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: