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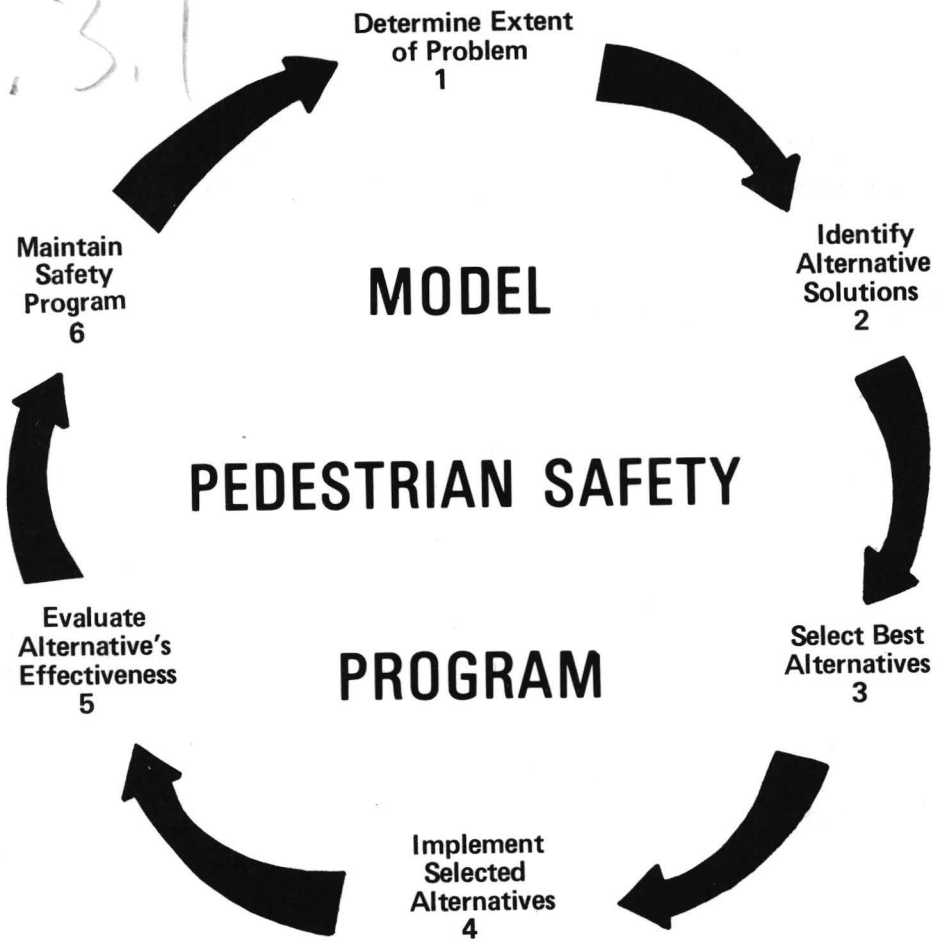
IMPLEMENTATION PACKAGE



USERS' MANUAL

U.S. DEPARTMENT OF TRANSPORTATION
Federal Highway Administration
Offices of Research and Development
Implementation Division
Washington, D.C. 20590

JUNE 1978

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TABLE OF CONTENTS

TABLE OF CONTENTS *(Continued)*

TABLE OF CONTENTS *(Continued)*

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Con't)

LIST OF TABLES

LIST OF TABLES (Cont'd)

INTRODUCTION

A safe pedestrian environment does not occur by luck or circumstance. Safety is created by design through constant attention and effort. Unfortunately, many safety efforts are haphazard or uncoordinated. There is a need for rational program development and solution implementation. This document is designed to serve that need. This *Model Pedestrian Safety Program Users' Manual* is written for both those with minimal safety program experience and those already involved in a safety program. Using these guideline suggestions, those of you without pedestrian safety experience can develop a complete and effective pedestrian safety program in your city, county or state. For those already involved, these guidelines will be a source of additional or alternative ideas and procedures which can be included in your current program.

Pedestrian accidents are known to be a national problem. They may also be a problem at your local level. Every year in the United States over 8000 pedestrians are killed and an additional 200,000+ are injured. In addition:

- Nearly 65 percent of the fatal and 85 percent of the injury accidents occur in urban areas.
- Pedestrians under 15 and over 64 years old account for half of the fatalities.
- Preschool children, although they are only eight percent of the population, are involved in 12–15 percent of the pedestrian accidents.
- About 55 percent of the children are hit while crossing the street between intersections.
- Half of all pedestrian deaths occur after the pedestrian has violated a traffic law or committed some other unsafe act.

These statistics do not accurately reflect the accident situation in any one locality. They do, however, indicate the types of problems individuals concerned with pedestrian safety must consider and solve. In any case, *solution to the national pedestrian safety problem does begin at the local level.*

This document was developed specifically to assist you, the individual or organization interested in planning and creating a safer environment for pedestrians. You are assumed to be aware that pedestrian deaths and injuries are economically and emotionally very expensive. You are assumed to be interested in improving pedestrian safety. Whether you are a politician, safety or safety-related professional, or a private citizen, the *Model Pedestrian Safety Program Users' Manual* has elements useful to you. Local neighborhood associations, civic groups, school groups, municipal, county, and state governments, highway departments, safety coordinators, police and traffic engineering departments all will find ideas, resources, procedures and implementation suggestions to aid efforts to create safety for the pedestrian.

This *Users' Manual* is designed to be a guide and resource. As a guide, it identifies steps to follow to set up a pedestrian safety program and provides information to help select safety

countermeasures. As a resource, it lists numerous possible solutions to safety problems and provides lists of additional references. (It should be noted that new developments are continually arising in the pedestrian safety field. Although this manual is currently up to date, it is *your* responsibility to keep up with future developments.)

It was not possible to develop guidelines specific to every potential user. To maximize this manual's effectiveness, *you* must adapt the procedures described to your particular situation. *You* must make the final decisions based on your own unique goals and limitations.

These guidelines are developed in a six-step process, outlined in Figure 1.

Step 1: Determine the Extent of the Pedestrian Safety Problem.
This step describes procedures useful for determining where pedestrian accidents and unsafe behaviors are occurring, what data are important in choosing rational solutions, and how the relevant data can be collected.

Step 2: Identify Alternative Solutions.
This step describes numerous countermeasures and facilities known to be effective in solving particular safety problems. Advantages, disadvantages, target populations and locations, and implementation considerations are listed for each alternative.

Step 3: Select the Best Alternatives (Benefit-Cost Analysis).
A procedure for comparing the benefit-to-cost ratio of possible alternatives, and selecting the best alternatives based on goals and limitations, is described.

Step 4: Implement Selected Alternatives.
This step discusses the organizational, scheduling, support and financial aspects of developing a successful safety program.

Step 5: Evaluate the Effectiveness of the Implemented Alternatives.
This step identifies methods of determining how effective the chosen alternatives actually were in aiding pedestrian safety.

Evaluation is not the final step in a safety program. While a particular problem area may have been improved, if the Pedestrian Safety Program is to continue, Step 6 is necessary.

Step 6: Maintain the Pedestrian Safety Program.
This step is the feedback movement returning to Step 1. A successful safety program is a never-ending loop; continual examination of the safety situation must be maintained.

Within this *Users' Manual,* each step is discussed in detail in its own section. In addition, several appendices provide more detailed technical data on specific topics and a glossary of terms used in the guidelines.

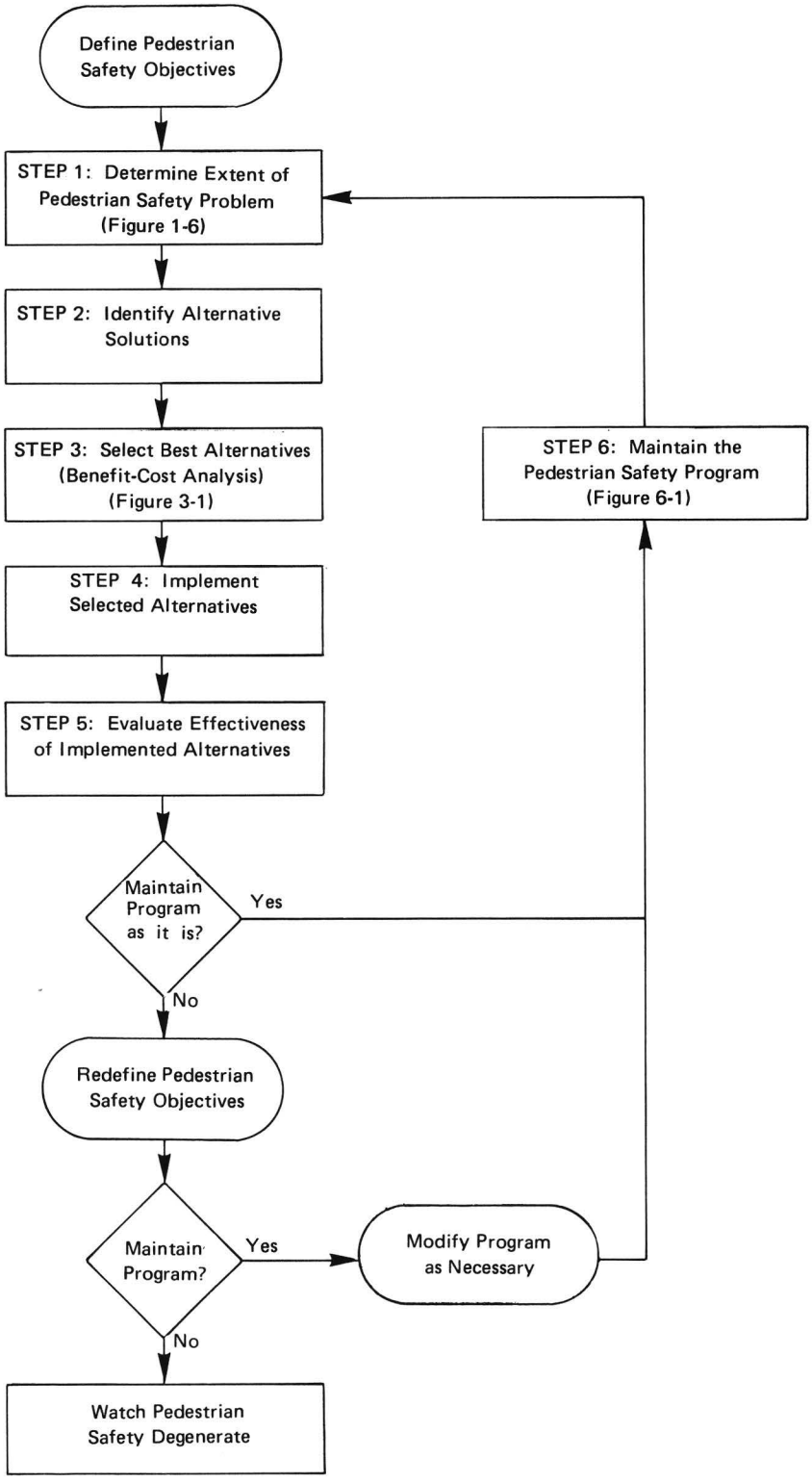
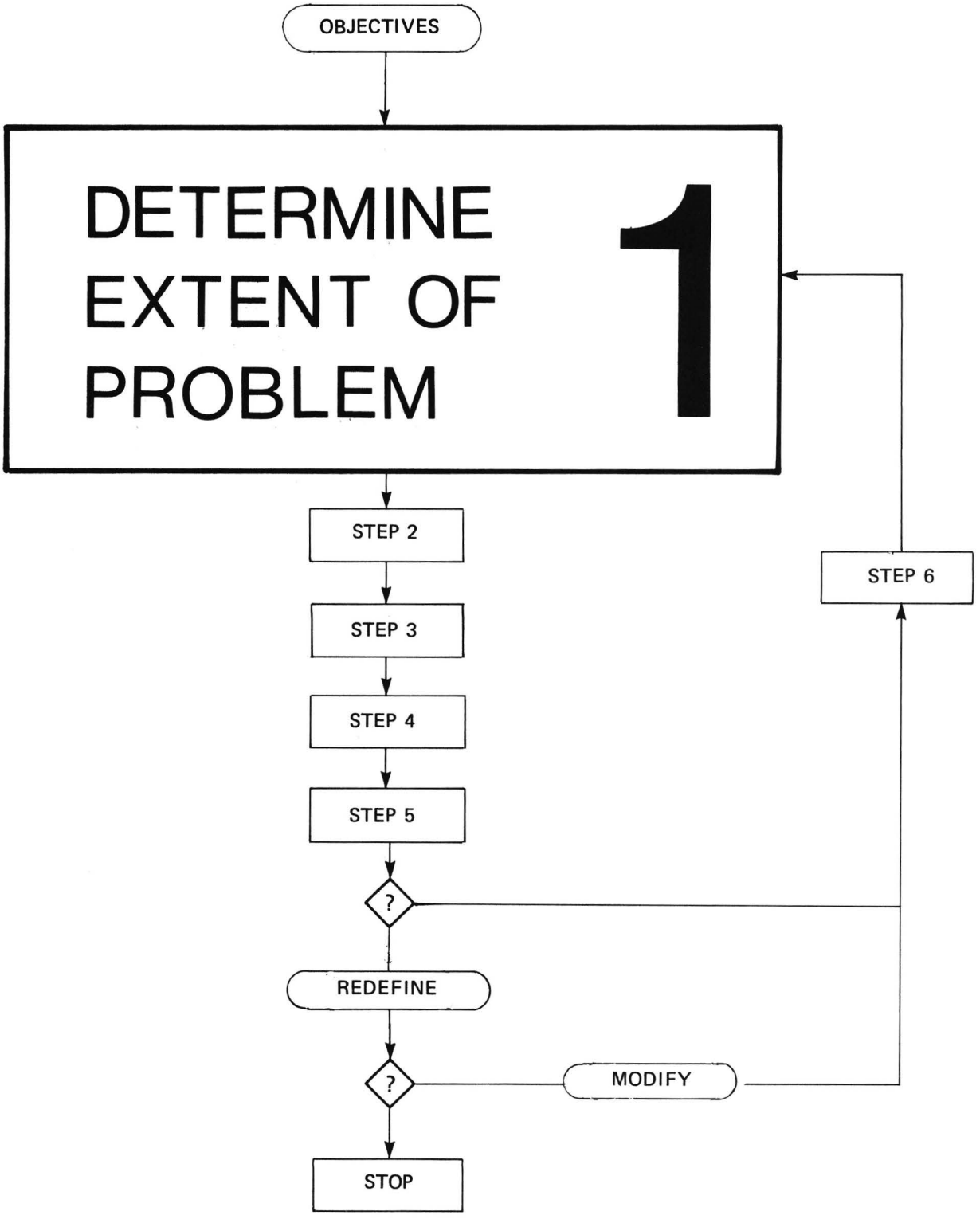
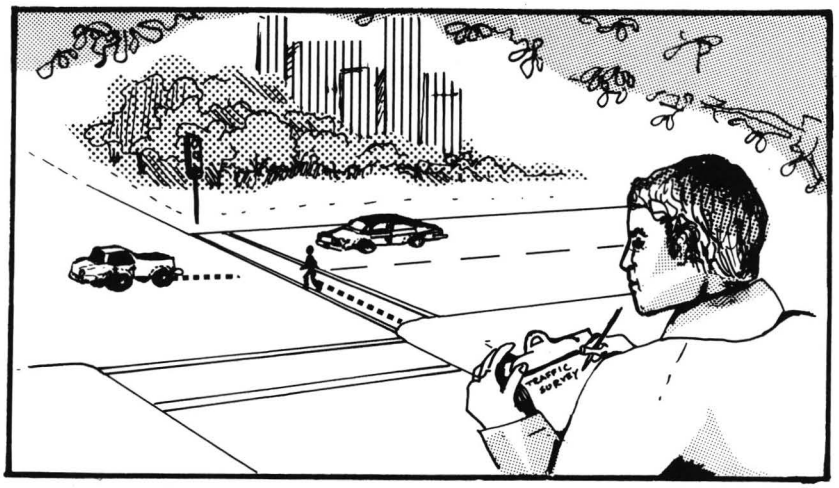


Figure I. Model Pedestrian Safety Program Outline.

It must be realized, however, that this *Users' Manual* cannot provide one of the prime elements of *every effective* safety program -- enthusiasm and commitment. The old saying "people are our most important resource," is equally applicable to the Model Pedestrian Safety Program. These guidelines can provide the what and how; you must provide the push, the involvement, and the long term interest to get the resources necessary to improve pedestrian safety. Once the "who" part of the equation is satisfied, the "what and how" from this manual will be effective in creating a safer pedestrian environment.


OBJECTIVES
DETERMINE EXTENT OF PROBLEM
1
STEP 2
STEP 3
STEP 4
STEP 5
?
REDEFINE
?
MODIFY
STOP
STEP 6



Behavioral Analysis

Citizen Complaints

Accident investigation and analysis

STEP 1: DETERMINE THE EXTENT OF THE PEDESTRIAN SAFETY PROBLEM*

The goal of every pedestrian safety program should be to reduce fatalities, injuries, and material losses resulting from pedestrian accidents. The initial step toward this goal is to determine the extent of the pedestrian safety problem by identifying hazardous locations. Information about these places can be collected from three primary sources:

A. Citizen Complaints: verbal or written notification about problem areas from "on-the-scene" private citizens, school personnel, police, or other sources.

B. Accident Investigation: collection and analysis of pedestrian accident data.

C. Nonaccident Behavioral Analysis: collection and analysis of data on pedestrian behaviors in a nonaccident context.

A. Citizen Complaints

It is impossible for transportation engineers, planners and other government officials to go around and look for all possible hazardous locations. The likelihood of seeing unsafe behaviors/conditions during their visits to a site is probably very low. Individuals who live in a particular neighborhood, cross certain streets, or pass through the same intersections on a daily basis are much more familiar with the long-term behavioral aspects of these locations. Information from these users can focus attention on a problem that might not have been noticed otherwise.

The importance of reports by concerned citizens to the responsible agency cannot be overestimated. These complaints act as notifications about a hazardous location. Courts evaluating lawsuits resulting from accidents have historically found the responsible agency negligent if it had been "put on notice" but did nothing about the situation. Locations identified through citizen reports or complaints must be further studied. Accident investigations and behavioral evaluations must be initiated to determine what the best solutions to the problem might be.

*A Glossary of Terms used in this step and the rest of the manual is provided in Appendix A. Because several of the ideas presented may be unfamiliar, it might be helpful to scan the glossary before continuing.

B. Accident Investigation and Analysis

Investigation and analysis of pedestrian accidents are important for several reasons.

- Accident reduction is the rationale for the whole effort.
- Accidents are a measure that most people can understand.
- Accident records can be used to identify the types of accidents occurring, their locations, conditions at the time, and most important, the precollision behaviors of the participants.
- With knowledge, through accident reconstruction, of the behavioral circumstances resulting in the collision, rational programs can be outlined to reduce future accident occurrence.
- Accident records provide a measure of a program's success or failure.

