee.

Better Definition of Code Values and Variables

Suggested formats for reporting accident information have been promulgated by the ANSI D-16.1 and D-20.1 reports, and more recently by the CADRE report (for NHTSA's "critical" variables) and the NGA report (for heavy vehicle accident involvements). Although these reference documents provide brief definitions of such variables as injury, accident cause, and vehicle description, they stop short of providing training documents to make all responses comparable.

The police injury scale (KABC0) seems to be interpreted differently in different parts of the country, and, to some extent, in different parts of individual states. The effect of this variation is to confuse the results when data are aggregated over more than one jurisdiction. This is a particular problem both in aggregating multistate data at the federal level (as in the NASS-GES, NASS-CDS, and the FARS), and in aggregating data over a state. A few states use alternatives to the KABC0 injury scale, and both FHWA and NHTSA have devised techniques for translating these to a common form for multistate files. There has been little attention, however, to the problem of the varied interpretation of the injury levels. This is a serious limitation to data quality, and injury statistics based on police data will continue to be of limited value until this problem is addressed and solved. The NSC's Traffic Records Committee has (as of 1992) appointed a working sub-committee to consider the injury reporting scale. At the very least new training materials should be considered to promote consistency in injury reporting.

There are evidently other variables with reporting inconsistencies. The coding of vehicle defects, shown in Figure 1 of this synthesis, demonstrates that states are far from identical in their coding of this factor. Factual data such as driver age, vehicle identification (when the VIN is derived from registration files), date and time of the crash are evidently consistently and accurately reported. Many other variables—road classification, whether or not drinking is evident in the accident, number of persons present, vehicle damage, and causation factors—all deserve to be reviewed.

The lead in reporting variables more consistently could be taken by any of several groups. NHTSA might pursue this problem as a supplement to the CADRE effort. Other agencies might continue to review appropriate parts of the accident report—FHWA (for road-related variables), the International Association of Chiefs of Police (for accident causation variables), and the American Association of Motor Vehicle Administrators (for factors related to registration). The NSC's Traffic Records Committee has had success in the past in encouraging states to adopt standards voluntarily. The committee might furnish the environment for continued studies and agreements regarding data quality. It has the advantages of broad representation as well as a history of fostering standardization. The members of this committee are active participants in the quest for quality in accident data. They have proposed a national agenda with quality as a leading topic and have also initiated an informative newsletter that is widely distributed in the traffic records community (*65*).

Promoting the Use of Accident Data

There are many unanswered questions about the long-term value of more computerization in the accident data field. The future cost of computer equipment (for example, laptops for initial data entry in the field) and the ultimate value of more timely processing need to be estimated and compared.

Accident data can be of great value if they are used intelligently. A potentially profitable use of the accident data file occurred in Michigan where the VINs in the accident data were cross-checked against the stolen vehicle file.

In New Mexico, officials from about 20 government agencies

and businesses meet periodically in committee to consider how each of them might make use of the available accident data. The committee includes representatives of New Mexico Medicaid, New Mexico State Police, New Mexico Department of Health, FHWA, the Division of Government Research at the University of New Mexico, emergency medical services, health plans, insurance companies, and representatives of several cities. One result—access to the accident data files permitted a medical insurer to subrogate the automobile insurance companies for medical costs that had been paid. The amount recovered in one year was on the order of a million dollars, and it was estimated that about $29.00 was recovered for each dollar invested in the data analysis and billing process. Another result was a pilot project with the state police allowing the law enforcement community to receive video images (faxes) of accident reports without human intervention. Other potential users are being encouraged to discover profitable uses for these data.

Satisfied customers can constitute a solid support group arguing for funding to maintain high quality in the accident data. Such a committee activity might well be emulated by most states.

