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MANAGEMENT OF ACCIDENT DATA SYSTEMS

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Report of a Workshop Sponsored by the Committee on Planning and Administration of Transportation Safety of the Transportation Research Board, held in Kings Island, Ohio, August 4-6, 1981.

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PREFACE

This summary of conference proceedings reflects, as objectively as possible, the views expressed by the participants. The views presented, therefore, are not necessarily those of any one of the participants but, rather, a summary of the points presented by the group.

A final section contains edited versions of the papers presented by each conference speaker. Due to length constraints, it was necessary to omit detailed discussions of the various computer programs used for data analysis. Complete documentation for each program presented is available from the specific conference paper authors.

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SUMMARY

Accident statistics and safety-related data have traditionally been used to answer three basic questions: What are the problems? What are the solutions and do the solutions work? Consequently, the major focus of the problem identification process has been on determining who is involved in accidents, where accidents happen, and why they occur.

Despite the large sums of money that have been spent to develop programs to answer these questions, the accident rate on our nation's highways remains one of the major health and economic problems in the United States today.

Highway safety agencies are now faced with another problem: Funding levels for FY 1982 have been drastically reduced. As a result, highway safety programs must now be developed not only to use accident data to meet safety goals, they must also produce tangible results and at the same time focus limited dollars in the areas where they will do the most good.

In response to the need to explore this important area, the Transportation Research Board conducted a national conference sponsored by the National Highway Traffic Safety Administration (NHTSA) and the Federal Highway Administration (FHWA) to define the state of the art and discuss techniques for using data to identify safety problems and evaluate programs and countermeasures to alleviate these problems.

Conference participants represented federal and state groups and private consultants concerned with highway safety programs. While a variety of views and opinions were expressed, the following basic questions were clearly of concern:

- Do current data-collection techniques produce usable information?
  - What procedures are states using to collect data?
  - What problems are they facing?
  - What problems result from the conflicting needs of various groups who use the data?
- Does data evaluation result in cost-effective solutions?
  - What are the problems in evaluating the data?
  - Can adequate exposure data be developed?
- What is the role of data in highway safety planning and analysis?
  - What questions should be asked and what kinds of data do they require?
  - Are integrated data systems necessary?

This summary of conference proceedings reflects, as objectively as possible, the views expressed by the participants in an attempt to answer these questions.

DATA COLLECTION

Do current data-collection techniques produce usable information? Most speakers addressed the problem of data collection and the inadequacy of accident, exposure, and evaluation data for safety analysis. It was generally acknowledged that data obtained from accident reports were inaccurate, unreliable, incomprehensive, and incomplete. These problems were described:

- Data from accident records are incomplete. Because of minimum reporting thresholds for property damage and injury, only certain accidents are reportable. And only about two-thirds of all reportable accidents are shown on official records.

  It was pointed out that such selective reporting, although not necessarily biased, can generate misleading results. The accidents of women and older drivers, for example, are reported less often than those of young male drivers.
- Data from accident reports are not comprehensive. The data are limited to the number of variables that can be used to describe the accident. Police reports are limited by the other duties the investigating officer must perform.
- Data from accident reports are often inaccurate. Few police officers have training in accident reconstruction, and those who do often lack the time to gather and analyze data. In addition, statements from witnesses and drivers are often conflicting and unreliable.
- Data from accident reports are inadequate. Other data are needed on exposure before conclusions can be drawn.

Another of the problems mentioned was the fact that accident data are frequently unreliable for particular subpopulations. In some states, for instance, data on motorcycle and moped accidents are combined, even though their characteristics vary. The lack of timeliness in reporting data by some agencies was also mentioned as a problem. As a result of these delays, data are sometimes a year or more old before they are available for problem analysis.

Adequate exposure data were cited as being extremely difficult to gather. Data on vehicle miles traveled (VMT), vehicle registration, and driver licensing are most frequently used for normalizing accident statistics. However, numbers of licensed drivers and vehicles are frequently not available for some types of vehicles or for political subdivisions below the state level. Also, since VMT figures are often obtained from gasoline tax revenues, they are generalized data with low statistical value. In addition, the number of smaller cars on the roadways and fluctuations in the availability and cost of fuel have raised questions on the validity of any VMT estimate based on gasoline taxes.

Although the need for other kinds of exposure data on population, miles of roadway, miles driven by sex or age, time of day or area, average daily traffic, amount of driver training, vehicle defects, and purpose of travel was reiterated, there was little discussion of the reasons such data were difficult to obtain or how a better data gathering system could be implemented.

In addition to these problems, an additional complication was cited in relation to the collection of control and evaluation data: that of programs that are improperly organized or too poorly funded to permit the collection of evaluation or control data. It was agreed that the costs of evaluation are not insignificant. One speaker suggested that while minimum costs of evaluation need not exceed 10 percent of the total project cost, projects requiring considerable data collection could cost more.

A number of concerns were expressed regarding the problems of gathering data into state or national data systems. One speaker noted that state records systems were generally not designed for safety analysis—but rather had evolved in response to the specific and varied requirements of many agencies. Thus, data files are maintained by a number of different agencies, each of which has designed its data files to meet its particular needs. Such data are difficult to integrate, and much cannot be used effectively for safety analysis. Manipulations to develop useful files are therefore extremely time consuming and costly.

Suggested solutions to some of these data inadequacy problems touch on some important issues concerning the types and levels of data necessary for program planning. One speaker from FHWA recommended including property-damage-only (PDO) accidents in the records systems. Some states, under pressure to reduce expenses, have considered eliminating these records from the system. It was felt that this could impair a state's ability to identify high-hazard locations and design countermeasures—that several injuries would have to occur before a specific location would be recognized as high hazard.

Other speakers acknowledged that minimum thresholds of property damage contribute to the inadequacies of accident data. They seemed to feel that eliminating such data prevented the system from being inundated with minor statistics that had no real benefit.

Another speaker suggested that another issue is whether something can be done to improve the reliability of accident data. One way to do this would be to restrict questions on accident reports to gather only vital data about the accident—who, what, where, and how bad. It was acknowledged that agencies and police have other functions and priorities, and that the responsibilities and needs of these groups must be accommodated if safety agencies want reliable data. Other peripheral information (such as the driver's occupation, etc.) is generally not critical to evaluation. When such information is needed, it can be obtained from other sources.

It was suggested that drivers' reports required by insurance companies and information from files now maintained by a number of different agencies could be the sources of supplemental data. Those recommended for consolidation include:

- The accident file now maintained by state police.
- The driver file now maintained by the licensing agency.
- The vehicle file maintained by the registering agency.
- The road file maintained by state and local highway departments.

It was felt that providing more access to these files would increase the amount of information available for analysis, reduce the need for extensive data collection, and provide information to control for exposure.

Also addressed was the need to eliminate the duplication of data and increase access to the files maintained by various agencies. For instance, it was suggested that a single agency should be made responsible for data collection and dissemination and for coordinating the efforts of federal and state governments. In Pennsylvania, such a system has been implemented; the Accident Records System provides a two-way exchange of information with the licensing, vehicle registration, and roadway information files.

A word of caution was frequently interjected, however. It was noted that the Pennsylvania program, while described as secure in terms of output, is nonetheless constrained by the limitations of input data. Another speaker warned that the time has passed when records systems would have been most amenable to consolidation and that making such changes now would be prohibitively expensive.

Several speakers also warned against waiting for the development of integrated data systems. It was pointed out that although developing an integrated data base may be an ultimate goal, safety analyses should not be deferred. Most states have better information than decision makers have traditionally used, and we cannot afford to wait until the ideal records system is developed. It was cautioned that the usefulness of highway records systems is often constrained by the ability of planners to access and analyze the data.

EVALUATION PROBLEMS

Does data evaluation result in cost-effective solutions? The consensus of the conference seems to be that this may not be possible given our current techniques.

It was generally acknowledged that few safety programs could demonstrate quantitative improvements—that the effects of most programs are marginal and that only rarely can a dramatic reduction in injuries or fatalities be seen.

It was also acknowledged, however, that despite their shortcomings, accident data are the best available criterion for evaluating program impact. They are the sole common denominator for comparing programs with different immediate objectives and they are the criteria most readily expressed for cost/benefit analyses.

One of the principal problems seems to stem from the fact that, where data are used to define the problems, success is determined in numerical terms. The results must be concrete; programs must show reductions in accidents, in injuries, in fatalities. And obtaining measurable results appears to be difficult, if not impossible.

Part of the problem, as several speakers pointed out, may be one of definition. For many projects, either the sample is too small to show a measurable impact or the impact itself is too small to be measured. And the smaller the impact, the more precise the measure must be. While some projects may in fact be cost effective, the measures may be often too expensive to reflect it. True impacts may also be obscured by differences in exposure or other accident-related factors that could be identified and controlled with better data.

Different data treatments used in evaluation may provide different conclusions as to the success or failure of a project. NHTSA used the decline of fatality rate per vehicle mile as evidence of the success of national safety programs; GAO used the increase in the absolute number of fatalities as evidence of its failure.

Exposure data are essential in identifying problems and countermeasures, and they must be considered in judging the success of a safety program. But it was agreed that the inadequacy of such data has created problems at all stages of program planning. Specifically cited were problems in determining the significance of overrepresentation, identifying target groups, testing hypotheses, and identifying cost-effective countermeasures.

The lack of properly trained personnel was also mentioned by many speakers as an impediment to evaluation. It was pointed out that two kinds of expertise are required—data analysis and highway safety management. Some states have used a team planning approach in order to combine these skills. Pennsylvania has reorganized its Department of Transportation into a new bureau that combines both analysis and program planning functions.

It was pointed out that as programs move from changes in vehicles and highways to making changes in the way people drive, countermeasures can make a difference of a few accidents per thousand drivers. However, modifying human behavior is an expensive and difficult task; in fact, it has been relatively ineffective in reducing the accident toll. Effective and efficient use of available resources requires that countermeasures be implemented, not where the problem is greatest, but where they do the most good.

Even if safety agencies could identify problem areas and were to develop countermeasures, it was acknowledged that they probably still could not determine the impact of individual projects. And without quantifiable impacts, they cannot sell their concepts and programs to their state legislatures, to the administration, and to Congress. It was cautioned, however, that effectiveness and economic analyses should be conducted to determine whether or not safety projects are justifiable—not to justify their selection.

One speaker suggested that intensive impact evaluations of selected programs could be performed on a national scale. The product of these evaluations could be observable, measurable impacts to demonstrate the effectiveness or ineffectiveness of highway safety programs. However, another speaker mentioned that national efforts to quantify impacts have sometimes produced vague and inconsistent findings that have led states to question, perhaps prematurely, the value of established, existing programs. An example of this is the motor vehicle inspection program. After more than 10 years of evaluation and the expenditure of millions of dollars, the accident reduction potential of these programs still has not been conclusively demonstrated. Under the impression that no conclusion is a negative conclusion, several states have repealed or abolished inspection requirements, some of which had been in place for more than 40 years.

ANALYTICAL TECHNIQUES

What is the role of data in highway safety planning and analysis? Many participants felt that too little effort has been placed on using analytical techniques for safety analysis. One speaker mentioned that some of the evaluation techniques currently being used are very elementary. It was noted that both user-oriented computer packages and simple manual procedures are available for conducting project and program evaluation. A number of speakers presented summaries of the automated packages currently being used. Among those discussed were:

- The Data Analysis and Reporting Techniques System (DART), which was developed by GENASYS Corporation to assist in the problem identification process for the acquisition, selection, and analysis of state accident data. A major objective of DART is to overcome the lack of integrated data resulting from poor communication between state agencies and to provide a mechanism for upgrading the traffic records system as integration capability is achieved.
- The Records Analysis for Problem Identification and Definition System (RAPID), which was designed to process state accident data by user-specified information needs. RAPID requires no previous computer knowledge; the user is guided through the process by responding to simple queries and interacting with the computer.
- The Michigan Dimensional Accident Surveillance (MIDAS) Model, which was developed to analyze the state's trunkline system. Two generations of the model have been developed: MIDAS-I, which groups all roadway segments with identical physical characteristics, and MIDAS-II, which treats roadway segments of variable lengths. MIDAS-II requires no prior data processing experience; the user enters the system with a simple command and selects operations from a menu of options.
- CASESTUDY and TAP, the Traffic Accident Profile, which are two computer systems used by the state of Texas for micro-level analysis of traffic record data. CASESTUDY aggregates information on individual accidents to identify problems in specific areas; TAP melds engineering, enforcement, and education programs.
- MTRS, the Model State Traffic Records System, which is being developed by A.F. Austin and Associates for the Alabama Office of Highway and Traffic Safety. The objectives of MTRS are to integrate information and operations of various systems and state agencies and reduce duplication of data, and to encourage comprehensive planning and evaluation throughout the state.
- ADAAS is a set of computer files used at the University of Michigan to analyze a variety of highway safety problems. ADAAS contains a large volume of separate accident and other files.

While there was general agreement that some type of analytical technique is necessary to evaluate accident data, there was no consensus as to the type of technique that should be used nor the type of data that should be included. Some participants felt that large volumes of data were very necessary, while others felt that these large numbers of data may contribute to the fact that the analysis results often reflect a zero impact. Still others felt that this zero impact was the result of highly disaggregated data, while some felt many of the problems in data analysis were the result of the data being too aggregated.

As a result, the questions regarding the role of data in problem identification, the type of data that should be collected, and the value of integrated data systems remain unanswered.

It was mentioned, however, that the current impediments to achieving safety results will not be overcome quickly or easily. It was estimated that improvement of safety programs would have taken at least 10 years with previous funding levels. As state budgets are reduced, it will become more imperative for safety administrators to improve both the efficiency of their operations and the effectiveness of their safety programs. The challenge to safety administrators is to develop more effective techniques to improve safety at a reduced cost.

OPENING REMARKS

Robert L. Marshall, School of Public Services and Missouri Safety Center, Central Missouri State University

This conference is being sponsored by the National Highway Traffic Safety Administration and the Federal Highway Administration and conducted by the Transportation Research Board of the National Research Council. These three organizations have worked cooperatively on a number of projects of mutual concern over the years. This particular conference concerns a subject critical to the various state and government agencies. Its specific objectives are

1. To provide impetus for state program managers to maximize their use of safety data available within the states to effectively and efficiently administer their programs;
2. To present, discuss, and evaluate analytical techniques that augment the states' capabilities for using data to identify problems, set goals, develop programs, establish priorities for projects, and evaluate highway safety programs, projects, and countermeasures; and
3. To establish the level of data analysis necessary to adequately administer state safety programs under the process approach to managing highway safety.

KEYNOTE

Patricia F. Waller, University of North Carolina

The costs of our highway transportation system—and the cost of failure—are high. Local, state, and federal governments have spent enormous sums of money on the highway transportation system, not just for the highways themselves but also for the supporting programs and institutions necessary to maintain the system. And virtually all segments of society have invested heavily in the vehicles that use the highway system.