Pedestrian-vehicle accidents are the result of a complex chain of interacting factors. They do *not* follow a simple cause and effect relationship. *Rarely*, if ever, does one single "cause" result in a collision. Unfortunately, historical precedent and tradition have contributed to the perpetuation of this idea. Because accident investigators frequently prepare reports for legal documentation, they tend to concentrate on identifying law violations instead of crash (injury) causal factors. "Cause" and "fault" in an accident are not necessarily synonomous.

The standard accident report form also contributes to this problem. Frequently accident reports contain one block for "Primary Cause," or several blocks for "Primary and Secondary Causes." These items may identify one or more of the conditions present at the time and location of the accident. However, they are of questionable value for accurately describing what happened during the accident. Arbitrary selection of one or more violation variables as the primary "cause" can lead to incorrect conclusions and, ultimately, the application of improper countermeasures. To counteract this problem, *behavioral* data must also be sought during the investigation.

Pedestrian Accident Reconstruction

A pedestrian accident may be defined as the result of a Behavioral Sequence of Events at a location which produces a pedestrian-vehicle collision.* Accident Reconstruction is the process of determining the Events Sequence which occurred immediately preceding, during and after the collision. Knowledge of this Behavioral Sequence leads to an understanding of the factors and conditions that precipitated the accident. Understanding what leads to and contributes to accidents and injuries *must* precede rational countermeasure selection.

*It should be noted that this discussion will deal *only* with pedestrian-vehicle accidents. Pedestrian-*non*vehicle accidents (such as falling down escalators or stairs, tipping over curbs, etc.) are not considered.

Investigating accidents as a Behavioral Events Sequence provides the opportunity to identify one or more points to address countermeasures and thereby avoid the collision. Within the Sequence of Events, each event (or Causal Factor) has its own unique contributing value. Modification or elimination of any one of them might alter the probability of crash occurrence or the severity of its outcome. To pinpoint these Causal Factors it is necessary to determine what conditions influence the behaviors in the Events Sequence. This information will provide a systematic structure for analyzing the human, vehicular and environmental factors involved, and the ways in which they interact.

Using this type of approach leads to the identification of:

- major aspects of the pedestrian accident process,
- methods of grouping these different aspects in order to understand accidents with common causal patterns, and
- the ways in which these patterns may be reviewed to identify possible countermeasures.

Pedestrian Accident Typology

Similarities and differences among the population of pedestrian accidents are such that a finite number of Accident Causal Types have been identified. Each of these has one or more countermeasures which directly address the behavioral sequence describing the Accident Type. Development of the Causal Types is based on reconstruction of the Sequence of Events in terms general enough to apply to the whole realm of pedestrian accidents, and specific enough to permit analytic understanding of individual crashes.

While the *specific* events will vary from accident to accident, *general* pedestrian and driver behaviors occur in all accidents. Failure of both participants to perform any one behavioral event will lead to a collision. These behaviors are grouped as follows:

- Search: the focus of a pedestrian's/driver's attention; watching where one is going.
- Detection: noticing a potential accident situation (e.g., the pedestrian seeing a car approaching; the driver seeing a pedestrian wanting to cross the street).
- Evaluation: determining the likelihood of an accident occurring.
- Decision: deciding what to do to avoid the accident.
- Human Action: doing what is necessary.
- Vehicle Action: response of the vehicle to the driver's input.

Figure 1-1 illustrates these general behaviors. In the figure, each event is identified by the activity that should be performed by the participant and its correct outcome ("Yes"). If all activities are performed by *either* participant, there is no accident. That is, if *either* the pedestrian *or* driver sequence is completed successfully, the collision is avoided. A failure ("No") at any step results in nonperformance of the following steps. If *both* the driver *and* the pedestrian do *not* perform any one of the activities in their Sequence of Events, an accident occurs.

These behavioral factors, in combination with locational and populational factors, define Causal Types. Ideally, each pedestrian accident can be assigned to a Causal Type by one or more of the following:

- Precipitating Events: specific nature of the failure in the Event Sequence that leads to a collision; factors leading directly and immediately to a crash (e.g., driver did not see pedestrian soon enough to react).
- Predisposing Factors: specific environmental, human or vehicle variables which *actually influence* the collision; factors which, in advance, create a susceptibility, inclination, or disposition toward a crash (e.g., parallel parked vehicles, drunk driver or pedestrian).
- Target Groups: subpopulations and/or types of physical locations involved (e.g., midblock location, children).

Note that for a given Accident Type, the Predisposing Factors are environmental, human or vehicle conditions that actually lead to the accident. Target Group variables include environmental, human or vehicle conditions only *associated* with it.

A Pedestrian Accident Type is distinguished by the presence or absence of one or more critical descriptors. Tables identifying the most frequently found pedestrian Accident Causal Types and their critical descriptors in urban, rural and freeway settings are found in Tables 1-1, 1-2 and 1-3. The Accident Typology is a useful tool for evaluating the pedestrian safety problem and for determining what steps might be taken to mitigate the problem. It helps to simplify accident analysis by grouping crashes according to specific behavioral and locational descriptors. This allows decision makers to visualize the important factors and their interrelationships. In turn, this provides a common and definitive basis for data collection, analysis, interpretation and, most important, application of results. Without such a discriminating accident typology, the position of the highway administrator would be analogous to a public health official who was trying to cure "disease," rather than selected *types* of diseases; there would be little basis for selecting countermeasures or for evaluating their effectiveness.

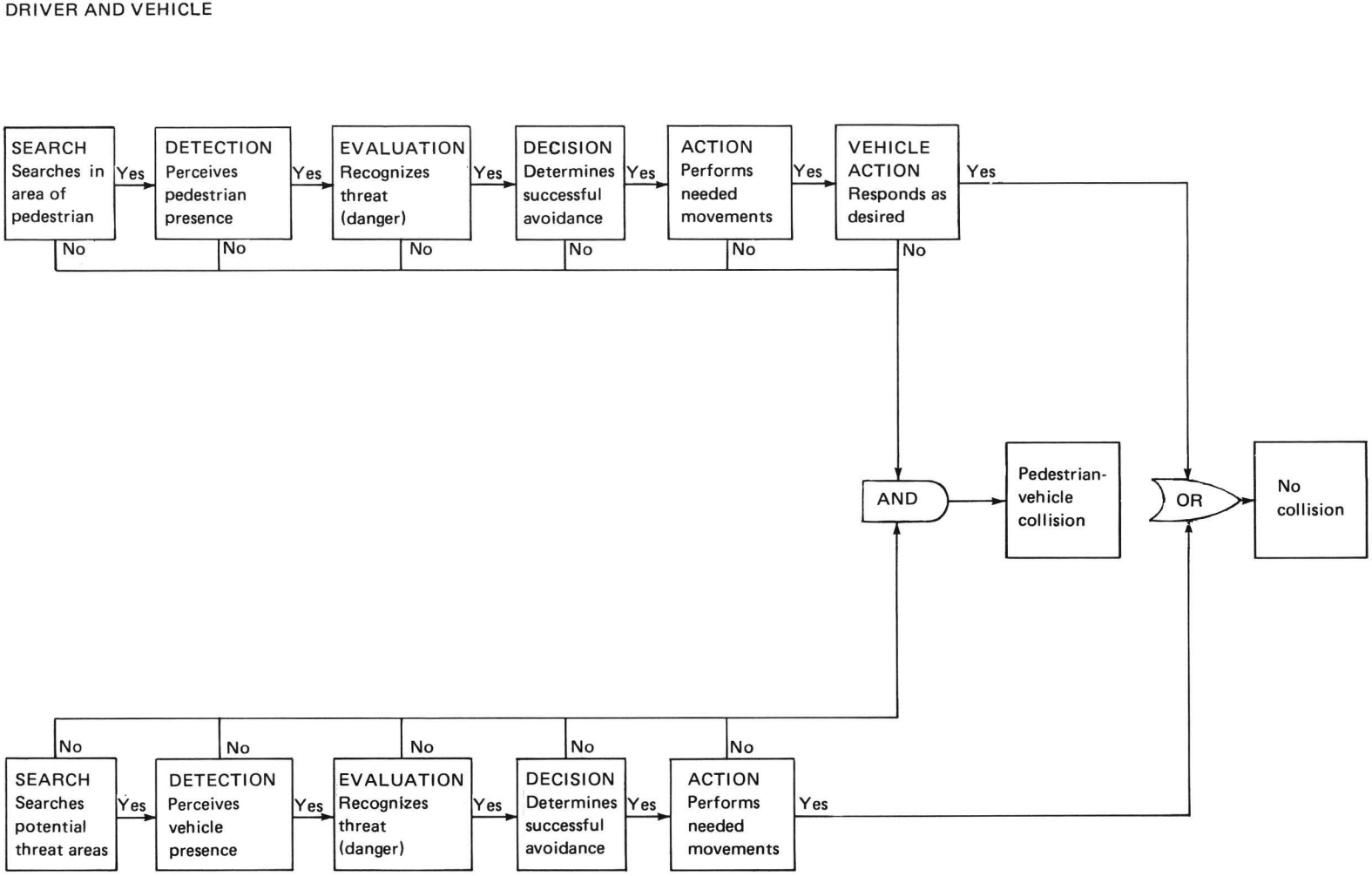


Figure 1-1. Generalized Behavioral Event Sequence
(From Snyder & Knoblauch, 1971)

Table 1-1

Urban Pedestrian Accident Types and Critical Behavioral Descriptors*

DART-OUT (FIRST HALF) (23%)

Midblock (not at intersection).

Pedestrian sudden appearance and short time exposure (driver does not have time to react to avoid collision).

Pedestrian crossed less than halfway.

DART-OUT (SECOND HALF) (9%)

Same as above except pedestrian gets at least halfway across before being struck.

MIDBLOCK DASH (7%)

Midblock (not at intersection).

Pedestrian running but *not* sudden appearance or short time exposure as above.

INTERSECTION DASH (12%)

Intersection.

Short time exposure *or* running.

Same as *Dart-out* except it occurs at an intersection.

VEHICLE TURN-MERGE WITH ATTENTION CONFLICT (4%)

Intersection or vehicle merge location.

Vehicle turning or merging into traffic.

Driver is attending to auto traffic in one direction and collides with pedestrian located in a different direction than that of the driver's attention.

TURNING VEHICLE (5%)

Intersection or vehicle merge location.

Vehicle turning or merging into traffic.

Driver attention *not* documented.

Pedestrian not running.

MULTIPLE THREAT (3%)

One or more vehicles stop in traffic lane (e.g. Lane 1) for pedestrian.

Pedestrian is hit as he steps into next parallel *same direction* traffic lane (e.g. Lane 2) by a vehicle moving in the same direction as the vehicle that stopped.

Collision vehicle driver's vision of pedestrian obstructed by the stopped vehicle.

BUS STOP RELATED (2%)

At a bus stop.

Pedestrian steps out from in front of bus at a bus stop and is struck by vehicle moving in same direction as bus while passing bus.

Same as Multiple Threat except that stopped vehicle is a bus at a bus stop.

VENDOR-ICE CREAM TRUCK (2%)

Pedestrian struck while going to or from a vendor in a vehicle on the street.

DISABLED VEHICLE RELATED (1%)

Pedestrian struck while working on or next to a disabled vehicle.

RESULT OF VEHICLE-VEHICLE CRASH (3%)

Pedestrian hit by vehicle(s) as a result of a vehicle-vehicle collision.

TRAPPED (1%)

Signalized intersection.

Pedestrian hit when traffic light turned red (for pedestrian) and cross traffic vehicles started moving.

*Percentages indicated are from recent research studies of urban pedestrian accidents (Snyder & Knoblauch, 1971; Knoblauch, 1975).

Table 1-2

Rural Pedestrian Accident Types and Critical Behavioral Descriptors*

DART-OUT (FIRST HALF) (11%)

Midblock (not at intersection).

Pedestrian sudden appearance and short time exposure (driver does not have time to react to avoid collision).

Pedestrian crossed less than halfway.

DART-OUT (SECOND HALF) (10%)

Same as above except pedestrian gets at least halfway across before being struck.

MIDBLOCK DASH (10%)

Midblock (not at intersection).

Pedestrian running but *not* sudden appearance or short time exposure as above.

INTERSECTION DASH (10%)

Intersection.

Short time exposure *or* running.

Same as *Dart-out* except it occurs at an intersection.

VEHICLE TURN-MERGE WITH ATTENTION CONFLICT (1%)

Intersection or vehicle merge location.

Vehicle is turning or merging into traffic.

Driver is attending to auto traffic in one direction and collides with pedestrian located in a different direction than that of the driver's attention.

TURNING VEHICLE (2%)

Intersection or vehicle merge location.

Vehicle turning or merging into traffic.

Driver attention *not* documented.

Pedestrian not running.

MULTIPLE THREAT (2%)

One or more vehicles stop in traffic lane (e.g. Lane 1) for pedestrian.

Pedestrian is hit as he steps into next parallel *same direction* traffic lane (e.g. Lane 2) by a vehicle going in the same direction as the vehicle that stopped.

Collision vehicle driver's vision of pedestrian obstructed by the stopped vehicle.

SCHOOL BUS RELATED (3%)

Pedestrian is hit while going to or from a school bus or school bus stop.

VENDOR-ICE CREAM TRUCK (1%)

Pedestrian struck while going to or from a vendor in a vehicle on the street.

DISABLED VEHICLE RELATED (6%)

Pedestrian struck while working on or next to a disabled vehicle.

RESULT OF VEHICLE-VEHICLE CRASH (1%)

Pedestrian hit by vehicle(s) as a result of a vehicle-vehicle collision.

BACKING-UP (2%)

Pedestrian hit by vehicle backing up.

WALKING ALONG ROADWAY (12%)

Pedestrian struck while walking along the edge of the highway or on the shoulder.

Can be walking facing or in the same direction as traffic.

HITCHHIKING (2%)

Pedestrian hit while atempting to thumb a ride.

WIERD (8%)

Unusual circumstances.

Not countermeasure corrective.

*Percentages are from recent research study of rural pedestrian accidents (Knoblauch, 1976).

Table 1-3

Freeway Pedestrian Accident Types and Critical Behavioral Descriptors*

DISABLED VEHICLE RELATED (20%)

Pedestrian struck while working on or next to a disabled vehicle.

RESULT OF VEHICLE-VEHICLE CRASH (10%)

Pedestrian hit by vehicle(s) as a result of a vehicle-vehicle collision.

WEIRD (10%)

Unusual circumstances.

Not countermeasure corrective.

HITCHHIKING (9%)

Pedestrian hit while attempting to thumb a ride.

WALKING TO/FROM DISABLED VEHICLE (8%)

Pedestrian struck while walking along the edge or shoulder of highway.

Reason for walking is because of disabled vehicle.

Can be walking facing or in same direction as traffic.

DART-OUT (5%)

Not at interchange.

Pedestrian sudden appearance and short time exposure (driver does not have time to react to avoid collision).

WALKING ALONG ROADWAY (5%)

Pedestrian struck while walking along the edge of the highway or on the shoulder.

Can be walking facing or in the same direction as traffic.

WORKING ON ROADWAY (3%)

Pedestrian (flagman or other construction worker) struck while working on the roadway or shoulder.

MIDBLOCK DASH

Not at interchange.

Pedestrian running but *not* sudden appearance or short time exposure.

VEHICLE TURN-MERGE WITH ATTENTION CONFLICT

Vehicle merge location.

Vehicle merging into traffic.

Driver is attending to auto traffic in one direction and collides with pedestrian located in a different direction than that of the driver's attention.

TURNING VEHICLE

Vehicle merge location.

Vehicle merging into traffic.

Driver attention *not* documented.

Pedestrian not running.

*Percentages are from recent research of freeway pedestrian accidents (Knoblauch et al., 1976).

Pedestrian Accident Data Collection

As was mentioned above, most standard (police) report forms identify a primary (and possibly secondary) accident "cause" – frequently a violation having little to do with the accident's occurrence. The data required to satisfy a Behavioral Event Sequence analysis are not available on most forms presently used.

The basic information that *should* be collected on each accident should identify the following three important items:

- target locations for countermeasure installation.
- target populations.
- Causal Factors relevant to valid countermeasure selection based on the target population.

Knowledge of who is involved in pedestrian accidents and how and where they are involved will allow corrective efforts to be aimed at the right target subjects (pedestrians, drivers, locations), or the right circumstances (Behavioral Event Sequence).

It is possible that the narrative section on the report form could contain the appropriate data. However, narratives are often cumbersome and do not always lend themselves to rapid analysis. In addition, the degree to which this section is completed usually depends on the thoroughness of the investigator. Unfortunately, thoroughness is frequently proportional to the severity of the accident.

Before establishing data collection techniques, the data relevant to determining Causal Types must be identified. This is done in Table 1-4. Not all of these data items are normally collected on standard accident reports. To obtain the required information, a Pedestrian Accident Supplemental Data Form should be developed and used by accident investigation personnel. Experience has shown that it is feasible to determine Pedestrian Accident Types from a standard police report in combination with a limited supplementary form.

For efficient analysis, the data from these two forms should be transferred to a Master Coding Form. Figure 1-2 illustrates such a Master Coding Form. This form lists all the items pertinent to reconstruction of the Behavioral Event Sequence leading to the crash. From it, the Accident Type can be determined.

Considering the wide use these additional and more meaningful data will get, and the more successful countermeasures that will presumedly result, the additional investigation cost and time can be recovered through reductions in accident frequency and severity. In addition, use of one Master Form (e.g., within a state) provides a means of *reliably* comparing accident statistics between jurisdictions. (See Appendix E: State Use of the Model Pedestrian Safety Program, for a further discussion on this topic.)

Table 1-4

Data Items for Pedestrian Accident Typology Determination

LOCATION
- Street Name(s)
- Impact Site

DATE

TIME

DAY OF WEEK

VEHICLE DRIVER
- Age
- Sex: Male, Female, Hit and Run

PEDESTRIAN
- Number Involved
- Age
- Sex
- Injury Severity of Each Pedestrian Involved

LIGHT CONDITIONS: Daylight, Dawn/Dusk, Dark

WEATHER CONDITIONS: Clear/Cloudy, Rain, Snow/Sleet, Fog/Mist, Other

ROADWAY CONDITIONS: Dry, Wet, Snow/Ice/Mud, Other

TYPE OF VEHICLE: Car, Taxi, Truck, Bus, Other

TYPE OF ROAD: One-way, Two-way, Divided, Expressway, Other

TYPE OF AREA: Residential, Commercial, Industrial, School, Undeveloped, Combination of. . .

TRAFFIC CONTROL: Full Signal, Stop/Yield Sign, None, Other

VEHICLE BEHAVIOR: Proceeding Straight, Backing, Turning Right, Turning Left, U-turning, Stopped in Traffic, Starting in Traffic, Stopping or Slowing, Entering/Leaving Parking Space, Other

ACCIDENT LOCATION:
- Intersection, Nonintersection
- Marked Crosswalk, Unmarked Crosswalk, Not in Crosswalk
- Street Lights On, Pedestrian Signal Present, Both

NUMBER OF TRAFFIC LANES

LANE IN WHICH PEDESTRIAN WAS STRUCK

DRIVER VISION BLOCKED BY: Standing Traffic, Parked Vehicle, Bus at Bus Stop, Other

DRIVER ACTION:
- Attempted Evasive Action to Avoid Pedestrian
- Attending to Traffic and Failed to See Pedestrian
- Under Influence of Alcohol/Drugs
- Made Turning/Merging Maneuver
- Made Improper Turn
- Disobeyed Sign/Signal
- Exceeding Speed Limit
- Combination. . .

PEDESTRIAN ACTION: Pedestrian Crossed
- From Behind Parked Vehicle
- At Bus Stop in Front of Bus
- At Bus Stop Behind Bus
- Against the Signal
- In Front of Standing Traffic

PEDESTRIAN ACTION:
- Running
- Crossing with Other Pedestrians
- Getting In/Out of Vehicle
- Going to/from Ice Cream Vendor
- Not Attempting to Cross Road
- Not Aware Vehicle Was Backing

PEDESTRIAN ACTION:
- Appeared Suddenly in Path of Vehicle
- Working on or Pushing Vehicle
- Attempted Evasive Action
- Walked/Ran Into Vehicle
- Working in Roadway
- Playing in Roadway
- Under Influence of Alcohol/Drugs

ACCIDENT TYPE

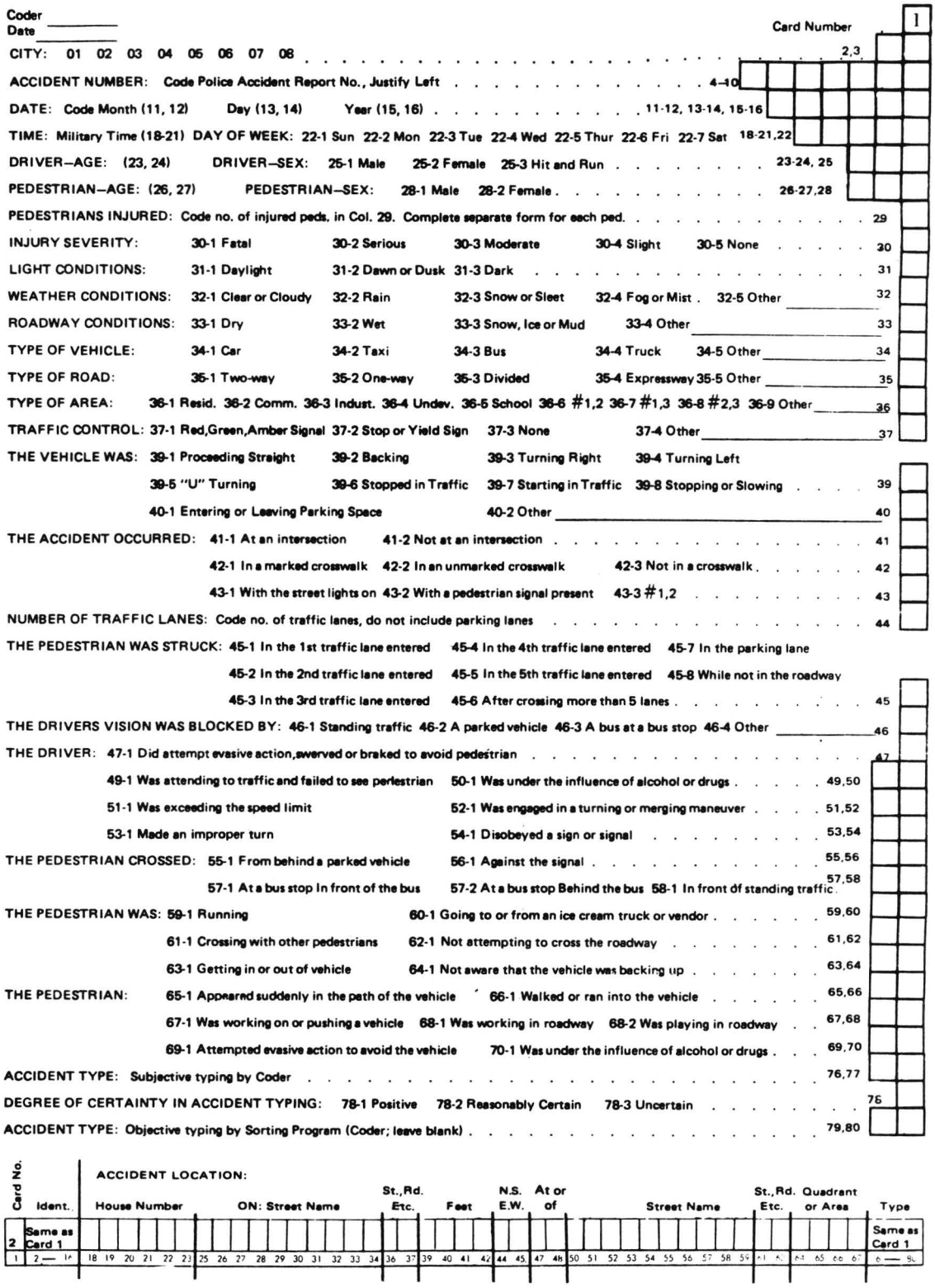


Figure 1-2. Example Pedestrian Accident Master Coding Form (Urban). (From Knoblauch, 1975)

To identify the data items required on a Supplemental Form for a particular locality:

- the current accident report form should be reviewed to see what relevant data are being collected on pedestrian accidents; and
- missing data needed to identify the Accident Types by predisposing and precipitating factors should be identified.

Figures 1-3 and 1-4 illustrate the Supplemental Data Forms from two cities. As can be seen, items on these forms are different because the data on the standard police forms are different for these two cities.

Of course, there must be a balance between accurate reporting and additional data for the sake of additional data. There is a practical limit on how much additional data (and therefore time) police departments are willing to collect on *each* pedestrian accident. A compromise must be reached between the involved agencies. Most existing forms collect adequate information on personal descriptors, location, traffic controls, and other descriptive data. The Supplemental Form must concentrate on the behavioral Causal Factors which will identify the various Accident Types.

There are two areas in which additional personnel time might be required – completion of the Supplemental Data Form, and transference of the data to the Master Coding Form for subsequent analysis.*

Problems with Accident Investigations

Identification of the appropriate data to collect and development of the forms necessary to collect that data are useless if local or other problems confound the process. There are at least three common problems in the accident investigation process: incomplete recording of data; failure of the investigating agency to analyze the data and/or make it *readily* available to prevention agencies; and statistical problems with the analysis.

Incomplete Recording. Complete data are essential to meaningful analysis. Therefore, it is imperative that reports be checked for incomplete or inconsistent data as soon as possible. It is impossible to make valid predictions about what countermeasures will be best for a particular problem without having all the facts available.

*If the supplemental report form would cause too much strain on the department's budget or personnel constraints, one alternative solution might be to subsample some portion of the total pedestrian accident population. However, possible sample bias would have to be monitored closely (e.g., more night accidents than is representative of the total picture because police have more time available to fill out the report).

LOCATION

Accident Occurred on _____ St., Ave., Etc.

At Intersection With _____ St., Ave., Etc.

Or, If

Not at Intersection Indicate _____ Number of feet North, South, East or West Of _____ Nearest intersecting St., Ave., Etc.

Accident number _____ (4-10) Time of collision _____ (18-21)

Date of collision _____ (11-16) Form completed by _____ (Officer)

SUPPLEMENTARY PEDESTRIAN DATA

- To be completed for all pedestrian injury accidents
- Check all responses that apply
- Forward through normal channels with the regular accident report form
- The following information is being collected for research purposes only

THE ACCIDENT OCCURRED:

42-1 ☐ In a marked crosswalk
42-2 ☐ In an unmarked crosswalk
42-3 ☐ Not in a crosswalk
43-1 ☐ With the street lights on
43-2 ☐ With a pedestrian signal ("Walk, Don't Walk") present

NUMBER OF TRAFFIC LANES:

44- ⌴ Indicate the total number of traffic lanes in both directions (do not include parking lanes)

THE PEDESTRIAN WAS STRUCK:

45-1 ☐ In the 1st traffic lane entered
45-2 ☐ In the 2nd traffic lane entered
45-3 ☐ In the 3rd traffic lane entered
45-4 ☐ In the 4th traffic lane entered
45-5 ☐ In the 5th traffic lane entered
45-6 ☐ After crossing more than 5 lanes
45-7 ☐ In the parking lane
45-8 ☐ While not in the roadway

THE DRIVER'S VISION WAS BLOCKED BY:

46-1 ☐ Standing traffic
46-2 ☐ A parked vehicle
46-3 ☐ A bus at a bus stop
46-4 ☐ Other, specify _____

THE DRIVER:

47-1 ☐ Did attempt evasive action, swerved or braked to avoid the pedestrian
49-1 ☐ Was attending to oncoming traffic and failed to see the pedestrian
51-1 ☐ Was exceeding the speed limit
52-1 ☐ Was engaged in a turning or merging maneuver

THE PEDESTRIAN CROSSED:

55-1 ☐ From behind a parked vehicle
56-1 ☐ Against the signal
57-1 ☐ At a bus stop in front of the bus
57-2 ☐ At a bus stop behind the bus
58-1 ☐ In front of standing traffic

THE PEDESTRIAN WAS:

59-1 ☐ Running
60-1 ☐ Going to or from an ice cream truck or vendor
61-1 ☐ Crossing with other pedestrians
62-1 ☐ Not attempting to cross the roadway
64-1 ☐ Not aware that the vehicle was backing up

THE PEDESTRIAN:

65-1 ☐ Appeared suddenly in the path of the vehicle (the driver's detection of the pedestrian was hampered by visual obstruction and/or by the pedestrian's unexpected movement)
66-1 ☐ Walked or ran into the vehicle (cases where the pedestrian impacts the vehicle rather than the vehicle striking the pedestrian)
69-1 ☐ Attempted evasive action, swerved or slowed to avoid the vehicle

OTHER NOTES OR COMMENTS: _____

_____

_____

_____

1 COMPLETE FORM FOR EACH PEDESTRIAN ACCIDENT

Figure 1-3. Example: Supplementary Data Form for City A. (From Knoblauch, 1975).

Date of Accident _____ (11-16)
Pct. of Occurrence _____ 2(64-67)
Accident No. _____ (4-10)
Completed by _____ (Officer)

SUPPLEMENTARY PEDESTRIAN DATA

Check all responses that apply
The following information is being collected for research purposes only

LOCATION: Accident Occurred on _____ St., Ave., Etc.
At Intersection With _____ St., Ave., Etc.
Or, If
Not at Intersection Indicate _____ No. of Feet North, South, East or West Of _____ Nearest Intersecting St., Ave., Etc.

TYPE OF ROAD:
35-1 ☐ City street
35-2 ☐ One-way city street
35-3 ☐ Divided roadway
35-4 ☐ Controlled access highway
35-6 ☐ Underpass 35-7 ☐ Overpass
35-8 ☐ Bridge 35-9 ☐ Tunnel
35-5 ☐ Other, specify _____

TYPE OF AREA:
36-1 ☐ Residential
36-2 ☐ Business
36-3 ☐ Industrial
36-4 ☐ Undeveloped
36-5 ☐ School
36-9 ☐ Parkway
36-9 ☐ Other, specify _____

THE ACCIDENT OCCURRED:
42-1 ☐ In a marked crosswalk
42-2 ☐ In an unmarked crosswalk
42-3 ☐ Not in a crosswalk
43-2 ☐ With a pedestrian signal ("Walk, Don't Walk") present

NUMBER OF TRAFFIC LANES:
44- ☐ Indicate the total number of traffic lanes in both directions (do not include parking lanes)

THE PEDESTRIAN WAS STRUCK:
45-1 ☐ In the 1st traffic lane entered 45-5 ☐ In the 5th traffic lane entered
45-2 ☐ In the 2nd traffic lane entered 45-6 ☐ After crossing more than 5 lanes
45-3 ☐ In the 3rd traffic lane entered 45-7 ☐ In the parking lane
45-4 ☐ In the 4th traffic lane entered 45-8 ☐ While not in the roadway

THE DRIVER'S VISION WAS BLOCKED BY:
46-1 ☐ Standing traffic
46-2 ☐ A parked vehicle
46-3 ☐ A bus at a bus stop
46-4 ☐ Other, specify _____

THE DRIVER:
47-1 ☐ Did attempt evasive action, swerved or braked to avoid the pedestrian
49-1 ☐ Was attending to oncoming traffic and failed to see the pedestrian
52-1 ☐ Was engaged in a turning or merging maneuver

THE PEDESTRIAN CROSSED:
57-1 ☐ At a bus stop in front of the bus
57-2 ☐ At a bus stop behind the bus
58-1 ☐ In front of standing traffic

THE PEDESTRIAN WAS:
59-1 ☐ Running
60-1 ☐ Going to or from an ice cream truck or vendor
61-1 ☐ Crossing with other pedestrians
62-1 ☐ Not attempting to cross the roadway
64-1 ☐ Not aware that the vehicle was backing up

THE PEDESTRIAN:
65-1 ☐ Appeared suddenly in the path of the vehicle (the driver's detection of the pedestrian was hampered by visual obstruction and/or by the pedestrian's unexpected movement)
66-1 ☐ Walked or ran into the vehicle (cases where the pedestrian impacts the vehicle rather than the vehicle striking the pedestrian)
67-1 ☐ Was working on or pushing a vehicle
69-1 ☐ Attempted evasive action, swerved or slowed to avoid the vehicle

OTHER NOTES OR COMMENTS: _____

Figure 1-4. Example: Supplementary Data Form for City B. (From Knoblauch, 1975).

Other problems resulting in incomplete data recording include:

- Selective Reporting. It is more likely that the more serious accidents will be reported, resulting in underrecording of less severe accidents.
- Information Subjectivity. Some data cannot be readily quantified (e.g., road surface slipperiness, driver/pedestrian condition). Therefore, their contribution to the overall analysis is questionable.
- Participant (Personal) Response Bias. Individuals involved in an accident may give conflicting or incorrect information, especially if they perceive themselves as being potentially at fault.
- Missing Data. This is particularly a problem if the accident scene must be quickly restored to normal operation.
- Removal of the Injured Pedestrian from the scene prior to investigation completion. Because pedestrians usually sustain injuries, they are frequently removed from the scene as soon as feasible.
- Minimal Physical Evidence at the scene of pedestrian accidents. Pedestrians seldom leave physical evidence of their movement prior to the crash. Their actions must be reconstructed from other evidence as best as possible.

Timely Reporting. One of the prime goals in the safety field should be to correct problem areas as soon as possible. For this to occur, knowledge of accident locations and participant behaviors must be available as soon as possible. Two methods can be used to accomplish this task: monthly accident statistical summaries, and plots of accident locations on a map (pin maps).

Monthly accident summaries provide the latest data on what is occurring on the roads. They identify current trends and show the effects of recently installed countermeasures. Data essential in a monthly statistical summary include:

- location.
- contributing environmental factors.
- precrash behaviors of participants.
- injury severity levels.

Another method of keeping track of accidents is to keep a pin map of accident locations. These maps provide a quick visual reference of hazardous locations, recurring patterns, or long-term trends. Different colored pins can be used to designate different participants (pedestrian, bicycle, motorcycle, vehicle only). Accident location identification is important in determining where to apply countermeasures. Pin maps can help readily identify locations where maximum benefit can be expected.

One of the problems with the use of pin maps is that they can eventually become overcrowded. Because this technique is primarily a method for keeping abreast of the current accident situation, pins designating accidents more than one year old should be removed. However, to maintain a permanent record for trend analysis, a color photograph of the map should be taken annually or semi-annually.

Statistical Problems. Because there are usually few pedestrian fatalities in any one block, intersection, neighborhood, or even locality, there is a problem in making statistically valid and reliable conclusions. Two procedures can be used to mitigate this problem. First, data from comparable sites can be aggregated. That is, accidents at geometrically similar locations or several blocks in a neighborhood can be analyzed as a group.

Second, fatal and injury accidents can also be aggregated – their behavioral sequence patterns are similar. A high correlation has been found between pedestrian behavior prior to the collision in injury and fatal accidents. That is, whether the result of the impact is a nonfatal or fatal injury is *not* related to the precrash behavior.

However, analysis of accidents of various population and location target groups must be done separately. Intersection accidents must be analyzed separately from nonintersection accidents. Child, adult and elderly person accidents, and rural/urban accidents, must be kept separate. For a more complete discussion of statistical problems in safety analysis, see Step 5: Evaluation.

Summary – Accident Investigation and Analysis

The basic objectives of pedestrian accident data collection, reduction and analysis are threefold:

- identify the precipitating, predisposing and situational factors (i.e., determine the Accident Type).
- determine the locations where these types are occurring.
- identify the population target group whose behavior must be modified.

The emphasis must be on pertinent, quality data that will allow rational accident countermeasure identification. The flow of the accident investigation process is illustrated in Figure 1-5. A method for prioritizing which accident locations to address first is developed in Step 4: Implementation (Prioritizing and Scheduling).

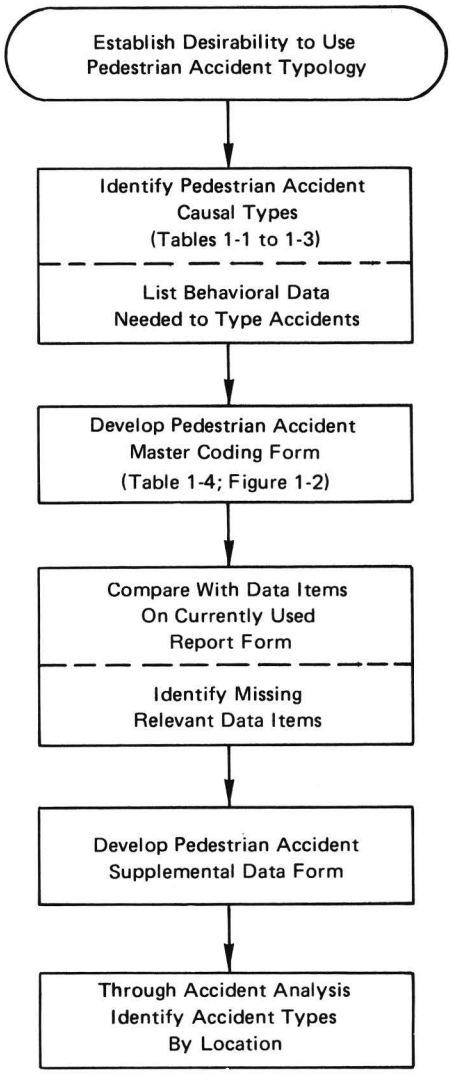


Figure 1-5. Accident Investigation Process Outline

C. Nonaccident Behavioral Analysis

The Accident Typology is defined in participant-behavior and location terms. Each Accident Type is distinguished by the presence or absence of critical descriptors. A collision occurs because both participants failed to perform one of the events in their Behavioral Events Sequence. However, not all pedestrians who exhibit such actions are involved in accidents. Likewise, not all vehicles hit pedestrians. The frequency of the sequence *not* leading to a collision is much higher than of it resulting in an accident. Therefore, collection of data on the frequencies of the accident-type *behaviors* in a noncollision situation is another important analysis tool.