REFERENCES

1. *Accident Facts 1990 Edition*, National Safety Council, Chicago, Illinois (1991).
2. *Truck Accident Study,* Ernst & Ernst, Cleveland, Ohio (1968), 77 pp.
3. Highway Safety Act of 1966.
4. Briggs, D. W. and B.V.Chatfield, *NCHRP Synthesis of Highway Practice 133: Integrated Highway Information Systems*, Transportation Research Board, National Research Council, Washington, D.C. (1987) p. 4.
5. *Critical Automated Data Reporting Elements*, Docket No. 90-07 Federal Register, Volume 57, No. 8, Monday, January 13, 1992, p. 1302.
6. *CADRE: Critical Automated Data Reporting Elements for Highway Safety Analysis*, Report of the National Safety Council's CADRE Task Force, May 31, 1991.
7. *Manual on Classification of Motor Vehicle Traffic Accidents*, Fifth Edition, ANSI D-16.1, October 1989.
8. *States' Model Motorist Data Base Data Element Dictionary for Traffic Records Systems*, ANSI D-20.1 (1979).
9. National Governors' Association, "Uniformity in Motor Carrier Accident Reporting: Recommendations for the States," National Governors' Association Center for Policy Research, June 1988.
10. Intermodal Surface Transportation Efficiency Act of 1991.
11. *FARS Coding and Validation Manual, 1991*, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, Washington, D.C. (1991).
12. "Motor Vehicle Accident Severity," FHWA Internal Publication HHS-12, July 6, 1992.
13. "Occupant Assessment Form," NHTSA's Internal Publication OA34, Variable Name: Injury Severity (Police Rating), undated.
14. Kish, Leslie, *Survey Sampling*, J. Wiley, New York (1965).
15. Cochran, W. G., *Sampling Techniques*, J. Wiley, New York (1963).
16. Cochran, W. G., "Historical Perspective," Chapter 2 of *Incomplete Data in Sample Surveys*, Copyright by Academic Press, Inc. (1983).
17. Scott, R. E. and P. S. Carroll, *Acquisition of Information on Exposure and on Non-Fatal Crashes, Volume II: Accident Data Inaccuracies,* Highway Safety Research Institute, University of Michigan, May 1971.
18. *A Report on the Washington Area Motor Vehicle Accident Cost Study*, Wilbur Smith and Associates, U.S. Bureau of Public Roads Report PB 173859, 1966.
19. Zylman, R., "Drivers' Records: Are They a Valid Measure of Driving Behavior?" *Accident Analysis and Prevention*, Vol. 4, No. 4 (Dec 1972) pp. 333-349.
20. Chipman, M., "Motor Vehicle Accident Fatality Statistics: An Investigation of Reliability," *Canadian Journal of Public Health*, Vol. 74, No. 6 (Nov-Dec 1983) pp. 381-385.
21. Maas, M.W. and S. Harris, "Police Recording of Road Accident In-Patients-Investigation into the Completeness, Representativity and Reliability of Police Records of Hospitalized Traffic Victims," *Accident Analysis and Prevention,* Vol 16, No. 3 (June 1984) pp. 167-184, UMTRI-55689.
22. Hauer, E. and A.S. Hakkert, Extent and Some Implications of Incomplete Accident Reporting, in *Transportation Research Record 1185, Transportation Research Board, National Research Council, Washington, D.C.* (1988) pp. 1-10.
23. Greenblatt, J., M. B. Merrin, D. Morganstein and S. Schwartz, *National Accident Sampling System Nonreported Accident Survey*, U.S. Department of Transportation, National Highway Traffic Safety Administration DOT HS-806198 (November 1981).
24. Fife, D., "Matching Fatal Accident Reporting System cases with National Center for Health Statistics motor vehicle deaths," *Accident Analysis & Prevention,* Vol. 21, pp. 79-83 (1989).
25. Fife, D. and R. Cadigan, "Regional Variation in Motor Vehicle Accident Reporting: Findings From Massachusetts," *Accident Analysis & Prevention*, Vol. 21, pp. 193-196 (1989).
26. Barancik, J. I. and D. Fife, "Discrepancies in Vehicular Crash Injury Reporting: Northeastern Ohio Trauma Study IV," *Accident Analysis and Prevention*, Vol. 17, No. 2 (1985) pp. 147-154.
27. McGuire, F. L., "The Nature of Bias in Official Accident and Violation Records," *Journal of Applied Psychology*, Vol. 57, pp. 300-305 (1973).
28. Laberge-Nadeau, C., R. Bourbeau, J. Granger "An epidemiological approach to road crashes and injuries in Quebec: nature, severity, direct costs, data quality and record linkage." Montreal University, Quebec, Canada/Ecole Polytechnique, Montreal, Quebec, Canada. 326 p. (1983).
29. O'Day, J., P. Gimotty, R. Kaplan, L. Huang, B. Bertram, K. Campbell, *Analysis of the National Crash Severity Study Data, Interim Report*, Report No. UM-HSRI-78-63, Highway Safety Research Institute, University of Michigan, Ann Arbor, 208 p. (1978).
30. Pendleton, O. J., N. J. Hatfield, and R. Bremen, Alcohol Involvement in Texas Driver Fatalities: Accident Reporting versus Blood Alcohol Concentration, in *Transportation Research Record 1068* (1986) pp. 65-70.
31. Partyka, S. C., "Serious Head Injury in Light Passenger Vehicles from Rail, Header, and Pillar Contact," Office of Vehicle Safety Standards, Rulemaking, National Highway Traffic Safety Administration, June 27, 1991.
32. Zegeer, C.V., *NCHRP Synthesis of Highway Practice 91: Highway Accident Analysis Systems*, Transportation Research Board, National Research Council, Washington, D.C. (July 1982).
33. Federal Highway Administration, *Evaluation of the Highway-Related Safety Program Standards*, U.S. Department of Transportation, Washington, D.C. (1977).
34. "Vehicle Damage Scale for Traffic Accident Investigators," National Safety Council (1984).
35. Griffin, L. I., "Bias in the TAD severity scale," Highway Safety Research Center, Chapel Hill, North Carolina, 53 pp. (1973).
36. O'Day, J., M. J. Compton, R. J. Kaplan, and P. A. Ruschmann, *Data Sources to Support the NHTSA Defects Investigation*