In spite of this, the area of highway safety has been neglected in relation to its importance. Injuries from motor vehicle accidents are a major health and economic problem in the United States and are the leading cause of death for persons between the ages of 6 months and 40 years. Children from 1 through 14 are more than 100 times more likely to die from motor vehicle injuries than from tuberculosis, diphtheria, whooping cough, strep throat, scarlet fever, polio, measles, and typhus combined. Motor vehicle injuries account for more new cases of paraplegia and quadriplegia than all other causes combined; they are the leading cause of head injuries, epilepsy, and death in the peacetime military.

According to a recent report in the American Journal of Public Health, more than 1.5 million persons suffer from cancer, coronary heart disease, and stroke each year, but more than 4 million will be injured in motor vehicle accidents. The costs of motor vehicle injuries, second only to those of cancer, exceed $20 billion per year. These costs are for emergency medical aid, hospital care, rehabilitation, lost wages, and other direct and indirect costs. They do not include costs of property damage or of the enforcement, judicial, penal, and other administrative systems that are called on to deal with the consequences of motor vehicle accidents.

Highway safety becomes an issue when the highway transportation system fails and injury or death results. It is important that we be able to identify the factors leading to system failure so that we can invest our limited dollars where they will have the greatest effect. Unfortunately, these factors cannot always be identified. Our current data systems either do not include the necessary information, or the data are included in a form that does not readily permit retrieval and analysis. An adequate data records system, therefore, is our starting point.

With an adequate system to link motor vehicle crash information to detailed injury and cost information, we can identify the kinds of crashes that lead to the more costly injuries. With a system to link data on driver licensing, training, and history with information on judicial proceedings and accidents, we can look for problem areas in our current programs.

Most of our traffic safety programs are based on the collected wisdom and best judgment of the people working in the field over the years. With sound data, we can know the effectiveness of these programs and can make decisions on implementing new programs that may entail the commitment of scarce resources or raise controversial questions of individual rights. We can replace subjective opinion and "best guesses" with objective data.

As agency budgets are cut, traffic accident data systems, like everything else, are being closely scrutinized. We will be required as never before to justify our data-collection and storage programs. Justification may be difficult, as the data system itself cannot reduce accidents. Yet, without this system, it will be impossible to evaluate the effectiveness of our highway safety programs and to decide how best to spend our limited dollars. We will have to translate our need for better accident statistics into costs and benefits. To meet the challenge, we will have to pool our expertise and develop innovative approaches to identifying and solving highway safety problems.

CHALLENGE TO THE CONFERENCE: THE FHWA PERSPECTIVE

Edwin M. Wood, Federal Highway Administration

State highway records systems have improved markedly since 1970 when the federal government provided separate funding for safety improvement. In 1976, only 30 states had location reference systems that included all federal-aid highways; by 1981, at least 46 states had such systems. Only 10 states could correlate traffic volume and accident data in 1976; today, 45 states have this capability, and more than half the states can also correlate highway inventory data with accident records.

The investments made by local, state, and federal governments in traffic, accident, and highway records systems have been substantial. NHTSA has been responsible for most of the federal grant money invested in traffic records systems, but since 1973 FHWA has also devoted more than $32 million of its 402 funds to accident data collection and records analysis.

To help improve the use of traffic records in developing highway safety programs, FHWA has named the link between accident data and traffic and highway inventory data as an emphasis area. The study of these data will help determine exposure rates and the safety performance of geometric features and highway hardware.

The need for traffic safety data and analysis capability is increasing with changing types and sizes of vehicles. The standard passenger car is becoming smaller and lighter. The trucking industry is increasing pressure to allow multiple trailers and heavier payloads. Motorcycle travel and moped sales are rising at a rapid rate. State highway data systems must provide the facts needed to identify problems resulting from the changing vehicle mix, to design countermeasures, and to develop, implement, and evaluate highway safety programs. To get these facts, we may need to modify our present record systems.

In spite of progress and increased need, recent gains may be eroding. Although state and federal financial resources have remained relatively constant over the past few years, inflation has reduced real buying power. States can afford only essential and effective highway safety improvements, and these uses must compete with other highway budget items for available funds.

At the same time, the administration has stated its intention to return decision-making authority to state and local governments and has eliminated separate funding categories that require a prescribed level of funding for specific program areas. This seeming reduced emphasis on safety has led some states to tighten their budgets by reducing the data to be included in their records systems.

This is a false economy. Every effort should be made to improve rather than reduce information going into records systems. Since safety programs will now have to compete with alternative uses, management has an increased need for records systems that will help identify problems, evaluate results, and provide justification for highway safety improvements. The challenge to the state highway safety agencies is clear. To improve their decision-making capability they must

- Increase the usefulness and responsiveness of accident, traffic, and highway records systems. Records systems must provide information needed for good safety management and justification of countermeasures. This information must be in a form that will allow meaningful analysis.
- Make full use of available information. States cannot afford to wait until they have the ideal records system. Most states have better information than decision makers have traditionally used. States must use the best information now available to improve decisions, work closely with the records system staff to identify what information is available, and begin using information even while it is being refined and improved.
- Improve communication between decision makers and records systems management. The records system should serve decision makers, but management does not always communicate its needs to the records systems staff. Nor do the records staff always tell management when they find a problem.
- Include property-damage-only accidents in the records systems. Under pressure to reduce expenses and in response to reductions in federal funding for categorical safety improvements, some states have considered the elimination of property-damage-only accidents from the records systems. This would be a mistake. The effectiveness of the accident records system in helping to identify high-hazard locations and to design appropriate countermeasures would be drastically reduced. Several injuries (and perhaps fatalities) would have to occur before the hazardousness of a specific location would be recognized.
- Assess the potential for success before systems are implemented. Knowing the accident problem does not always help identify appropriate countermeasures. For example, driver errors and alcohol are often identified as major factors in traffic accidents, but trying to convince drivers that they should not make errors or drink alcohol is not necessarily an effective solution. Modifying human behavior is an expensive and difficult task and, in fact, it has been ineffective in reducing the accident toll. Effective and efficient use of available resources requires that countermeasures be implemented, not where the problem is greatest but rather where the countermeasure will produce the most benefit.
- Improve the compatibility of state records systems. The hindsight of some states can serve as the foresight of others. Pitfalls can be avoided and more rapid progress can be made at a considerable savings. Good identification of safety needs and comprehensive evaluations are expensive. Each state should not need to prove the extent of each problem or the worth of each solution. By improving the compatibility of state records systems, states can share information and avoid unnecessary expense. The Office of Highway Safety will work with interested states to develop compatible records systems.
- Identify "most hazardous elements" for safety upgrading. State records systems must be used to detect hazardous elements as well as high accident locations. States must give more attention to preventing accidents involving highway elements that have been identified through accident records as being hazardous.

The Office of Highway Safety is working to enhance traffic records capabilities of state and local governments. Efforts will be concentrated on providing technical assistance (including assistance in developing training programs), serving as a clearinghouse for new technology, and initiating multistate analyses to identify problems and evaluate results.

We have made a tremendous investment in state traffic records systems. Now it is time to make that investment pay dividends. We must increase the use of the data we already have and continue to plug the data gaps. We must work together across state and local lines. We must share our experience and support each other in this effort.

We have a common goal—to make our safety programs more effective. Our records systems can help us accomplish this goal. The FHWA is committed to supporting improvement of traffic records systems through increased technical support.

CHALLENGE TO THE CONFERENCE: THE NHTSA PERSPECTIVE

Robert B. Voas, National Highway Traffic Safety Administration

The task before this conference is simple and compelling. We are here to help states plan their safety programs scientifically on the basis of accident data, that is, to help them put safety efforts and funds where objective data indicate the safety problem is worst.

Two recent developments have made this task critical: the 60 percent reduction in the FY 1982 budget for the state and community highway safety program and the recent U.S. General Accounting Office criticism of the current problem identification process prescribed by NHTSA.

The reduction in funding has required limiting federal support to a few areas. Federal funds can still be used for state data systems, but the funding of administrative costs for all highway safety programs is no longer permitted. As a result, program planning activities will probably be shifted to state budgets. This may mean less money for problem identification; however, if this activity can be shown to increase the efficiency with which safety funds are spent, it should survive the transition from federal to state support.

Safety problem identification takes place at the national, state, and community levels. At NHTSA headquarters, new safety problems are detected and analyzed as part of the research and development efforts, and state data and national trends are analyzed to assist states with their problem identification programs. In state planning agencies, highway safety problems are studied for the state as a whole and for the counties and districts applying for safety grants. In the counties and communities selected for grants, problems are analyzed to specify local problems and to help plan police patrols, roadway improvements, and educational programs. If record systems are adequate, if methods of accessing these systems and analyzing data are effective, and if competent personnel are available at each of these three levels, then the problem identification process can be an effective means of managing the nation's safety program.

But there are a number of difficulties inherent in the problem identification process. These can be grouped into three areas: administrative, mechanical, and technical.

ADMINISTRATIVE ISSUES

1. Pressure for Concrete Results

Safety specialists have always been under some pressure to demonstrate concrete results; however, in the past, they have been able to justify programs on the basis of such intangible goals as the improvement of driver knowledge or the efficiency of safety systems. These justifications are not likely to be adequate for management that relies on objective statistical data. Once the problem identification process has isolated a target group and if funds are provided for safety programs on the basis of this analysis, administrators, legislators, and the public will naturally expect a reduction in the number of accidents involving this target group. Programs will have to produce tangible results.

2. Reduced Emphasis on Support Activities

This problem is a corollary of the first. If success is to be judged by reductions in accidents, support activities will be deemphasized. It is difficult to demonstrate the accident-reducing potential of a better driver licensing data system, an improved police communication system, or a better breath tester. Such projects will lose out to selective traffic enforcement projects that are more clearly defined in the problem identification process and can show a measurable impact on accidents.

3. Emphasis on Large Rather than Small Projects

The problem identification process can lead to an overemphasis on large projects. Because most safety programs can achieve a 10 or 15 percent improvement at most, the projects must cover a large number of accidents to produce a statistically significant reduction in crashes. If accident reduction is the criteria for program support, then small projects in small communities will be out, and large projects in major urban areas will be in.

4. Inadequate Opportunity for Program Evaluation

Careful analysis of the causes of accidents and the isolation of target groups may improve program evaluation; however, the many practical restraints to evaluating programs are likely to remain and may even be made worse by recent reductions in funds. Having performed a sophisticated analysis to plan a project, the scientist may find that the project is carried out in a manner that makes evaluation impractical or that funding for evaluation or the collection of control data is inadequate. However, the need for continued scientific research should not be allowed to conflict with state safety program goals. For example, researchers have been critical of the ASAP program for failing to fund control sites and carry out research designs. They saw the project as a research effort. NHTSA, on the other hand, saw ASAP as an action program designed to stimulate state attention to the alcohol problem.

MECHANICAL PROBLEMS

1. Incomplete Data

According to a recent report comparing insurance claims with state accident data, one-third of reportable crashes goes unreported. Because the reporting of property-damage-only accidents is known to be incomplete and because the required reporting levels are affected by inflation and legislative changes, most states have relied on injury-accident rather than total accident data. These data are by definition incomplete.

Incomplete reporting is not necessarily highly biased reporting. For example, we have been studying blood alcohol concentration (BAC) reports sent to state accident reporting systems. In 10 states, BAC data were available on 80-85 percent of fatally injured drivers; in the remaining 40 states, information was available on 30-35 percent. Despite the large difference in percent reporting, the proportions of drivers with an illegal BAC were approximately the same.

On the other hand, selective reporting can result in misleading data. For example, the accidents of women and older drivers tend to be reported less often than the accidents of younger, male drivers. Differences such as these could be particularly misleading in problem analysis.

2. Lack of Exposure Data

The lack of adequate exposure data for normalizing accident information is a major limitation to problem identification. Driver licensing, vehicle registration, and vehicle miles of travel (VMT) are the most frequently used information for normalizing accident data. However, the number of smaller cars on our roadways has made suspect any VMT estimates based on gasoline taxes. Numbers of licensed drivers and licensed vehicles are frequently not available for political subdivisions below the state level and for some types of vehicles, such as motorcycles. Accurate data on numbers of vehicles are frequently not available even at the state level.

3. Lack of Appropriately Trained Personnel

Many state safety offices use both data analysts, who call up data for the use of others, and highway safety management specialists, who are responsible for planning but have little experience with data systems or data analysis. A complete set of skills is needed for problem identification. To get around this problem, many states use a team planning approach.

4. Lack of Adequate Access System

A good state highway safety record system is the foundation for problem analysis, but the usefulness of such a system is limited by the ability of the planners to access and analyze data. This conference will consider several access systems that have been developed especially for highway safety research and management and for standard statistical packages available for data analysis.

TECHNICAL ISSUES

1. Variations in Data Treatment

Highway safety problems can be defined through a number of different methods: through statistical comparisons between areas or time series comparisons within a single area; through absolute number of crashes or accident rates based on normalizing data; and through trends or changes in trends. Each method provides a different result.

For example, according to absolute numbers, male drivers between the ages of 16 and 35 are highly overrepresented in weekend nighttime accidents. But if the data are normalized, then teenage drivers are overrepresented on a per-vehicle-mile basis and older drivers are overrepresented because they drive more frequently at night. Normalized data also suggest different countermeasures. For the teenage driver, the problem is one of skill or attitude, and training may be a useful countermeasure. For the male driver between 20 and 35, the problem is one of nighttime exposure, and the countermeasure would involve reducing that exposure. For the elderly driver, the problem is a combination of low exposure with increased risk per mile or unit of exposure.

Different data treatments can determine the success or failure of a safety program. For example, NHTSA has pointed to the declining fatality rate per 100 million vehicle miles as evidence of the success of national highway and motor vehicle safety programs; in its critique of the grant program, the U.S. General Accounting Office emphasized the increase in absolute numbers of fatalities since 1965 and therefore questioned the value of the program.

Policy considerations may also differ, depending on whether the focus is on total exposure or on risk per unit of exposure. For example, a recent study claimed that driver education was causing teenage fatalities. While teenagers in fact have a higher rate of accidents per mile driven, most of the increase in fatalities cited in the study was due not to a change in risk per mile, but rather to increased exposure resulting from the availability of high school driver education.

How then shall we use accident records for problem analysis and planning? The accident record systems lend themselves to analysis of total numbers of accidents, and our methods of correcting the exposure are relatively weak. If we use total numbers of accidents as our measure of success, we may find ourselves defining alternative transportation systems (mass transit) as highway safety programs. This may be appropriate; then again, we may not want to spend our limited safety funds on mass transit.

In all probability, there is no single measure applicable to all situations. But it will be our task to find appropriate ways of using accident statistics to define problems and to manage highway safety programs.

