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Computerized Street Index for Michigan Accident Location Index System

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Federal highway safety standard 9 provides guidelines to traffic engineers in their identification and surveillance of accident locations. The state of Michigan developed a comprehensive, computerized system of accident inventory called the Michigan accident location index. This system required the coding and computing of the 192 000 km (120 000 miles) of roadway in the state. The procedure for computerizing the roadway network consisted of three tasks: data coding, data entry, and resolution of edit and cross-reference errors. The use of computer programs to assist in each of these tasks resulted in a methodology that proved to be a fast, accurate, and cost-effective approach.

Recent highway accident statistics indicate that the annual number and rate of traffic accident deaths and injuries have declined significantly since the early 1960s. This, along with the fact that vehicle kilometers of travel have generally increased during the last two decades, gives an indication that positive gains are being made by implementing highway safety improvement programs on the highway system.

The implementation of such improvements at selected locations, however, requires a comprehensive procedure for identification and surveillance of locations that have high accident rates. This is the basic theme of federal highway safety standard 9, which provides guidelines to traffic engineers in their identification and surveillance of accident locations.

Highway safety engineers and researchers recognize that in various parts of the country there are serious deficiencies in highway accident record keeping and in the use of such records for safety analysis. These deficiencies include the following:

1. Many states have computerized accident-locating systems on their state and Interstate routes, but most local communities (counties, cities, and villages) do not have access to or use of such a process of accident record keeping—and such communities oversee almost 90 percent of the highway system.
2. Although we are required to maintain records of fatal and personal-injury accidents, many communities stop there and do not record accidents that result in property damage. This reduces the chances that actual highway deficiencies will be recognized when a highway system is analyzed for safety problems.
3. Different communities have different standards for keeping records of the property-damage type of accident. Some record only damages in excess of $200 whereas others keep records of all property-damage accidents.
4. Although every community uses some procedure for recording accidents, all too often the means to analyze the accident experience at a particular location or along a segment of roadway does not exist or represents a very time-consuming manual effort.

All of these differences in accident record-keeping practices result in a nonuniform, incomplete accident location system that traffic and safety engineers are forced to use in analyzing safety-deficient highway locations, identifying locations that have high accident rates, and monitoring the accident behavior of these locations.

In recognition of this fact, the Michigan Department of State Highways and Transportation (MDSHT) and the Michigan Department of State Police jointly launched a program to develop a comprehensive, computerized accident inventory system that will keep a record of all accidents that occur in the state. The basic purpose of this system is to identify and analyze hazardous locations on all roadways for safety improvement projects, selective enforcement projects, and other operational practices that will affect accident experience in the state. The Michigan accident location index (MALI) was developed by the Michigan Department of State Police and MDSHT through a Section 402 federal safety grant (under Section 402 of the Highway Safety Act of 1966) secured by the Michigan Office of Highway Safety Planning. The availability of a street index is essential for a computerized accident-locating system. This paper describes the procedure for developing a comprehensive street index for the state of Michigan.

DESCRIPTION OF THE SYSTEM

MALI is a computer-assisted process for storing and analyzing information on traffic accident locations and accident experience at such locations (1, p. 127). The system is designed to generate a computerized description of such locations directly from the physical location information observed and reported by police officers. All local police departments in the state of Michigan are required to report all fatality, personal injury, and property damage accidents in excess of $200 to the Michigan state police for the central traffic accident system. All accidents are referenced by distance and direction from the nearest cross-street intersection. The ability of MALI to locate accidents by the common or locally known street name reported by the police officer offers a distinct advantage over accident inventory systems that require a manually coded street or intersection code. Additional references, such as freeways, expressways, and

ramps, are provided for state routes through the use of the historical highway mileage points. The MALI system provides the foundation on which accidents are analyzed and very hazardous locations are identified and makes continuous surveillance and maintenance of such locations possible.

