Highway Safety: An Agenda for Action

HARRY E. STRATE

Among transportation modes, approaches to safety improvement are significantly different because vehicle and facility design and the driver or operator control functions are unique to each mode. The highway-automobile mode represents the lowest level of operational and design control of any mode, and results in lower levels of driver or operator performance. This factor and the growing degree of legal liability make an organized systematic approach to enhancing highway safety imperative. These dual requirements underline the need for an empirically based highway safety program that has the capability of gauging system operation through monitoring of actual accident experience and analysis of physical evidence. A comprehensive highway transportation safety program must achieve maximum use from available funds and respond to certain minimum standards of safe design and operation. An effective safety-improvement program at the state or metropolitan level involves processes of data collection, data analysis, engineering studies, formulation of project priorities, implementation, and postimplementation evaluation. Street surveillance and control-device management involve organized review, monitoring, and follow-up of corrective measures. The emphasis in both programs is to create (a) a single point of responsibility, (b) a permanent documented record, and (c) special recognition of conditions of citizen complaints or review findings. Each jurisdiction that maintains authority over highway operations must take aggressive positive action to coordinate and implement safety-improvement programs. Although no program can be implemented instantaneously, a definitive agenda must be established that will result in establishment of procedures as quickly as possible.

The comprehensive, systematic solution of safety problems is long overdue in each of the nation's transportation modes. However, the safety crisis must compete with many other national and international priorities, such as energy and air pollution. Although transportation safety possesses significantly more drama and political volatility following a catastrophic accident, persistent pressure on citizens' personal health and pocketbook is lacking. In other words, the perception is that safety problems go away. This manifestation of the problem hampers the ability of federal, state, and local governments to mount a continuing offensive designed to improve transportation safety.

SAFETY PERFORMANCE

Transportation modes show markedly different safety-performance records. As summarized in Figure 1 [from Safety in Urban Mass Transportation (1)], scheduled air service tends to have the highest fatality rate per number of occupants but is placed in the top rank when vehicle miles (air miles) are considered. Significantly, motorcycle safety is second only to general air by these measures of safety performance.

Among transportation modes, safety-improvement approaches are significantly different because vehicle and facility design and the driver or operator control functions are unique. The highway-automobile mode represents the lowest level of operational and design control of any mode. Three areas of wide variability are evident:

1. Vehicle: size, weight, and operating characteristics;
2. Facility: design and operational standards; and
3. Driver: training, capability, and temperament.

In short, the less conformity and uniformity in an operating system, the greater the chance for operational failure in the form of accidents and injuries. This unique characteristic underlines the need for an empirically based highway safety program that has the capability to gauge system operation through monitoring of actual experience and analysis of physical evidence.

DEVELOPMENTS IN HIGHWAY SAFETY

In the early 1950s, the concept of developing a systematic approach to highway safety began to appear in technical papers and government regulations. In the late 1960s and early 1970s, the comprehensiveness of highway safety was emphasized through legislation and research. During the same time, the need to organize and systematize a program approach was emphasized through the private and public sectors.

Even with this acceptance, the systematic-process approach to highway safety has been the most difficult to implement and lags in many areas. Contributing to this difficulty has been the phenomenon of highway safety in its entirety. The emotion and volatility connected with motor vehicle accidents and fatalities can divert attention from many pragmatic program concerns. However, a greater problem has been the relative scarcity of funds for highway safety systems development. The process approach is founded on data collection and much study. The analysis, development, and implementation related to effective action to improve highway safety can be costly and labor-intensive.

Many forces are at work that continually shape and direct the form and substance of the highway safety program. Two of the most powerful are federal regulations and legal precedent. The following sections explore the comprehensive, systematic approach to highway safety as dictated by the new Federal Highway Administration (FHWA) regulation in the Federal-Aid Highway Program Manual (2) and program direction dictated by court opinion. A comprehensive highway safety program in today's environment must address both regulations and court-based demands.

Federal Regulations

The overall program framework is embodied in the FHWA Federal-Aid Highway Program Manual (2). The processes of safety-improvement planning, implementation, and evaluation are the basic concepts of the directive. The policy statement contained in the directive asserts (2):

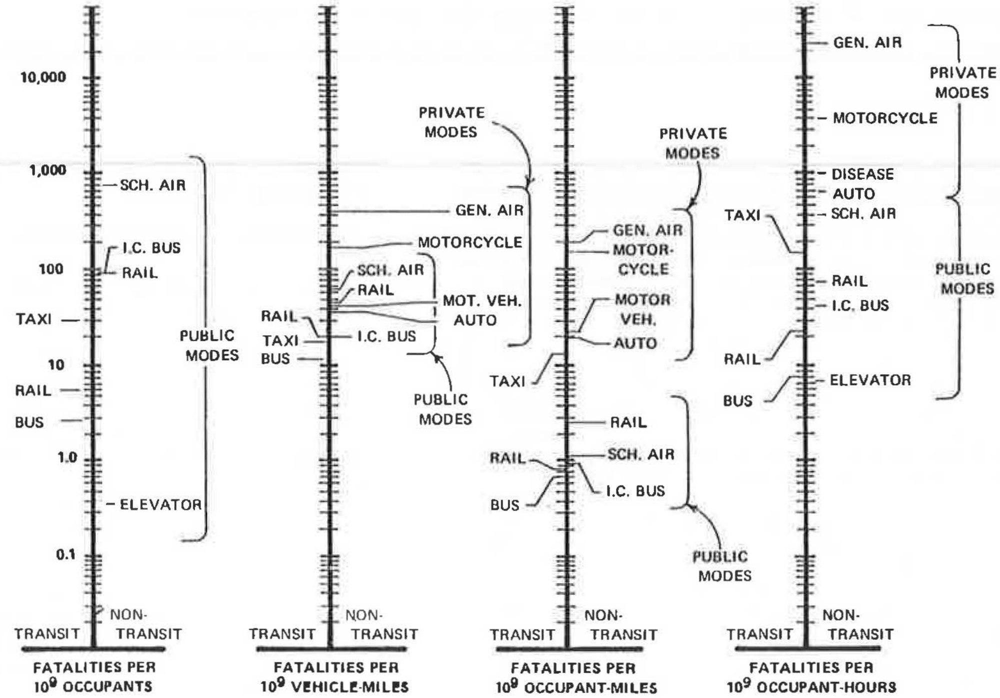
> Each State shall develop and implement, on a continuing basis, a highway safety improvement program which has the overall objective of reducing the number .and severity of accidents and decreasing the potential for accidents on all highways.