INTRODUCTION AND CONFERENCE PURPOSE

Wayne S. Ferguson, Virginia Highway and Transportation Research Council

When the need for this conference was established by the Transportation Research Board's Committee about a year and one-half ago, we did not envision the environment in which highway safety practitioners would find themselves today. Certainly the need to curb inflation and to promote real economic growth is of such national significance that, if deep cuts in federal spending are now necessary in many areas of federal activity, we would not argue that this program alone ought to be exempted. We would maintain, I believe, that unsuccessful programs ought to be cut and successful ones sustained. Have we been successful? Apparently, many people think not. We need to assess both where we are and how we got here.

To be sure, things are not as bad as they might be. But the funding levels proposed for FY 1982 and beyond reflect a substantial retreat from the commitments of resources to highway safety that began in 1966-1967. And we need to ask, Have we in the state and community programs done our jobs so well that further effort is not needed? Or have we done so poorly that further financial commitment seems, in investment terms, a poor risk? I am afraid that the answer is, We don't know.

I believe that the U.S. General Accounting Office noted in its October 1980 report to Congress that the state and community highway safety programs are a poor investment alternative in these days of lowered expectations of government.

If we were business people meeting here today to discuss the condition of our companies or our industries and the prospects were for 65-70 percent reductions in operating revenues, it is almost a certainty that we would know precisely how and why we had come to this position. We would be working on recovering our lost markets and lost customers.

But those of us promoting and selling improved highway transportation safety through the state and community grants program do not know what has been successful and what has not. I think part of the problem derives from the fact that we have not recognized that the bits and pieces of highway safety information we collect and maintain must be organized into a management information system to effectively plan, analyze, and oversee the highway transportation system. We have not defined our problems clearly enough and identified those factors amenable to countermeasures through the grant system.

Industry spends millions analyzing its products and its markets and carefully tailoring its short- and long-range plans to the changing environment. In comparison, we spend a pittance on identifying and analyzing those characteristics of the highway traffic crash problem so that we can sharply focus on the goals and objectives of our spending programs.

If we are ever to sharpen the focus of our programs, we must find a way to make our management information systems more useful. We hope this conference will provide a start.

TRAFFIC RECORDS ANALYSIS IN TEXAS

Barry Lovelace and John Staha, Texas State Department of Highways and Public Transportation

In Texas we use the traffic record as a source of data for three levels of problem identification and analysis: macro, midrange, and micro. This three-layer concept has been adopted as a means for "layering" into problem identification for decision making. The purpose of the macro level is for statewide comparisons and problem assessment. It consists of problem identification by using the Fatal Accident Reporting System (FARS) at a gross level and will not be discussed here. The midrange level is the basis for resource allocation; the micro level is used for treatment. Texas uses different techniques for each:

- SAVE CITY/SAVE COUNTY is a decision model used for midrange analyses. Cities and counties are rank-ordered by accident count and rate to form a basis for resource allocation.
- CASESTUDY and Traffic Accident Profile (TAP) are two computer programs used for microlevel analyses. The purpose of CASESTUDY is to retrieve information on individual accidents to identify problems in specific areas. TAP melds

engineering, enforcement, and education in an effort to get programs to work together.

Summaries of each of these techniques follow.

SAVE CITY/SAVE COUNTY INDEX

It has been axiomatic in the field of safety that an accident-free environment is not only desirable but possible. Taken to its extreme, the concept has come to mean that accident reduction is equally important in all environments, the scale of the problem and cost/benefit notwithstanding. Applied to the allocation of traffic safety resources, this has meant that any community or eligible agency has an equal claim on available resources, and appropriate mechanisms have been developed to ensure distribution on that basis. The Texas FY 1982 Highway Safety Plan is a major departure from the traditional values of the traffic safety field.

Texas receives one of the largest state allocations of NHTSA resources, but even this level of funding is inadequate, primarily because of the geographic scope of Texas and the unique problems it presents. Beginning from a premise that each district office of the Texas State Department of Highways and Public Transportation has some traffic safety problems severe enough to merit funding, the Save City/Save County program was developed with the assistance of the Texas Transportation Institute (TTI).

Save City/Save County is a decision model based on the assumption that a certain number of traffic accidents will occur regardless of the level of effort or the relative effectiveness of countermeasures. Communities above the median occurrence level obviously have more severe problems than those falling below the median. Such a measure of need is absolute; it fails to show relative severity for purposes of comparison. To alleviate this problem, a set of formulas was developed that assigns weights to two common factors (accident rate and number of accidents) to construct an index of potential accident savings for each city or county. It should be emphasized that these accident savings figures are not finite; they have no intrinsic meaning and do not represent accurate projections of anticipated reduction in the occurrence of accidents. They are, however, relative rankings of severity. These rankings are used as a basis for the selection of candidate sites.

CASESTUDY

Traffic safety analysts frequently find that they need detailed information on narrowly defined subsets of a state's accident data base. A traffic engineer in Texas, for example, may be interested in analyzing accidents along a 5-mile stretch of Interstate highway. An engineer for a motor vehicle manufacturer may be interested in learning more about single vehicle roll-over accidents for a given make or model of car. A driver education teacher may desire information on nighttime accidents involving novice drivers.

If the subset of accidents at issue is small, it is often possible to retrieve all of the individual accident reports contained within that subset for a period of one or more years. If the subset contains no more than a few hundred accident reports, it is feasible to go to the state agency in charge of maintaining these reports and request a photocopy of each. Individual accident reports are typically identified and retrieved by accident case number rather than by location, vehicle make and model, or time of day.

To analyze small subsets of the Texas accident data base without having to retrieve individual accident reports, TTI has developed a computer program known as CASESTUDY. In using CASESTUDY, an analyst defines a subset of accidents, such as fatal motor accidents, those that occur on Interstate highways between certain hours, or accidents involving pedestrian or bicycle casualties. This subset may be further defined by a variable or combination of variables related to accident, driver, vehicle, or casualty.

Once the subset of accidents is defined, the CASESTUDY program is run. Program output includes a single sheet of paper for each accident under consideration. These individual sheets of paper are referred to as case studies or <u>proxy reports</u>, i.e., proxies for the investigating officer's accident report. Half of each proxy report provides information on a particular accident. Included are variables such as time of day, day of week, month of year, county, road, type, severity level, weather conditions, road surface conditions, location, and number of people injured in the accident. The other half contains details on the first three drivers and vehicles involved in the accident. Information includes vehicle make, style, year, type; vehicle defect; contributing factors to the accident; and driver's age, sex, and race.

Each proxy report contains an accident case number. If the analyst desires additional information on a particular accident—information that appears on the investigating officer's accident report but not on the proxy report—that accident can be accessed by case number through the Texas Department of Public Safety (DPS). Identification of the case number is particularly important given the size of the accident file: during calendar year 1980, DPS encoded reports on approximately 480 000 accidents.

The CASESTUDY program is then used to summarize the information contained in the proxy reports. This summarization consists of univariate printouts of all the variables in the proxy report. A subset of 100 accidents would produce 100 pages of proxy reports and several summary pages of univariate tables displaying accident, vehicle, and driver information relevant to those 100 accidents.

One major problem in Texas is the amount and type of data that are being collected. As previously noted, the file is very large and difficult to mesh. Also, seemingly irrelevant information such as color of the driver's clothing is being recorded while important information regarding the vehicle is not.

Regardless of these problems, however, the summary information provided by CASESTUDY, along with the individual proxy reports, is of assistance to local traffic engineering and enforcement personnel in suggesting when, where, why, and how accidents occur. And the information contained in the CASESTUDY report—supplemented by law enforcement experience and engineering judgment—will help in selecting countermeasures to reduce the frequency and severity of accidents.

TRAFFIC ACCIDENT PROFILE

The Traffic Accident Profile provides information on a city's traffic accident problems and suggests possible countermeasures. Its primary uses are to identify the types of engineering work that are necessary and to define the operational development of police plans. TAP is most effective for medium to large cities (e.g., accidents by time of day and day of week by weather conditions). In smaller cities the cells used for analysis are so small that all significance is lost. Target areas are defined by an iterative process after an arbitrary decision has been made regarding the number of areas to be evaluated in each city.

Target area analysis involves the following four steps:

1. Identifying target areas on the basis of accident totals (this involves selecting the 10 streets in a local jurisdiction with the highest number of accidents);
2. Generating tables for each of the 10 target areas on factors that might affect accidents in the target area;
3. Making commands on traffic safety problems suggested by the tables; and
4. Recommending potential countermeasures in the areas of enforcement, engineering, or education.

Analysis of target area tables is a subjective procedure supported by a general knowledge of traffic safety programs. The main factors used to identify apparent traffic safety problems are the percentage and the frequency of accidents in each cell.

The traffic accident file constitutes an exceptionally rich source of information. It should not be overlooked as a resource for multiple purposes: policy analysis, resource allocation, problem identification, and countermeasure design.

STATE-OF-THE-ART TECHNIQUES FOR COST-EFFECTIVE SOLUTIONS

Martin R. Parker, Jr., Progressive Consultants Corporation

The U.S. General Accounting Office has suggested that the Highway Safety Program has achieved only limited success in reducing the number and severity of accidents. The problems impeding the development of effective safety programs have been identified for many years. Some of the major problems are as follows:

- The direct measures of safety—accident reports—are incomplete, inaccurately reported and coded, and biased. They also fluctuate widely from year to year at a location. Thus, it is difficult to use accident records to accurately identify safety goals and problems.
- Few administrative and effectiveness evaluations of safety projects have been conducted by using sound analytical techniques. In most cases, the impacts of projects on safety have not been determined.
- Accident records systems are generally not designed for safety analysis.
- There is considerable duplication of accident records and safety-related data, and much of the available data is not used for safety purposes.
- Research results obtained from studies conducted by federal and state agencies, universities, and other agencies are not used effectively to improve safety programs.
- Many safety administrators believe that every dollar spent on safety is worthwhile.
- Many agencies do not have personnel adequately trained to conduct safety analyses.
- Effectiveness and economic analyses are often conducted to justify the selection of safety projects rather than to determine whether projects are justifiable.

Every state has made progress implementing safety programs during the past 80 years; achieving further significant reductions in accidents and their severity during the next several decades may be impossible. A more realistic goal may be to maintain the current accident rate or number of accidents per 100 000 population (or registered vehicles). This pessimistic view is, in part, supported by the following observations:

1. The current impediments to achieving safety results cannot be overcome immediately. Even with pre-1981 safety funding levels, it would take 10 years or more to upgrade safety programs to the point where significant measurable results could be shown.
2. There are no major developments envisioned within the foreseeable future that will lead to improvements in highway safety. For example, no major highway construction program, such as the interstate system, is contemplated.
3. Safety budgets at the state and local level are likely to be reduced as funds are spent on more pressing issues such as maintaining essential services.

Given existing and future constraints, it is imperative that safety administrators improve the efficiency of their operations and the effectiveness of their safety projects and programs. Fortunately, the analytical techniques and technical equipment for achieving success are available. The challenge faced by safety administrators is to apply state-of-the-art methods to increase the probability of implementing cost-effective solutions. In many cases, the techniques are not labor intensive, nor do they require large capital investments for implementation.

While the level of effort is often a function of the size and safety responsibilities of an agency, a number of techniques are applicable for all agencies. Some of the most pertinent measures are described below.

PLANNING TECHNIQUES

Program administrators must establish an efficient procedure for using accident data to meet safety goals. In the planning phase, the administrator must have a data base capable of identifying specific safety problems and evaluating project impacts. The results of completed research and data bases such as National Accident Sampling System may fill the need.

While developing an integrated data base may be an ultimate goal of a safety agency, safety analyses should not be deferred until the base is completed. Local agencies can and should identify many important safety problems with existing data sources.

ANALYTICAL TECHNIQUES

Too often, little effort has been placed on using analytical techniques for safety analysis. For example, many safety effectiveness evaluations are currently being conducted simply as a comparison of the before-and-after accident frequencies. A number of user-oriented automated packages are available for more sophisticated analysis, but not all techniques require installation of complete packages. Simple manual procedures for conducting project and program evaluations have been developed by the Federal Highway Administration. The National Highway Institute will provide the manual and training course at no cost to the states.

PERSONNEL ISSUES

Safety analyses cannot be accomplished without properly trained personnel. Although desirable, it is not absolutely necessary that professional engineers make up the majority of the staff. It is essential, however, that the performance of the staff be measured. A measure of staff performance is provided by the answers to the following questions:

1. Do staff members have access to and use professional journals such as those published by the Transportation Research Board and Institute of Traffic Engineers to upgrade or improve their safety analysis?
2. Is the staff actively involved with other safety-related agencies and with the public?
3. When did the staff last attend a safety training course or seminar?
4. When did the staff last use a new or more efficient method to conduct safety analysis?

If the answers to the first two questions are no, immediate corrective administrative action is necessary. If the answers to questions 3 and 4 are "last week", the safety program is likely to be operating efficiently.

TECHNIQUES FOR COST/BENEFIT ANALYSIS

The ultimate goal of all safety projects is to reduce accidents in the most cost-effective manner. The use of the incremental cost/benefit ratio and of dynamic and integral programming is appropriate for selecting safety improvements that will optimize safety benefits for every dollar spent.

Dynamic programming is an optimization technique that transfers a multistage decision problem in a series of one-stage decision problems. It is used to allocate money to obtain the maximum possible benefits under a fixed-budget. The three possible levels of dynamic programming are:

1. Single-stage (used to evaluate a single project with several alternatives),
2. Multistage (involves selection among several projects with several alternatives each), and
3. Multistage with a time factor (used where several alternatives are considered and various time periods are involved).

Basic input into the dynamic programming model consists of (a) initial costs and maintenance costs for each project alternative, (b) accident benefits for each project alternative, and (c) budget available for improvements. Dynamic programming can take advantage of greater benefits by choosing a project that will yield greater benefits, even though it shows a lower cost/benefit ratio than another alternative. Therefore, expenditure for a group of projects chosen by dynamic programming can yield greater dollar benefits than expenditure for the same projects chosen through the cost/benefit technique. In some instances, the same projects will be selected. The optimal selection of projects is sometimes fairly obvious by using manual techniques; however, where many projects are involved, computer analysis must be used.

USING DATA ANALYSIS AND REPORTING TECHNIQUES (DART) FOR PROBLEM IDENTIFICATION

John W. Larmer, GENASYS Corporation

The Data Analysis and Reporting Techniques (DART) system was developed by GENASYS Corporation under a series of NHTSA contracts. It is a computer software statistical system that was specifically designed to assist in the problem identification process for the acquisition, selection, and analysis of state accident data.

The objective of the DART system is to overcome the lack of integrated data that resulted from poor communication between state agencies. Historically, a state agency designed a traffic records system to meet its particular needs. Other agencies requiring the same information were rarely consulted. As a result, several components of the overall traffic records system were developed, and each was organized and operated differently. This presented a basic problem in the development of an integrated system.