State, county, and city engineering and police departments have access to a battery of computer programs that analyze the accidents that occur on all roads and streets in the state (the MALI software was developed by the state police and MDSHT). Accident location data and the analysis capability provided by the MALI system will also assist federal, state, and local government agencies in the development of systematic and cost-effective highway safety programs. Local government agencies are the primary beneficiaries of this system since there are only a few agencies in the state that have capabilities for developing and maintaining computerized accident information systems. An additional benefit for local communities is that the reports and analyses produced by the MALI system are provided by the state at no charge to the agency.

The MALI system is designed to produce a variety of accident reports on a county-by-county basis for the entire state of Michigan. The report, ranking of intersection accidents, provides statistics based on the total number of accidents that occur within 45 m (50 yd) of a given intersection (2). These reports can rank intersections countywide or for an individual city or township on a monthly, quarterly, semiannual, or annual basis. The report, log of accident, provides a complete printout of essential information for every accident reported at a given intersection or on a particular roadway segment. These reports clearly identify major problem intersections and may assist in directing corrective actions to the locations where they are most needed. They provide valuable information to traffic engineers and traffic enforcement agencies at all levels of government.

DATA BASE

One of the prerequisites for the MALI computerized accident system is the coding of the entire state highway network. This coding is done on a county-by-county basis and is referred to as the street index. The street index, a data base file that represents the physical highway network, is seen by the computer as a set of intersecting lines. Computerization of the highway network is an extremely time-consuming process since the index is developed by measuring and coding the distances between all intersections for all roadways in each county.

Several years ago, MDSHT began coding the state trunk-line system by using their own in-house labor force and trained personnel at various county levels to perform the coding of the street network for counties. Although the progress of network coding had been significant, it was recognized that the rate of progress was slow and that it would require an extraordinary effort to complete the highway network coding for the entire state of Michigan. [It is important to point out here that, unlike various other states, Michigan had set a goal of coding and computerizing the entire 192 000-km (120 000-mile) state highway network.] The state trunk-line system had already been coded through the in-house efforts of MDSHT; to computerize the local highway network for the entire state, the state police and MDSHT secured a Section 402 federal safety grant. The contract consisted of coding approximately 136 000 km (85 000 miles) of highway network and was to be completed in two calendar years.

Table 1. Function codes for street index.

Code	Information
GS	Indicates start of generation of a new street; includes city or township name and name of the county
SN	Indicates name of the street being generated and distance and direction to first intersection; the first SN card is called the primary name, and additional SN cards are coded for alternate names and common misspellings
IS	Indicates occurrence of an intersecting cross street; contains the primary name of the cross street and distance and direction to the next intersection
IR	Serves the same function as the IS but indicates an intersecting ramp
IT	Serves the same function as the IS but indicates an intersecting railroad crossing
CB	Indicates that the street crossed into a new township or city and signifies that IS cards following this CB card lie in that jurisdiction
EG	Indicates the end of the street

CODING OF HIGHWAY NETWORKS

The coding of highway networks is extremely important to the success of the MALI project since it is essential in establishing a complete inventory system. Accuracy in fixing the location of streets as well as in spelling street names is extremely critical in developing a complete picture of highway accidents. The MALI system is nearly 100 percent accurate in locating accidents. There is always, however, the potential for police officers to misspell the name of the referencing streets or erroneously record a highway accident. This problem is inherent in any record-keeping process. To maintain continuity and a high rate of accuracy, coding and data entry of accident reports are performed in-house by the state police.

The coding of the street index was based on several sources, including county certified maps, maps compiled under Michigan Act 51 (cities), and recent aerial photographs. For those sources of data that did not indicate interblock distances (aerial photographs, Act 51 maps, and sectional blowup maps), the distances between intersections were obtained by using a digitizer.

Three tasks were involved in developing a street index for an individual county:

1. The roadways were coded.
2. The coded network was entered into the computer. Cathode-ray-tube (CRT) terminals were used for data entry and were driven by a program developed specifically for this project.
3. The street index was put through a series of edit checks in which programs were cross referenced and errors corrected.