Legal Precedent

If we place highway safety concerns in the context of current legal developments, as summarized by David C. Oliver, FHWA legal counsel (3),

> Litigation over highway accidents has become a way of life.... It is clear to me that either highway officials provide a safe thoroughfare or highway construction will come to a halt--bankrupt by the increasing awards given to the victims of a system which is unsafe.

Figure 1. Comparative safety performance of transit and nontransit modes.



Together the forces of regulation and legal precedent dictate that a comprehensive, systematic highway safety program must

1. Obtain maximum use from available funds and
2. Respond to certain minimum standards of safe design and operation regardless of cost (and perhaps funding availability).

HIGHWAY SAFETY EXPENDITURES

Safety improvements total more than 20 percent of all federal-aid highway construction funds spent annually. In fiscal year 1979, there was approximately $8.5 billion obligated for all federal-aid programs administered by FHWA. Of this, rough indications are that $2.0 billion, or nearly 24 percent, was spent for safety improvements.

In order to relate to these figures, two important points must be made. First, total state and local expenditures are about four times federal expenditures for highways. In other words, an $8.5 billion federal expenditure relates to a $34 billion state and local expenditure. The latter figure includes maintenance, police, construction, and other highway-related activities. The impact of this ratio is that nationwide expenditures for highway safety are realistically in the $8-billion to $9-billion range when all safety expenditures are considered.

The second point is that the actual safety benefits realized from expenditures of these dollars vary dramatically. In fact, an imperceptible safety improvement is achieved in far too many cases. The purpose of an effective process for safety improvement is to elevate the cost-effectiveness of the $8 billion expended annually through better program and project planning, development, and evaluation.

EVALUATION RESULTS

The payoff from implementing a comprehensive safety-improvement program is achieved through initiation of effective and economical highway improvements. More-reliable definition of safety problems and more cost-effectiveness analyses during formulation of project priorities will lead to enhanced overall program performance.

Program Cost-Effectiveness

Safety programs that stress the need for systematic analysis generally reap a higher rate of return than those that do not. Table 1 [from Strate (4)] summarizes the accident evaluations achieved through federally funded safety programs. All programs achieved significant reductions.

Considering overall cost per unit of effect, recent evaluation results demonstrate that permanent improvements such as elimination of obstacles or upgrading of Interstates reduce fatal accidents with the most cost-effectiveness. As shown in Figure 2 [from Strate (5)], the high-hazard location program based on accident-data analysis ranks best for total accident reduction. These two results underline the need for a two-stage safety approach of cost-effectiveness analysis and minimum design standards. Quantifying the dollar benefits of accident reductions, Table 2 [from Strate (4)] shows the benefit/cost ranking of these programs (benefits are calculated by using annual U.S. Department of Transportation societal costs). Although all programs were effective, the categorical safety construction program made possible by the 1973 Highway Safety Act, as amended, resulted in the highest composite

Table 1. Accident reduction by safety construction programs.

	Reduction by Accident Severity (%)			
Program	Fatal	Injury	PDO[a]	Total
Categorical	25	8	11	10
Interstate safety	29	7	2	4
Other federal-aid	20	12	10	11
All federal-aid	26	8	8	8

[a]PDO = property damage only.

Figure 2. Cost-effectiveness of highway safety programs.