DART was thus developed in an effort to deal with these partially integrated traffic records systems. While there was little doubt that a tool for analysis was needed immediately within the highway safety management program, it was unlikely that an integrated traffic records system would be a reality within the near future. DART was designed to address this problem; consequently, it allows for upgrading of the traffic records system as integration capability is achieved.

An initial decision was made to create a subsystem that would require information from all the other data subsystems. Thus, the safety analysis and reporting system required group analysis of accidents so that the problem identification process could be implemented. This emphasis on problem identification has placed the burden on states to develop better data, better records systems, and better data analysis capabilities. However, dependence on accident records systems has revealed the inadequacy of many state systems to support a coordinated problem identification process. The analytical techniques used by many states are merely elementary analyses—an indication of a potential problem.

The use of DART in the problem identification process is one way to improve a state's analytical capability. Problem identification is simply an iterative process of comparative analyses that narrows the potential problem populations until the true problem is identified. The effectiveness of countermeasures can be evaluated by performing the same analysis after a period of time has passed.

Analysis through use of the DART system must be performed on a static data file. At least one full year—ideally multiple years—of data is used to develop trends and to evaluate the impact of ongoing programs.

The first step is to produce a full file univariate that will show areas of high accident involvement. A full file univariate is a one-way frequency distribution of each data element present on the data file. The file also reduces each subset of all data elements to a relative percentage or weight in the overall population under analysis. High involvement does not necessarily mean that a problem has been identified; this step in the process is designed to lead the researcher on into comparative analysis.

The next step in our problem identification process is to isolate the potential problem groups highlighted on the univariate and to look at attributes that may contribute to their accidents. The researcher may decide to break the groups down further—for example, into males and females within specific counties. The selection process allows a comparison of county versus county, male versus female, etc., by any attribute selected and in any combination. The DART output of such a comparison of accidents would be a table showing these figures.

The frequency of accidents by each age group can then be compared, and any discrepancies can be determined. Each age group is reduced to a common denominator, that is, to its relative weight percentage within the population. By using this common denominator as the basis for comparison, it can be surmised that potential problems rest within different age groups by sex. The DART report would be (a) a table showing both accident frequencies for males and females in each age group and the percentages representing those frequencies, and (b) a graph comparing the percentages. The comparison highlights overrepresentation in various age groups.

The process has thus far succeeded in illustrating vast differences between males and females by age group. In order to establish what can be expected, these facts must now be compared with normalizing data. Normalizing data are external factors used to determine the appropriate weight to be given to the accident figures for each sex and age group. If further analysis is to be based on exposure, one criterion that may establish exposure to accidents would be the number of licensed male and female drivers. The computer would be asked to supply a report on the number of licensed drivers by sex and age.

In the next step, the number of licensed drivers by sex and age is reduced to a weight (percentage) within the population 16 to 30 years of age. The percentage of accidents involving males can then be compared against that of male licensed drivers, and the percentage of accidents involving females against that of female licensed drivers. The DART graphs showing these comparisons would indicate the extent of overrepresentation in particular age groups with respect to exposure.

The main thrust of this presentation was to illustrate that DART is a tool that can be used efficiently with accident and related exposure data. The use of such a tool can upgrade the skills of the analyst and uncover areas of data collection that need improvement. The challenge is to broaden the awareness, acceptance, and use of tools such as DART for highway safety management.

USE OF RAPID FOR PROBLEM IDENTIFICATION AND EVALUATION

David B. Brown, Auburn University, Alabama

The RAPID (Records Analysis for Problem Identification and Definition) system is a user-oriented computer system specifically designed to process state accident data. As opposed to a standardized report generator, RAPID enables the user to specify informational needs. By responding to simple queries, the user is guided through the process, interacting directly with the computer. RAPID has two specialized software modules: (a) ACT, which automatically generates priorities among cities within population subgroupings for any user-defined subset of accidents, and (b) AIM, which finds high-accident concentration areas on the roadway for any user-specified accident type. RAPID also draws on the resources of the Statistical Package in the Social Sciences (SPSS), automatically furnishing the appropriate SPSS labels, codes, and ranges, as well as all control statements and format specifications.

No computer knowledge is required to use RAPID. Although RAPID uses a standard statistical package to produce output, the user does not need to understand how to assemble statistical control statements. This is handled entirely by the RAPID system.

RAPID has been installed for Alabama, South Carolina, Kentucky, Tennessee, and Delaware. It is a portable package that can be applied to any state's accident data as well as to other types of data where statistical processing is required. It is available on commercial time-sharing systems if state resources do not permit in-house installation.

RAPID provides the user with the following capabilities:

- Create a subset, including variables, of the master data base according to any logical specification. Subsets requested could include all pedestrian accidents, alcohol-related accidents in a given county or city, or motorcycle accidents between milepost 235 and 240 on Interstate 85.
- Obtain labeled univariant frequency distributions for the variables chosen to be included in subsets. The production of total statewide univariant distribution for all variables falls within this capability.
- Obtain labeled histograms of frequency distributions.
- Obtain fully labeled bivariant (crosstab) analyses for any of the subset variables.
- Perform up to eight levels of multivariant analyses for any subset produced. For example, in the three-level analysis, a crosstab of accident time of day by day of the week could be produced for all severity levels.
- Obtain a correlation table for all combinations of subject variables.
- Find high accident locations according to user-specified criteria. (Locations are specified by road codes and mileposts.) The interactive nature of this task enables the user to try any number of alternative criteria in order to obtain the number and type of high accident locations the user needs to work with.
- Obtain univariant distributions of any or all variables for the locations found to be high accident locations. (The same capability also exists for any other location specified by the user.) A separate report is produced for each high accident location and for each accident. This condenses the information for ease of review before location investigations.
- Obtain any of the reports specified by the above capabilities for any or all of the high accident locations.
- Create a logically restricted subset from any previously created subset. Because the user can obtain many different logical restrictions (for example, composite geographical areas) from a subset without rereading the master data base, which is usually stored on tape, computer time can be greatly reduced.
- Integrate demographic information and thereby establish priorities among political subdivisions for various accident types. For example, RAPID produces priority lists for cities by population grouping according to the number of motorcycle accidents divided by any one of several demographic indexes, such as population, miles driven, or number of registered motorcycles.
- Obtain further statistical analyses (RAPSTAT), including analysis of variance, breakdown analysis, regression analysis, scatter diagrams, and a variety of student's t-test options.
- Obtain accident report numbers for any subset of accident records so that hard copy for particular types of accidents can be retrieved.

The RAPID system can be best explained by tracing the data from the origin to the final output report.

When a pedestrian accident occurs, an officer in the field records the accident on a standardized form, which is sent to a central point for data entry. Along with thousands of other records, it becomes part of the state's accident records data base, which is generally stored on tape.

The accident records data base is generally not constructed with problem identification in mind. In fact, it contains virtually all of the "codable" elements from the accident records. Many of these are not required for problem identification work, and they are generally not in a form compatible with problem identification. For example, the pedestrian's actual age is probably coded on the tape, whereas age intervals (e.g., 0-4, 5-7, 8-9, 10-15, 16-21, etc.) would be much more useful for problem identification and cross tabulation. In addition, certain calculations and other data manipulation might be required to satisfy the requirements of problem identification. For these reasons, the data base must be cleaned up before it can be used for problem identification. This may be done once a year for the data base compiled from the previous year. The program that reformats and puts the data elements into their proper intervals is known as the BASE program.

The BASE program is then run to create a new tape, the RAPID master data base, which is totally compatible with RAPID formats and objectives. RAPID can work on any properly formatted data base. The arrangement, number, and type of variables are totally flexible and may be specified by the user during the development of the BASE program. Since the new, properly formatted tape is too large to generate statistical reports efficiently, a subset of the RAPID master data base can be created on highway speed direct access storage whenever processing is required. This subset can be either retained for repeated use (cataloged) or used immediately and deleted.

Any number of subsets of the RAPID master data base may be established. User commands specify the variables and the logic. For example, the pedestrian accident record might become part of subsets for a statewide pedestrian analysis and for analysis of all accidents in the city.

Residing in a small subset, the data are now ready for quick processing through any of the RAPID processing options—frequencies, histograms, crosstabs, multivariant analyses, correlation analysis—or through any of the RAPSTAT options. Data may also be processed through the other RAPID specialized software options.

If a user wants to do many logical restrictions without going back to the RAPID master data base stored on tape, he or she can logically restrict from a previously created RAPID disk subset by using slightly modified commands. The process is quicker than creating the first subset. The result is referenced in the RAPID documentation as a restricted subset, which is processed immediately by the system and then deleted. An unlimited number of these restricted subsets can be created and processed simultaneously from any given subset.

The philosophy under which RAPID was developed is quite simple: to free the user from all unnecessary operations without sacrificing computer efficiency. There are many trade-offs among user flexibility, computer efficiency, and simplicity. Quite often an overemphasis on one will lead to a critical sacrifice of the other. By understanding what is actually taking place within RAPID as well as the reason for the current RAPID design, the user can better understand and employ the full resources at his or her disposal.

ACCIDENT DATA: A LIMITED TOOL FOR EVALUATION

A. James McKnight, National Public Services Research Institute

Accident statistics used for highway safety program evaluation have been criticized as long as they have been compiled. The charges leveled against them are that they are neither representative nor comprehensive nor accurate. They are also inadequate; other data are needed before accurate conclusions may be drawn.

Accident statistics do not include all of the accidents that occur. They are not supposed to. Minimum thresholds of property damage and injury are used in all accident reporting systems to keep the system from being swamped with statistics on minor accidents that would be of no real benefit to the practitioner or scientist.

The problem is that a large number of the accidents that are supposed to be reported are not. Drivers surveyed on their accident experience almost invariably list more reportable accidents than are shown on their official records. Only a third of all insurance claims appears on state motor vehicle records, even though police are called to the scene about three-fourths of the time. Can countermeasures directed at a population of accidents be legitimately evaluated through a sample of those accidents?

Data from accident reports are not comprehensive. They are limited to the number of variables that can be used to describe the accident. Police reports are limited by the many other duties the police must perform at the accident scene. Drivers' reports are limited by the amount of information the police can request without losing a driver's cooperation. Information provided in accident reports is often inaccurate. Few police have enough training in accident reconstruction to determine what really happened. Those that have the training often lack the time necessary to gather and analyze the available data. Data sources are often unreliable. Most of the information concerning speeds and direction, for example, comes from the people involved. Driver reports, both those given orally to the police and those submitted in written form, are frequently distorted by misperception, inability to recall, and simple bias.

Data other than accident data are needed to evaluate the impact of highway safety programs. Other factors such as exposure or outside causes may be responsible for changes in the number or severity of accidents.

When the effect of these factors cannot be controlled experimentally by the way the program is conducted, they must be controlled statistically through the use of data that describe their nature and magnitude. However, vehicle and driver records are kept for on-line, operational use—not for compiling statistics.

From the criticism, it might seem that accident data were inadequate to assess the impacts of highway safety programs. Actually, accident data have proven sufficiently representative, complete, and accurate to provide some measure of the impact of highway safety programs on the real accident experience of people, vehicles, and roads.

The problem arises when, in the evaluation, impact is not found. The effects of most safety programs are marginal; only rarely does a safety program achieve results that could be called dramatic. As we move from changes in the vehicle and highway to changes in the way people drive, we are lucky to find countermeasures that make a difference of more than a few accidents per thousand drivers.

The smaller the impact, the more precise the measure must be. Of the many programs that have produced no discernible impact, a substantial share could have been shown to be cost-effective had a more precise measure of impact been used. The same is true where outside factors are involved. A true impact may be masked by differences in exposure and other accident-related factors that could be identified and controlled with better data.

Despite their shortcomings, accident data are the best available criteria for evaluating program impact. Accidents define safety; for administrators and legislators they are the most convincing evidence of impact. Accidents are also the only common denominator in comparing programs with different immediate objectives and are the criteria most readily expressed in the dollar terms needed for cost/benefit analyses.

The issue is not whether accidents are acceptable criteria for evaluating highway safety programs; rather, it is what can be done to improve their reliability as a measure of program impacts. Some suggestions include (a) limiting the data, (b) making better use of driver reports, (c) consolidating files, and (d) collecting exposure data.

LIMITING THE DATA

We need to recognize that the agencies we rely on have functions other than serving as data pipelines. We have to do a better job of accommodating our requests to what they are able to provide.

The job of the traffic police is to keep the street safe. In an accident, they must protect the accident scene, take care of the injured, and see that damaged vehicles are cleared away so that traffic can start moving again. Serving as an arm of research and evaluation is the least of their concerns, and their priorities are not going to change. If we want reliable accident information, we must accommodate police responsibilities, not add to them.

One way to do this is to reduce the amount of information requested. For evaluation, it is most important to know who, what, where, and how bad. If we can collect this information reliably, we can assess the involvement of the people, vehicles, and roads toward which our programs are directed. Other information, such as whether the sun was out, what direction cars were traveling, or where the vehicle was hit, is not generally critical to evaluation; when it is, it can be obtained from other sources.

We can also limit the kinds of information officers are required to report. We need to eliminate information that officers cannot collect accurately because they have neither the training nor the time. Cutting out information that cannot be reliably gathered will reduce the amount of information to be collected without sacrificing the usefulness of the reports.

If paperwork is reduced, police will be more willing to prepare reports. Therefore, the number of reported accidents will increase.

MAKING BETTER USE OF DRIVER REPORTS

In most states, drivers involved in accidents that meet minimum damage thresholds are required to furnish reports of accidents to their insurance agencies. These reports duplicate the content if not the format of the police reports. Prepared under less trying circumstances than the police report, they could be used to provide information now currently furnished by the police. Such information would include weather conditions, speed, and the use of restraints. Drivers' reports could also be used to collect information not currently collected, such as amount of driving experience, destination, and annual mileage. Certainly, any expansion of the content of the accident reports should be directed toward drivers' reports rather than police reports.

In addition, supplementary drivers' reports could be used to collect a greater depth of information for selected classes of accidents. Drivers would be selected on the basis of information provided in the routine reports. Selection of forms and addressing of letters would be completely automated.

CONSOLIDATING FILES

Traffic records are currently maintained in a number of files by a number of different agencies. The most common files are

1. An accident file consisting of police reports, generally maintained by the state police;
2. A driver file containing information about drivers and traffic violations, maintained by the agency that issues licenses;
3. A vehicle file containing information about the vehicle, maintained by the agency that registers motor vehicles; and
4. A road file containing information about road segments and locations, maintained by state and local highway departments.