"Activity Sampling," the collection of nonaccident behavioral data, consists of the following.

- Make a number of observations of the study behaviors, particularly those associated with target accident types, during a succession of time periods.
- Compute the percentage of target behaviors in each time period (e.g., before and after a facility installation).
- Examine the percentages to see if the frequency of occurrence of any of the behaviors changed significantly between the study periods.*

Nonaccident Behavioral Analyses are useful as shorter-term techniques (relative to accident analysis) to determine the level of hazard of a site, and to evaluate the effectiveness or noneffectiveness of an installed countermeasure.

Unsafe (Accident Type) Behavior Data Collection

Pedestrian accidents are the result of certain pedestrian and driver/vehicle behavior sequences. The Accident Typology uses locational, environmental and behavioral descriptors to define each Causal Type. Evaluating the nonaccident occurrence of the individual descriptors can help determine the likelihood of the occurrence of that accident Causal Type. For example, some countermeasures are designed to increase the probability of a pedestrian detecting oncoming vehicles. Therefore, sampling the frequency of occurrence of these countermeasure-specific descriptors will detect whether the Events Sequence is being affected in the manner and to the degree expected. Table 1-5 lists and defines numerous behavioral items which are relevant to determining the degree of hazard at a site and should be collected. Table 1-6 lists several locational (site specific) items that also should be collected. Appendix B: Data Collection Techniques, describes several methods of collecting the necessary data for these analyses.

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*A more detailed discussion of the statistical procedures involved in accident and behavioral analysis appears in Step 5: Evaluation.

Table 1-5
Behavioral Evaluation Data Items

Pedestrian	
Aborted Crossing:	return to curb after having had both feet in roadway.
Turning Conflict (pedestrian):	number of pedestrians passing within one car length in front of a *turning* vehicle.
Turning Conflict (pedestrian):	number of pedestrians whose movement is interrupted (hesitation) by turning traffic.
Crossing Against Light:	entry and exit from roadway while perpendicular traffic has green signal.
Vehicle Induced Hesitation:	pedestrian stops forward movement in roadway to allow one or more vehicles to pass.
Leaving Crosswalk:	exiting from crosswalk area into traffic lane.
Walking Outside of Crosswalk:	crossing all traffic lanes outside crosswalk area.
Trapped on Median:	stop or hesitation *while on median* waiting for passage of one or more vehicles.
Walking on Median:	movement parallel to the roadway while on the median.
Bus Stop Related:	crossing (against the light) in front of bus stopped at bus stop.
Vehicle Overtaking:	pedestrian steps into roadway and moves in front of stopped or standing (*not* parked) vehicle into lane of traffic moving in same direction (Multiple Threat behavior).
Running into Roadway:	entry into roadway while running.
Running in Roadway:	start of running after entry into roadway.
Sudden Appearance:	running into roadway from between parked vehicles (Dart-out behavior).
Backup Movement:	momentary reversal in pedestrian direction of travel.
Approach Search Behavior:	looking for oncoming traffic before stepping off curb.
Crossing Search Behavior:	looking for oncoming traffic while crossing the roadway.
Gap Size Accepted:	distance to closest approaching vehicle in lane as pedestrian enters lane.
Delay:	length of time spent waiting for acceptable gap.
Physical Condition:	ability to cross.
Vehicle	
Delay:	length of time spent waiting for pedestrians to clear roadway.
Approach Speed:	travel velocity.
Turning Conflict (vehicle):	number of turning vehicles having pedestrians cross within one car length in front of them.

Table 1-6

Locational (Site Specific) Data Items

Number of Lanes	Day of Week
Time of Day	Intersection/Nonintersection
Visual Obstructions	Urban/Rural
Illumination	Type of Markings
Weather	Traffic Controls
Sight Distance	Signal Timing
Roadway Width	Nature of Neighborhood
Speed Limit	

Aggregate Behavioral Data

Knowledge about the frequency of accidents and accident causing behaviors is less meaningful without knowing its occurrence relative to all behaviors of the total population – i.e., its relative percentage in the population. These "Involvement Rates" are calculated by dividing the number of individuals exhibiting the subject Behavior/Accident Type by the total population at the site. Percentage changes provide a means of comparison for evaluating the effects of a countermeasure installation (see Step 5: Evaluation). Table 1-7 lists several demographic subcategories for relating who is exhibiting the behaviors relative to their representation in the total population.

Table 1-7

Site Specific Population Data Items

Pedestrian Sex	Origin-Destination
Pedestrian Age	Trip Purpose
Pedestrian Social Situation (Alone/Group)	Physical Condition
	Vehicle Type
Group Size	Vehicles Turning/Straight
Direction of Travel	

Summary – Nonaccident Behavioral Analysis

Data on the behavioral characteristics of the nonaccident population are very useful for two reasons. First, they provide a short-term method for evaluating the effectiveness/noneffectiveness of accident countermeasures. Second, they help determine the degree of hazard of a particular site which helps establish priorities between sites for facility implementation. (For example, a crosswalk with five pedestrian accidents per year and 100 pedestrians per day is probably more "hazardous" than a site with five accidents per year and 2000 crossings per day. Similarly, the percentage of unsafe behaviors at two sites can be compared.) These Involvement Rates provide data which measure the relative risk of an accident at a site and therefore the degree of hazardousness. Using these data, priorities can be established for where to address the safety problem first.

Step 1 Summary

The initial step of this program has outlined several methods useful for identifying hazardous locations and determining what behaviors or circumstances are causing it to be hazardous. Figure 1-6 summarizes Step 1 in a flow chart.

It must be remembered that the three data sources discussed – Citizen Complaints, Accident Investigation and Analysis, and Nonaccident Behavioral Analysis – are not mutually exclusive. Information from one source must be combined with data from the others. Coordination of the entire information gathering network must be established and maintained.

Once problem areas have been identified, the next step is to determine what to do about them. Numerous countermeasures known to positively affect pedestrian safety are described in Step 2: Identify Alternative Solutions. Specific countermeasures known to address the specific Behavior/Accident Types described in Step 1 are also identified in Step 2.

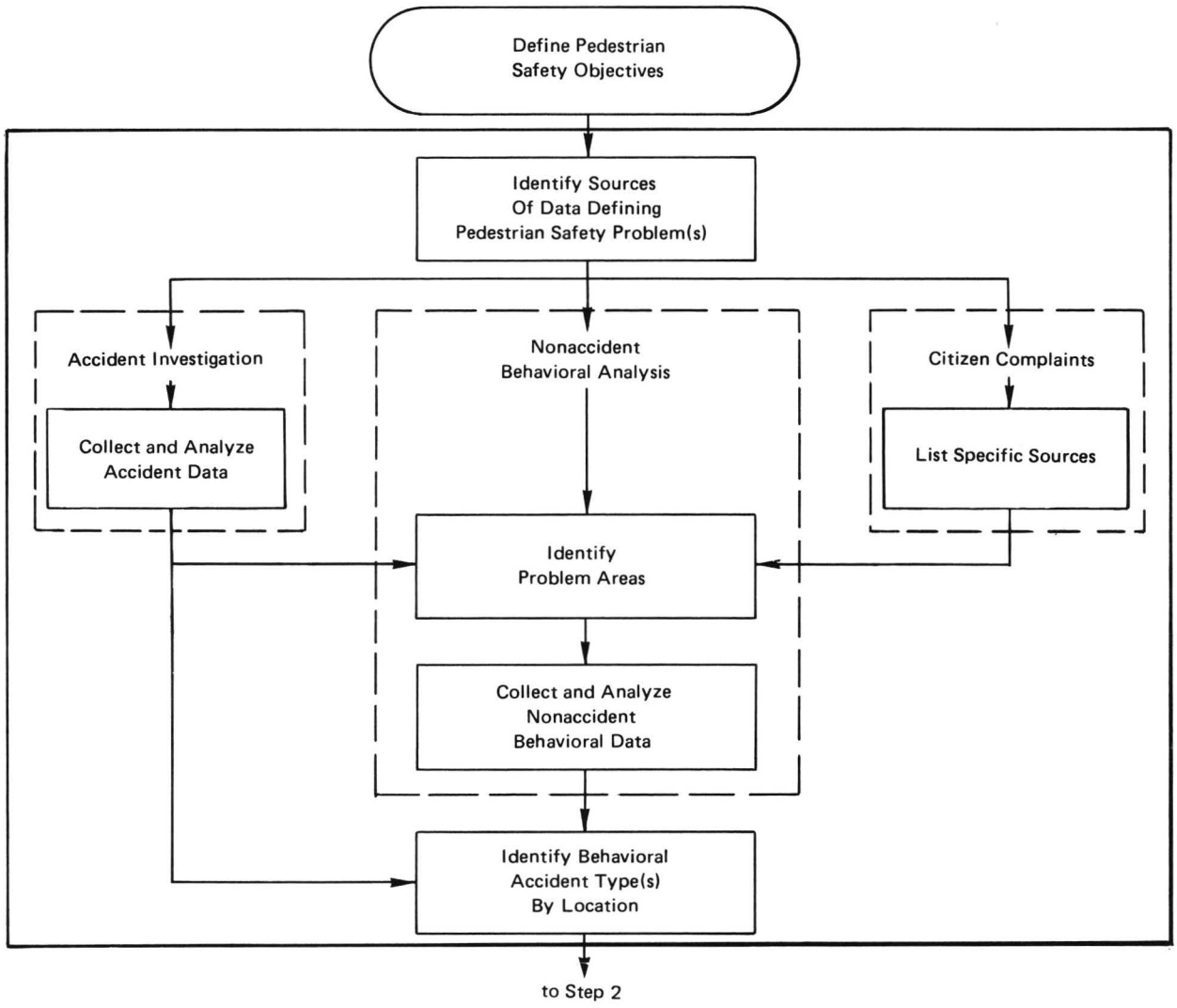

Figure 1-6. Step 1: Identify Extent of Problem Outline

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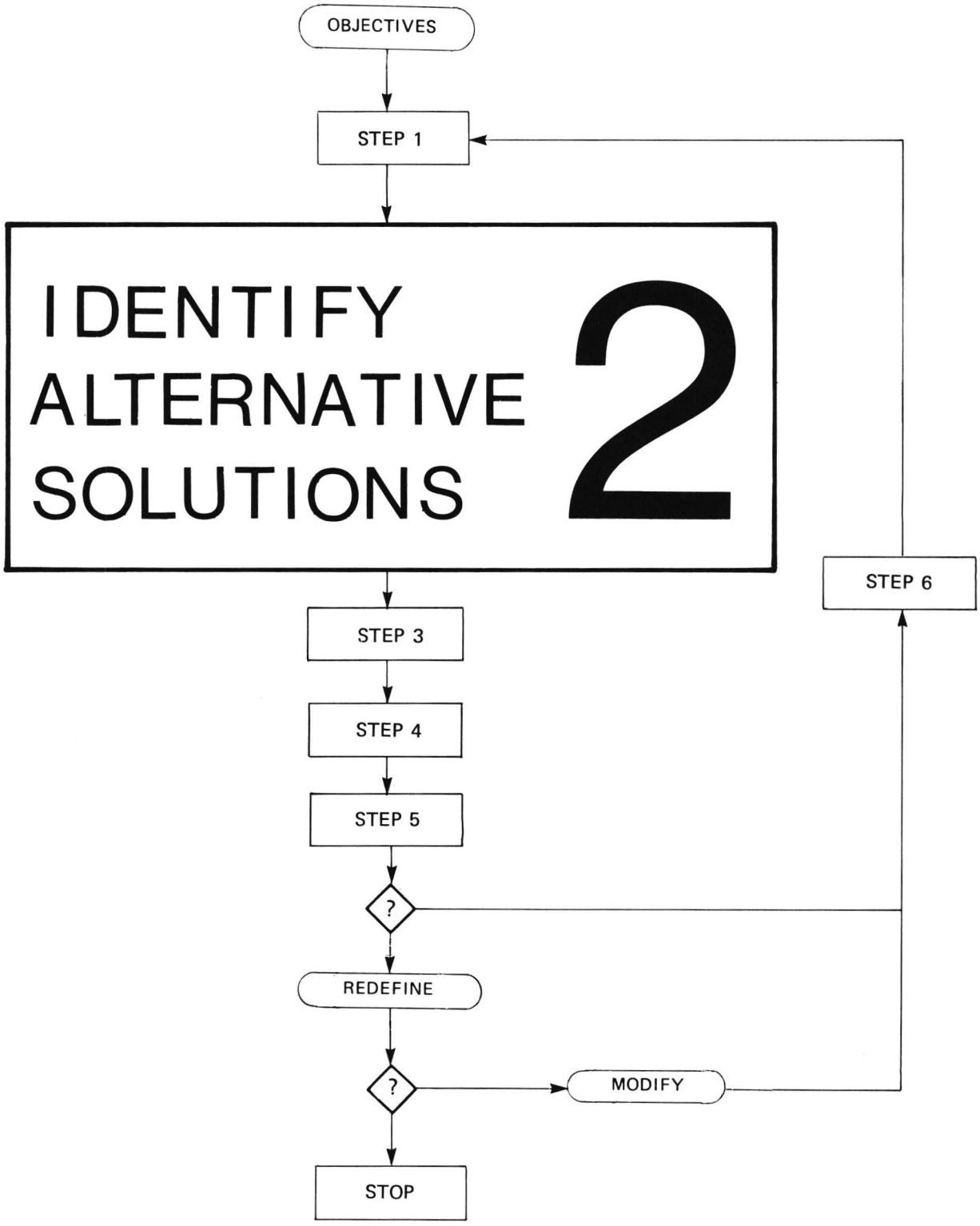
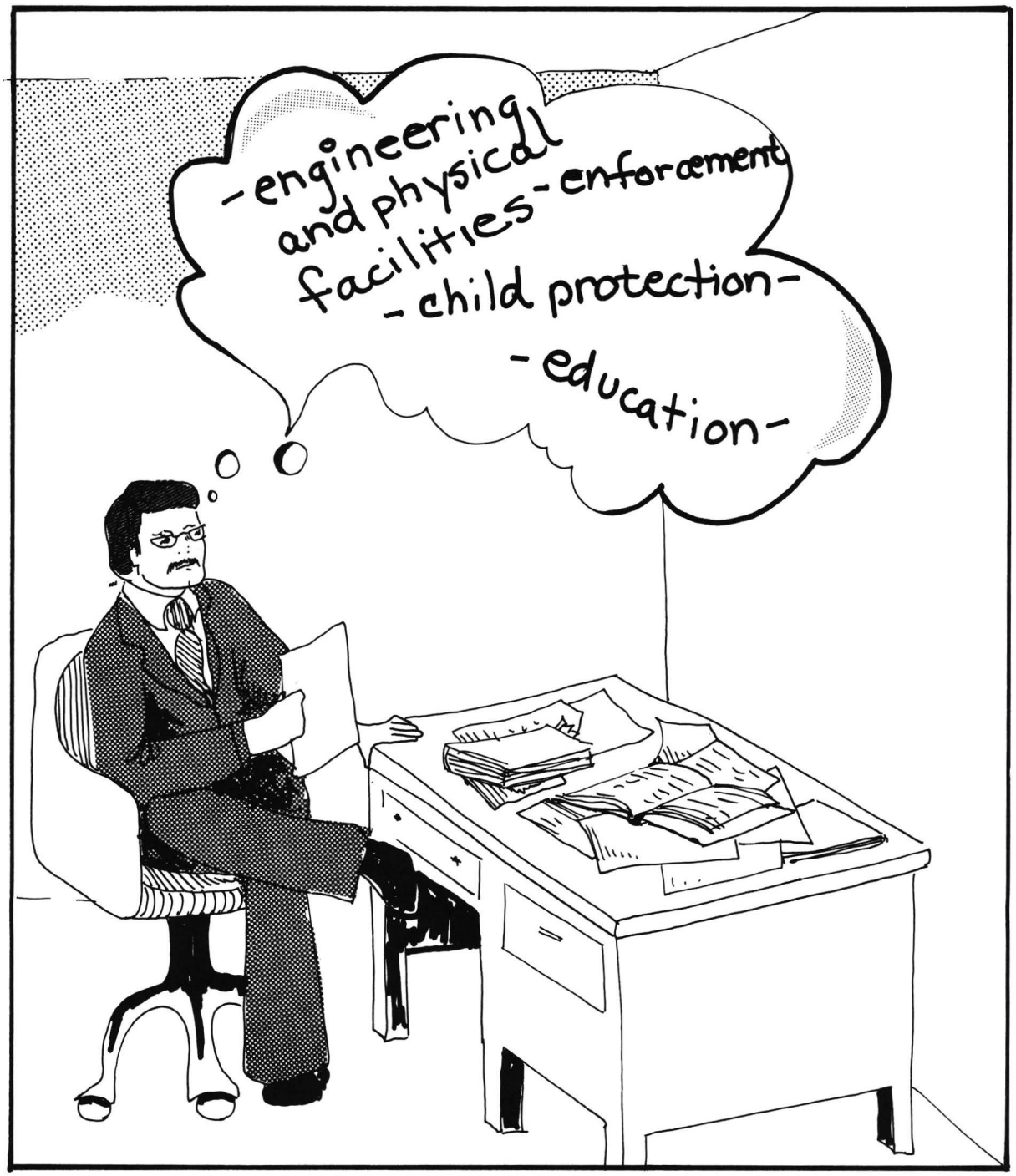

OBJECTIVES
STEP 1
IDENTIFY ALTERNATIVE SOLUTIONS
2
STEP 3
STEP 4
STEP 5
?
REDEFINE
?
MODIFY
STOP
STEP 6



IDENTIFY SOLUTIONS

STEP 2: IDENTIFY ALTERNATIVE SOLUTIONS

Step 1 provided methods for determining what the safety problems in your area are. The next step is to consider *all* the possible solutions and identify those known to be effective in combatting the particular problems or problem areas. Step 2 lists numerous solutions (countermeasures and facilities) to pedestrian safety problems. It also contains Tables 2-1 to 2-3 which match these countermeasures with the Behavior/Accident Types they are known to affect.

In using Step 2, look over all the possible countermeasures noting those that may be helpful. There is usually *no single cure* for a specific accident or safety problem. It is imperative to keep an open mind and at least consider all possible solutions before making a choice (see Step 3).

Organization of Step 2

The solutions are grouped into four major areas. Three of these reflect the three Es of pedestrian safety: Engineering and Physical Countermeasures, Education, and Enforcement. Because child safety is a special problem, facilities relating only to children are grouped under Child Protection. Within these groups, each countermeasure is treated as thoroughly as possible under the following headings:

- Definition.
- Associated Behavioral and Accident Data: a list of facts about pedestrian accidents and behaviors as they relate to the countermeasure.
- Varieties or Examples: identification and definitions of specific design variations or kinds of the general countermeasure.
- Tables giving a detailed compilation of data about the countermeasure. These tables include:
  - Advantages.
  - Disadvantages.
  - Target People: those who will benefit most.
  - Target Locations: areas where it will be most effective.
  - Implementation Considerations: factors or problems that must be considered before and during implementation.
- Pertinent References: a list of documents providing more information on the countermeasure and its use. Numbers in parentheses refer to these references.