System, Final Report, Highway Safety Research Institute, Ann Arbor, Michigan, Report No. DOT/HS 803 531, 138 p. (1978).

37. Douglass, R. L., "The Operational Meaning of Reported Alcohol Involvement in Official State Accident Data: A Comparative Analysis," Highway Safety Research Institute, Systems Analysis Group, Ann Arbor, Michigan, 6 p. *HIT Lab Reports*, Vol. 4, No. 9 (May 1974) pp. 1-6.
38. Douglass, R. L. and L. D. Filkins, "Empirical Development of a Surrogate Measure of Alcohol Involvement in Official Accident Data," Highway Safety Research Institute, Systems Analysis Group, Ann Arbor, Michigan, 5 p. *HIT Lab Reports*, Vol. 4, No. 9 (May 1974) pp. 7-11.
39. Taylor, W. C. and S. Malik, "Accident Datafile Accuracy," Michigan State University, College of Engineering, East Lansing, 10 pp. (1987).
40. Shinar, D., J. R. Treat and S. T. McDonald, "The Validity of Police Reported Accident Data," *Accident Analysis and Prevention*, Vol. 15, No. 3 (June 1983) pp. 175-191.
41. Campbell, B. J. and J. McLean, "Collection and Analysis of Collision Data for Determining the Effectiveness of Some Vehicle Systems," University of North Carolina Highway Safety Research Center, Prepared for the Motor Vehicle Manufacturers of the United States, Inc. (1972).
42. Hutchinson, J. W. and T. W. Kennedy, "Use of Accident Records in Highway Research," *Highway Research News*, No. 13 (June 1964) pp. 1-8.
43. Figgers, R. and C. E. Nash, "Accurately Reporting Belt Use in Automobile Crashes," *Police Chief*, Vol. 56, No. 7, p. 50 (July 1989).
44. Partyka, S. C., "Differences in Reported Car Weight Between Fatality and Registration Data Files," *Accident Analysis and Prevention*, Vol. 22, pp. 161-166 (1990).
45. Sivak, M. and J. O'Day, "Survey Concerning International Computer Files of Road Accidents," *Accident Analysis and Prevention*, Vol. 20, No. 66, pp. 459-463 (1988).
46. "Pennsylvania Accident Record System Analysts Coding Guide," Pennsylvania Department of Transportation, Center for Highway Safety, Accident Information Systems Division, September 27, 1988.
47. Loukissas, P. and J. Mace, *Conversion of Pennsylvania Accident Data to Account for Change in Reporting*, Pennsylvania Transportation Institute, University Park, 88 pp. Report No. PTI-8219 (1982).
48. Hargroves, B. T. and J. M. Hargroves, *Accuracy of Virginia Accident Data*, Virginia Highway and Transportation Research Council, Charlottesville, 93 pp. Report No. VHTRC-82-R13 (1982).
49. Abkowitz, M. D., "Availability and Quality of Data for Assessing Heavy Truck Safety," *Transportation Quarterly*, Vol. 44, No. 2, pp. 203-239 (April 1990).
50. Chatfield et al., *Transportation Research Circular 293: Introduction to Comprehensive Computerized Safety Recordkeeping Systems (CCSRS)*, Transportation Research Board, National Research Council (July 1985).
51. Smith, K. W., R. U. Anderson and J. W. Davis, "An Implementation of CCSRS," Division of Government Research, Institute for Applied Research Services, University of New Mexico (January 1986).
52. *SAS User's Guide: Basics, Version 5 Edition*, SAS Institute, Inc., Cary, North Carolina, 1290 pp. (1985).