It would be helpful if accident data collected from police reports were made a part of the driver, vehicle, and road files. If the accident information were sufficiently limited, it could be recorded in its entirety. This consolidation would have the following advantages:

- Increased Amount of Information—Since the data in each file would be available, more information could be obtained about the people, vehicles, and roads involved in each accident than could be obtained from accident reports.
- Limited Data Collection—The accident report would only provide positive identification of the people, vehicles, and locations. All other information, such as driver age, vehicle engine size, and roadway surface, would be drawn from the appropriate files.
- Control of Exposure—Every time accidents were analyzed, we would know exactly the population on which the accidents were based. Analysis could be made on a per-driver, per-vehicle, and per-road-location, or per-road-mile basis. This would provide control over changes in the numbers of people, vehicles, and road location or miles occurring between groups being compared in the evaluation.

Most road files already contain a volume of accident information, but the agencies responsible for driver and vehicle files may not welcome the addition of accident information. The highway safety agency could periodically duplicate these files for their own use and add the accident information. With their own files, evaluators could analyze information without having to work around operational uses of the file.

COLLECTING EXPOSURE DATA

Research studies are designed to control differences in exposure among groups being compared. In evaluation studies, the differences in exposure must be adjusted. In the past, changes in exposure were fairly gradual and predictable from trends of previous years. More recently, however, wide fluctuations in the availability and cost of fuel have produced substantial and unsystematic variations in exposure. Until now, exposure data have been collected almost as an afterthought, but now it must be accorded the same priority as the collection of accident data.

Highway departments have done well in determining exposure of various road segments. This is so largely because the same information (traffic counts) is used for operational purposes.

Some states have begun to collect odometer readings as a renewal registration requirement to provide estimates of annual vehicle mileage. For drivers, estimates of miles traveled could be obtained as part of the license renewal process. This source would furnish a third to a quarter sample of the driver population each year. Estimates of total exposure would be generated from this sample.

None of these suggestions will solve problems that limit the usefulness of accident data for evaluation. We are not seeking solutions but ways of ameliorating these problems so that our truly cost-effective programs will be recognized.

MINIMUM RESOURCES REQUIRED FOR PROBLEM IDENTIFICATION, GOAL SETTING, AND PROGRAM EVALUATION

Jerry G. Pigman, Kentucky Transportation Research Program, University of Kentucky

The minimum resources needed to use accident statistics and other data effectively for highway safety program administration are directly related to the problem identification, goal setting, and evaluation tasks outlined in the Highway Safety Program. This program is expected to undergo a number of changes in FY 1982 as activities are streamlined to keep budgets within new funding limits.

The new NHTSA guidelines call for significant reduction in all activities. Specifically, the problem identification or analysis portion of the state's highway safety plan will be required to be only a three- to five-page summary broadly describing the state's highway safety problem, statewide evaluation plans will no longer be required, and the past requirement for one in-depth evaluation each year has been waived. However, administrative evaluation of each project will still be required to determine whether projects meet their objectives. In addition, all impact projects will be subjected to some form of impact evaluation, and the data on a minimum number of specified impact measures must be provided to NHTSA.

It is important to note that a problem identification summary will require a thorough analysis of specific program areas before summary data can be presented. Similarly, even though evaluation requirements will be reduced and some responsibility will be shifted to NHTSA, a significant amount of data for project impact evaluation will have to be collected by the states.

PROBLEM IDENTIFICATION

While many projects have immediate objectives such as increased safety-belt use, reduction in drinking and driving, or compliance with the speed limit, their ultimate goals should be to reduce the frequency and severity of accidents. The development of effective safety programs requires accurate identification of accident causes.

The problem identification process is used to determine the magnitude of various highway safety problems based on accident statistics. It involves the following steps:

1. Identification of data sources and collection of data,
2. Collection of normalizing data,
3. Analysis of data,
4. Development of the problem identification report, and
5. Ranking of identified problems.

Identification of data sources and collection of the data can be overwhelming tasks. States need adequate technical staff and an accessible computerized accident data base. The major data collection effort will be centered on the accident, driver, vehicle, and roadway files. As an example of the effort required to identify problem areas, Kentucky's problem identification report for FY 1982 includes 24 areas that were investigated. This comprehensive problem identification process may be more than the streamlined safety program can justify in the future; however, a data base has been established that will be of significant value for future programs. It is interesting to note that the areas targeted by NHTSA for FY 1982 funding are the following: alcohol countermeasures, police traffic services, emergency medical services, and traffic records. In addition, other areas that were mentioned as candidates for funding were occupant restraint and motorcycle safety. In comparison, those areas recommended for safety project implementation in Kentucky's FY 1982 problem identification report were speed-related accidents, alcohol-related accidents, safety-belt use, school-bus accidents, and vehicle defects.

The analysis to normalize accident statistics requires data on population, licensed drivers, registered vehicles, miles of roadway, miles driven, and average daily traffic. The most commonly used and readily accessible measures of exposure are population and registered vehicles, but mileage driven is particularly important in preventing misinterpretation of data. When mileage data are not available, it becomes necessary to use only population data and to evaluate the results accordingly. Because offices of highway safety most often do not have the capability to collect data on miles driven, highway safety programs must depend on data provided by other state agencies.

The analysis plan must specifically identify individuals responsible for analysis and the overall approach. Generally, the problem areas investigated will dictate the level of analysis required. The availability of normalizing data must be determined before the overall analysis plan is implemented.

In the first cut or overview, accident rates should be calculated for various jurisdictional or geographic subdivisions on a statewide basis. At this stage it may be helpful to further segregate the data by population groups. Average and critical rates can then be calculated by population category, and normalizing data can be used to establish the differences in accident frequencies.

In the next level of data analysis, subgroups of drivers, pedestrians, or vehicles, and specific problem areas such as alcohol or speeding, are identified. Additional analysis of subgroups is necessary to identify problem populations by jurisdiction, age, and sex, or problem highway locations.

Computer packages or automated data management systems such as DART, RAPID, and ADAAS appear to be necessary for performing the required levels of analysis. Data from national files to compare with state data are a useful supplement.

The problem identification report can be prepared in many forms but should include a summary of findings, conclusions, and suggested countermeasures. The findings should present the problem areas investigated, explain briefly why the problems exist, and estimate their magnitude. The conclusions should be a more refined summary of findings and a precise delineation of the problems. Countermeasures should be suggested for problems that appear to have reasonable solutions.

The priority ranking of problems used to plan countermeasure programs should be based on the degree of overrepresentation and the expectation of reasonable countermeasures to eliminate or reduce the problems. The target population and cost/benefit of the countermeasures should also be considered.

Limiting factors in the analysis are the quality and availability of data, the availability of data processing hardware and software, the number and capability of personnel, and time and budget. At this time of funding cutbacks, it has become even more necessary to establish the minimum resources required to use accident statistics and safety-related data. The core of an analysis team should be a technically oriented person who is thoroughly familiar with accident, driver, vehicle, and roadway data files. This person should also have basic statistical capabilities. Generally, the only additional support personnel required are computer programmers, technicians for data summary, and graphic artists for preparing the report.

In Kentucky, the reports for FY 1980 and FY 1981 were prepared by the Kentucky Department of Transportation by using two engineers and a support staff. The FY 1982 problem-identification report, which was generally an update of previous reports, was prepared by the same staff after being transferred to the University of Kentucky. With background data accumulated to prepare these reports and the narrowing of the problem areas eligible for funding in FY 1982, it appears that an adequate report could be completed for a reasonable cost in the future.

GOAL SETTING

Goal setting necessarily depends on problem identification; realistically, only solutions of identified problems can be singled out as practical goals. Thus, while goal setting is basically an administrative process, the decision makers must draw on support data from problem identification.

The first step in the goal-setting process is to establish initial goals and objectives for each problem area identified. The NHTSA guidelines for highway safety management present six factors that should be used in determining safety program goals. These are as follows:

1. Cumulative effort of program module impact goals on overall highway safety program impact goals,
2. Relation to support goals,
3. Link to identified problems,
4. Relation to proposed programs and projects,
5. Relation to program and project evaluation, and
6. Available sources.

Each program module is based on specific goals set in this step. When the detailed project development has been completed, the goals and objectives in each problem area should be adjusted to reflect the specific projects and activities planned. At this stage, the reasonableness and cost-effectiveness of the countermeasures should again be considered.

The second step to the goal-setting process is to combine the goals for the individual problem area into overall goals for the highway safety program. Overall goals are not a simple summary of individual goals; some may overlap. Generally, setting the initial goals and objectives should be the responsibility of the state highway agency with endorsement from NHTSA regional offices.

EVALUATION

The purpose of project evaluation is to measure the effects of a program or project against the objectives that it was designed to achieve. Specifically, the evaluation is conducted for the following reasons:

1. To determine the effectiveness of new projects as compared to existing projects,
2. To see where old projects could be improved or expanded to increase their effectiveness in achieving their objectives,
3. To measure the cause-and-effect impact of projects,
4. To discover in quantitative terms what projects have accomplished and at what cost,
5. To help select alternatives to achieve a project's objectives, and
6. To satisfy state and federal requirements for project funding.

Evaluation may be viewed as a prerequisite to planning and, therefore, as an essential part of the management process. Because evaluation requires both a statement of project objectives and a systematic collection of data on the achievement of objectives, it enables program coordinators and project managers to maintain project direction and to gauge short- and long-term consequences. Therefore, evaluation serves as the basis for change in project effort or emphasis. It allows managers to increase project effectiveness by learning from past experiences.

Like all administrative functions, evaluation requires time, money, facilities, and personnel. Since there is a very close relation between evaluation results and management decisions, it is essential that the managers have adequate staff support to perform the analysis and to provide the advice needed for a proper evaluation. The agency size and evaluation requirements will dictate the organization and size of the staff. A state can create a separate evaluation unit responsible for designing evaluation components for each program unit or assign the basic responsibility for evaluation to a staff member responsible for program element development. The first approach would involve assembling a highly specialized staff, including systems analysts and operations researchers. Such a system is frequently too expensive for state safety agencies and has the disadvantage of creating an unmanageable evaluation bureaucracy that could become self-serving and unresponsive to management needs. Under the second approach, the program manager would require support from specialists in evaluation and mathematical systems analysts hired on a consulting basis.

Generally, two basic skills are required for program evaluation: experimental design, which presumes a knowledge of statistical principles, quantitative methods, and data processing. Evaluation of most highway traffic safety programs involves the collection and analysis of data. Direct presentation of the data is often very meaningful; however, more complicated approaches that use computer-assisted data processing allow more precise and complete evaluation. The appropriate level of sophistication is usually difficult to determine, and a frequent mistake is an evaluation effort that is inconsistent with the nature of the project. This is frequently a problem when dealing with outside professional evaluators or in-house staff evaluators.

A state safety agency attempting to develop and maintain an evaluation capability should include on its staff one individual with specific academic training in experimental design, data analysis, and data presentation. Other specialists should have advanced training in statistics and computer use and should be able to apply their skills in experimental design and research in social program areas. In the early stages of developing a state evaluation program, personnel with backgrounds in both evaluation and research methodologies will be needed. As they may not be needed fulltime, they can be hired as consultants. They will be called on to assist in determining personnel requirements, to provide input in the initial development of evaluation work plans, and to review the evaluation methodology developed by the program staff. Although consultants to provide this type of assistance can be found in government agencies, these services are more typically performed by universities or the private sector.

The cost of the evaluation must be considered an integral part of program and project costs. Project plans should provide for adequate funding of its evaluation component. Projects generally fall into one of three broad categories: (a) monitoring operations that require minimal evaluation, (b) projects that provide a definite evaluation plan requiring some data collection, and (c) projects that require a relatively detailed evaluation because of the countermeasures they employ (projects in this category may allocate substantial funds for evaluation and may employ outside evaluators).

The evaluation costs in these three categories vary greatly, depending on the nature of the project. Costs for projects in the first category should be minimal. Costs for those in the third category may be substantial. To provide the minimum resources to evaluate highway safety programs, evaluation costs need not exceed 10 percent of the total project cost. Exceptions to this guideline may involve sophisticated programs requiring unusual efforts in data collection and analysis.

Reduced funding available for the Highway Safety Program in FY 1982 will obviously result in reduced staffing at both the state and federal levels. However, evaluation activities cannot be reduced proportionately because the emphasis on demonstrating impacts will increase when future funding for the program is being considered. The need for evaluation will have to be met with the reduced resources. Although NHTSA's new evaluation policy will simplify current procedures and shift some of the analytical effort from the state to the federal level, the states will continue to need technical staff to plan and manage project evaluations.

The new NHTSA guidelines provide for three types of evaluations: administrative, effectiveness, and state program. Administrative evaluation includes a comparison of planned versus actual performance or activity and the determination of unit cost in achieving the level of activity. This type of evaluation has always been required on all projects and can usually be achieved through the National Project Reporting System (NPRS). NHTSA data requirements will be limited to an initial summary of data from the project agreement and a final collection of minimum data on the performance measures specified in the project agreement. States will have very little involvement in this type of evaluation because data collection will be the responsibility of the NHTSA regional offices.

Effectiveness or impact evaluation includes the determination of the effectiveness of a project in changing behavior or in reducing death and injury on the highway. Data on impact measures have always been required of all impact projects. For this type of evaluation, NHTSA will provide data analysis services when requested by a state.

At present, NHTSA requires two types of project impact evaluations. States have been required to collect accident data on conditions before, during, and after the project as part of the evaluation phase of all projects. In addition, each state has been required to conduct at least one detailed impact evaluation each year. The requirement for the detailed evaluation has been dropped in the new guidelines, and the states are being encouraged to conduct minimal effectiveness evaluations on all their impact projects. Where the state requires analytical assistance to conduct an impact evaluation, NHTSA will perform analyses after accident data have been collected.

State program evaluation includes a general review and a program summary emphasizing accomplishments, particularly those of innovative and impact projects. Annual and semiannual reports have always been required; however, requirements for semiannual reports will be eliminated, and annual reports will be simplified. Annual reports are expected to be 10 to 20 pages long and they will be issued by the states each year on January 1.

DATA ANALYSIS AND INTERPRETATION PROBLEMS

James Nugent, Indiana Division of Traffic Safety

There are two sides to the problem identification process: the managerial side, which pertains to the way problem identification interacts with the overall state management process, and the technical side, which pertains to the statistical procedures and constraints in data analysis. It is the technical side of problem identification that concerns us here.

In practice, the technical aspect of problem identification involves the empirical techniques used to reveal correlations among accident variables. Correlations, however, do not necessarily relate to causality. A theory or hypothesis must be constructed and tested to explain the correlations, the extent of their association, and how they interact to produce accident conditions.

There are, then, two steps in technical problem identification. First, from the current research available, a hypothesis is made of the problems that exist, the circumstances under which they develop, and how they can be measured. Second, the data gathered from statewide accident records are used to test the hypothesis and to determine the magnitude of the problems in each locality.

