CHAPTER 6

SUMMARY AND CONCLUSIONS

This chapter summarizes key points by chapter, highlights those elements of the methodology open to expansion and/or refinement and draws conclusions regarding the expected usefulness of the manual.

CHAPTER 1 - INTRODUCTION

A comprehensive highway safety program is needed to reduce the large and varied impacts of traffic crashes on Southeast Michigan residents. A crucial element of such a program is the collection and effective use of crash data to identify and correct safety deficiencies in the roadway system.

The shortage of traffic engineers in Southeast Michigan has resulted in many communities assigning traffic safety as a collateral duty to law enforcement and public works personnel. SEMCOG has created this manual to assist these personnel (and others) in their analysis of roadway-related traffic safety problems. The manual provides a set of user-friendly tools for checking a location's crash history, identifying possible crash causes and countermeasures and conducting benefit/cost (B/C) analyses of selected countermeasures.

CHAPTER 2 - DATA COLLECTION AND MAINTENANCE

Potentially useful in identifying and analyzing traffic safety problems are data on crashes, traffic volume and composition, traffic control devices, roadway and roadside design features, perceived operational and safety problems, maintenance of objects struck in crashes, traffic citation patterns and adverse litigation history.

Crash Data

The State of Michigan Traffic Crash Report, or UD-10, is used to code numerous details describing the crash scene, roadway conditions, persons and vehicles involved, sequence of events, type of crash and resulting injuries and property damage. One of the most important sections of the UD-10, however, is the box entitled "Crash Diagram and Remarks." Due in part to its value in diagnosing roadway-related causal factors, this section should be completed carefully and conscientiously for all crashes.

Traffic Volume and Composition

Volume data allow for the computation of exposure-based crash rates, thus preventing the potentially misleading classification of a relatively safe high-volume location as "high-crash" simply because it has experienced a relatively large number of crashes. Information on the composition of traffic can be useful in explaining differing crash histories of two otherwise similar locations.

Perceived Operational and Safety Problems

The complaints and concerns of road users are sometimes useful in identifying potential crash locations (i.e., locations where developing patterns of behavior may lead to future crashes). Also, high-crash locations experiencing unusually high numbers of user complaints may warrant more immediate attention.

Manual Location Files

These files are used to store by location the paper copies of crash reports and other traffic and roadway data. Such files are valuable in an archival sense even if computerized systems are used to facilitate data retrieval and analysis. Manual files provide important access to individual crash diagrams.

Central files should normally be kept current for at least three years. Any given crash analysis will need data for a multiple of 12 continuous months to avoid seasonal biases. The best record-retention policy from an analytical point of view is to maintain active files for the three full calendar years immediately preceding the current year.

Spot Maps

Spot maps display crash frequencies by location in the roadway network. They provide a quick visual overview of crash concentrations and typically have been used in the past to supplement manual location filing systems for small- to medium-sized networks. However, recent developments in Geographic Information Systems (GIS) are increasing the feasibility of also using spot maps with larger, computerized filing systems.

Computerized Record Systems

These systems operate by coding selected data from hard-copy reports into electronic data bases. Most computerized record systems contain several data bases to separately file crash reports, traffic volume data, traffic control device inventories and other relevant data. These data bases should be set up so that they can be linked, by location and time period, for the computation of crash rates and for analyzing correlations between crash history and roadway features of interest.

The Michigan State Police developed the Michigan Accident Location Index (MALI) system in the early 1980s as a computerized process for storing and analyzing statewide crash information. Government agencies and law enforcement personnel may use MALI to identify crash patterns and locate problem areas.

SEMCOG's Accident Analysis System (SAAS) allows SEMCOG staff to provide MALI data to its local communities in formats easy for them to use. Two basic data types are provided upon request. One type is a log of selected UD-10 crash variables for specific locations of interest. The other type consists of the most recent year's MALI data for roadways within a community's boundaries, in either paper or machine-readable form.

CHAPTER 3 - IDENTIFICATION OF HIGH-CRASH LOCATIONS

As indicated at the beginning of Chapter 2, a wide variety of sources should be considered in selecting candidate locations to be evaluated. The Spot Map and Crash Frequency Methods are often used to preliminarily identify candidate or suspect locations using crash data. Suspect locations should be further evaluated using the Crash Rate, Frequency-Rate, Crash Severity and/or Crash Probability Index (CPI) Methods.

Time and Length Considerations

For statistical reliability, high-crash locations should be identified whenever possible on the basis of a three-year rather than a one-year crash history. This is especially important for low-volume locations having relatively few crashes in most years.

In crash analyses, spot locations should be defined to include the area of influence of the feature in question. Driver behavior can be influenced as far as 500 feet from a curve and 250 feet from an intersection (or further with severe congestion). Consideration should also be given to typical crash location reporting precision and accuracy.