Table 2-1

Urban Setting

Relationship Between Frequently Occurring Accident Types and Potential Countermeasures

Behavioral and Locational Accident Type \ Countermeasures	Engineering and Physical																						Child			Educ.		
	Barrier: Median	Barrier: Roadside/Sidewalk	Barrier: Street Closure	Bus Stop Relocation	Crosswalk: Intersection	Crosswalk: Midblock	Diagonal Parking-1Way Street	Grade Separation	Facilities for Handicapped	Lighting: Crosswalk	Lighting: Street	One-Way Streets	Retroreflective Materials	Safety Islands	Sidewalk/Pathway	Signal: Ped. (Shared)	Signal: Ped. (Delayed)	Signal: Ped. (Separated)	Signal: Traffic	Signs and Markings	Urban Ped Environment	Crossing Guards	Play Streets	Safe Route to School	Education: Pedestrian	Education: Driver	Enforcement
Dart-out (First Half)	●	●				●	●														●		●		●	●	●
Dart-out (Second Half)	●	●				●	●							●							●		●		●	●	●
Midblock Dash	●	●				●								●							●		●		●	●	●
Intersection Dash					●			●						●											●	●	
Turn-Merge Conflict								●									●	●				●			●	●	
Turning Vehicle								●									●	●				●			●	●	
Multiple Threat								●		●	●					●	●	●	●		●		●		●	●	
Bus Stop Related				●																	●				●	●	
School Bus Stop Related				●																					●	●	
Ice Cream Vendor																				●					●	●	
Trapped								●						●		●	●	●							●	●	
Backup																									●	●	
Walking on Roadway		●									●		●		●					●					●	●	
Result Vehicle-Vehicle Crash																				●					●	●	
Hitchhiking											●		●												●	●	
Working in Roadway																				●						●	
Disabled Vehicle Related																				●							
Nighttime Situation										●	●		●												●	●	
Handicapped Pedestrians									●																	●	
In General																									●	●	●

*Dots designate countermeasures known to positively affect the indicated behavior/accident types.

Table 2-2

Rural Setting

Relationship Between Frequently Occurring Accident Types and Potential Countermeasures

Behavioral and Locational Accident Type / Countermeasures	Engineering and Physical																						Child			Educ.		
	Barrier: Median	Barrier: Roadside/Sidewalk	Barrier: Street Closure	Bus Stop Relocation	Crosswalk: Intersection	Crosswalk: Midblock	Diagonal Parking-1Way Street	Grade Separation	Facilities for Handicapped	Lighting: Crosswalk	Lighting: Street	One-Way Streets	Retroreflective Materials	Safety Islands	Sidewalk/Pathway	Signal: Ped. (Shared)	Signal: Ped. (Delayed)	Signal: Ped. (Separated)	Signal: Traffic	Signs and Markings	Urban Ped Environment	Crossing Guards	Play Streets	Safe Route to School	Education: Pedestrian	Education: Driver	Enforcement
Dart-out (First Half)	●	●				●																			●	●	●
Dart-out (Second Half)	●	●				●						●		●											●	●	●
Midblock Dash	●	●				●								●											●	●	●
Intersection Dash					●					●	●			●			●	●		●					●	●	●
Turn-Merge Conflict																	●	●							●	●	
Turning Vehicle																	●	●							●	●	
Multiple Threat										●	●					●	●	●	●						●	●	
Bus Stop Related				●																					●	●	
School Bus Stop Related				●																					●	●	
Ice Cream Vendor																				●					●	●	
Trapped					●									●			●								●	●	
Backup																									●	●	
Walking on Roadway		●									●		●		●					●					●	●	
Result Vehicle-Vehicle Crash																				●					●	●	
Hitchhiking											●		●												●	●	
Working in Roadway																				●						●	
Disabled Vehicle Related																				●							
Nighttime Situation										●	●		●												●	●	
Handicapped Pedestrians									●																	●	
In General																									●	●	●

*Dots designate countermeasures known to positively affect the indicated behavior/accident types.

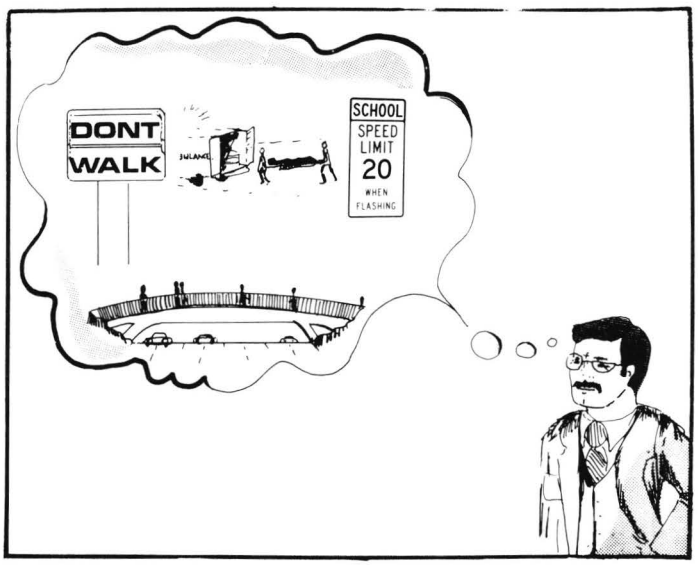
Table 2-3

Freeway Setting
Relationship Between Frequently Occurring Accident Types and Potential Countermeasures

Behavioral and Locational Accident Type / Countermeasures	Engineering and Physical																							Child			Educ.		
	Barrier: Median	Barrier: Roadside/Sidewalk	Barrier: Street Closure	Bus Stop Relocation	Crosswalk: Intersection	Crosswalk: Midblock	Diagonal Parking-1 Way Street	Grade Separation	Facilities for Handicapped	Lighting: Crosswalk	Lighting: Street	One-Way Streets	Retroreflective Materials	Safety Islands	Sidewalk/Pathway	Signal: Ped. (Shared)	Signal: Ped. (Delayed)	Signal: Ped. (Separated)	Signal: Traffic	Signs and Markings	Urban Ped Environment	Crossing Guards	Play Streets	Safe Route to School	Education: Pedestrian	Education: Driver	Enforcement
Dart-out (First Half)	●	●						●																	●	●	●
Dart-out (Second Half)	●	●						●																	●	●	●
Midblock Dash	●	●						●																	●	●	●
Interchange Dash	●	●													●										●	●	●
Turn-Merge Conflict		●						●																	●	●	
Turning Vehicle		●																							●	●	
Multiple Threat								●			●														●	●	
Bus Stop Related																											
School Bus Stop Related																											
Ice Cream Vendor																											
Trapped																											
Backup																									●	●	
Walking on Roadway		●									●		●							●					●	●	●
Result Vehicle-Vehicle Crash		●																		●					●	●	
Hitchhiking		●									●		●							●					●	●	●
Working in Roadway											●		●							●					●	●	
Disabled Vehicle Related																				●					●	●	
Nighttime Situation											●		●												●	●	
Handicapped Pedestrians																											
In General																									●	●	●

*Dots designate countermeasures known to positively affect the indicated behavior/accident types.

ENGINEERING AND PHYSICAL COUNTERMEASURES



ENGINEERING and PHYSICAL FACILITIES

Barriers

Definition

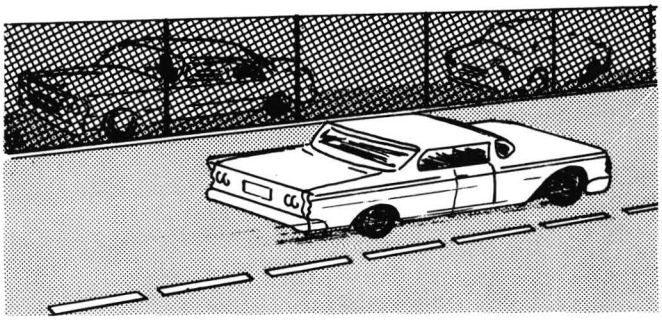
Chains, fences or similar devices separating pedestrian and vehicular traffic. They can be positive barriers channeling pedestrians to safe crossings, or negative barriers preventing pedestrians from crossing at hazardous locations or vehicles from entering certain streets.

Associated Behavioral and Accident Data

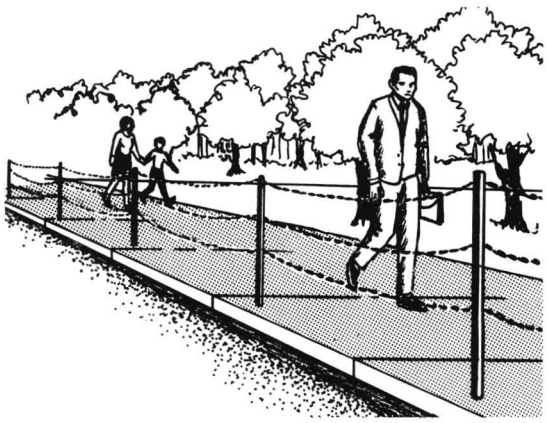
- A large percentage (almost 40 percent) of pedestrian deaths occur while crossing between intersections; the injury rate shows the same trend (1).
- Median barriers can significantly reduce midblock crossings and running in the roadway (2).
- Median and Meter-post barriers can reduce the incidence of pedestrians darting out into traffic from behind parked cars (2).
- About 15 percent of freeway pedestrian accidents involve pedestrians running or walking across the freeway (6).
- Fences located near freeway interchanges can prevent people from crossing freeways (5).

Varieties of Barriers

- Pedestrian
  - Median Barriers: generally chain link fences located along a median or area separating opposing traffic lanes which prevent pedestrians from crossing at nonintersection locations. They can be installed exclusively as pedestrian barriers or be incorporated with vehicle-separating median barriers (e.g. guardrails).

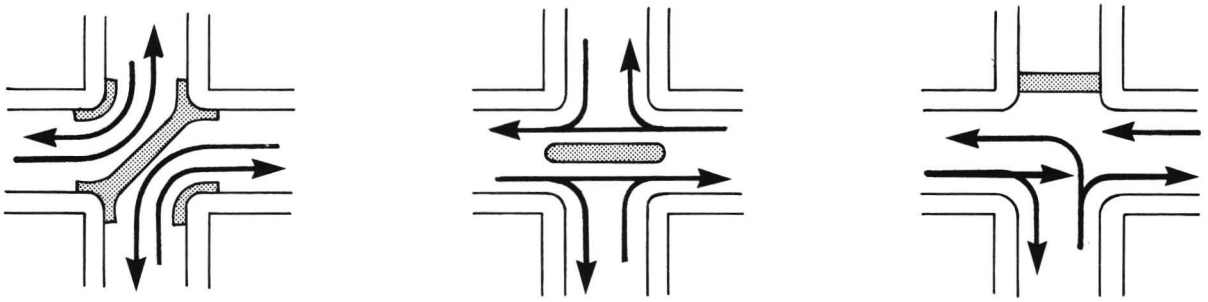


- Sidewalk Barriers: barriers located along or near the edge of a sidewalk to channel pedestrians to crosswalks or grade-separated facilities, or to impede their crossing at hazardous locations. Common construction materials include chain link fencing, pipe and chain/cable, planters or other sidewalk furniture, and hedges.



- Roadside Barriers: generally high chain link fences located alongside a highway or freeway to prevent pedestrians from crossing the road.

- Vehicle
  - Median Barriers: guardrails, concrete barriers, fences, or hedges used to separate opposing lanes of traffic.
  - Shoulder Barriers: guardrails or other barriers used to separate vehicle and pedestrian traffic.
  - Street Closure Barriers: concrete, wood or live plant barriers used to prevent vehicles from entering particular streets or blocks. These barriers can completely close off a street to make an auto-free zone or play street, or more simply divert vehicles, thus reducing the amount of through traffic in the neighborhood. Street closure barriers can be either permanent or temporary.



Pertinent References – Barriers

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2. Berger, W.G. Urban Pedestrian accident countermeasures experimental evaluation. Volume I: Behavioral evaluation studies. Prepared by BioTechnology, Inc., for the National Highway Traffic Safety Administration and Federal Highway Administration, February 1975.
3. Federal Highway Administration. *Manual on Uniform Traffic Control Devices for Streets and Highways.* Washington, DC: U.S. Government Printing Office, 1971.
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5. Ferlis, R.A., & Kagan, L.S. Planning for pedestrian movements at interchanges. Prepared by Peat, Marwick, Mitchell & Co. & RTKL Associates, Inc., for the Federal Highway Administration, July 1974. (NTIS PB 245-037).
6. Knoblauch, R.L., Moore, W., Jr., & Schmitz, P.R. Pedestrian accidents occurring on freeways: An investigation of causative factors. Accident data collection and analysis. Prepared by BioTechnology, Inc., for the Federal Highway Administration, June 1976.
7. National Highway Traffic Safety Administration. *Highway Safety Program Manual. Volume 14: Pedestrian Safety.* Washington, DC: U.S. Government Printing Office, November 1974.
8. Templer, J.A. The priority accessible network: A manual for making the city accessible to the elderly and handicapped pedestrian. Prepared by the Pedestrian Research Laboratory, Georgia Institute of Technology, for the Federal Highway Administration. In progress (estimated date 1978).
9. Yaksich, S., Jr. The pedestrian's role in traffic control. Paper presented at the Tenth Pan American Highway Congress, Montevideo, Uruguay, February 1967.

BARRIERS

	ADVANTAGES	DISADVANTAGES
PEDESTRIAN. IN GENERAL.	Channel pedestrians to safe crossing areas. Can prevent pedestrians from crossing unsafely.	Block direct routes across the street. Snow, leaf, etc. removal and maintenance problems. Pedestrians don't like them (2). People often try to climb barriers or cut holes in them instead of going to safer crossing locations. Expensive. Most designs are aesthetically unpleasing.
MEDIAN.	Prevent midblock crossings. Can reduce incidence of pedestrians running in the roadway. Can reduce dart out behavior.	People often try to climb them or cut holes in them.
SIDEWALK.	Channel pedestrians to safe crossing facilities. May help orient blind pedestrians (8). See also "Facilities for the Handicapped." Can reduce the incidence of dart-out behavior, especially from behind parked cars.	Pedestrians can easily climb over pipe and chain or rail barriers. Blind pedestrians have difficulty detecting pipe and chain barriers because their canes sweep under the chain. Block vehicle loading/unloading procedures. Block direct routes across a street. Pipe and chain barriers can cause motorist injuries in accidents. Interfere with parking.
ROADSIDE.	Channel pedestrians to safe crossing locations. Prevent pedestrians from walking along or into hazardous roadways. Can prevent accidents at interchanges.	People often try to climb them or cut holes in them. Snow, leaf, etc. removal and maintenance problems. May put stranded motorists in danger, forcing them to walk along hazardous roads (5).

Figure 1-7. Barriers Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Locations with poor sight distance. Locations with inadequate street lighting. Locations where children might dart out into the street. Locations where pedestrians deliberately violate laws or go where not intended. Locations where use of signs is insufficient to prevent unsafe behavior.	The need for barriers should be considered when planning pedestrian facilities instead of after pedestrians have started behaving unsafely. The community must be involved in any decision to install a barrier. Barriers can be set up temporarily as an experiment to analyze their local effectiveness. Careful studies of pedestrian movement should precede installation of barriers. Barriers located where the hazard is apparent may be more effective (8). Barriers should not reduce visibility.
All pedestrians who cross at midblock.	Along medians on major or high speed roads. Locations with high midblock crossing accidents or behavior.	
All pedestrians.	Hazardous locations. Street corners where crosswalks have been set back from the intersection (4). Between meter posts (2). Around school yards located adjacent to the road. In the area of freeway interchanges (5). At locations where parking is prohibited.	Chain or cable barriers must be high enough to prevent people from stepping over them (7). Guide signs should be placed at barriers to point pedestrians to the safer location. Barriers should be made of flexible materials. Post and cable/chain type barriers are generally more effective and pleasing than fencing in urban areas (8). Fencing is more appropriate in rural areas (8).
All pedestrians.	In the area of interchanges. Along major or high speed roads.	Barriers should be continuous for maximum efficiency.

Figure 1-7. Barriers Countermeasure Matrix (continued)

BARRIERS

	ADVANTAGES	DISADVANTAGES
VEHICLE. IN GENERAL.	May serve a dual purpose by channelizing or controlling pedestrians too.	Community members may be antagonistic toward vehicle barriers.
STREET CLOSURE.	Prevent vehicles from entering certain streets (play streets, malls). Can reduce vehicle speeds and volumes in residential areas. Can be temporary or permanent.	Interrupt vehicle flow. Limit easy access of emergency and sanitation vehicles. Possibility of auto accidents caused by barriers. Complicated planning process involving street rerouting and engineering studies. Expensive.

Figure 1-7. Barriers Countermeasure Matrix (continued)

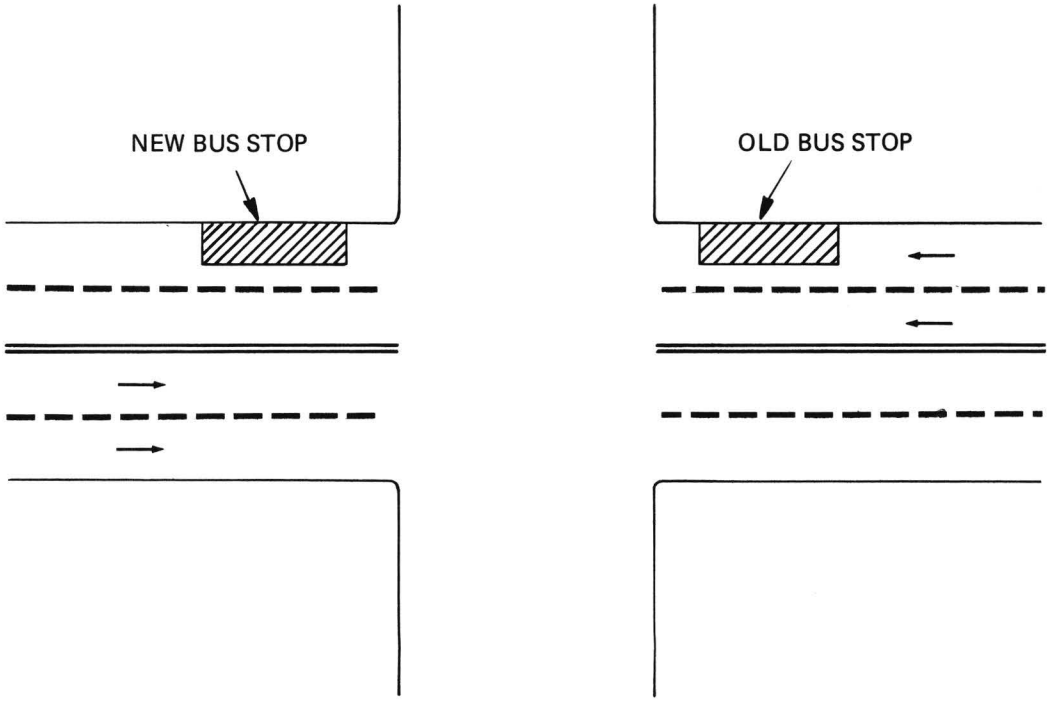
TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Motorists.	Hazardous locations. Construction zones. Locations where automobiles must be channelized.	Detailed standards for vehicle barriers can be found in the MUTCD (3).
Motorists.	Residential areas in which vehicle through traffic is to be discouraged. Locations with many young children. Urban locations where malls are being installed.	Closing of streets involves many political and engineering processes. (See also "Urban Pedestrian Enviornments," and "Play Streets.")