At the state level, a number of problems limit the usefulness of accident records as the primary data source:

- Accident data are often gathered from a single data-gathering instrument that must serve many needs and agencies.
- Accident reports are often unreliable or invalid.
- Adequate exposure data are often lacking.
- The real significance of overrepresentation is often difficult to establish.

TECHNICAL CONSTRAINTS TO PROBLEM IDENTIFICATION

Accident Reports As the Sole Data-Gathering Instrument

Highway safety agencies often must rely on data from accident report forms that must serve the needs of several agencies. Even when they have input into the development of procedures, the safety agencies still cannot get all the information they require. Recently, Indiana redesigned its central accident records system. As a part of that process, a committee of representatives from several agencies met to develop a new accident report form that would serve their diverse needs. To prevent the form from becoming unmanageable, each agency was required to justify each data element and report that would be required. The Division of Traffic Safety, the only agency interested in research requiring a broad-based information system, found such justification difficult. Consequently, the report form that emerged was a compromise. Although far better than the previous form, it fell short of being an adequate instrument for research.

Data Validity and Reliability

Data gathered from accident reports is often incomplete and unreliable. Indiana, which is not an especially large state, has 225 000 accidents annually; these accidents result in more than 440 000 records on vehicles, drivers, and injured occupants. Roughly two-thirds of the reports on these accidents are generated by an investigative agency, and the remainder is reported by the public. There is little quality control, and it cannot be assumed that the inherent bias of such reports is randomly distributed.

Even with training, police often give inaccurate and incomplete reports. Indiana requires every new state and local police officer to be formally trained in accident investigation. A report by the Institute for Research in Public Safety, however, demonstrated that police frequently misidentify descriptive data, omit relevant information, and exhibit a low sensitivity to accident causation factors. According to one study, even such a simple factor as driver age was incorrectly identified in 11.6 percent of the accidents reviewed. In descriptions of the accident environment, police performance did not exceed the chance level of any factors cited. If these are the results of disinterested and professional police officers, it is reasonable to question the reliability of reports from accident participants.

Accident data may be highy unreliable for some particular subpopulations. In some states, data on motorcycle and moped accidents are combined. Because the characteristics of the two operators have been shown to be quite different, this mingling of statistics hinders proper assessment of the problem and selection of countermeasures. Similar problems are involved in obtaining separate data on trucks (and pickups), school buses, and off-road vehicles. Any attempt to refine these kinds of data is constrained by a large error factor.

Exposure Data

Exposure data used to normalize accident data are based on time, travel, events, vehicle attributes, vehicle type, and driver attributes. No one measure can serve all analytical needs; appropriate data are determined by the hypothesis being tested. For example, motorcycle exposure data are virtually nonexistent. Without exposure data, however, prioritization and comparison become problematic.

Exposure data are difficult and sometimes impossible to obtain. In Indiana, for example, annual vehicle miles traveled are obtained from gasoline tax revenues, but such broad data are obviously of low statistical value. The Department of Highways conducts special studies throughout the year, but these do not provide exposure data by age, sex, vehicle type, vehicle defect, or political subdivision.

The lack of exposure data poses severe problems in the identification of target groups. Young drivers, for example, are thought to be overrepresented in accident samples because the proportion of young drivers involved in accidents is greater than the proportion of young licensed drivers. However, the data are not controlled for vehicle miles traveled by young drivers, miles driven by sex, or the time or area in which the miles are driven. It may be possible to assume that exposure is a constant if comparisons can be made among similar groups, for example, young drivers in certain classes of urban areas controlled for population, registered vehicles, and socioeconomic factors. However, this kind of comparison is frequently impracticable. Indianapolis, for instance, is demographically unlike any other city in Indiana.

The lack of data also makes it difficult to test hypotheses. Gasoline supplies most likely affect accident rates, but the effect of fluctuations probably will not be uniform among all groups. Discretionary travel probably is the most dramatically affected, while commuting patterns may prove relatively inelastic, at least in the short run. Fatality rates, which are thought to be more sensitive to discretionary travel, may fall. In Indiana, the total number of reported accidents rose by more than 31 000 during 1976-1978, while the number of fatal accidents increased by only 50. However, since the state has no reliable estimate of vehicle miles by type of travel, it is not known if the smaller proportional increase in fatalities was the result of a drop in discretionary travel.

Adequate exposure data are essential in identifying countermeasures. A problem group may have a high absolute number of accidents, but if it also has a high exposure rate and, hence, a low accident rate, effective countermeasures may involve inordinate expense.

Some studies can be conducted without exposure data. For example, the effect of repealing a state's mandatory motorcycle helmet law may be determined by comparing the ratio of fatalities to injuries or accidents before and after the law was repealed. If helmets had reduced fatalities, the ratio would be expected to increase over time. Unfortunately, not many highway safety problems lend themselves to this kind of analysis.

Significance of Overrepresentation

Even assuming that groups overrepresented in accidents can be statistically isolated, the significance of the figures must still be determined. The problem is that comparisons must be made with similar populations, not the total population. For example, the number of moped accidents has risen over the past four years in Indiana. But because there is no population with which to compare Indiana's sample, a goodness-of-fit test cannot be made, and the significance of the rise cannot be determined. In addition, the isolation of an overrepresented group may or may not indicate causality—even if a statistical relation among a set of variables can be demonstrated.

DIRECTION OF HIGHWAY SAFETY PROGRAM

Many highway safety agencies are not major forces in developing state highway safety policy or in implementing highway safety programs. The difficulty of the state agencies in directing highway safety efforts effectively is probably the most serious problem in the national program. Highway safety agencies must be strengthened within their organizational and political milieu. Their statutory authority must be increased and their technical staff must be upgraded. Unified federal guidance is needed in problem identification, program management, and evaluation.

As a first step, the federal government should conduct the research to develop accident causation methodology, exposure data, and analytical techniques. This research is properly the province of the federal government and research institutions, while the application of that research should be that of the states. Without federal assistance and cooperation, there is little chance that highway safety agencies will increase their effectiveness.

MANAGEMENT USE OF ACCIDENT TRAFFIC STATISTICS AND SAFETY-RELATED DATA: A STATE PERSPECTIVE

John A. Pachuta, Pennsylvania Department of Transportation

Pennsylvania, like most states, is suffering from the shrinking tax dollar—revenues are down, expenses are up. We had experienced a considerable decline in fuel tax and associated revenues even before the current administration's federal budget reductions. To consolidate our resources and increase effectiveness in directing Pennsylania's Highway Safety Program, we have combined our operational and program personnel into a single department. As a result, Pennsylvania now has in place a responsive accident-reporting system that provides useful management information for implementing a statewide highway safety program.

HIGHWAY SAFETY ORGANIZATION

Until two years ago, Pennsylvania's Section 402 Highway Safety Program was managed by the Highway Safety Group (HSG) of the state's Department of Transportation (Penn DOT). The program manager, as head of this group, reported directly to the secretary of transportation, who was designated the governor's highway safety representative. Although idealistic in design, this structure was impractical. The HSG was independent of operational areas, but support from these areas was often difficult to enlist. In addition, HSG was only one of many responsibilities of the state's Secretary of Transportation, and consequently could command little of the secretary's attention.

Early in 1980, Transportation Secretary Thomas Larson approved a reorganization of Penn DOT. The HSG was combined with the former Bureau of Accident Analysis and other related, formerly independent groups to form the Bureau of Safety Programming. The new bureau was placed under the deputy secretary for safety administration (SA)—one of five deputates reporting to the secretary—and Deputy Secretary John J. Zogby, as head of SA, was designated the governor's representative. In essence, this reorganization placed the accident data collectors and users together at the operational level.

As in any reorganization, establishing new lines of communication, redefining responsibilities, and physically realigning work areas made the work flow awkward at first, but the benefits became apparent almost immediately. The new organization has resulted in one of the finest problem identification efforts to be found in the highway safety plan process, and Pennsylvania is now in a position to devise a performance-oriented highway safety program.

ACCIDENT RECORD SYSTEM

The Pennsylvania Accident Record System (ARS) compiles information on 150 000 reportable motor vehicle accidents (including about 2000 fatal accidents) each year. Up to 657 data elements that relate to the driver, vehicle, roadway, conditions, and circumstances of the crash are recorded on each accident record. Accident information is maintained in a "live," year-to-date file accessible for analysis; a three-year, fixed accident record file provides the basis for highway safety problem identification and program management.

The ARS provides a two-way exchange of information with the operator license (OL), vehicle registration (VR), and Pennsylvania roadway information system (PARIS) files. The creation of an accident record updates the driver record on the OL file, and the OL checks the validity of driver information on the accident record. Roadway information on the ARS report is checked against the PARIS data base, and incorrect data on the accident location are noted and corrected.

DATA ANALYSIS

Both MARK IV and DART/OMNITAB are used to run a number of year-end programs against our accident data base. These programs provide a number of outputs, including a municipal accident priority rating, which ranks each of Pennsylvania's 2564 municipalities; wet-weather accident location clusters under which our skid-testing program is directed (this program recently won praise from the National Transportation Safety Board based on our skidding accident rates); intersection rankings within municipalities; and fixed-object-hit clusters within engineering districts. Our programming capabilities have been expanded to the degree that, for some years now, Pennsylvania has not had to employ Fatal Accident Reporting System (FARS) analysts. The FARS information is programmatically retrieved from the various data bases, converted to FARS format, and submitted by tape each month.

With the output side relatively secure, our analyses are now constrained only by the limitations of input data. Data inadequacies are a result of the latitude of interpretations made by those reporting accidents and the lack of understanding in the field concerning how these data are used. By meeting with investigating agencies and by addressing problems in a bimonthly newsletter, we have significantly improved the data input to our system.

PROBLEM IDENTIFICATION: THE GAO PERSPECTIVE

Dennis J. Parker, U.S. General Accounting Office

Why did the U.S. General Accounting Office (GAO) decide to review the highway safety grant program of NHTSA? Once every two years, the GAO auditing groups are required to develop a list of federal programs that should be reviewed for economy, efficiency, and effectiveness. Taking into consideration such factors as the amount of federal money involved and congressional interest, they then list by priority the programs they hope to review within a given time period.

In the June 1978 program plan for the transportation systems and policies issue area, the Highway Safety Audit Group (HSAG) identified as a priority assignment the evaluation of the management and effectiveness of federal highway safety grants to states and local communities. This program covers about two-thirds of NHTSA's annual budget and is of considerable interest to Congress.

SCOPE OF HIGHWAY SAFETY GRANT PROGRAM REVIEW

In May 1979, HSAG began a review of the highway safety grant program and, on October 15, 1980, the group issued a report to the Congress, Highway Safety Grant Program Achieves Limited Success (CED-81-16). This review focused on the activities of state highway safety agencies and summarized the overall accomplishments of the program. The administrative responsibilities and duties of NHTSA's and the Federal Highway Administration's (FHWA's) headquarters, regional, and division offices were also reviewed.

Nine states were included in the review: Maryland, Pennsylvania, Illinois, Ohio, Texas, New Mexico, Colorado, South Dakota, and Utah. These states were chosen because they represent the following variances:

1. Four of the states are in the West, where motor vehicle fatalities increased 25 percent from 1975 to 1978.
2. Three of the states are in the Midwest, where fatalities increased 11 percent from 1975 to 1978.
3. Two of the states are in the Northeast, where fatalities increased only 3 percent from 1975 to 1978.

About 25 percent of the total $1.3 billion in grant funds allocated through FY 1979 were provided to those nine states. Allocations by state ranged from $6 million to about $50 million. About 25 percent of the recent motor vehicle fatalities occurred within those nine states. Fatalities by state ranged from 200 to 3600 annually.

As many highway safety officials as possible were interviewed within the nine states, NHTSA, and FHWA. A number of aspects of the highway safety grant program were discussed, including (a) the ability of federal and state governments to perform adequate safety planning through data analysis and problem identification techniques and (b) the requirements that affect how the safety grant program is carried out, including mandating (earmarking) grant funds to specific safety areas.

WEAKNESS OF THE PROBLEM IDENTIFICATION PROCESS

Inadequate Data

State and NHTSA officials were concerned primarily about the lack of adequate data. The specific problems included lack of trained staff to gather and analyze data; cost of maintaining and updating data; lack of an adequate collection system to ensure uniform, complete, and accurate data; and NHTSA's inability to fill in where state systems are weak.

NHTSA and FHWA recognized many of these weaknesses during a joint task force effort to improve the content and quality of state accident data. The following conclusions were outlined in a draft executive summary issued in July 1981, Accident Data Improvement Plan:

1. Accident data are not collected uniformly within all states.
2. Accident statistics compiled from state-furnished information are incomplete.
3. Data elements available for accident analysis vary significantly among states.
4. Routine feedback needed to improve report accuracy is missing in the majority of the states.
5. Adequate accident investigation training is not provided for state and local police officers.

Other groups outside of government are concerned with the accuracy and completeness of state accident data. The American Motorcyclist Association, for example, recently issued a second report on the accuracy of current motorcycle statistics. It concluded that uniform and representative data, as well as credible exposure data, must be maintained before properly founded motorcycle safety programs can be developed.

Lack of Problem Identification Criteria

NHTSA's problem identification manual calls for states to generate a large number of reports from their traffic records. However, there are no specific criteria for states to determine how significant a problem must be before grant funds can be used to resolve it. As a result, state officials also complained that time and money were being wasted on data analyses that would probably not affect how the funds were spent.

The GAO report recommended that the U.S. Secretary of Transportation establish criteria for the level of analysis necessary to address safety problems and evaluate results and to work with state highway safety agencies to ensure that the criteria are followed.

State Versus Federal Priorities

NHTSA and FHWA have been encouraging states to identify their most pressing highway safety problems before selecting projects to correct them. In some states, such as Maryland and South Dakota, officials told GAO investigators that they found the problem identification process to be a good way to manage grant funds. Other state officials, however, complained that the process does not work; the breakdown occurs, they said, because less than one-third of the grant funds is available to solve different state-identified problems than those already identified by the federal government.

Although federal earmarking of funds is likely to continue even when state problem identification analyses indicate that funds could be better spent elsewhere, the situation should improve. Congress is concerned with the ability of the states to identify and address their highway safety problems. A recent U.S. Senate bill (S. 1377, June 17, 1981) proposes to amend section 402(a) of the Highway Safety Act to read:

> "Each State shall have a highway safety program designed to reduce traffic deaths and injuries by identifying its highway safety problems, by adopting measures to reduce its highway safety problems, and by evaluating the effectiveness of such measures."

If the bill is adopted by Congress and subsequently becomes a part of the Highway Safety Act, the requirement for states to identify their highway safety problems will then be firmly recognized.

GOAL-SETTING PROBLEMS
B. J. Campbell, University of North Carolina

About a year ago there was much discussion—and some confusion—about setting quantified or numerical goals for programs. Some states saw quantified goals as something NHTSA wanted for them, whereas NHTSA felt that it was responding to a need expressed by the states.