Crash Frequency Method

This method ranks suspect locations by crash frequency and then identifies high-crash locations as those having frequencies exceeding a critical frequency. The Crash Frequency Method has the disadvantage that it tends to rank a high-volume location as a high-crash location, even if the location has a relatively low number of crashes for its traffic volume.

Crash Rate Method

This method compares the number of crashes to the volume of traffic, with the latter measured either as the number of vehicles crossing a spot in a given time period or as the number of vehicle-miles of travel along a segment in that period. The Crash Rate Method is less likely to unfairly condemn high-volume locations; however, it does tend to unfairly condemn low-volume locations having relatively few crashes.

Crash Severity Methods

Accounting for crash severity (or injury level) in identifying and treating high-crash locations should result in higher system-wide loss reductions due to the more serious, as well as more frequently experienced, hazards being addressed. Two specific crash severity methods, the Equivalent Property-Damage-Only (EPDO) Method and Relative Severity Index (RSI) Method, are presented in Chapter 3.

Crash severity methods require crash counts by injury severity level. Due to the relatively small numbers of crashes at the more severe levels, however, longer analysis periods are typically needed to produce reliable counts for these methods. From three to as many as seven years of crash data may be needed, depending on traffic volumes and overall crash frequencies.

CPI Method

This method combines the advantages of the Crash Frequency and Crash Rate Methods with a simplified severity method. When the location's crash history is significantly worse than average for one of these measures, it is assigned penalty points. These points are then summed across measures to determine an overall CPI. High-crash locations are selected from the top of a list of locations sorted in descending order by non-zero CPI.

Tables of critical values for use in statistical significance testing are included in this manual. These tables can be used with the CPI, Crash Frequency and Crash Rate Methods.

Example Using Alternative Methods

Data for a hypothetical urban intersection are used to illustrate all of the above methods for identifying high-crash locations, with the exception of the Spot Map Method.

Identifying Locations with Potential Safety Problems

The methods just discussed are not suitable for identifying locations with potential safety problems. Such locations appear to be of concern but have not yet experienced sufficiently frequent and/or severe crashes to qualify as high-crash locations. Agencies may wish to identify and possibly treat these locations before serious losses occur.

CHAPTER 4 - DETERMINATION OF COUNTERMEASURES, CRASH-REDUCTION FACTORS AND COSTS

A methodology is presented and illustrated for identifying a location's crash patterns and possible causes and countermeasures related to those patterns. Specific countermeasures are listed, along with representative values for effectiveness and cost.

Crash Pattern Identification

When crashes of a particular type constitute an unexpectedly large proportion of a location's reported crashes, a significant crash pattern is said to exist. An eight-step, worksheet-assisted method for identifying and prioritizing crash patterns is described in this chapter.

Studies by SEMCOG and others have linked several commonly recurring crash patterns with their typical causes. This manual presents these linkages in a form easily applied by others in evaluating crash patterns occurring at specific locations of concern.

Determination of Possible Causes

Possible causes may be determined for just one, a few or all significant crash patterns found for a location. Focusing first on the more highly over-represented and severe crash patterns (in terms of injury levels) will speed up the process of isolating those causes responsible for the greatest crash losses occurring at a high-crash location.
A seven-step method is described for identifying and prioritizing a location's possible crash causes. At the core of this method is a figure listing 21 possible causes of multiple-vehicle crash patterns. By following the prescribed steps and using tools no more sophisticated than a highlighter, the analyst is able to create a list of higher-priority crash causes. Before proceeding to countermeasure determination, this list is purged of those countermeasures which are inconsistent with basic location features.

Determination of Possible Countermeasures

Possible countermeasures are determined for a specific location, crash pattern and cause by consulting the appropriate table in Chapter 4 and extracting those countermeasures consistent with existing conditions, policies and agency capabilities. Users of this manual may also wish to consider crash causes and/or counter-measures unique to local conditions which they have successfully identified in past traffic safety analyses.

The recommended methodology for identifying crash causes and countermeasures should generally be limited in its application to the preliminary planning and budgeting of a safety improvement program. This is especially important for the more costly countermeasures and those which may have unexpected or undesirable side-effects at particular locations. Additional studies will often be necessary to properly justify and design the countermeasures preliminarily selected here; for example, proposed traffic control devices should be evaluated against applicable warrants in the Michigan Manual of Uniform Traffic Control Devices (Michigan, 1994).

Data for B/C Analyses

To compute B/C ratios for crash countermeasures, data are needed on countermeasure crash-reduction potential, costs, service life and salvage value. Such data are given in Chapter 4 for many common traffic engineering actions. A method for computing the anticipated effectiveness of countermeasure combinations is also presented.