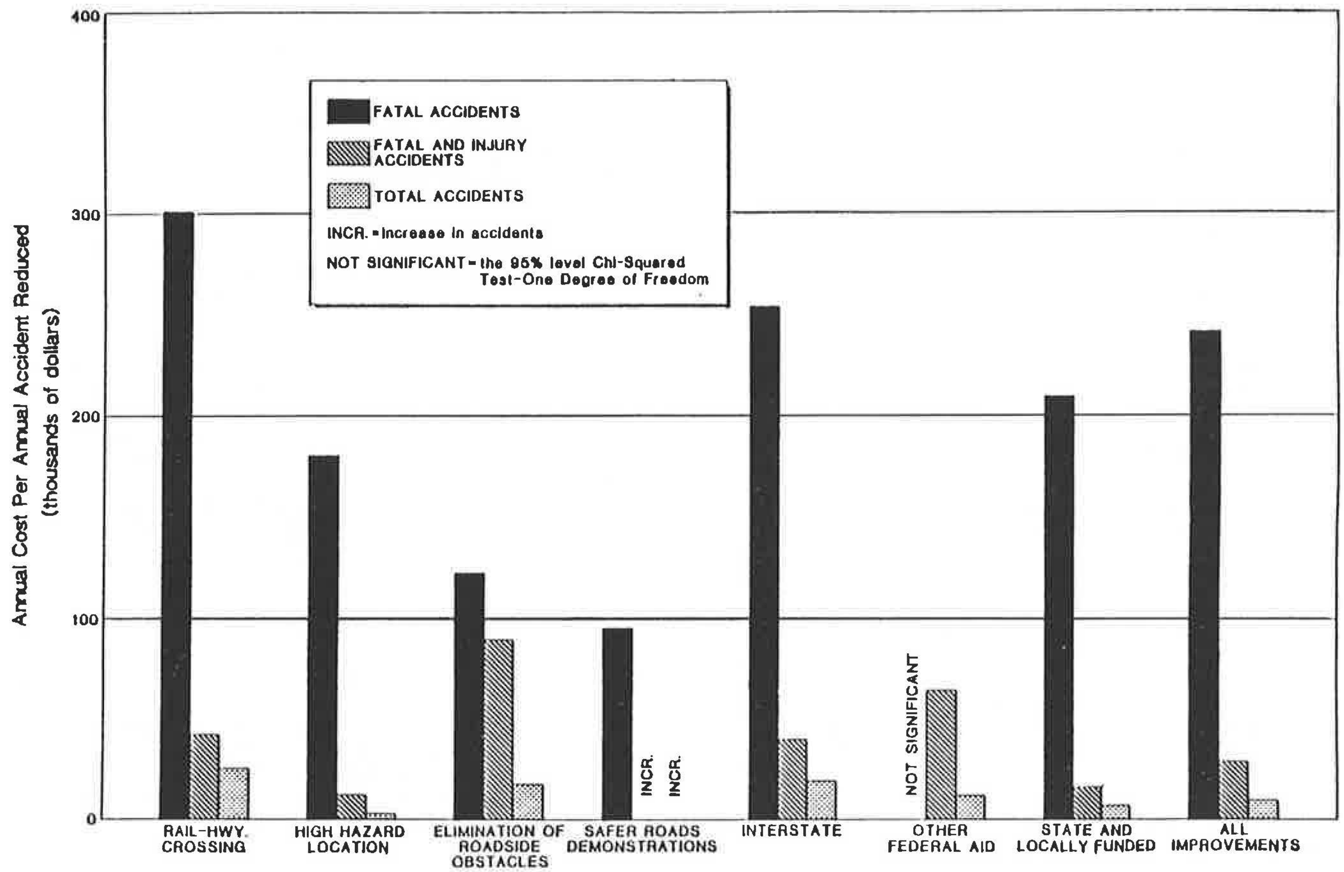


Table 2. Benefit/cost ranking of federally funded safety improvements.

Safety Program or Funding Source	Rank	B/C[a]
Safer-roads demonstration	1	4.5
High-hazard location	2	3.0
Total categorical safety[b]	–	2.6
Interstate safety	3	1.9
Roadside obstacle	4	1.6
All federally funded	–	1.6
Other federal-aid[c]	5	0.4
Rail-highway crossing	NS	NS

Note: NS = not statistically significant.
[a]Ratio of annual safety benefits to annual construction costs.
[b]Includes safer-roads demonstration, high-hazard location, roadside obstacle, and rail-highway crossing.
[c]Includes primary, secondary, urban, etc., federal-aid funds.

benefit/cost ratio. The low payoff of other federal-aid improvements is partly explained by the failure to follow strict data-analysis requirements. The categorical safety programs carry the strictest requirements for systematic safety analysis prior to implementation.

Cost-Effectiveness of Improvements

Individual safety improvements have demonstrated economical effectiveness in solving safety problems. Table 3 [from Strate (4)] ranks the improvements by benefit/cost ratios calculated as in Table 2. The overall effectiveness is only tempered by the relatively high cost of some improvements. Traffic signs and roadside, minor-structural, and sight-distance improvements constitute the calculated benefit/cost ratio. Careful analysis and formulation of priorities are needed to deliver effective, low-cost improvements to areas of highest safety need.

STATE PROGRAM IMPLEMENTATION

Since the early 1960s, most states have been striving to implement a comprehensive safety-improvement program. Several have developed remarkable systems capable of fulfilling most day-to-day operating needs. Progress nationwide has been less than desirable, however.

Deficiencies

Within the general theme of overall slow progress in implementation are five common deficiencies in state implementation efforts:

1. Data-system incompatibility: Data-system incompatibility can result from a number of causes. Generally, the two most common are failure to develop adequate roadway data files and accident data files and failure to effectively interface the two.
2. Inadequate data analysis: Data analysis is often restricted to identification of high-accident locations with no consideration of accident potential. This deficiency limits consideration of a full range of investment opportunities.
3. Failure to prioritize by safety payoff: Formulation of project priorities based on anticipated safety payoff is necessary to optimize budget investments. Relying solely on geographic distribution and a first-come, first-served basis, as is often the case, will probably not accomplish the best expenditure of scarce funds.

Table 3. Ranking of highway safety improvements by benefit/cost ratio.

Rank	Description	Code	Ratio[a]
1	Traffic signs	60	9.30
2	Other roadside improvements	69	5.92
3	Minor structural improvements	33	5.71
4	Intersection sight distance	13	5.33
5	Other intersection improvements	19	4.38
6	Road edge guardrail	62	3.80
7	Pavement grooving	25	3.78
8	Highway divided—new median	22	3.52
9	Safety provisions for roadside feature and appurtenance	90	3.21
10	Markings and delineators	64	2.90
11	Pavement widening and shoulder improvement	24	2.33
12	Intersection channelization	10	2.31
13	Pavement widening—no lanes added	20	2.28
14	Signs and guardrail	6C	2.13
15	Intersection traffic signals	11	2.12
–	All improvements	–	1.76
16	Railroad flashing lights replacing signs	–	1.74
17	Median barrier	63	1.72
18	Intersection channelization and traffic signals	12	1.66
19	Combination cross-section improvements	29	1.26
20	Lanes added—no median	21	1.15
21	Railroad automatic gates replacing signs	55	1.15
22	Pavement overlay (skid treatment)	26	1.12
23	Horizontal alignment	40	1.00
24	Other structural improvements	39	0.79
25	Replace bridge	31	0.27
26	Railroad grade separation	51	0.13
27	Shoulder, breakaway signs, guardrail, marking, lighting, and drainage structure	91	0.08
28	New bridge	32	Incr[b]
29	Shoulder widening or improvement	23	Incr
30	Vertical and horizontal alignment	42	Incr
31	Pavement widening and overlay	2A	Incr
32	Side slopes, widen bridge, guardrail, misc.	9C	Incr
33	Lighting	65	Incr
34	Guardrail, drainage structures, misc.	6F	Incr

[a]Ratio of annual safety benefits to annual construction cost.
[b]Incr = increase in accident costs.