53. Transportation Research Board, "Study Report of Methods to Improve the Application of State Traffic Records Systems, Phase 1 and Phase 2 Reports," National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, D.C. (September 1987).
54. Heath, W. M., "California Tank Truck Accident Survey, February 1, 1980 to January 31, 1981," California Highway Patrol, Enforcement Services Division (December 1981).
55. Council, F. M., "Selection of Participating States for the Highway Safety Information System, Task C Technical Memo," Highway Safety Research Center, University of North Carolina (September 1988).
56. "Guidebook for the Michigan State Data Files," Highway Safety Research Center, University of North Carolina, Federal Highway Administration, Washington, D.C. (January 1990) (Similar books have been prepared for the other states listed).
57. "Assessing State Accident Data Using SAS," National Center for Statistics and Analysis, U. S. Department of Transportation, National Highway Traffic Safety Administration, undated (but probably 1991).
58. Johnson, S. W. and E. VanSciver, "Sensitivity Index Demonstration Project", National Association of Governors Highway Safety Representatives, supported by a grant from NHTSA (1991).
59. *IIHS Status Report*, Vol 27, No. 1, January 25, 1992, p. 3.
60. "High Tech Comes to Parking Violations," *The University Record*, Ann Arbor, Michigan, April 6, 1992.
61. *Guidelines for Establishing and Operating Quality Action Teams*, FHWA-FL-91-005, Federal Highway Administration, Washington, D.C.
62. "Federal Express: Employees Eliminate Problems Instead of Fighting Fires," *Business Marketing*, Vol. 75 Issue 2 (February 1990) pp. 40,42.
63. "County Traffic Safety Commissions," *Wisconsin Statutes* 89-90, County Highways Section, Article 83.013.
64. O'Day, J., M. Sivak, A. C.Wagenaar, and J. E. Haney, "Seat-Belt Laws: Traps to Avoid in Evaluation Studies," *The UMTRI Research Review*, Volume 16, No. 1 (July-August 1985).
65. EXCHANGE, a Newsletter of the National Safety Council's Traffic Records Committee, Vol 1, No. 3, Chicago, Illinois (March 1992).

GLOSSARY

402 funds: NHTSA grants to states, usually for highway safety pilot programs

ANSI: American National Standards Institute

CADRE: Critical Automated Data Reporting Elements for Highway Safety Analysis

CCSRS: Comprehensive Computerized Safety Recordkeeping Systems (pronounced scissors)

D-16.1: ANSI Standard "Manual on Classification of Motor Vehicle Traffic Accidents"

D-20.1: ANSI Standard "States' Model Motorist Data Base Data Element Dictionary for Traffic Records Systems"

DMV: Department of Motor Vehicles

FARS: Fatal Accident Reporting System

FHWA: Federal Highway Administration

GIS: Geographic Information System

GNP: Gross National Product

GPS: Global Positioning System

HSIS: Highway Safety Information System (FHWA)

IHIS: Integrated Highway Information Systems

IIHS: Insurance Institute for Highway Safety

ISTEA: Intermodal Surface Transportation Efficiency Act of 1991

KABC: A subset of KABC0 with the non-injuries missing

KABC0: The usual police report injury scale

K = Killed
A = Severe Injury
B = Moderate Injury
C = Minor Injury
0 = No Injury

Loran-C: A ground based low frequency hyperbolic radio navigation system.