Basically, goal quantification is an advance statement of how well the planner hopes a program will succeed. The problem is that in many cases there is no objective data to indicate the benefits of a particular program. Frequently, past evaluations and analyses have not been done, and numbers are pulled out of the air. For instance, 30 percent improvement sounds good, but it is unrealistic and unattainable. To bring about such a large improvement would require a higher level of funding than is usually available. Even if the project were funded, the evaluation data might not be sensitive enough to show a definite improvement.

Actually, the best number to pick for a goal is close to zero. Then, if the data suggest that the impact is somewhere around zero—it may not be zero, but it is probably not 60 or 70 percent either—the improvement is probably fairly modest.

Goals made in advance often have no basis. Program planners do not necessarily know how their countermeasures will work. In one project in North Carolina, a pilot project was set up to teach students a few rudimentary emergency maneuvers as part of their driver education. The standard 30 classroom h and 6 h behind the wheel were augmented with additional time behind the wheel during which the students were taught recovery maneuvers on the range—i.e., off the street and under safe circumstances. There was no basis for forecasting a percentage improvement that the program was to effect. In fact, when the project was evaluated, no improvement was found. If there were a benefit, it could not be measured in terms of subsequent accidents within the size population analyzed.

It is easier to set and meet administrative goals than impact goals. A goal of distributing 100 000 posters or of making 50 speeches to an average audience of 30 each is realistic, and the success of the project can be measured.

If impact goals must be set, however, several rules of thumb may help in setting them realistically. When a project planner starts with a program, he or she generally knows how much money can be spent. The planner also has the capability to estimate the cost of an accident. A 1974-1975 NHTSA estimate was $4000 per accident. Fatalities, injuries, and property damage were factored into this figure. Adjusted for inflation, this figure may be about $6000. By dividing the project amount by the accident cost, the planner gets a number of accidents that represents the project break-even point. For example, for a $60 000 project, the break-even point (the goal) would be to prevent 10 accidents.

Another way to set realistic goals is to determine the size of change that can be detected with some statistical significance. Where there is no such basis, setting quantitative goals should be avoided.

MANAGEMENT USE OF ACCIDENT STATISTICS: ADMINISTRATIVE AND ORGANIZATIONAL PROBLEMS
Cordell Smith, Colorado Division of Highway Safety

One of the most difficult problems faced by state highway safety managers is the lack of integrated and consistent traffic records. As the national highway safety effort was being developed, the need for systematic records was recognized, but not emphasized. As policy has shifted toward improved planning and evaluation, the seriousness of this oversight has become apparent.

In Colorado, available traffic records are used (a) to identify problems and set priorities, (b) to evaluate project or program impact, (c) to determine program cost/benefit, (d) to set goals within the departmental management-by-objective program, and (e) to justify programs to state legislators. But, like most states and NHTSA, Colorado is not doing the job that it could in these areas. The data are inadequate, and there are insufficient resources to upgrade our traffic records system.

The Colorado records system is used to address these specific questions:

- Which municipality or county has the worst accident problem based on vehicle miles of travel, population, miles of road, etc.? Would increased enforcement affect this problem?
- Which emergency medical service (EMS) district has the slowest response time or the best on-scene medical care? Why?
- Who are the people involved in alcohol-related crashes? If we develop a profile, could we intervene at some point before the individual is involved in a serious crash?
- What is the contribution of the roadway environment to the crash situation?
- What is the contribution of the motor vehicle inspection program?

- What is the contribution of the use of motorcycle helmets and occupant restraints in preventing serious injury or death?

Assuming safety agencies could answer such questions and were to develop countermeasure programs, they probably still could not determine the impact of individual projects. It may not always be possible to measure the effects of highway safety programs, but without quantifiable impacts to show, safety agencies cannot sell their concepts and programs to state legislatures, to the administration, and to Congress. In short, the system fails at the points critical to the continuation of highway safety.

WHY DOES IT FAIL?

State traffic records systems generally evolve in response to specific and varied demands and requirements. No one could have foreseen their extensive use in planning and evaluating highway safety programs. Consequently, the record systems are often out of date and lack the sophistication to deliver the complex data needed by highway safety researchers.

In addition, there is a lack of coordination between the efforts of the federal and state governments. The time has passed when records systems would have been most amenable to consolidation and change. To make these changes now would be prohibitively expensive.

Data inconsistencies result from differing definitions and lack of coordination between strategies, different reporting timeframes, and reporting errors on the part of source agencies. Because each agency designs its data files with specific uses in mind, few data can be integrated and much cannot be used for highway safety analysis at all. For example, under Colorado law, the Department of Revenue is charged with collecting and maintaining accident record, driver licensing, and vehicle registration files. These files are maintained for tax and fee collection, not for highway safety analysis. Hence, the data are not adequate for use by the Division of Highway Safety, and the manipulations that must be performed to develop useful files are time-consuming and costly.

Lack of timeliness in reporting data by some agencies affects the responsiveness of highway safety programs. Often, as a result of these delays, data are a year old before they are available for problem analyses.

Investigating officers are often responsible for the inaccuracy or incompleteness of data on accident reports. This is a situation that does not readily lend itself to correction. Although desirable, it would be extremely expensive to train every investigating officer in the state.

Most of these problems could be solved with enough money. Funding, however, is simply not adequate to correct most of these shortcomings, and the current national sentiment to reduce the cost of government does not make the future look promising.

WHAT CAN BE DONE?

Coordinating efforts of state and federal agencies could alleviate some of the duplication and inconsistencies in reporting. Ideally, one central agency should be responsible for data collection and dissemination. If this is not possible, then coordination between agencies must be established.

Innovative programs should be developed for on-site accident investigation. These programs could augment the Fatal Accident Report System (FARS) and National Accident Sampling System (NASS). Comprehensive management information systems should be developed for those areas of activity for which few or no data exist. Colorado is doing this with EMS. Data are not yet available to determine the impact of the program, but the system was designed with this in mind.

Intensive impact evaluations of selected programs could be performed on a national scale. The product of these evaluations would be observable, measurable impacts to demonstrate the effectiveness or ineffectiveness of highway safety programs. However, application of this approach to projects whose success depends on changes in human driver behavior is difficult. Past efforts at the national level have not resulted in products that are practical or possible to implement at the state level.

In many instances, these national efforts to quantify impacts have produced vague and inconsistent findings that have led state decision makers to question, perhaps prematurely, the value of established, existing programs. An obvious example of this is the motor vehicle inspection program. After more than 10 years and after the expenditure of millions of dollars, the crash reduction potential of these programs still has not been demonstrated conclusively. As a result, decision makers in several states have repealed or abolished inspection requirements, some of which had been in place for more than 40 years.

In many instances, NHTSA's research activity has been directed or influenced by political whim. Priorities established by federal administrators result in research and expenditures in areas that are of questionable value to the states. The result is the atmosphere of criticism characterized by U.S. General Accounting Office reports.

The absence of long-range research planning by NHTSA is an impediment to proper long-term planning for state highway safety programs. NHTSA research programs now drift with the constantly changing management decisions (or lack of them). When emphasis program areas are established in NHTSA, states should be an integral part of the process. States have the right to expect that such emphasis programs will be based on logic, that the programs will be supported by evidence of accident reduction, and that evaluation models containing data requirements and records system demands must be made available.

Today, driving in the United States is safer than driving anywhere else in the world. Much of this has been accomplished since the passage of the Highway Safety Act in 1966 and the establishment of a State Highway Safety Agency. Yet, despite these accomplishments, the Highway Safety Program remains the target of criticism—for which the lack of national leadership and lack of a unified national highway safety program are largely responsible.

ESTABLISHING THE LEVEL OF ANALYSIS REQUIRED TO ADEQUATELY ADMINISTER SAFETY PROGRAMS

Bennie R. Maffet, Kentucky Department of Transportation

We have come a long way since 1967 when we first started looking at traffic accident statistics. There have been many improvements in highway safety projects, and some of our programs to justify and evaluate these projects have become quite sophisticated. But federal support is shrinking. The question now is, What level of analysis is really necessary?

There is no set level. The National Highway Traffic Safety Administration (NHTSA) and the Federal Highway Administration (FHWA) have set minimal levels. New programs are being designed, and the rules of the game are changing. But with cuts in funding, states will not support a lot of these activities. It will be difficult to develop and use more sophisticated programs or to implement recommended improvements. States may even be asked to justify why they need to collect traffic accident data at all. Thus, the level of analysis needed cannot be prescribed. It will depend on what the states can afford and what will result in the greatest improvement. States all have basic tools for problem identification and establishing priorities. Better to use these than to be caught in an all-or-nothing situation.

When we leave this conference, we should go back to our states ready to support a coordinated effort. It does not have to be a governor's task force. We need to communicate with the people who make decisions and those who have input into decisions. The times ahead are going to be critical. The opinions on the level of analysis that we need cover a vast spectrum. Somewhere between the extremes is the level of analysis that we can afford and that we can use. We need to look at the resources we have in our own states. We need to see what level of analysis is necessary to support our highway safety programs and to make improvements.

USE OF ACCIDENT STATISTICS IN MICHIGAN

Thomas L. Maleck, Michigan Department of Transportation

The Michigan Department of Transportation has been storing and analyzing accident data in an automated format for more than 20 years. During this time, its analytic capabilities and data resources have steadily improved.

The department's systematic analytic tool was the SCREEN system. Operational in 1971, SCREEN provided tabular reports and an automated collision diagram. Its sole data sources were traffic volumes and accident reports. The automated collision diagrams required manual coding of the road geometry.

The Michigan Department of Transportation relied on minimum threshold numbers or rates of total accidents to identify roadway segments or intersections meriting engineering attention. The problem was that the system identified many of the same sites each year without showing a correctable pattern of accidents, while other locations that may have warranted improvement were not flagged for attention. The process was labor-intensive, and small projects were overlooked.

In 1969, work was begun to locate all accidents in the state (trunkline and local roads) with a uniform system. The Michigan Accident Location Index (MALI) was completed in January 1979 (the trunkline system was completed earlier in 1975). Principal features of the MALI system are the common accident report form used by all state and local agencies and the accident location system based on street intersections and street names.

In mid-1976, the department made a commitment to upgrade its ability to locate highway segments with correctable accident patterns and to widen its scope of analysis. The goal was to develop non-labor-intensive procedures for predicting the expected impacts of incremental alterations. A prototype model called the Michigan Dimensional Accident Surveillance (MIDAS) was developed for analyzing the state trunkline system (9000 miles).

MIDAS-I

The first generation model, MIDAS-I, may be described as a grouping of all roadway segments with identical physical and accident characteristics into dimensional families, each with its own unique distribution and statistical attributes. Physical characteristics used to group roadway segments included posted speed limits, presence of traffic signals, lane and shoulder widths, turns, and geometric data derived from the department's photolog (sequential 35mm color photographs taken every 52.8 ft along state trunklines and the Interstate system).

Although the photolog is the backbone for referencing all other data used in the project, the system has limitations. The precision of indexing the data has a maximum error of $\pm$52.8 ft; the film may be one to three years old; vertical curves, grades, and horizontal curves cannot be measured; and information on crossroads is difficult to obtain.

Only one alternative method was found to overcome the deficiencies. The degree of horizontal curvature and delta angle of deflection was obtained from right-of-way maps. Photolog and the right-of-way maps were then used simultaneously to establish mileage points at the beginning and end of each horizontal curve.

The location and magnitude of posted speed limits were obtained from paper files of departmental traffic control orders (TCO). The photolog was used again to determine a control-section mileage point for the end of each zone. Segments of roadway not covered by a TCO were defaulted to a 55-mph speed limit as provided by state law. The locations of traffic signals and special phasing and turn prohibitions were obtained from paper files. Because the width of shoulders along a roadway fluctuates, widths were established within the ranges of 0-4, 4-8, 8-10, and 10-12 ft.

With MIDAS-I, cells were rigidly structured by discriminating on all of the discrete variables. The dependent variables were the number of injury accidents (years) per segment for each type of accident. The result was a histogram showing distribution of accident frequencies for a set of constant variables. Recognizable patterns (usually a Poisson distribution) were evident.

A typical set of histograms for a family of intersections could show distribution of total, right-angle, left-turn, and nondaylight accidents. MIDAS-I produced 16 000 such histograms.

By analyzing each cell for the variance in the number of accidents per segment, outliers could be identified. An outlier is any segment whose dependent variable is of sufficient magnitude, when compared with its peers, that the probability of the event occurring by chance is remote. (In the histograms, the outliers are designated by an "O" as opposed to an "X" for the inliers.) The outliers are most likely a result of an unidentified variable.

At this point, MIDAS-I offered an objective, accurate means of identifying significant accident patterns, independent of the magnitude of accidents or accident rate. However, a system was still needed that would permit the evaluation of safety alternatives by predicting the expected number of accidents. The need for reliable accident predictive algorithms necessitated major changes in the methodology. Thus, MIDAS-II was developed.

MIDAS-II

With MIDAS-II, roadway segments were reestablished with variable lengths. A segment was created whenever there was a change in an independent variable.

Intersections were treated as dimensionless points with the same geometric attributes as the encompassing segments but with additional intersection-related attributes. A roadway segment could encompass zero to several intersections.

Also as part of MIDAS-II, considerable effort was spent in developing user-friendly software. No prior data-processing experience is necessary. The user enters the system with a simple command, and a menu of options is offered. The user interactively selects the analyses and the desired outputs. The end product of the process, which takes less than 5 min, is a stand-alone report complete with title page. The program is executed in a form displayed on the screen of the computer terminal.

Example outputs are

1. Intersection profile,
2. Directional analysis with a prediction of the expected number of accidents by type,

3. Overlay of a histogram of accidents with a histogram of volume by hours of the day,
4. Histogram of accidents by day of week,
5. Histogram of accidents by month,
6. Histogram of accidents by year,
7. One-line listings of each accident by approach,
8. Before-and-after analysis by year, and
9. Before-and-after analysis by approach.

The other principal enhancement of MIDAS-II is the development of a family of accident-predictive algorithms.

RESULTS

A number of conclusions were drawn from the Michigan MIDAS-II modeling experience. For intersection related accidents, the independent variables with the greatest impact on reducing the total variance were signalization, county, laneage, type of intersection, shoulder width, right-turn lanes, annual daily traffic, and lane widths. Posted speed limit does not have a consistent impact on reducing the variance (demonstrates nearly equal number of positive and negative relationships). Models for nonintersection accidents did not have good correlation coefficients. Laneage was the most important independent variable followed by county, posted speed limit, annual daily traffic, and activity density.

Meaningful modeling of nonintersection accidents is probably not feasible without improving the ability to locate accidents more accurately. Too many highway segments are of insufficient length. The reason for using a variable length segment instead of a uniform length of 0.2 mile is to create a longer analytic unit. However, by using a variable length actually reduced segment length from 0.2 mile to an average of 0.13 mile.