The coding of a street index required the generation of a code for each street and roadway in a county. Function codes on each line of data indicated the type of information contained on that line. The basic function codes are given in Table 1.

In an effort to minimize coding and keypunching errors for data in excess of 700 000 lines, we developed an interactive terminal (IT) program to enter the coded highway network data into the computer files. The data are entered through the CRTs as the computer program prompts the operator for each piece of information. As the data are entered, various diagnostics are performed by the program on the input stream, and any detected errors are corrected at that point. These diagnostics consist of verifying the requested function code, checking the length of street names against the allowable

length, verifying that the distances entered are numeric, and verifying that the directions entered are one of the eight compass directions. When a line of data is completed, the information is displayed on the CRT screen and is verified again before it is written to a disk file. This procedure minimizes the possibilities of error in the process of data entry.

After the data are entered, several sets of programs process the street index. Some of these programs perform edit checks of each data field and the logical progression of the coding. The edit checks consist of verifying the spellings of the city and township names, the presence of GS and EG codes at their proper location, and the distances coded on the CB cards. Any errors detected in the edit review are recorded, and the data file is updated.

An additional program performs a cross-reference check for each street. These errors stipulate that A street crosses B street but not vice versa. This program was critical in developing the final street index. To properly generate the data base, it was essential that the spellings of cross streets match their respective primary name spellings. Misspelling of cross-street names or primary names would result in a cross-reference error. In addition, miscoded or missing CB cards would place the intersection in the wrong city or township and indicate an error.

All edit and cross-reference errors are resolved, and the data file is updated. At this point, the updated file is again processed through the edit and cross-reference programs. This check is continued until all edit and cross-reference errors are completely resolved, which usually requires two or three iterations of the procedure. The street index is then transferred to magnetic tape to build the accident files.

The coding of the street index was expected to be completed by early 1979; it will thus have taken approximately 17 or 18 months to develop a street index for 136 000 km (85 000 miles) of roadways [some 56 000 km (35 000 miles) of county roads and state trunk lines had already been coded]. At the completion of this building of a street index, all accidents in the state will be under a computer system and will be available as a source of data for the identification of high-hazard locations, selective enforcement projects, and accident analysis. The system is unique in that it can locate and analyze accidents on all types of highways in the state. It can also reference off-road accidents and accidents that occur at or near railroad crossings. The use of the IT function code indicates the crossing of an at-grade railroad. In subsequent data retrieval, those accidents that are influenced by a particular crossing or all crossings may be selected. The coding of a "pseudointersection" (two imaginary streets that intersect each other) for a city or township allows the recording of off-road accidents (i.e., parking lots, private drives, and trails). The standard MALI report features can be used to analyze these pseudointersections.

The need for such an accident-locating system cannot be overemphasized in an era in which we are trying to create a hazard-free highway system. The MALI system will help traffic and safety engineers and law-enforcement agencies in performing their day-to-day and long-range activities.

The cost incurred in coding the street index for the 72 Michigan counties [136 000 km (85 000 miles)] was approximately $4.18/km ($6.75/mile). This includes extremely congested areas such as the city of Detroit and Wayne and Southern Oakland Counties as well as sparsely populated counties in the upper peninsula of Michigan. Future enhancement of the system through development of the Michigan dimensional accident surveillance model (MIDAS) is planned by MDSHT. MIDAS will combine information on the vehicle, the driver, road characteristics, and roadway volumes with the accident data base. This system will provide for rate analysis and comparison of similar roadway features and thus provide a more extensive and useful tool for engineering analysis.

CONCLUSION

The system is currently working under practical operating constraints in Michigan, and 34 counties are fully indexed and on-line. The remaining 49 counties are in various stages of being merged to the master accident file. When the merge is completed, the entire state highway network will be available as a data base for the location and analysis of accidents. The methodology described for the development of the street index proved to be an accurate, fast, and cost-effective procedure.

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