4. Deficient project evaluations: Once implemented, projects should be evaluated to assure that their results match expectations. Project evaluations may be put off or delayed because of competing work tasks. A state's failure to pursue evaluation programs actively may cause safety programs to stagnate.

5. Exclusion of local highway needs: Local highway systems are not generally included in the various safety processes. Data collection and analysis processes do not address unique local road circumstances. Project priorities and postimplementation evaluations often do not include local safety-improvement projects. Significantly, this deficiency not only includes low-volume roads in low-density areas but may also include high-volume roads in heavily populated areas.

Tort Liability

Also since the 1960s, the number of tort claims and lawsuits has increased markedly. According to a recent report from the American Association of State Highway and Transportation Officials (AASHTO), claims pending against state governments total more than $4 billion for design, maintenance, or operational flaws. The defense of sovereign immunity is now limited to less than one-third of the states. Because of the increasing cost of liability insurance, states are turning to self-insurance and comprehensive programs of risk management to demonstrate care for and attention to issues of motorist safety.

Management Concerns

The commitment to formalize and implement a comprehensive safety-program approach carries with it certain management concerns:

1. Who will assume the lead responsibility and what will be the roles and responsibilities of supporting departments, agencies, and personnel?
2. Will the program reduce or increase liability?
3. What assurance is there that the team can formulate and implement a cohesive, effective safety program?
4. Will the cost of implementation be in line with benefits to be received and will the new system be any better than the system currently in use?
5. How much continuing burden will this approach place on operating and overhead costs?

No glib answers can be offered for these concerns because answers will vary by state. Of course, the most overriding concern is whether the ability or expertise possessed by state or local agency personnel is sufficient to guide and administer the programs to fruition. The presence or absence of expertise will affect the capability to implement an effective program. Expanding the staff, training, or obtaining consultant services are all viable options to be considered by the program manager.

SAFETY-IMPROVEMENT PROCESSES

Description of Processes

In order to implement this program approach, process concepts must be translated into concrete procedures, accepted engineering techniques, or other understandable terms. In all likelihood, questions that pertain to several areas will be left to state and local agencies:

1. What should the emphasis be on local road systems?
2. What data elements should be routinely collected and updated?
3. What analysis techniques give the desired results?
4. What level of personnel and funding should be devoted to the program?

Before these issues can be addressed, the processes must be understood, since they address the activities of safety-improvement development.

The highway safety program should be composed of two equal parts: (a) safety improvements based on accident analysis and (b) street surveillance and control-device management.

The overall safety-improvement process is defined as a series of empirically based activities undertaken to effectively and economically improve the safety afforded the traveling public who use the nation's highways. These improvements are implemented through activities that systematically identify and analyze problems, develop alternative solutions, apply the solution, and then judge the success in solving the problem. The processes that make up the highway safety program are data collection, data analysis, engineering studies, priority formulation, implementation, and evaluation.

Street surveillance and control-device management are keyed to making quick remedial treatments for unsafe conditions. The routine risk-management program is a means to limit liability through conduct of routine comprehensive activities such as inventorying traffic-control devices and developing design reviews. Although most of these activities are currently being conducted, they are rarely organized or coordinated to gain maximum legal or safety benefits.

Data Collection

The data collection process is defined as those activities involved with the collection, storage, and retrieval of data to be used to support safety-improvement implementation. Data requirements and system organization and operation are determined by the analyses, studies, etc. that will be performed in subsequent processes.

Data Elements

Data to be collected and stored are dictated by needs from analysis, engineering studies, priority formulation, and evaluation processes. The data collection process should not strive to collect all data, only those that are routinely or frequently used and economically justified. Data elements should include the following:

1. Accident data (by location of occurrence): location, time and date, severity, weather and light conditions, pavement conditions, intended path and type of accident, and types of vehicles involved; and
2. Roadway data by location: traffic volumes and mix, geometric layout (horizontal, vertical, angle of intersection, etc.), functional classification, number of lanes and width, pavement type, control devices, curb and shoulder type and width, special operational practices, railroad grade crossings (including description), bridges (including description), land use, and speed limit.

Because the lists are practically limitless, especially regarding roadway data elements, the task is to define a set of data that are actually used as well as desirable. Starting small, designing an expandable system, and establishing procedures for collection of additional data probably constitutes the most realistic and economical approach.

Basic Systems

Three basic systems, shown in Figure 3 [from Strate (6)], constitute the core of the data collection process--the location reference system, the accident data system, and the roadway data system. These systems may be organized within an overall statewide traffic records system and coordinated with driver or vehicle records systems, but the key relationship for highway-improvement purposes is among the three systems.

The location reference system is necessary to report and record traffic accidents, to collect highway and traffic data, and to interface the two records. Although locations are needed on state and local highways alike, the types of referencing systems and their accuracy can vary dramatically without adverse impact on overall system operations.

The accident data system extends from the reporting of accidents through the storage and retrieval of data. Key considerations in the accident reporting and recording system are state and local agency participation in the statewide system, use of a uniform accident report form, checks for report and coding accuracy, and processing, storing, and retrieval of information and reports.

The roadway data system involves collection and storage of highway and traffic data through inventories, photologging, traffic counting, maintenance reports, sufficiency ratings, etc. Considerations in storing and retrieving the data may include method and location of storage and filing, interface with other systems, and accessibility and availability to users.