Figure 1-7. Barriers Countermeasure Matrix (continued)

Bus Stop Relocation

Definition

Moving a transit or school bus stop from the nearside to the far side of an intersection. (School bus stop relocation is discussed under "School Bus Routing and Patrols."



Associated Behavioral and Accident Data

- Reduces the number of people entering the street in front of a bus (1).
- Reduces the frequency of bus-stop-related accidents (4).

BUS STOP RELOCATION

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Reduces number of bus stop related accidents. Waiting passengers assemble at less-crowded sections of the sidewalk, reducing interference with crossing pedestrians (3). Buses in the bus stop will not obscure traffic control devices or pedestrian movements at the intersection (3). Reduces conflicts between buses and right-turning vehicles (3, 6). Stopped buses do not obstruct sight distance to the left for vehicles entering or crossing from a side street (3). Left-turning buses can turn from the left lane instead of having to cross traffic from a nearside bus stop (3). Buses can rejoin moving lanes more easily, saving time and energy (3, 6).	May increase bus stop operation time because delays at signals will no longer be used for passenger pickup (5). Where the bus stop is too short for occasional heavy demand, the overflow will obstruct cross street traffic (3). Cars illegally parked in the bus stop may cause buses to overhang into the cross street (3). May interfere with transfer operations, forcing transferring passengers to cross more streets. On streets with parking, there may be conflict between buses pulling out and traffic in the travel lanes (2). Stops on a narrow street or within a moving lane may block traffic on both the street with the bus route and on the cross street (3). A bus standing at a far-side stop obscures sight distance, to the right, of a driver entering the bus street from the right (3).

Figure 1-8. Bus Stop Relocation Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Transit bus passengers. School bus passengers.	Locations with bus-related pedestrian accidents. Locations where bus passengers frequently cross in front of buses. Intersections with heavy left- or right-turning traffic (3). Locations where bus routes and heavy traffic diverge (3). Intersections with signals, stop or yield signs where traffic flow or parking is critical (3).	Bus stop relocation is not universally applicable. At transfer points, it may be better to use a combination of near side and farside stops. In deciding whether to relocate a bus stop the following should be considered (2, 3): – Bus-related pedestrian accidents – Number of buses using the stop – Location – Number of passengers per bus and time to load and unload – Parking situation – Vehicle movement and possible conflicts – Sight distance of pedestrians and motorists – Bus transfer points

Figure 1-8. Bus Stop Relocation Countermeasure Matrix (continued)

Pertinent References: Bus Stop Relocation

1. Berger, W.G. Urban pedestrian accident countermeasures experimental evaluation. Volume I: Behavioral evaluation studies. Prepared by BioTechnology, Inc., for the National Highway Traffic Safety Administration and Federal Highway Administration, February 1975.
2. Highway Research Board. *Highway Capacity Manual – 1965.* Special Report 87. Washington, DC: Highway Research Board, 1965.
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5. Kraft, W.H., & Boardman, T.J. Location of bus stops. *Transportation Engineering Journal of ASCE. Proceedings of the American Society of Civil Engineers,* February 1972, *98*(TE1), 103-116.
6. Terry, D.S., & Thomas, G.J. Farside bus stops are better. *Traffic Engineering,* March 1971, *41*(6), 21-29.

Crosswalks

Definition

The portion of the roadway designated for pedestrians to cross the street. They can be marked on the road surface, or unmarked and designated by prolongation of the lateral lines of sidewalks or pedestrian pathways on opposite sides of the street.

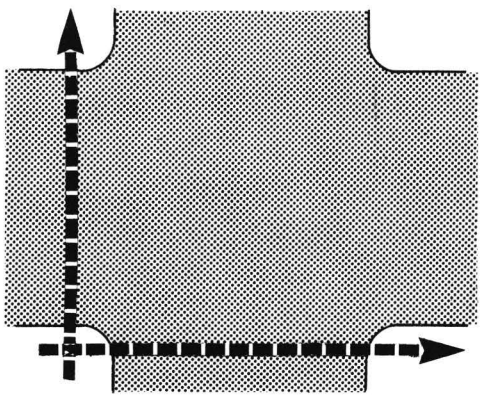
Associated Behavioral and Accident Data

- Crosswalks present an "illusion" of safety. They do not totally separate pedestrians and vehicles.
- Unjustified *marked* crosswalks have shown a much higher accident rate than unmarked crosswalks (4, 7).
- Pedestrians tend to use the shortest and easiest routes in crossing and will not use crosswalks if they are inconvenient (4).
- Large numbers of crosswalks and crosswalk signs may increase motorist noncompliance (9).
- Many cities are limiting the use of midblock crosswalks because drivers often do not expect crosswalks in these locations and, therefore, tend to be less attentive to pedestrians trying to cross (9).

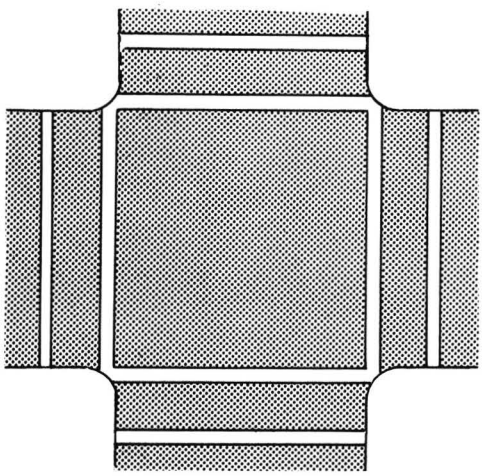
Varieties of Crosswalks

Crosswalks can be located at intersections or in midblock, and can be signalized or nonsignalized. (Behavioral and Accident Data for signalized crosswalks are discussed under the heading "Signals.") This section covers only nonsignalized crosswalks.

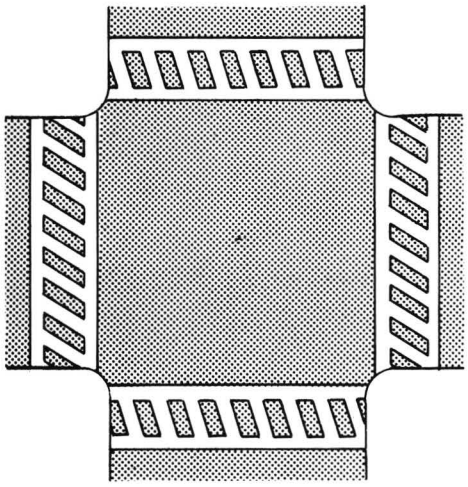
- *Unmarked Crosswalk:* the portion of a roadway at an intersection included within the prolongation of the boundary lines of sidewalks or pathways used by pedestrians; does not include the prolongation of alley lines.



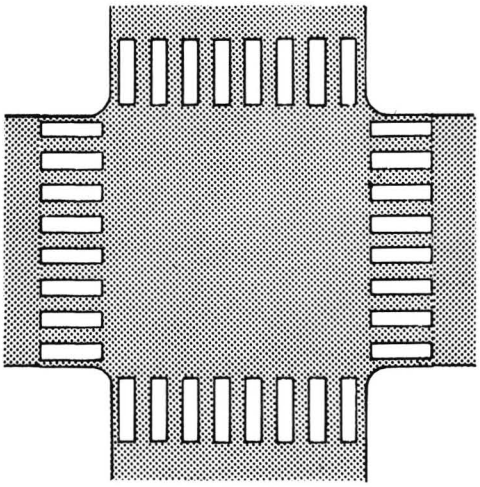
- *Marked Crosswalk:* part of the road distinctly indicated for pedestrians by lines or other markings on the road surface. Markings can be two solid parallel lines, stripes running parallel to the direction of vehicle flow, diagonally slanted stripes, or "solid" markings made by painting the entire crosswalk area or constructing it of material different than the roadway surface.



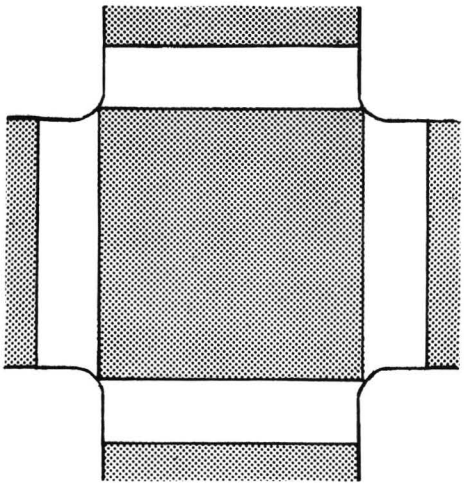
Parallel Lines



Zebra

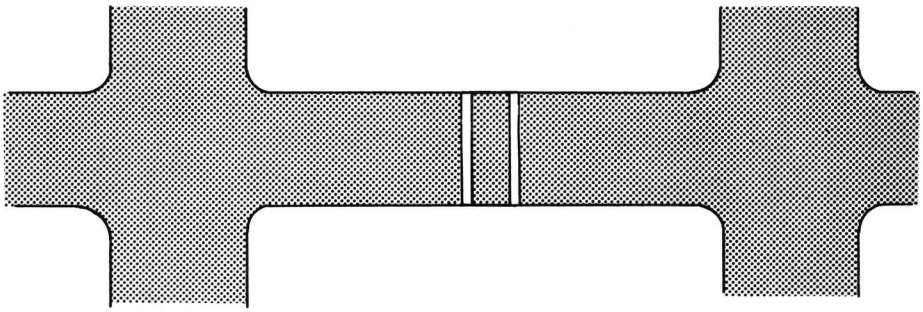


Ladder



Solid

- *Midblock Crosswalk:* a marked crosswalk located between intersections; possibly with pedestrian-actuated signals.



CROSSWALKS

	ADVANTAGES	DISADVANTAGES
UNMARKED.	No expense. Have fewer accidents than marked crosswalks (4).	Do not clearly indicate the preferred pedestrian path.
MARKED.	High pedestrian compliance. Can reduce vehicle violations of pedestrian's right of way. Act as a warning device and reminder to motorists of the potential presence of pedestrians. Relatively inexpensive. May help enforce pedestrian regulations (4). Channel pedestrians across complicated or dangerous intersections. Can position pedestrians where they can be best seen. May show pedestrians the shortest route.	Present an illusion of safety; pedestrians may feel overly secure. Do not totally separate pedestrians and vehicles. Have more accidents (per usage) than unmarked crosswalks (4). Have more severe accidents than unmarked crosswalks (4). Motorists don't see crosswalks as well as pedestrians may think (4). Overuse may cause disrespect for all pedestrian and traffic control devices (4). Pedestrians won't use them if they feel they aren't necessary or if they are inconvenient. Require pedestrian education. Need continual maintenance (snow removal, repainting).
DIAGONAL OR LADDER-STRIPED.	Make the crosswalk more visible to motorists. Can minimize maintenance if the "black" stripes are positioned along the vehicle tire tracks.	Require additional paint to mark.
MIDBLOCK.	If they are available, pedestrians will use and obey them (1). Prevent pedestrians from crossing from behind parked vehicles (1). Prevent running in the road, pedestrian hesitation and crossing out of the crosswalk (1). May reduce vehicle speeds in the area around the crosswalk (1).	Pedestrians may develop a false sense of security. Reduce number of parking spaces. May reduce traffic flow capacity. Programmed signal systems may have to be retimed.

Figure 1-9. Cross Walks Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
	Locations that don't meet the warrants for marked crosswalks.	Traffic engineering studies or warrants may show the need to change some marked crosswalks to unmarked crosswalks.
All pedestrians. Motorists.	Intersections in downtown or commercial areas, and along school routes. Areas of high pedestrian concentration. Locations with low or moderate vehicle flow. Complex or confusing intersections requiring pedestrian channelization. Signalized intersections. Midblock locations where many pedestrians cross. *Not* at locations at the top of a hill.	Uniformity of crosswalk design and location is necessary for good compliance. A careful engineering study should be made before marking crosswalks at locations without signals or stop signs. Warrants should be developed and used in determining the need for marked crosswalks. Warrants should reflect (4): – Pedestrian channelization needs – Vehicle speeds and gaps – Pedestrian volume – General conditions, (illumination, geometry, accident history, pedestrian visibility) Factors to consider in designing a crosswalk include: – The needs of the handicapped (see reference 8). – Advance warning signs – Vehicle stop lines – Overhead lighting – Reflectorization – Adequate sight-distance through the elimination of visual clutter.
All pedestrians.	Locations without other traffic controls and with a high volume of pedestrian crossings. Locations where a crosswalk may not be expected.	Materials used for these markings should not be slippery when wet.
All pedestrians, particularly those who run or walk into the street at midblock.	Locations with heavy midblock pedestrian flow.	Warning signs should be posted to alert drivers to potential pedestrians. Adequate sight distance must be provided. This can be done by prohibiting parking near the crosswalk.

Figure 1-9. Cross Walks Countermeasure Matrix (continued)

Pertinent References – Crosswalks

1. Berger, W.G. Urban pedestrian accident countermeasures experimental evaluation. Volume I: Behavioral evaluation studies. Prepared by BioTechnology, Inc., for the National Highway Traffic Safety Administration and Federal Highway Administration, February 1975.
2. Cleveland, D.E. Pedestrian crosswalk safety studies. Prepared by the Highway Safety Research Institute, University of Michigan, Ann Arbor, for the Pedestrian Safety Demonstration Project, City of Detroit, July 1969.
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9. Vallette, G.R., & McDivitt, J.A. Model pedestrian safety program. Interim Report. Volume II: Review of operational experience. Prepared by BioTechnology, Inc., for the Federal Highway Administration, March 1977.

Emergency Medical Services

Definition

Facilities which increase the likelihood of an accident participant's survival through rapid and expert attention to their injuries and timely transport to hospital or other medical services.

Associated Behavioral and Accident Data

- Pedestrians almost always are injured in a collision with a vehicle (1).
- Pedestrians between the ages of 5-14 and over 45 have the highest fatality rate (1).

EMERGENCY MEDICAL SERVICES

	ADVANTAGES	DISADVANTAGES	
IN GENERAL.	Can help reduce the frequency of fatalities in pedestrian accidents by providing life-supporting medical attention. Can keep injuries from becoming more serious.	Expensive.	

Figure 1-10. Emergency Medical Services Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All persons involved in accidents.	All accident sites.	Technicians arriving at the accident scene must be medically trained so that the injured receive proper medical treatment. Can be associated with the fire department, hospitals, or volunteer rescue organizations. Coordination must be established between various services and locations to ensure timely response to all accidents. Attendants should be allowed to administer whatever medical attention is required and possible at the accident scene.

Figure 1-10. Emergency Medical Services Countermeasure Matrix (continued)

Pertinent References – Emergency Medical Services

American Automobile Association. *Manual on Pedestrian Safety*. Washington, DC: American Automobile Association, 1964.

Powell, M.D., Gemmell, M.K., Murray, D., & Howe, W.P. Community action program for traffic safety. Guide 2: Legal authority. Prepared by the National Association of Counties, for the National Highway Safety Bureau, September 1970.

Vallette, G.R., & McDivitt, J.A. Model pedestrian safety program. Interim Report. Volume II: Review of operational experience. Prepared by BioTechnology, Inc., for the Federal Highway Administration, March 1977.

Grade Separation

Definitions

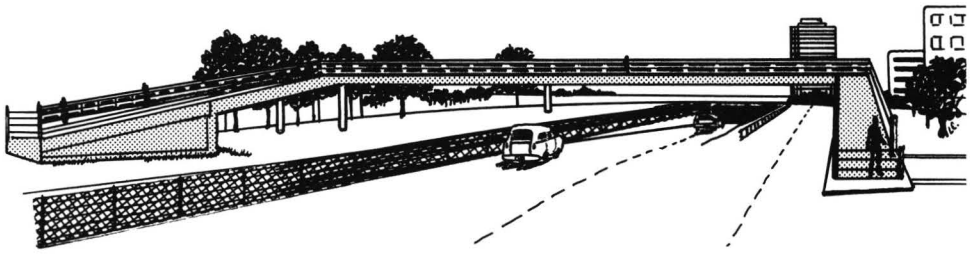
A facility allowing free-flowing, noninteracting, generally perpendicular flow of pedestrians and vehicles. Grade-separated facilities are located one or more levels above or below ground (vehicle) level.

Associated Behavioral and Accident Data

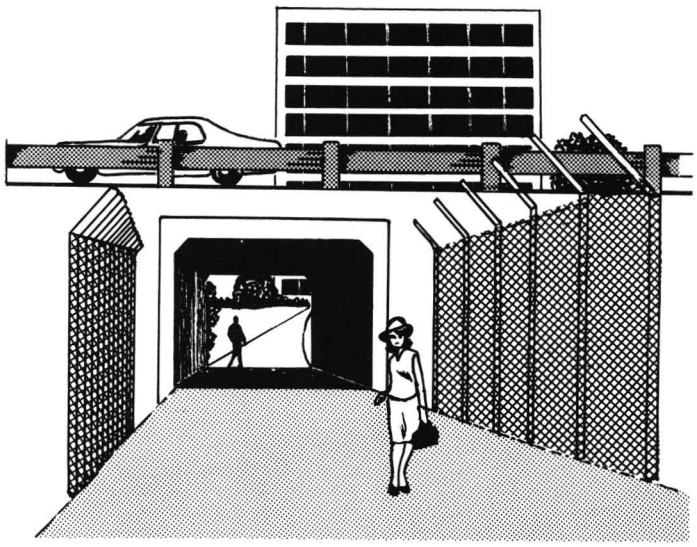
- Grade-separated facilities provide total separation of pedestrians and vehicles, thus eliminating potential conflicts and accidents *for pedestrians using them.*

Varieties of Grade-Separated Facilities

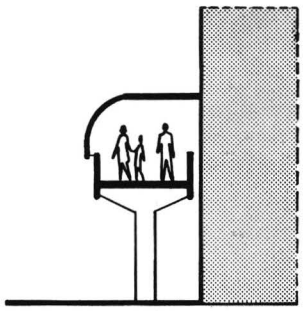
- Overpass/Bridge: above-ground passageway or bridge over a roadway. Both ends of the overpass are at grade level, with stairs or ramps taking the pedestrian up over the roadway.