MADD: Mothers Against Drunk Driving

MALI: Michigan Accident Location Index

MCMIS: Motor Carrier Management Information System

NAGHSR: National Association of Governors' Highway Safety Representatives

NASS: National Accident Sampling System

NASS/CDS: NASS Crashworthiness Data System

NASS/GES: NASS General Estimates System

NCSS: National Crash Severity Study

NGA: National Governors' Association

NHTSA: National Highway Traffic Safety Administration

NSC: National Safety Council

PC-SAS: A version of the SAS statistical package for use on a PC

PC: Personal Computer

PDO: Property Damage Only

PENNDOT: Pennsylvania Department of Transportation

rms: root mean square

SAS: Statistical Analysis System, a software package for data analysis

STEP: Selective Traffic Enforcement Programs

SWITRS: Statewide Integrated Traffic Records System

TAD: Traffic Accident Data

TRB: Transportation Research Board

TRC: Traffic Records Committee (of the NSC)

TRIS: Transportation Research Information Service

UDOT: Utah Department of Transportation

UMTRI: University of Michigan Transportation Research Institute

VIN: Vehicle Identification Number

APPENDIX A
LIST OF CONTACTS

Nearly every state has a program to improve its capabilities in accident data collection and data processing. Although there may be activities in several different departments within a state (transportation, police, finance, etc.) the governor's highway safety representative can almost always refer inquiries to the proper office.

A recent list (October 1992) has been provided by the National Association of Governors' Highway Safety Representatives, and it is correct for telephone numbers and office addresses at that time. The offices are considered relatively permanent. Because they may change frequently, the names of individuals are not provided in this list.

ALABAMA
Department of Economic and Community Affairs
Montgomery, AL 36103-5690
P.O. Box 5690, 401 Adams Avenue
Montgomery, AL 36105-2399
PHONE: 205-242-5100
FAX: 205-242-5515

ARIZONA
Governor's Office of Hwy. Safety
3010 N. Second Street, Suite 105
Phoenix, AZ 85012
PHONE: 602-255-3216
FAX: 602-255-1265

ARKANSAS
Highway Safety Program
Highway and Transportation Dept.
P.O. Box 2261
11300 Baseline Road
Little Rock, AR 72203
PHONE: 501-569-2648
FAX: 501-455-1978

CALIFORNIA
Office of Traffic Safety
Business, Transportation, and Housing Agency
7000 Franklin Blvd., Suite 440
Sacramento, CA 95823
PHONE: 916-445-0527
FAX: 916-324-9606

COLORADO
Office of Transportation Safety
Colorado Dept. of Transportation
4201 East Arkansas Avenue
Denver, CO 80222
PHONE: 303-757-9381
FAX: 303-757-9439

CONNECTICUT
Transportation Highway Safety
Office of Highway Safety
Department of Transportation
P.O. Box Drawer A
24 Wolcott Hill Road
Wethersfield, CT 06109-0801
PHONE: 203-666-4343
FAX: 203-666-1270

DELAWARE
DE Office of Highway Safety
1441 N. DuPont Highway
Dover, DE 19901
PHONE: 302-739-4475
FAX: 302-739-5613

FLORIDA
Dept. of Transportation
Office of Highway Safety
605 Swannee Street, MS 17
Tallahassee, FL 32399-0405
PHONE: 904-488-5455
FAX: 904-922-2935

GEORGIA
Office of Highway Safety
Equitable Building
100 Peachtree Street, Suite 2000
Atlanta, GA 30303
PHONE: 404-656-6996
FAX: 404-651-9107

IDAHO
Office of Highway Safety
Idaho Transportation Dept.
P.O. Box 7129
3311 West State Street
Boise, ID 83707-1129
PHONE: 208-334-8101
FAX: 208-334-3858