Data Analysis

The data analysis process involves the examination of collected data to identify highway locations, features, or practices that have the highest accident potential. The analysis is performed to discover problems susceptible to treatment and correction by safety improvements.

Analysis Techniques

Data available through the data systems as well as other inputs shown in Figure 4 [from Strate (6)] are used in the data analysis. Any of the analyses shown in the process, individually or in combination, could be acceptable for any given highway segment. Considerations in selecting the analysis technique would include traffic volumes, expected accident experience, and availability of funds for implementation of improvements. Additional considerations in implementing the process include the following:

1. Timing, form, and reliability of data or comparisons routinely supplied to the analysis staff;
2. Timing, quality, and expected use of routine analysis made by staff;
3. Quantity, type, and turnaround time afforded special requests; and
4. Number and expertise of the analysis staff.

Nonaccident Indicators

Of special significance are attempts to develop indicators of accident potential other than acci-

Figure 3. Systems that are core of data collection process.

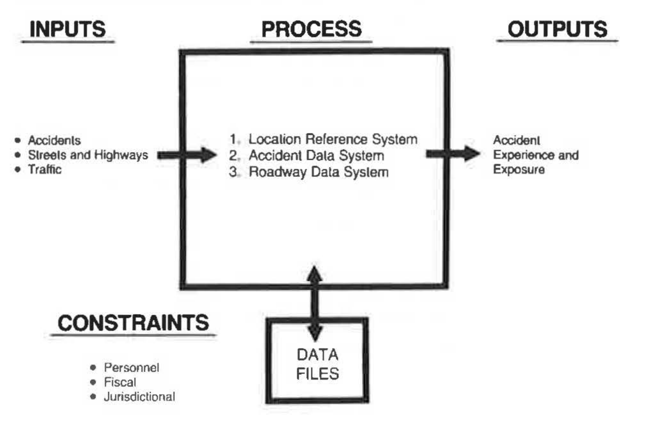
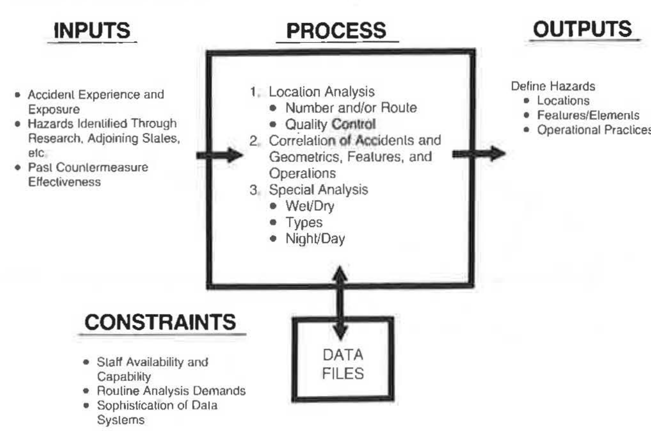


Figure 4. Data analysis process.



dents. The hope is to identify and correct hazards before pain, suffering, and economic loss are inflicted through accident experience. Some familiar techniques, such as skid testing and hazard indices, and some developing techniques, such as conflicts analysis and erratic maneuvers, are most reliably and economically applied during the engineering study phases. At present, the most accurate non-accident hazard indicators are correlation of geometrics and accidents, consideration of locations that have similar characteristics, and some types of sufficiency ratings.

Outputs

Three general types of listings or outputs could be expected from the process, as shown in Figure 4. These may be organized by road system, responsible agency, or some other classification to facilitate study of the most serious problems first. Process outputs include the following hazards:

1. Locations expressed in terms of intersections, spots, or segments;
2. Roadway features, design elements, or roadside hardware; and
3. Traffic operational practices that include traffic control through construction zones, reversible lanes, contraflow lanes, diagonal parking, etc.

Engineering Studies

The engineering study process develops safety improvements to solve the problems identified during the data analysis process. This is accomplished through additional detailed data analysis, supplementary studies, and on-site visits.

Until this point, the purpose of the safety process has been to learn more about what is taking place within the transportation system. The engineering study process in Figure 5 [from Strate (6)] begins the activities necessary to alter current highway performance through safety-improvement actions. Based on the hazards identified, this process strives to prescribe what action or actions can effectively remedy the problems.

Figure 5. Engineering study process.

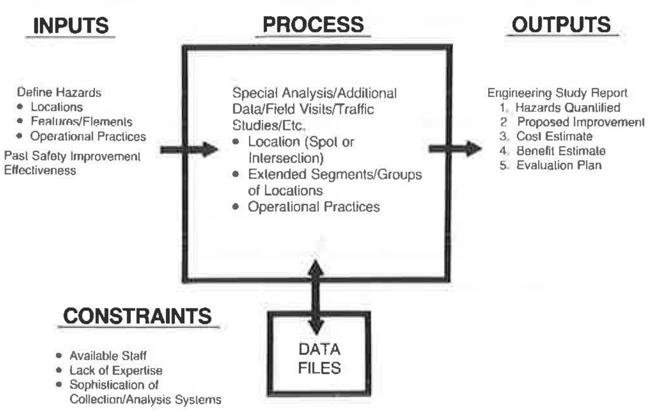
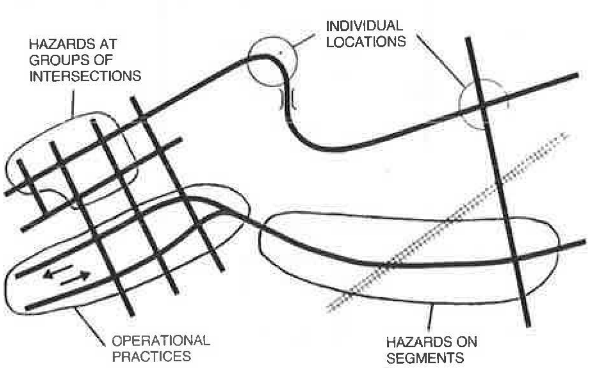


Figure 6. Types of engineering studies.