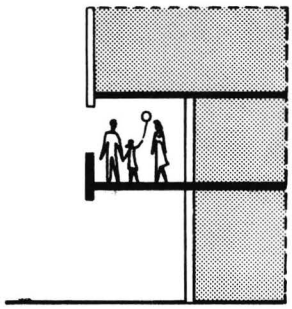
- Underpass/Tunnel: has the same function as an overpass, except that the stairs or ramps lead down to an underground passage. Both ends are at grade level.



- Below-Grade Networks: extensive underground walkways that carry pedestrians perpendicular and parallel to the vehicles flowing above them. These networks are frequently associated with rapid transit rail (subway) systems.
- Elevated Walkways: "sidewalks" located above ground level. They generally run parallel to the vehicle direction of flow, and can be free-standing or part of an adjacent building (e.g., as an arcade).

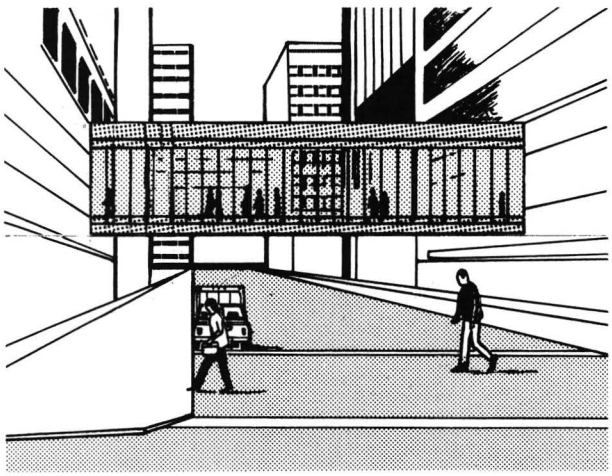


Free-Standing Walkway



Integral Walkway

- Skyways/Skywalks: generally enclosed crossovers one or more levels above ground level. Located in urban areas, they connect opposing buildings at the elevated level in midblock, perpendicular to vehicle flow.



Pertinent References – Grade Separation

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3. Demetsky, M.J., & Perfater, M.A. An assessment of pedestrian attitudes and behavior in suburban environments. *Transportation Research Record*, 1975, *540*, 46-55.
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5. Institute of Traffic Engineers. Committee 4E-4. Pedestrian overcrossing – Criteria and priorities. *Traffic Engineering*, October 1972, *43*(1), 34-39, 68.
6. Klatt, R. Determination of priorities for pedestrian overpasses. Omaha Department of Public Works, Traffic Engineering Division, Omaha, NB, March 1975.
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9. Zaidel, D., Algarishi, A., & Katz, A. Factors affecting the use of pedestrian overpasses. *Proceedings, International Conference on Pedestrian Safety*. Volume I. Haifa, Israel, December 1976. Technion, Haifa: Michlol-Publishing House, 1976, 7F1-15.

GRADE SEPARATION

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Completely separate pedestrians and vehicles. Improve vehicle circulation (8). Can reduce pedestrian delay (8).	Very expensive. Can increase pedestrian travel time by forcing pedestrians to take an indirect route. Use of grade-separated facilities is often not high and therefore may not eliminate accidents at sites where they are located (9).
OVERPASS/ BRIDGE.	Provide convenient and safe crossings. Easier to maintain than underpasses (3). Less expensive than underpasses (7).	Need high clearance for trucks. Unenclosed versions provide an opportunity for people to drop items onto passing vehicles (8). Can be aesthetically displeasing.
UNDERPASS/ TUNNEL.	Do not create an eyesore or impinge on the visual environment. Protect pedestrians from inclement weather. Underpasses are shorter in length. (They only have to be deep enough to go under the road, whereas overpasses must be high enough to allow trucks to pass under.	Generally higher construction costs then overpasses (7). Maintenance problems (drainage, litter, vandalism, lighting). Require adequate lighting. Potential crime problems.

Figure 1-11. Grade Separation Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Areas with high vehicle volumes and/or speed. Wide roadways. Areas with inclement weather (enclosed facilities). Areas of extreme hazard.	Such facilities are expensive. Less expensive alternatives should be considered before choosing grade separation. (Prioritization methods are available in References 1, 2 and 6). Barriers may be required to channel pedestrians to the grade-separated crossing. Ramps for the handicapped, elderly and bicyclists must be provided. Pedestrians probably will not use grade-separated facilities if they (3, 9): — Are not easily accessible — Do not provide a relatively direct path to the desired destination — Significantly increase the time required to get to the desired destination — Are not well lighted and don't provide a feeling of personal security.
All pedestrians.	Locations with high vehicle volumes and/or speed. Near schools. Locations where the adjacent land is significantly higher than the road.	Ramps for the handicapped, elderly and bicyclist must be provided.
All pedestrians.	Preferably *not* near schools because of potential loitering and fighting problems (3). Locations where the topography makes it feasible. *Not* in areas where the water table is close to the surface (7).	Tunnels should be as wide as possible, with no turns, to allow maximum daylight illumination. Ramps are necessary for the handicapped, elderly and bicyclists. Gates may be needed to close the underpass when not in use.

Figure 1-11. Grade Separation Countermeasure Matrix (continued)

GRADE SEPARATION

	ADVANTAGES	DISADVANTAGES
BELOW-GRADE NETWORK.	Provides protection from sun and harsh weather. Doesn't disturb the urban landscape. Expansion is possible, linking other underground systems or major activity centers (8). Doesn't have to follow grid pattern of streets. Can be built in increments (8).	Very high construction costs for complete system. Requires numerous entry points. Loss of visual contact with the city causes lack of orientation and coherence (8). Emergency service problems. Artificial environment. High crime potential. Pedestrians see them as unsafe and monotonous. Problems in linking old and new buildings (8).
ELEVATED WALKWAYS.	Provide direct, convenient paths. Can be expanded. Compact and efficient arrangement of retail space (8). Provide cover for at-grade pedestrian level. Can be enclosed for bad weather. May use public rights of way (8).	Pedestrians won't use them if they're not convenient. Potential danger of falling objects if not enclosed. Very high construction costs for complete system. Must provide numerous entry points. Possible decline in retail activity at-grade (8). Additional visual clutter. Emergency service problems. Security problems. Coordination with property owners may be difficult. Difficult to coordinate with at- and below-grade systems (8). Possible crime at-grade under skywalk.

Figure 1-11. Grade Separation Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Areas with abandoned underground facilities or with retail frontage. Areas of new construction.	The planning process for underground networks, skyways, and elevated walkways is complex. (See the section "Urban Pedestrian Environments.")
All pedestrians.	Areas with new construction.	See "Urban Pedestrian Environments.

Figure 1-11. Grade Separation Countermeasure Matrix (continued)

Facilities for the Handicapped

Definition

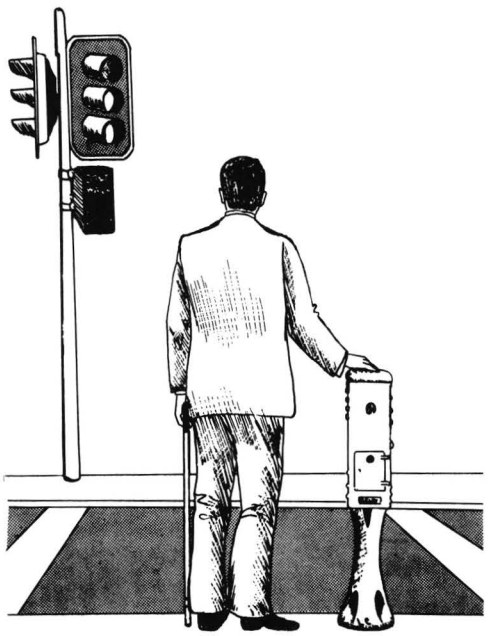
Traffic engineering devices that aid those with physical disabilities; (e.g. blindness, deafness, loss of limb).

Associated Behavioral and Accident Considerations

- Over 25 percent of the population can be considered handicapped, including the blind, the deaf, those temporarily or permanently in wheelchairs or on crutches, and the chronically ill (2).
- The blind are generally cautious and are rarely involved in serious accidents (4).
- A majority of the handicapped enjoy walking or being outdoors and many depend on walking as a means of transportation (5).

Varieties of Facilities for the Handicapped

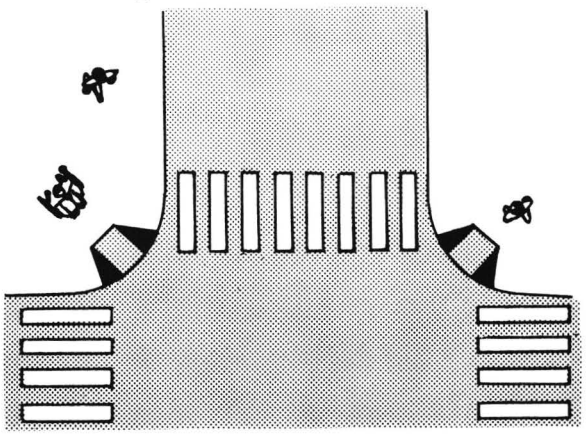
- Signal-related
  - Audio: pedestrian signals augmented with bells, horns, buzzers or clicking sounds to indicate when the WALK signal is on.
  - Tactile: devices keyed to the signal that vibrate to let the blind touching the device know when they can cross; may be located on signal pedestals or on hip-high posts (as in Japan) (4).



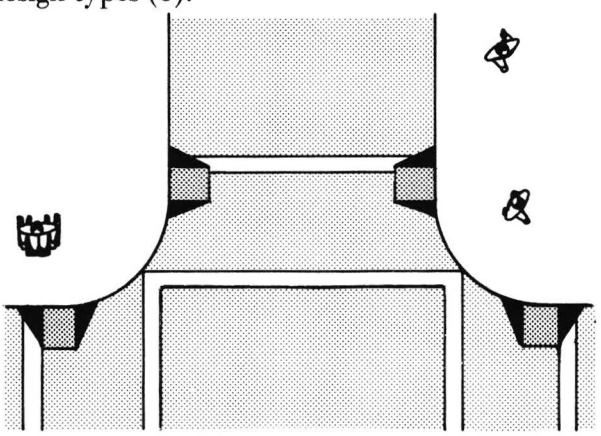
- Combination Audio and Tactile ("Ticker" used in Sweden): small vibrating boxes located on signal posts which give off a clicking sound so they can be easily located (4).
- Special Pedestrian-activated: signals that, when actuated by pedestrians, give a longer than usual WALK phase.

- Sign-related
  - Braille maps and signs providing information to the blind.
  - Warning signs for motorists indicating the presence of handicapped people in the area.

- Sidewalk-related
  - Curb ramp: sloped structure for pedestrians which cuts through a curb or builds up to the curb from street level; helps those in wheelchairs, on crutches, and the elderly to negotiate curbs. There are many different design types (6).

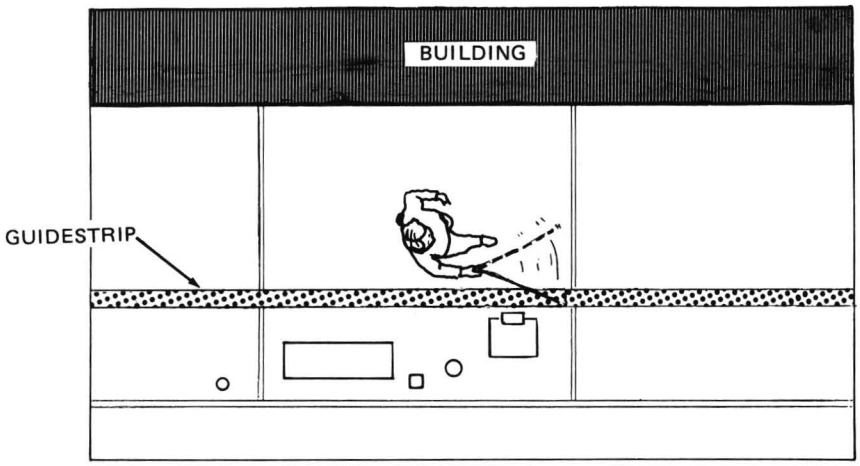


Ramps Cutting Through Curb



Ramps Built Up to Curb

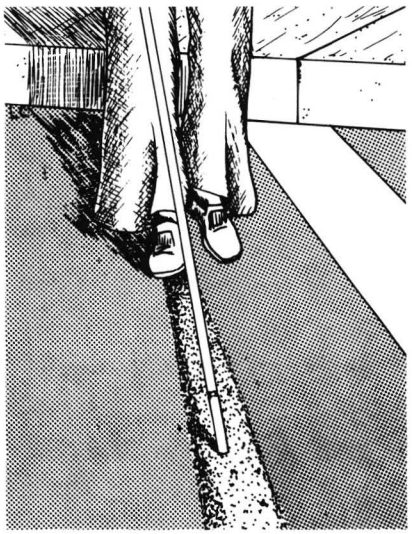
– Guidestrips: tactile strips located along the edge of a walkway to guide blind pedestrians; can be made of sand or glass beads set in thermoplastic (6).



– Handrails: rails along ramps and sloping sidewalks for the deaf (who may have equilibrium problems due to ear injury), the blind (to orient themselves), and others with mobility problems. For more information see Reference 6.

– Careful location of street furniture away from the pedestrian traffic stream to give the blind and those in wheelchairs a clear space.

- Crosswalk-related
  – Guidestrips: raised markings of epoxy and gravel that can be felt by a blind person with a cane and used as a guide to cross the street (3).



	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Permit those with minor and serious handicaps to travel more freely. Can also benefit people who aren't handicapped (1).	Are generally expensive. Require research and careful planning.
SIGNALS. Audio	A majority of the blind, even those with hearing problems also, prefer them (4). Can also benefit the sighted who have allowed their attention to wander (4). Signals of varying frequencies may also help the deaf (4). Can give directional sound clues (4).	Disturb area residents at night. May mask other street noises upon which the blind depend. May cause the blind to become over-dependent on audio signals, reducing their skills to cross unsignalized intersections (4).
Tactile	Tell blind people when it is safe to cross the street. Allow the blind to hear traffic sounds on which they depend (4). Have an unambiguous association with the relevant crossings (4).	Difficult to find. The blind feel selfconscious using them (4). Lack of tracking function (4). Those designed are crude and have maintenance problems (4).
Combination Audio and Tactile	Inexpensive. Tactile boxes are easy to find because they give off a clicling noise.	Don't tell pedestrians in which direction it is safe to cross.
Lengthened phases.	Allow more crossing time for the elderly, the handicapped and slow walkers.	Increase vehicle delay. May disturb the overall signal system.

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians, but the handicapped and elderly in particular.	Any location where there are pedestrians or conditions requiring them.	Workable compromises in facility design can be obtained by consulting a committee made up of people with different kinds of disabilities (2). The handicapped must be considered when planning sidewalks and curbs, street furniture placement, and traffic signals. HUD Block Grant funds are available for removal of architectural barriers.
The blind.	In city cores, near transit terminals, institutions for the blind, shopping centers (4).	Adequate signals for complex intersections have not yet been devised. The blind feel insecure about clearance phases (4).
The blind.	In city cores, near transit terminals, institutions for the blind, shopping centers.	
The blind.	In city cores, near transit terminals, institutions for the blind, shopping centers.	
Elderly people with mobility problems.	On wide streets.	

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix (continued)

	ADVANTAGES	DISADVANTAGES
CURB RAMPS.	Allow the elderly and others with mobility problems to move more freely across intersections.	May cause orientation problems for the blind. Involve redesigning of curbs. Snow and litter removal problems. Possible increase in bicycle use of sidewalks, because ramps allow easy crossing of streets. Ramps built up to the curb may be run over by cars and may cause drainage problems.
SIDEWALK GUIDESTRIPS.	Help the blind travel more freely and safely down the sidewalk. Warn the blind about non-sidewalk areas (e.g., the street, edges of parking lots).	Require careful planning by experts.
LOCATION OF STREET FURNITURE AWAY FROM PEDESTRIAN STREAM.	Provides a clear path for all pedestrians. Removes possibly hazardous objects from the path of the blind.	Involves additional expense for moving existing street furniture. Street furniture may block drivers' view of potential dart-outs.

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Elderly. People in wheelchairs or on crutches. People with strollers or carriages.	All curbs in downtown areas. Areas in which there are concentrations of handicapped pedestrians. Within the crosswalk. Away from the direct line of travel used by the blind. Locations where they will not be obstructed by parked cars, street furniture, etc.	There are numerous ramp designs which suit different situations. (Detailed explanations can be found in Reference 6). When ramps are installed, corresponding ramps on the opposite side of the road are necessary for free movement. Ramp surfaces should be nonslip and easy to clean. Ramp sides should be sloped. Some ramps may need handrails (6). Recommended maximum gradients for ramps are available in Reference 6. Ramps should have no lip at the top or bottom. Even a lip as small as ½" will impede some people in wheelchairs (6). The blind find it easier to negotiate intersections with angular versus round corners (5).
The blind.	Sidewalks where the blind may need help in orienting themselves. Sidewalks with complicated geometrics. Wide sidewalks.	To be useful, guidestrips must be constructed so the blind can feel them with their canes.
All pedestrians, particularly the blind and those in wheelchairs.	All sidewalks.	A strip may be provided along the curb to house street furniture. The area may be textured differently from the sidewalk to give the blind further orientation.

1 in = 25.4 mm

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix (continued)

	ADVANTAGES	DISADVANTAGES
CROSSWALK GUIDESTRIPS (3).	Help the blind align themselves with intersections. Help the blind across complicated intersections. Are relatively permanent.	Require careful planning by experts. The blind need special training in their use.

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
The blind.	Intersections commonly used by the blind. Intersections with more than 4 legs. "T-Intersections." Diagonal or skew intersections. Dog-legged and offset intersections. Intersections with unusually large radius curb returns. Other intersections with unusual geometrics. Unusually wide streets that may pose orientation problems.	Guidestrips are directional guides; they do not assure a pedestrian's safety. Guidestrips should not be at all intersections, only those with special problems. They should be installed only under the guidance of a traffic engineer and a mobility specialist. Travel guide strips should include markers on the curb to help locate them.

Figure 1-12. Facilities for the Handicapped Countermeasure Matrix (continued)

Pertinent References – Facilities for the Handicapped

1. Fruin, J.J. *Pedestrian Planning and Design.* New York: Metropolitan Association of Urban Designers and Environmental Planners, Inc., 1971.
2. Herms, B.F. The role of the disabled pedestrian. Paper presented at the 29th Annual Meeting of the Western District, Institute of Transportation Engineers, San Diego, July 1976.
3. Herms, B.F., Elias, H., & Robbins, D.O. Guidestrips for visually handicapped pedestrians. *Proceedings of the MAUDEP Seminar on Planning, Design, and Implementation of Bicycle/Pedestrian Facilities,* San Diego, December 1974. Berkeley: Institute of Transportation and Traffic Engineering, University of California, May 1975, 266-276.
4. Hulscher, F.R. Traffic signal facilities for blind pedestrians. Prepared by the Department of Motor Transport, New South Wales, Australia, 1975.
5. Roberts, D.C. Pedestrian needs – Insights from a pilot survey of blind and deaf individuals. *Public Roads,* June 1972, *37*(1), 29-31.
6. Templer, J.A. The priority accessible network: A manual for making the city accessible to the elderly and handicapped pedestrian. Prepared by the Pedestrian Research Laboratory, Georgia Institute of Technology, for the Federal Highway Administration. In progress (estimated date 1978).