ILLINOIS
Bureau of Safety Programs
Department of Transportation
P.O. Box 19245
3215 Executive Park Drive
Springfield, IL 62794-9245
PHONE: 217-782-4974
FAX: 217-782-9159

INDIANA
Public Safety & Drugs, Governor's Office
Room 206, State House
Indianapolis, IN 46204
PHONE: 317-232-2588
FAX: 317-232-3443

IOWA
Governor's Traffic Safety Bureau
Department of Public Safety
307 East 7th Street
Des Moines, IA 50319-0248
PHONE: 515-281-3907
FAX: 515-281-6190

KANSAS
Traffic Safety Administrator
Office of Traffic Safety
Thacher Building, 2nd Floor
217 S.E. 4th
Topeka, KS 66603
PHONE: 913-296-3756
FAX: 913-296-0963

KENTUCKY
Highway Safety Branch
Kentucky State Police Headquarters
919 Versailles Road
Frankfort, KY 40601
PHONE: 502-695-6356
FAX: 502-564-6615

LOUISIANA
Highway Safety Commission
Department of Public Safety
P.O. Box 66336
Baton Rouge, LA 70896
PHONE: 504-925-6991
FAX: 504-922-0083

MAINE
Bureau of Highway Safety
Department of Public Safety
Station #42
Augusta, ME 04333
PHONE: 207-624-8756

MARYLAND
Office of Traffic & Safety
State Highway Administration
7491 Connelley Drive
Hanover, MD 21076
PHONE: 410-787-7697
FAX: 410-553-6399

MASSACHUSETTS
Governor's Highway Safety Bureau
100 Cambridge Street, Room 2104
Saltonstall State Office Bldg.
Boston, MA 02202
PHONE: 617-727-5073
FAX: 617-727-5077

MICHIGAN
Office of Highway Safety Planning
300 South Washington Square
Knapps Center, Suite 300
Lansing, MI 48913
PHONE: 517-334-5200
FAX: 517-482-8236

MINNESOTA
Office of Traffic Safety
Department of Public Safety
207 Transportation Building
395 John Ireland Boulevard
St. Paul, MN 55155
PHONE: 612-296-3804
FAX: 612-297-5728

MISSISSIPPI
Highway Safety Office
Division of Public Safety Planning
Department of Public Safety
301 West Pearl Street
Jackson, MS 39203-3088
PHONE: 601-949-2225
FAX: 601-960-4263

MISSOURI
Division of Highway Safety
Department of Public Safety
P.O. Box 104808, 1719 Southridge
Jefferson City, MO 65110-4808
PHONE: 314-751-7643
FAX: 314-634-5977

MONTANA
Highway Traffic Safety
Department of Justice
303 North Roberts
Helena, MT 59620
PHONE: 406-444-3412

NEBRASKA
Office of Highway Safety
Department of Motor Vehicles
P.O. Box 94612
301 Centennial Mall South
Lincoln, NE 68509-4789
PHONE: 402-471-2515
FAX:402-471-9594

NEVADA
Highway Safety Coordinator
Office of Traffic Safety
Department of Motor Vehicles and Public Safety
555 Wright Way
Carson City, NV 89711-0999
PHONE: 702-687-5720
FAX: 702-687-5328

NEW HAMPSHIRE
Highway Safety Agency
Pine Inn Plaza
117 Manchester Street
Concord, NH 03301
PHONE: 603-271-2131
FAX: 603-271-3790

NEW JERSEY
Division of Highway Traffic Safety
Dept. of Law & Public Safety, CN 048
Trenton, NJ 08625
PHONE: 609-588-3750
FAX: 609-588-7716

NEW MEXICO
Traffic Safety Bureau
Highway & Transportation Dept.
P.O. Box 1149
Santa Fe, NM 87504-1149
PHONE: 505-827-0427
FAX: 505-827-0431

NEW YORK
Governor's Traffic Safety Cmte.
Swan St. Bldg., Empire State Plaza Swan St.
Albany, NY 12228
PHONE: 518-474-3135
FAX: 518-473-0041