Appendix D contains lists of other common countermeasures for which SEMCOG does not currently have cost and/or crash reduction data. SEMCOG acknowledges that the local agencies often have better first-hand knowledge of such data. As the revision of this manual continues, the contribution of any such data would be greatly appreciated.

Example of Pattern/Cause/Countermeasure Identification

The earlier intersection example is continued in order to illustrate the methodology for identifying significant crash patterns and possible causes, countermeasures and countermeasure combinations. This example shows how three patterns are identified and ranked; 15 possible causes of these patterns are reduced to six feasible higher-priority possible causes; 24 possible countermeasures for these higher-priority causes are reduced to 11 feasible countermeasures; and eight of these feasible higher-priority countermeasures are combined into two logical countermeasure "packages."

CHAPTER 5 - BENEFIT/COST ANALYSIS

The B/C analysis compares a countermeasure's expected benefit (in terms of reduced crashes) to its expected cost (for selection, design, implementation, operation and maintenance). A recommended worksheet-assisted methodology for B/C analysis is presented and illustrated in this chapter.

Highway Crash Costs

The B/C analysis of proposed crash counter-measures should use comprehensive unit crash costs based on the Willingness-to-Pay Method. Such costs incorporate quality-of-life considerations as well as the direct and indirect costs of resources lost in crashes.

A Nine-Step B/C Analysis Methodology

The first seven steps for a given countermeasure determine the annual average safety benefit, implementation cost, net annual operating and maintenance costs, service life, salvage value, interest rate and other economic factors. The last two steps compute the B/C ratio by two alternative methods: the Equivalent Uniform Annual Benefit and Cost Method and the Present Worth of Benefits and Costs Method (both methods yield the same ratio).

Example of B/C Analysis

The intersection example used in Chapters 3 and 4 is continued here as a way of illustrating completion of the recommended B/C analysis worksheet.

Project Selection

Three relatively simple methods of using benefit and cost data to prioritize safety improvement projects are briefly discussed. These methods are the Net Benefit Method, B/C Ratio Method and Incremental B/C Method.

APPENDICES

Appendices to this manual include Formulas for Computing Critical Values (A), Synthesis of Crash-Reduction Data (B), Synthesis of Countermeasure Cost and Service Life Data (C) Additional Countermeasure Default Values (D), Compound Interest Tables (E), Reproducible Figures and Tables (F), References (G) and an Acronym List (H).

FUTURE ENHANCEMENTS

Although comprehensive, this first edition of the SEMCOG Traffic Safety Manual contains several parts open to expansion and/or refinement. Potential enhancements include, but are not necessarily limited to:

1. providing missing cost data and crash-reduction factors, where feasible, for currently listed countermeasures;

2. creating critical value tables for other spot location types and segments;

3. periodically updating critical value tables using the latest available crash and traffic volume data for Southeast Michigan;

4. computing critical crash percentages larger than simple sample averages, so as to allow testing on the basis of statistical significance;

5. providing critical crash percentages for the eight crash patterns categorized by object struck and by driving situation (listed in Chapter 4);

6. listing possible causes of crash patterns categorized by object struck and by driving situation;

7. listing possible countermeasures for crash patterns categorized by object struck and by driving situation;

8. providing cost data and crash-reduction factors, where feasible, for newly identified crash countermeasures; and

9. making other additions and changes prompted by user comments.

SEMCOG would appreciate receiving not only comments on the manual and its contents, but also additional information on the crash causes and countermeasures which are detailed in the manual. Please contact SEMCOG staff to confirm that a listed countermeasure is one for which you have additional cost or effectiveness data. Information on causes and countermeasures not listed in the manual are also welcome. Comments, questions and data should be directed to SEMCOG's Transportation Department, either by mail at 660 Plaza Drive, Suite 1900, Detroit, Michigan, 48226, or by telephone at (313) 961-4266.

SEMCOG has created a menu-driven personal computer software package based on the methods outlined in this manual. A prototype version of this software package, called the Comprehensive Analysis Safety Tool (CAST), was first demonstrated in September 1995. Additional refinements to the prototype are ongoing. Further information on CAST can be obtained by calling or writing SEMCOG at the location indicated above.

CONCLUSIONS

The tools presented in the SEMCOG Traffic Safety Manual will:

- assist in more thoroughly and efficiently identifying traffic safety problems, possible solutions and the relative benefits and costs of those solutions;

- facilitate a quick sketch-planning approach to developing preliminary plans and budgets for traffic safety improvements;

- enable engineers, non-engineers and others not specially trained in traffic engineering to conduct comprehensive preliminary safety analyses; and

- provide a good foundation for the further development and maintenance of user-friendly software for the personal computer.