Highway Improvements

Engineering studies are intended to develop three distinctly different types of highway improvements, as shown in Figure 6 [from Strate (6)]. The three outputs of the analysis function and measures of past improvement effectiveness are the bases for those studies. The first type, hazardous locations, is the basis for improving roadway safety at singular locations (spots or intersections). For each location, accident data reports, current traffic data, and highway data are necessary. The accident and roadway environment data systems should be designed to provide this information. An engineering study to develop alternative corrective measures is performed that involves field visits and special analysis. The study results in quantification of the hazard or hazards, recommended improvements, costs for improvements, measures of potential benefits, and a plan for evaluation after improvement implementation.

The second type, hazardous roadway features, design elements, etc., is the basis for improving systemwide roadway safety. The thrust is to address accident potential more squarely by looking at a number of locations or extended highway segments. Design reviews and performance reviews must be keyed to the on-going analysis of design and roadway hazards. For each potential hazard, accident data and reports, traffic data, and necessary highway data are obtained from the accident and roadway data systems. In some cases, special inventories may be necessary to further quantify problem areas.

The third type, hazardous traffic operational practices, is similar in intent to the study types just discussed. The purpose is to tie operational reviews to accident data functions, especially in the case of unique, experimental, or complex traffic operation practices. This engineering study will strive to correlate accidents and operational practices and to seek locations that have similar accident-causing characteristics. Data requirements and study outputs are similar to those identified above.

For the second and third types, two points are important. First, studies and reviews may be performed by jurisdiction, state highway district, geographic area, or major route. Second, these improvements may be warranted by some overall accident experience, by hazard identification, or by being the type of improvement that lends itself to systemwide project implementation.

Study Techniques

The performance of engineering studies may involve a number of study techniques and methods. Techniques that can be used during this part of the process include the following: collision/condition diagrams, sufficiency ratings, operational reviews, conflicts analysis, erratic maneuvers, lane-replacement studies, speed studies, turning movements, skid testing, and hazard indicators.

Project Priority Formulation

Formulation of priorities is achieved through systematic comparison of alternative safety improvements. Constraints of funding and available personnel require that improvements be implemented that best contribute to the accomplishment of overall program objectives.

Projects are scheduled for implementation based on results of the engineering studies. Priority safety improvements are identified and then matched against other highway needs through a statewide programming of projects. The formulation of priorities and development of implementation schedules shown in Figure 7 [from Strate (6)] must consider a wide range of technical and management factors.

The overall objectives of the safety program require consideration of the magnitude of the safety problem and potential improvement effectiveness. The five considerations are shown in Figure 5. Although relationships of costs and benefits are important, relationships affect improvements. These are shown under Constraints in Figure 5 and tend to restrict the outputs of the process.

Collected data and engineering studies are used to develop aids to decision making. Economic analyses offer the most assistance in establishing improvement priorities. Some of these include benefit/cost ratio, incremental benefit/cost ratio, rate of return, cost-effectiveness, net benefit, and dynamic and integer programming.

Implementation

The implementation process is defined as those activities that lead directly to removal, installation, and construction of approved improvements.

The process that leads to implementation of improvements may be the most complex in many ways. In addition, the many technical details, contracting procedures, and administrative regulations can be rigorous and time-consuming. Based on an approved program and schedule of projects, the activities involved in implementation of safety improvements are shown in Figure 8 [from Strate (6)].

Less complex and costly projects can often be implemented with less-sophisticated designs or by in-house personnel at a savings over contract efforts. Further, some improvements fall under the auspices of maintenance and operations personnel. Time and overhead can be saved by a careful management study of the implementation process.

Evaluation

The evaluation process involves the examination of past improvement and program decisions, the judgment of the degree of success in accomplishing objectives, and the recommendation of methods or information to improve the quality of future decisions. The results of the first five processes are evaluated in order to implement an adaptable and continually improving state safety program.

Evaluation Types

The parameters that define safety evaluations are shown in Figure 9 [from Strate (6)]. Evaluations may be classified as three types--effectiveness, economic, and administrative. Effectiveness (or impact) evaluation measures the achievement of ultimate objectives such as the reduction in the rate of accident occurrence. Economic evaluations generally quantify effectiveness in terms of dollar expenditure to achieve given results. Administrative evaluations measure the attainment of intermediate or management objectives such as unit cost, timeliness, staff productivity, etc.

Methodologies

In addition to types of evaluation, evaluation criteria may be categorized as one of three methodologies--scientific, clinical, or personal. A large degree of statistical reliability and data collection and analysis are sought in the scientific approach. Personal evaluations are subjective and rely on the past experience of the evaluator for the evaluation criteria. A broad middle ground exists in which scientific and personal evaluations inter-

Figure 7. Improvement priorities.

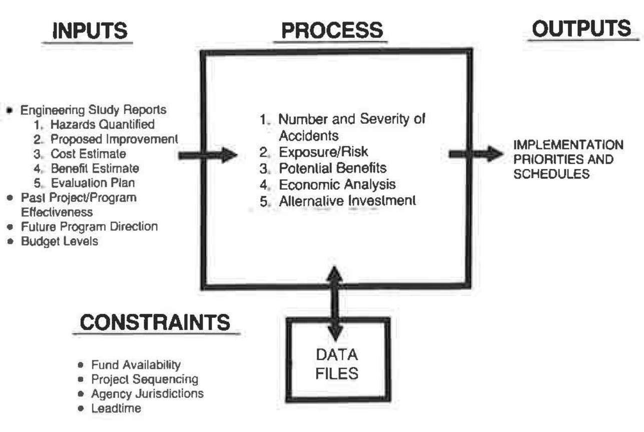


Figure 8. Implementation-related activities.