NORTH CAROLINA
Governor's Highway Safety Program
Governor's Hwy. Safety Rep.
215 East Lane Street
Raleigh, NC 27601
PHONE: 919-733-3083
FAX: 919-733-0604

NORTH DAKOTA
Driver Licensing & Traffic Safety
Department of Transportation
608 East Boulevard Avenue
Bismarck, ND 58505-0700
PHONE: 701-224-2600
FAX: 701-224-4545

OHIO
Department of Highway Safety
P.O. Box 7167
240 Parsons Avenue
Columbus, OH 43266-0563
PHONE: 614-466-3383 or 2550
FAX:614-466-0433

OKLAHOMA
Governor's Representative
Oklahoma Highway Safety Office
3223 N. Lincoln
Oklahoma City, OK 73105
PHONE: 405-521-3314
FAX: 405-378-2524

OREGON
Traffic Safety Division
Department of Transportation
400 State Library Building
Salem, OR 97310
PHONE: 503-378-3669
FAX: 503-378-8445

PENNSYLVANIA
Director, Center for Hwy. Safety
Department of Transportation
215 Transportation & Safety Bldg. 1200
Harrisburg, PA 17120
PHONE: 717-787-7350
FAX: 717-783-8217

RHODE ISLAND
Governor's Office of Hwy. Safety
345 Harris Avenue
Providence, RI 02909
PHONE: 401-277-3024
FAX: 401-277-3942

SOUTH CAROLINA
Office of Highway Safety Programs
Division of Public Safety
1205 Pendleton Street, Rm. 412
Columbia, SC 29201
PHONE: 803-734-0421
FAX: 803-734-0486

SOUTH DAKOTA
Office of Highway Safety
Dept. of Commerce & Regulation
118 West Capitol Avenue
Pierre, SD 57501
PHONE: 605-773-3675
FAX: 605-773-5825

TENNESSEE
Highway Safety Office
Department of Transportation
505 Deaderick Street, Suite 600
James K. Polk State Office Bldg.
Nashville, TN 37243-0341
PHONE: 615-741-2589
FAX: 615-741-2508

TEXAS
Traffic Operations Engineer
Department of Transportation
125 E. 11th Street, D-18STO
Austin, TX 78701-2483
PHONE: 512-416-3206
FAX: 512-416-3161

UTAH
Highway Safety Office
Department of Public Safety
4501 South 2700 West
Salt Lake City, UT 84119
PHONE: 801-965-4401
FAX: 801-965-4969

VERMONT
Highway Safety Program
Governor's Hwy. Safety Program
133 State Street
Montpelier, VT 05633
PHONE: 802-828-2665
FAX: 802-828-2098

VIRGINIA
Deputy Commissioner
Transportation Safety
Department of Motor Vehicles
P.O. Box 27412
2300 West Broad Street
Richmond, VA 23269
PHONE: 804-367-6614
FAX: 804-367-6631

WASHINGTON
Washington Traffic Safety Commission
1000 South Cherry Street, MS/PD-11
Olympia, WA 98504
PHONE: 206-753-6197
FAX: 206-586-6489

WEST VIRGINIA
Highway Safety Coordinator
Criminal Justice and
Highway Safety Office
1204 Kanawha Boulevard, East
Charleston, WV 25301
PHONE: 304-558-8814
FAX: 304-558-0391

WISCONSIN
Office of Transportation Safety
Department of Transportation
P.O. Box 7910
4802 Sheboygan Avenue, Suite 809
Madison, WI 53707-7910
PHONE: 608-266-0402
FAX: 608-267-0441

WYOMING
State Highway Safety Engineer
Highway Safety Program
Wyoming Transportation Department
P.O. Box 1708
Cheyenne, WY 82003-1708
PHONE: 307-777-4450
FAX: 307-777-4250

THE TRANSPORTATION RESEARCH BOARD is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. It evolved in 1974 from the Highway Research Board, which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 270 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

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The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce Alberts and Dr. Robert M. White are chairman and vice chairman, respectively, of the National Research Council.

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

ADDRESS CORRECTION REQUESTED

000021-05
Robert M Smith
Research & Asst Matls Engr
Idaho Transportation Dept
3311 W State St
P O Box 7129