The procedure for predetermining outlying segments may require revision. A segment with a statistically significant number of rear-end accidents was considered an outlier when modeling was done not only for rear-end accidents but for all accident types as well (such as parking accidents). Although volumes were considered in the model-building process, highway (segment) capacity was not. Further investigation will be conducted into the use of volume/capacity ratios as a predictive variable.

A large amount of the initial variance was explained by the models. It appears that environmental factors may have a large influence on accidents—if a county is an adequate surrogate measure of population density.

The error rate of the MIDAS-II predictions is not known. The absolute standard error is not large, often about one accident per year. The percentage error, however, is large. Several factors contribute to the problem. First, most segments have no accidents during the study period (often dividing the standard error by a small mean). Second, the predominance of short segments limits the ability to assign nonintersection accidents accurately. (This may explain why the standard error for nonintersection accidents is higher than that for intersection accidents.) Third, accidents are a discrete function and thus may attribute to the error since the models predict a fractional number of accidents.

The anticipated use of the models is for predicting the expected change in accidents for each change in one or more independent variables. The relative error between predictions is unknown and may be considerably less than the absolute error.

The relations do not necessarily indicate cause and effect. Because of the lack of accessibility, many variables suspected to be important are not included in the model.

CONCLUSION

The object of this paper was to describe the process Michigan went through, not to defend it. If there is a better process, we will use it. However, we are getting extremely good results—much better than expected.

We found that modeling separately made a tremendous difference. But the model is already outdated. There are many procedures we want to apply to improve our ability to explain what is going on. Software life is about one month to six weeks. That is how fast it is changing. The process is dynamic. Software is marginally built so that any one element can be pulled out, changed, and plugged in. That is why Michigan gets concerned when the U.S. General Accounting Office says to wait four years to see what happens. In four years, the people who did the programming and maintain the system will be gone, and we cannot train replacements easily.

The biggest problem in implementing the process is not the data—they can be gathered if you use some imagination—and not the math—that is pretty simple. The biggest problem is people. A major problem in implementing this program was getting people who had both the ability and the dedication to put it together. Even then it took a year to get them trained.

Another problem is resistance to change. The people who maintained the previous system will be of little or no help. The problem is getting the users to accept the new system—to make them see that it is better and faster.

MODEL TRAFFIC RECORDS SYSTEM

Dan Kaufman, A. F. Austin and Associates

The Model State Traffic Records System (MTRS) is being developed by A. F. Austin and Associates, Inc., in cooperation with the Alabama Office of Highway and Traffic Safety (OHTS) and NHTSA. The four main objectives for development of the MTRS are

1. To integrate information now stored in different forms and on various systems throughout the state,
2. To integrate operations and information of various state agencies now operating in various parts of the safety system,
3. To reduce duplication of data and operations now maintained by separate political or organizational entities, and
4. To develop a model that can be transported to other states so that system technology and project experience can be shared.

Meeting these objectives will achieve the overall goal of the MTRS, which is to interrelate all traffic safety information and operations so that sound traffic safety programs can be developed, monitored, and evaluated.

Without a consolidated traffic safety system, management is taking a shot-in-the-dark approach to determining programs, priorities, and funding. The MTRS is being developed as a tool for management in traffic safety planning and evaluation. The MTRS consolidates all relevant information into a single source system capable of retrieving information on an as-needed basis.

The MTRS was developed by using a two-step process: the logical design—identification of what and how it is to be accomplished—and the physical design—the development of the data-processing system. The logical design ensures that the system is structured properly to support management.

The operational and management decisions identified in the logical design were consolidated into five major program areas:

1. The Driver, Pedestrian, and Passenger Safety Program implements safety activities concerning drivers, pedestrians, and vehicle passengers. The program includes procedures for the driver licensing (including driver history), law enforcement, law adjudication (courts), and driver education projects.

2. The Vehicle Safety Program implements vehicle safety activities including vehicle titling, registration, and inspection projects. The planning, coordination, and evaluation of these activities are included in the Planning and Evaluation Program.

3. The Post-Accident-Response Program is an operational program for emergency medical services (EMS) activities both before and after an accident. The program includes the decision-and-action procedures for the licensing of EMS personnel and organizations and the implementation of EMS program improvements defined in the Planning and Evaluation Program.

4. The Roadway Environment Improvement Program consists of the operational activities for designing, constructing, and maintaining highways when these functions are performed for safety reasons. The program includes the operational decision-and-action procedures for major roadway design and construction, spot roadway improvements, and roadway maintenance projects. All planning and evaluation activities are included in the Planning and Evaluation Program.

5. The Safety Planning and Evaluation Program is the nucleus of the MTRS. Planning, coordination, and evaluation of all programs and projects mentioned above are performed within this program. This program provides state officials with the means to make intelligent decisions on the effectiveness of the overall safety program and of the individual elements. The program also points out areas that need further attention.

The MTRS data base is implemented on an IBM 4341 by using the IMS data base management software. The data base consists of the driver, accident, citation, vehicle, and miscellaneous operational files. The EMS files and school bus files reside on microcomputers connected to the IBM system by high-speed communication lines.

Even though EMS, school bus, and roadway files are not physically resident on the IBM 4341 system, the data are accessible in an on-line environment and are linked to relevant mainframe data via key fields association. The IBM 4341 software is capable of accessing needed data from any of the distributed systems, and the distributed systems are also capable of accessing relevant data on the mainframe.

The MTRS data base contains the following major files:

1. Driver data base, which is used primarily for operational purposes. On-line statistical programs also use this and related data bases for safety program development, monitoring, and evaluation.

2. Accident data base, which is used primarily for operations and to provide detailed accident report inquiries and reports on request. On-line statistical programs are also available by using this and related data bases for safety program development, monitoring, and evaluation.

3. Vehicle data base, which is used solely for operational purposes in the on-line mode. Because the accident report contains vehicle data, the statistical process seldom uses these data except for vehicle inspection information.

These three data bases contain duplicate keys that facilitate analysis of accident frequency as related to (a) type of driver; (b) number of citations and frequency of driver; (c) age and type of vehicle; (d) roadway type, condition, and traffic volume; and (e) citation frequency for selected roadways. Information is extracted monthly to produce a series of accident inventory and analysis reports. The information is matched against the roadway environment file, and the combined data are used to update the statistical analysis data base and accident location master file.

At the end of each quarter, the monthly accident and UTC data extract files are merged to create quarterly accident and UTC master files. These files are then used to generate a series of scheduled reports. In most states, the accident file is extracted and an accident file is created for processing by some type of standard statistical package such as DART, RAPID, or OMNITAB. Although the MTRS uses this technique to create its standard statistical file, linkages to other information files allow MTRS to access driver files, UTC files, vehicle files, statistical table files, and roadway environment files to create an expanded record for each accident. This expanded accident record can then be processed by the statistical package in either an on-line or a batch mode.

Summary reports of the monthly and quarterly reports are prepared annually, and the MTRS history tape is created from the quarterly master files. A comparison report is prepared to show trends between annual tables on the MTRS statistical table files. Tables are purged as required, and each table is set up for the next year.

Cross-reference files, including the node/milepost, the node/railroad, and the milepost/node cross reference files, are updated as information is received and processed. Roadway environment data are updated as road inventories are taken.

In summary, the MTRS meets its objectives by solving the following problems:

- Integration of Information—The problem of fragmented and mismatched information is resolved by updating all related data from one input source and by linking related files by common keys.
- Integration of Operations—Communications and control problems are resolved by providing automatic system notifications when events occur that affect other operations.
- Elimination of Duplication—Duplication of data and operations is reduced by establishing the system on a function rather than an organizational structure. A single file of common data may be updated and shared by multiple agencies that perform similar functions.
- Comprehensive Planning and Evaluation—Highway safety problems are isolated by applying accident and UTC data supported by roadway environment, driver, and vehicle background information to (a) location analysis techniques to identify hazardous locations and (b) standard statistical analysis techniques to identify patterns that indicate possible problem areas.

ADAAS AND USE OF SAFETY-RELATED DATA FILES

James O'Day, University of Michigan

The Automated Data Access and Analysis System (ADAAS) is a set of computer files used at the University of Michigan for looking at a variety of highway safety problems. It is not a particularly portable system—the computer programs are, but the installation with all the data is not.

The system began because questions needed to be answered and the only way to get answers was to go into the files by hand. So we put together a relatively small data set in a computer system and used a modification of an existing system developed by the Institute for Social Research at the university as an analysis package. The systems were essentially the type developed to process interview data, which is what a traffic accident record is.

The system has grown in size and complexity. Today about 250 separate accident and other sorts of files are maintained. Because of the volume, they are stored on tape rather than disk. In addition to Michigan data, we keep data from other states that are particularly interesting to us.

We have kept the Washington State data since 1974. Washington has some particularly useful data that were not duplicated by other states. For instance, Washington maintains a record of vehicle occupants, and data are recorded on both injured and noninjured passengers. Most other states do not do this. It has been a longstanding practice to report only the injuries or fatalities on the accident report and to forget about anyone in the car who was not hurt. But Washington State seems to pay great attention to recording information on everyone in the car.

It is useful to have a large battery of data sets in order to be able to answer a variety of questions. State data sets vary in their level of detail from one state to another, so if information not in one file is needed, a second source can sometimes provide it.

Some distributions are not meaningful at the state level. For relatively rare events, one might find no occurrences in a year of data from a single state—unless it were a very large state. It is useful in such a case to look at a large set of national data and to estimate frequencies in a smaller jurisdiction from that. National data may be useful, too, as a standard of comparison for a state.

Several national data sources are available.

- National Accident Sampling System (NASS)
- Fatal Accident Reporting System (FARS)
- National Crash Severity Study (NCSS)
- Truck Inventory and Use Survey (TIU)
- National Personal Transportation Study (NPTS)
- Bureau of Motor Carrier Safety (BMCS)

The National Crash Severity Study includes such information as number of days a crash victim was hospitalized. From this, an estimate can be made of the number of days hospitalized by accident class or by age group. If this type of information is useful, it is only available on a national basis, and, although there is no ideal way of transferring the data to a state, reasonable estimates may be made by population ratio adjustment.

The Truck Inventory and Use Survey, a census for the U.S. Department of Transportation in 1977, represents the number of trucks in the United States. Data are included on all types of trucks—from pickup trucks to large tractor trailers. The information includes whether the truck had power steering, radial tires, drive reduction equipment, speed fans, and so on. This information, along with the number of miles traveled by such vehicles in the United States, can be compared with known accident data with the same characteristics and then used as an exposure data set.

To illustrate the use of the Truck Inventory and Use Survey and the exposure data, we can compare the number of miles traveled by tractors with single trailers with miles traveled by tractors with double trailers by type of product they were carrying. Products were grouped into four types: farm, light, heavy, and mixed; and then into three ranges: local, short haul (less than 200 miles), and long haul. It becomes obvious that double trailers were predominant in the long-haul, heavy-cargo group. That is just an example of the output of the exposure file.

The Truck Inventory and Use Survey is done nominally every five years, but it typically takes two or more years to get to the publication stage, so the data are always a few years old. The survey is a relatively straightforward sample and is easy to use.

Another useful exposure file is the National Personal Transportation Study, also done for the U.S. Department of Transportation. This study involved a series of interviews of people all over the United States. Detailed questions were asked about every trip on particular days, whether by foot, bicycle, bus, or passenger car. This information was relatively well recorded.

Data from this study are useful in developing such information as the number of miles per passenger or per driver as a function of the age. One may compute (by using a combination of FARS and NPTS) the number of driver or occupant fatalities per mile traveled, which is the ratio of the number of car fatalities (from FARS) divided by the occupant miles (from NPTS).

Using data has become rather easy over the past 10 years. Computers are set up to do complex things with simple instructions. The big problem is thinking up the right question. The computer takes away the drudgery and the need to learn a lot of very fancy programming skills, but it does not take away the responsibility for thinking. The advantage of a computer is that it allows the user time to think hard about what the problem is, what the answers mean, and where to go next.

The ADAAS system might best be thought of as a library of information. When I have a question, I can go to the library and look for a book with the data I need. If the data arrangement in published material is not what I want—and it often is not—I can then ask the computer to rearrange the data for me. If I have enough sources of data, I can usually find some that will give me the information I am after. The library analogy is an apt one; the data sets are comparable to the book on the shelves, the computer is equivalent to the research librarian, but the results can be information arranged to your needs more precisely than the normal library can accomplish.

CLOSING REMARKS

Robert L. Marshall, School of Public Services and Missouri Safety Center, Central Missouri State University

I believe the three conference objectives have been met:

- To provide impetus for state program managers to maximize their use of safety data available within the states to effectively and efficiently administer their programs
- To present, discuss, and evaluate analytical techniques that augment the states' capabilities for using data
- To establish the level of data analysis necessary to adequately administer state safety programs

Our conference should make a significant contribution to highway traffic safety. I have drawn some conclusions from our discussions that I would like to share with you:

- The recent GAO report, entitled Highway Safety Grant Program Achieves Limited Success, may have been based on a nonrepresentative selection of cases, thus producing biased results. Therefore, policymakers should balance their views regarding program effectiveness with other credible evidence of program benefits.
- NHTSA and FHWA seem to disagree on the most basic requirements of a state accident data base (for example, should property-damage-only accidents be included, and, if so, what should the

reporting threshold be?). Therefore, they should cooperate in funding research for a sensitivity analysis of the characteristics of traffic safety data elements. The objective of the analysis would be to develop a uniform and consistent model data base for state consideration.

- Although setting numerical goals for highway safety programs and countermeasures may be reasonable and proper in many cases, in other cases it may be both inappropriate and ill-advised. NHTSA and FHWA should support the development of guidelines and documentation to help administrators select realistic goals for countermeasures.
- Many existing state traffic records systems are limited in scope and capability, but the limited funds available for highway safety argue against making comprehensive and costly alterations in state traffic records systems. Safety agencies can and should do more with existing data; they should not let their inability to make major system improvements prevent them from using such systems for safety management. In developing a data base, two points are essential: it must be cost-effective and it must have the capability for repetitive use.
- The appropriateness of state problem identification efforts may differ significantly for engineering (FHWA 3+ standards) and nonengineering (NHTSA driver and vehicle standards) areas. Federal agencies should reconsider and redefine the requirements of state problem identification according to the characteristics and limitations of the data that apply in each case.
- A high degree of technical and statistical sophistication has been achieved in the traffic records systems of some few states. FHWA and NHTSA should cooperate in efforts to transfer such technology through printed materials, workshops, short courses, and advanced training courses.

Much progress has been made in traffic safety over the past 15 years. The fatality rate has been reduced by nearly 50 percent since the passage of the Highway Safety Act in 1966. The system, I believe, is working.

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