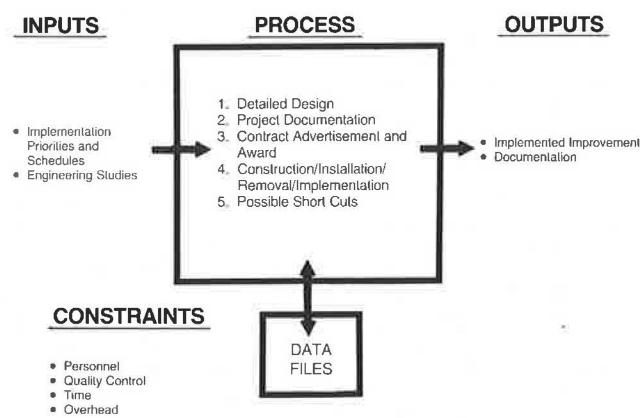
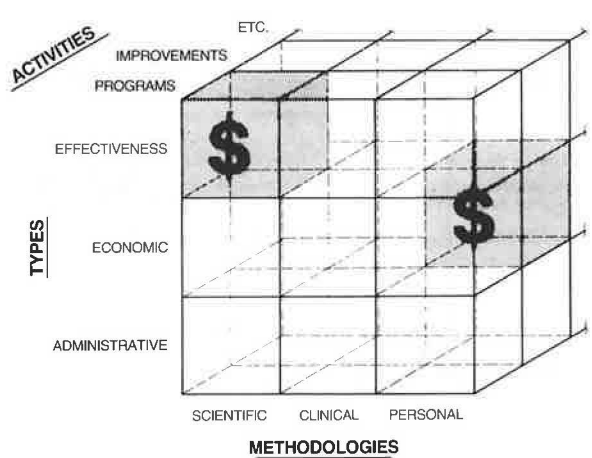


Figure 9. Types of highway safety evaluation.



mingle to produce many degrees of precision; this type is referred to as clinical.

Evaluations may be made of many types of past decisions. Individual improvements may be evaluated, as may entire funding programs. The operation of the data collection system and the methodology used to formulate priorities can each be evaluated as to the degree of accomplishment of defined objectives.

These three factors interrelate to affect the cost, complexity, and staff requirements to perform the evaluations. Broad-based scientific evaluations of program effectiveness would be costly, whereas personnel judgments of an office's operational efficiency would not. To be worthwhile, an evaluation process must be keyed to the entire safety program and the need for information by the decision maker.

Figure 10 [from Strate (6)] summarizes the process inputs, outputs, and constraints. Because safety evaluations are performed after the fact, they are often viewed as optional activities that have low funding and staffing priority. However, evaluations provide valuable input into upgrading the quality and quantity of information concerning the performance of the highway system and the effectiveness of the safety-improvement program.

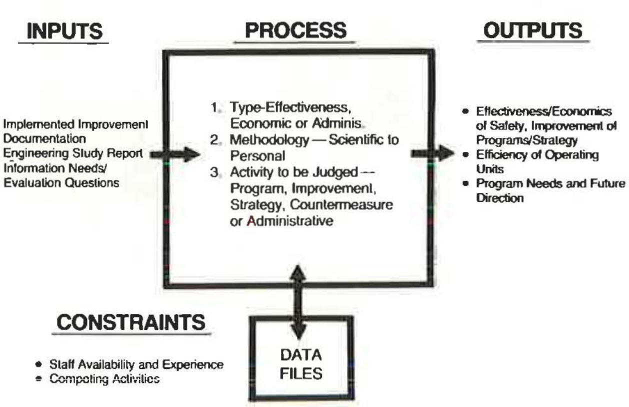
STREET SURVEILLANCE AND CONTROL-DEVICE MANAGEMENT

As contrasted with accident data collection and analysis, activities connected with street surveillance and control device management take advantage of visual, routine inspection of the road and street system. Although some coordination might be achieved with the process for safety improvement, the emphasis is to be placed on firsthand knowledge and management of actual physical and operational conditions. These activities are composed of three distinct subactivities: street surveillance, control-device management, and corrective measures.

Street Surveillance

Street surveillance takes advantage of organized (e.g., design reviews) and voluntary (e.g., citizen complaints) activities to create a permanent record of physical developments. The following street-surveillance activities are annual: drive or walk inspection, photographic record, photographic update, skid testing, and design and operations reviews. The following are routine: employee monitoring (including traffic-control devices), citizen complaints (including those about traffic-control devices), commission meetings, maintenance records, and hot spots.

Figure 10. Evaluation summary.



For each of the activities given above, these factors should be considered, especially in response to tort-liability issues:

1. Creation of a permanent documented record of all surveillance activities, including time and date, names and positions of those participating, location and scope of activity, description and purpose of activity, findings and recommendations, and follow-up activities;
2. Creation of a single point of responsibility of each surveillance function; and
3. Special attention to conditions of citizen complaints.

Control-Device Management

Control-device management strives to organize and monitor the performance of replacement signs, pavement markings, delineators, and signals. These activities go beyond simple reference to the FHWA Manual on Uniform Traffic Control Devices and involve specific activities for materials and inventory control. The growing sophistication in techniques and materials requires a special emphasis in recording and maintaining accurate records. The following control-device-management activities are performed annually: traffic-control-device inventory and inventory update; the following are routine: enforcement of standards; inspection of construction, maintenance, and utility zones (including during the night, in wet weather, and under other adverse conditions); and hot spots.

Of special importance is the review of the performance of signs, signals, etc. under adverse conditions. Although special design and operations review is an important tool, all agency employees should receive instructions in monitoring and reporting defective devices.

Corrective Measures

Remedial activities in the form of maintenance, replacement, or improvement are an essential complement to surveillance and management activities. The following corrective measures are annual: sign replacement, minor road repairs (e.g., potholes), pavement overlays, and safety improvements. Routine corrective measures, which are essential, include the following: maintenance of signs and markings, minor road repairs, improvement of sight distance (impaired by trees, brush, etc.), and hot spots.

As in the first two groups of activities, maintenance of a permanent record to document type and time of remedial treatment is essential. The system should be designed to report back to the originator of the report or complaint as a positive aid to follow-up.

SUMMARY AND CONCLUSIONS

The need for an organized process approach to highway safety has grown in acceptance. As stated in the U.S. Department of Transportation's Evaluation of the Highway Safety Program (7):

> Over the past two decades much has been learned about the effectiveness of safety planning and evaluation techniques... [and] the need for comprehensive, "do everything" action has given way to a widespread adoption of an organized system to define, implement, and evaluate cost-effective improvements.

Yet care must be taken not to carry this direction to its illogical extreme either by requiring cost-effectiveness analysis for all maintenance-type improvements or by foolishly reducing expenditures or operational standards to create a false economy of current savings.

Federal regulations and case laws have been developed based on reviews, facts, and court cases that have evolved over the last four years. The comprehensive approach made up of the processes included in the planning, implementation, and evaluation functions can lead to implementation of the most effective and economical highway safety improvements. At the same time, surveillance and control-device management will assure that a high daily level of safety is afforded the traveling public.

Based on recent regulatory and legal developments, the course of action is clear. Each state and affected municipality must establish an agenda to accomplish organization of a comprehensive, systematic approach to highway transportation safety improvement. Although safety problems may appear to go away, they are in fact lingering transportation system weaknesses that appear at times of catastrophic accidents. To oversee implementation, each state and metropolitan area should develop a single point of responsibility and, with authority to require adherence to standards, insist on implementation of safety actions.

REFERENCES

1. Safety in Urban Mass Transportation. Battelle, Columbus Laboratories, Columbus, OH; U.S. Department of Transportation, 3 vols., 1975-1976.
2. Federal-Aid Highway Program Manual. FHWA, U.S. Department of Transportation, Vol. 8, Chapter 2, Section 3, March 5, 1979.
3. D.C. Oliver. Liability and Highway-Safety Practice. Traffic Engineering, May 1977.
4. H.E. Strate. The Evaluation of Federal Highway Safety Program Effectiveness. FHWA, U.S. Department of Transportation, Aug. 1978.
5. H.E. Strate. Effectiveness Evaluations--An Engineer's View. Presented at ASCE Specialty Conference, San Diego, CA, March 1980.
6. H.E. Strate. Making Highways Safe: A Realistic Approach. ITE Journal, Vol. 50, No. 3, March 1980, pp. 21-29.
7. An Evaluation of the Highway Safety Program--A Report to the Congress from the Secretary of Transportation. National Highway Traffic Safety Administration, U.S. Department of Transportation, Rept. DOT-HS-802-481, July 1977.

Publication of this paper sponsored by Committee on Transportation System Safety.

Interstate Safety Improvement Program

J.G. PIGMAN, K.R. AGENT, AND C.V. ZEGEER

The purpose of this paper is to prepare prioritized rankings of recommended improvements that could be implemented for the Interstate Safety Improvement Program in Kentucky. Considerable detail is presented that documents analysis procedures used to determine sites, sections, and elements of the roadway in need of improvement. The average number of accidents per interchange, bridge, 1.6-km (1.0-mile) section, and 0.48-km (0.3-mile) spot was summarized for large urban, medium urban, and rural sections of the Interstate system. At specified levels of statistical significance, critical numbers of accidents and critical accident rates were calculated to assist in identifying high-accident locations. A limited field inventory of the Interstate system was conducted, and the results are incorporated into the program. Dynamic programming was used to develop prioritized rankings for safety improvements that totaled approximately $27 500 000. A user's guide for preparation of a safety improvement program was developed.

To provide the highest degree of safety on the Interstate system, there is a need to continually upgrade and make improvements. The program described here is intended to identify specific locations, elements, or sections of highways that are hazardous or potentially hazardous and to implement correction of the identified hazards. Accident analyses are the basis for recommending improvements. Interstate funds are not available for safety improvements unless they are justified and selected under the provisions of the Federal Highway Administration (FHWA) Federal-Aid Program Manual (1).

A previous report dealt with development of procedures for preparation of an Interstate Safety Improvement Program (2). The purpose of this report is to prepare prioritized rankings of recommended improvements that could be implemented as part of the Interstate Safety Improvement Program in Kentucky.

PROCEDURE

Accident Analyses

All police-reported accidents in Kentucky are coded and placed in a computer accident file. An extensive amount of data is coded for each accident. However, for the analysis necessary in this study, copies of the accident reports were necessary. To obtain these, a manual search of all police-reported accidents in 1976 was conducted.

From the reports, each accident was classified into one of three broad categories: (a) interchange-related, (b) bridge-related, or (c) related to other highway sections. Each accident was assigned a code based on an analysis of the accident description. The accident types for the three broad categories are given in Table 1. These data, along with information to identify the location of the accident, were punched on computer cards. The Interstate system was divided into three groups based on population of the general area.

Lists of high-accident interchanges, bridges, and other highway sections were obtained. A list of the location of interchanges and bridges was obtained. Accidents classified as either bridge-related or interchange-related were assigned to a specific bridge or interchange. By using this procedure, the number of accidents that occurred on each interchange and bridge was obtained. The number of accidents could then be compared with a critical number of accidents. The critical number of an interchange, bridge, or specific length of road was calculated by using the following equation (3):