Lighting

Definition

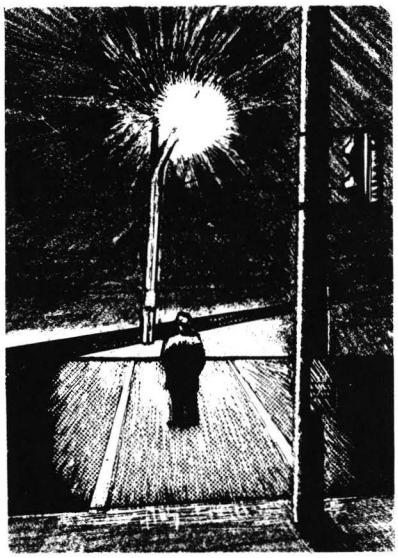
The use of lights to illuminate roads, sidewalks and crosswalks.

Associated Behavioral and Accident Data

- Despite limited night travel, 35-42 percent of pedestrian accidents occur during darkness (10, 11).
- Improved lighting can reduce pedestrian accidents at night by almost one half (9, 13).
- Pedestrians at well lit locations choose larger gaps for crossing (9).

Varieties of Lighting Facilities

- Street Lighting: lighting of streets for vehicles or as a crime deterrent; pedestrian safety is a side benefit.
- Crosswalk Lighting: special illumination of crosswalks to increase pedestrian visibility.



LIGHTING

	ADVANTAGES	DISADVANTAGES
STREET LIGHTING.	Reduces pedestrian and vehicle accidents. Improves pedestrian visibility to the driver. Citizens may willingly pay additional taxes for lighting upgrading. Helps the deaf and those in wheelchairs use streets more safely (14). Helps reduce crime.	Expensive.
CROSSWALK LIGHTING.	May help prevent nighttime accidents at crosswalks (9). Indicates high hazard crosswalks. Can improve pedestrian visibility, increases clothing brightness (9). Causes pedestrians to pay more attention to the crossing, as they are less distracted (9). Can bring about safer driver behavior at crosswalks (9). Allows drivers to see far enough ahead to stop safely at higher speeds (9). Pedestrians at well lit crosswalks choose larger gaps. Pedestrian and neighborhood attitudes toward crosswalk lighting are good (3).	Expensive. Pedestrians may develop a false sense of security. Crosswalk lighting systems must be carefully studied and designed by professional engineers. Depending on lighting scheme, may illuminate crosswalk and top of pedestrian's head only, not the entire pedestrian.

Figure 1-13. Lighting Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	In rural areas at high hazard spots, intersections, traffic circles, bridges and tunnels. At high nighttime accident locations.	Luminaires should be directed where needed and provide brightness without glare. Recommendations for illumination levels are available in References 1 and 7.
All pedestrians.	Crosswalks with a high nighttime accident rate. Locations where the visibility of pedestrians is limited by adverse geometric or environmental conditions (fog).	Before installing crosswalk lighting, studies should be made on accidents, visibility problems, volumes, community values and funding. Warrants for lighting are available in Reference 3.

Figure 1-13. Lighting Countermeasure Matrix (continued)

Pertinent References – Lighting

1. American Association of State Highway and Transportation Officials. Committee on Planning and Design Policies. *An Informational Guide for Roadway Lighting.* Washington, DC: American Association of State Highway and Transportation Officials, March 1969.
2. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
3. Freedman, M., Janoff, M.S., Koth, B.W., & McCunney, W. Fixed illumination for pedestrian protection. Final Report. Prepared by the Franklin Institute Research Laboratories, for the Federal Highway Administration, December 1975. (NTIS PB 256-299).
4. Freedman, M., Janoff, M.S., Koth, B.W., & McCunney, W. Fixed illumination for pedestrian protection. Users Manual. Prepared by the Franklin Institute Research Laboratories, for the Federal Highway Administration, December 1975. (NTIS PB 256-672).
5. Fruin, J.J. *Pedestrian Planning and Design.* New York: Metropolitan Association of Urban Designers and Environmental Planners, Inc., 1971.
6. Gallagher, V.P., & Janoff, M.S. Interaction between fixed and vehicular illumination systems. Prepared by the Franklin Institute Research Laboratories, for the Federal Highway Administration, July 1972. (NTIS PB 214-812).
7. Illuminating Engineering Society. American national standard practice for roadway lighting. *Journal of the Illuminating Engineering Society,* July 1972, *1*(4), 334-374.
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12. Malo, A.F., Freed, A., Cleveland, D.E., Arthungal, J.V., & Jorgeson, C. An innovative pedestrian crosswalk safety device demonstration. Report No. TrS-8. Prepared by the Highway Safety Research Institute, University of Michigan, Ann Arbor, and the Detroit Department of Streets and Traffic, 1971.
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14. Roberts, D.C. Pedestrian needs – Insights from a pilot survey of blind and deaf individuals. *Public Roads,* June 1972, *37*(1), 29-31.

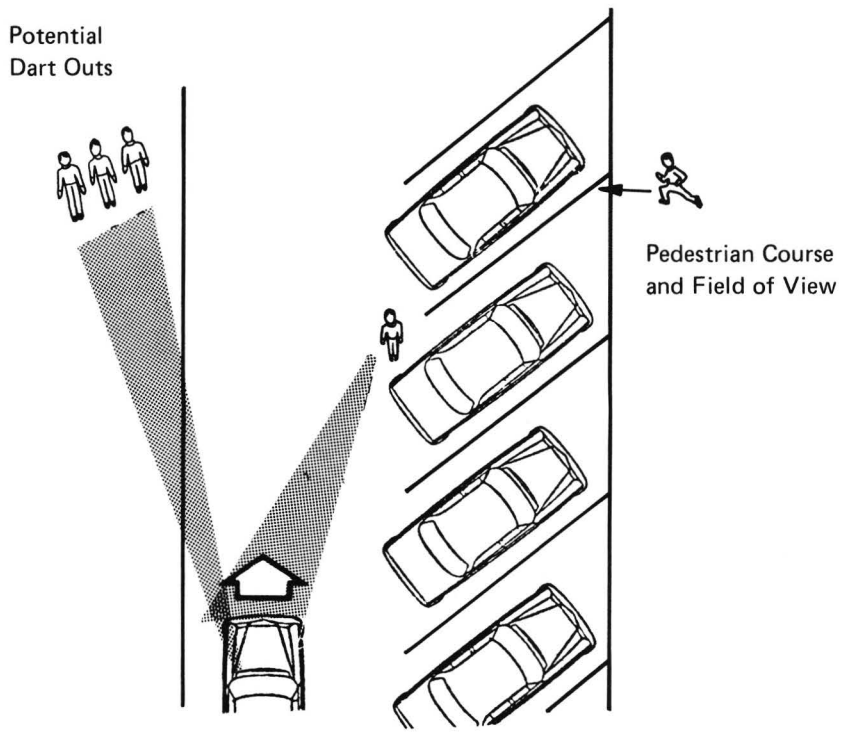
One-Way Streets and Diagonal Parking

Definitions

- One-way Street: street on which vehicles may travel in only one direction.
- Diagonal Parking: situation in which vehicles may park only head-in at an angle. In this context as a pedestrian safety countermeasure, parking is prohibited on the opposite side of the street.

Associated Behavioral and Accident Data

- Conversion to one-way streets can reduce pedestrian accidents 20 to 50 percent by improving the drivers' field of vision and necessitating that pedestrians have to look only in one direction when crossing (1, 3, 5).
- Diagonal parking can reduce accidents involving pedestrians darting out from behind parked cars because pedestrian and motorist fields of view are improved, pedestrians act more cautiously, and vehicle speeds tend to decrease (2).



One Way Street with Diagonal Parking

The increased vehicle speeds on one way streets and the traffic safety problems associated with diagonal parking requires extreme care when considering this pedestrian safety approach. The use of diagonal parking is limited to streets with low speeds that do not carry thru traffic (functionally classified as local or land access street).

ONE-WAY STREETS AND DIAGONAL PARKING

	ADVANTAGES	DISADVANTAGES
ONE-WAY STREETS.	Reduce complexity of crossing and scanning tasks; pedestrians have to look in only one direction. Driver does not have to deal with opposing traffic and can give more attention to pedestrians. Can reduce pedestrian risk and accidents. Provide greater gaps in traffic (3). Increase street capacity (3) Reduce pedestrian and vehicle delay (1). Permit simpler signalization (1).	At intersections pedestrians may not be able to see traffic signals because there is only one direction of traffic flow, while there are two directions of pedestrian flow (3). Can increase vehicle speed. Possible problems with neighborhood acceptance (2). Possible negative effects on transit and emergency travel (3). Some vehicles will have to travel longer routes (3). Can increase vehicle volume on affected streets. There is danger from cars going the wrong way on the street.
DIAGONAL PARKING.	Can reduce dart-out behavior and accidents. Can improve pedestrian sight lines and pedestrian scanning behavior (2). Can reduce vehicle speed; drivers use more caution (2).	Takes up space from travel lanes. Increases vehicle risk of being hit while pulling out of parking space (2). Can reduce vehicle parking space (2). Possible street sweeping problems if street is one way with no provision for vehicle removal during cleaning operations. Possible problems with neighborhood acceptance (2).

Figure 1-14. One-Way Streets and Diagonal Parking Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Children and elderly pedestrians.	Areas with many children. Areas with many dart-out accidents or behaviors. Streets with midblock or unsignalized crossings or high speed traffic. Areas in which suitable parallel streets are available to accommodate vehicle flow in the opposite direction.	Considerations for both one-way streets and diagonal parking are: The change must be planned within the street, transit, and traffic system. Objectives for changing the street should be clear. Conversion to one-way streets has shown no negative effect on business or economic conditions (3). Changes must be made in signs, markings, signals, and other traffic control devices. Parking regulations must be considered. The public must be educated about the change. Plans must be made to combat increased vehicle speeds that may result from change to one-way streets. Transition areas between one-way and two-way streets are hazardous and require special treatment (3).
Children	Areas with many children. Areas with many dart-out accidents or behaviors. Residential areas.	

Figure 1-14. One-Way Streets and Diagonal Parking Countermeasure Matrix (continued)

Pertinent References – One-Way Streets and Diagonal Parking

1. American Automobile Association. *Manual on Pedestrian Safety*. Washington, DC: American Automobile Association, 1964.
2. Berger, W.G. Urban Pedestrian accident countermeasures experimental evaluation. Volume I: Behavioral evaluation studies. Prepared by BioTechnology, Inc., for the National Highway Traffic Safety Administration and Federal Highway Administration, February 1975.
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4. Jacobs, G.D., & Wilson, D.G. A study of pedestrian risk in crossing busy roads in four towns. Report LR-106. Prepared by the Road Research Laboratory, Crowthorne, Berkshire, England, 1967.
5. Yaksich, S., Jr. The pedestrian's role in traffic control. Paper presented at the Tenth Pan American Highway Congress, Montevideo, Uruguay, February 1967.

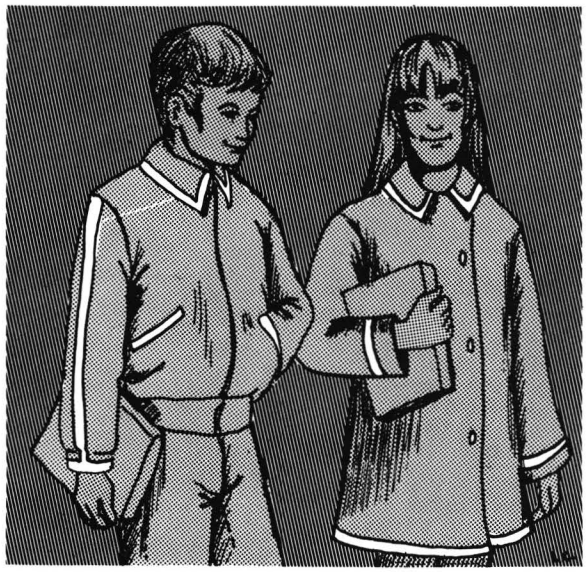
Retroreflective Materials

Definition

Materials which brilliantly reflect light from vehicle headlights back to the driver, thus increasing the visibility of a person wearing such materials. Two types of retroreflective materials are currently in production. One is composed of millions of tiny glass beads bonded to cloth or to a material that can be transferred to cloth. The second design uses microscopic prismatic elements as the reflecting medium on a flexible vinyl material. Adhesive backing allows for transferring the material to cloth.

Associated Behavioral and Accident Data

- Despite reduced levels of night pedestrian travel, more pedestrians are killed or injured at night than during daylight hours (2).
- The average pedestrian estimates his visibility in the dark to be twice what it actually is (1).
- Reflectorization can increase the visibility of a pedestrian five times (1, 5).
- The visibility of retroreflective materials give drivers a safe stopping margin, even at high speeds (5).
- To be truly effective, retroreflective materials must be worn by everyone, not just a few individuals.



RETROREFLECTIVE MATERIALS

	ADVANTAGES	DISADVANTAGES
IN GENERAL	Inexpensive. Easy to implement. Can substantially reduce nighttime pedestrian accidents. Increase the visibility of pedestrians.	Depends on voluntary use. Nonstandardized materials may not be properly understood by motorists. If all pedestrians don't use the materials, nonusers will be at a higher risk level because motorists won't expect them.

Figure 1-15. Retroreflective Materials Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians who walk in the dark, especially children. Police officers. Nighttime construction crews.	All areas, but especially rural and other locations with little or no illumination.	There are three major U.S. manufacturers and distributors of retroreflective materials: Reflexite Corporation 199 Whiting Street New Britain, Connecticut 06051 Safety Premiums Raymond D. Strakosch, Inc. 9 Cross Street Norwalk, Connecticut 06851 3M Company Safety Systems Department 3M Center St. Paul, Minnesota 55101 Local outlets should be established.

Figure 1-15. Retroreflective Materials Countermeasure Matrix (continued)

Pertinent References – Retroreflective Materials

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2. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
3. Hazlett, R.D., & Allen, M.J. The ability to see the pedestrian at night: The effects of clothing reflectorization and driver intoxication. *American Journal of Optometry and Archives of American Academy of Optometry,* April 1968, *45* (4), 246-258.
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Safety Islands

Definition

Pedestrian refuge area between opposing traffic lanes or within an intersection; includes islands originally installed to channel vehicle traffic, but used by pedestrians.

Associated Behavioral and Accident Data

- Some pedestrians are not able to completely cross at an intersection at the rate at which signals are timed (3).
- Running at intersections to make the light is a common accident cause (1, 4).
- Safety islands can provide a refuge on wide or busy roads and at confusing intersections.

Varieties of Safety Islands

- Roadway-Level Islands: islands marked on the road with paint, raised markers, or other distinguishing material.
- Raised Islands/Medians: islands raised above the level of the road and designated with a curb.
- Loading Islands: raised islands serving as refuges for loading and unloading passengers from transit vehicles.

SAFETY ISLANDS

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Can channelize and separate pedestrian and vehicle traffic. Minimize pedestrian exposure to traffic, allowing pedestrians to cross in stages. Permit pedestrians to look for traffic in one direction at a time. Give pedestrians a resting place on wide roads or intersections.	Present an "illusion of safety". Potential street sweeping or plowing problems. May cause damage to vehicles if drivers don't see them.
LOADING.	Provide transit passengers with a refuge from traffic.	May increase danger because pedestrians may step off them into the traffic flow. Present an "illusion of safety" as cars can run over them.

Figure 1-16. Safety Islands Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians, especially those who can't safely cross the entire roadway during one signal cycle, or one gap in vehicle traffic.	Multi-lane roads. Large or irregularly shaped intersections. Complex/busy signalized intersections. Streets with many elderly or handicapped pedestrians.	Installation should be preceded by engineering studies to determine design and effect on traffic flow. Safety islands should be considered during the planning process for complex streets or intersections, rather than after construction. Islands must be visible at all times and from a distance (2). This can be achieved through: – Illumination – Reflectorization – Size – Marking – Signing – Placement of signs, etc. that might hide a pedestrian from view. The needs of the handicapped must be considered, including locational guides for the blind and curb ramps or cuts. (6).
Pedestrians waiting for transportation.		Barriers may be necessary to keep pedestrians from stepping into traffic.

Figure 1-16. Safety Islands Countermeasure Matrix (continued)

Pertinent References – Safety Islands

1. American Automobile Association. *Manual on Pedestrian Safety*. Washington, DC: American Automobile Association, 1964.
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Sidewalks

Definition

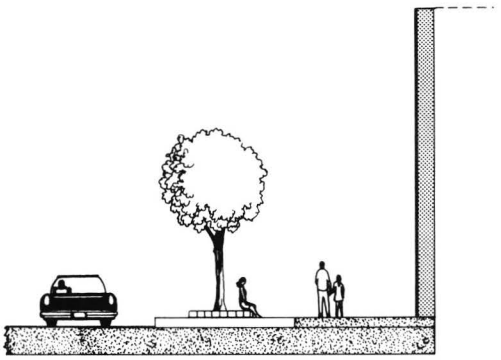
At-grade areas for pedestrian travel; includes walkways between the curb lines or edge of a roadway and the adjacent property lines; includes both permanent and temporary walkways of all types of construction materials.

Associated Behavioral and Accident Data

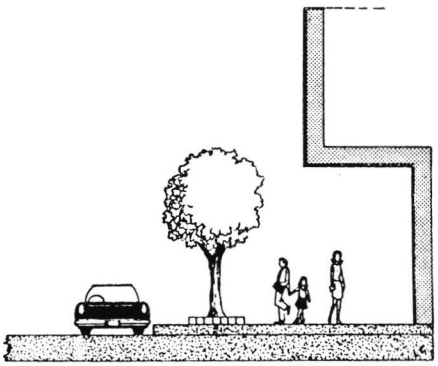
- Sidewalks can eliminate accidents to pedestrians who might otherwise be walking, standing or playing in the roadway. They are of direct benefit to pedestrians in areas of high pedestrian and/or high vehicle traffic (6).
- Sidewalks will *not* completely separate pedestrians and vehicles. Contiguous sidewalks in particular may give only an illusion of safety. Vigilance by the pedestrian is still required.

Varieties of Sidewalks

- Shoulder Improvements: area adjacent to the roadway that has been cleared of physical obstructions for use by pedestrians.
- Pathway: temporary gravel or asphalt walkway along the roadside.
- Permanent Sidewalk: concrete walkway separated from the road by a curb or gutter.
- Widened Sidewalk: walkway that has been widened by reducing the street area (generally the parking lane); landscaping and amenities can provide a buffer zone.



- Arcade Setback: walkway that has been widened by taking space from the first floor of a building.



SIDEWALKS

	ADVANTAGES	DISADVANTAGES
PERMANENT SIDEWALKS AND SIDEWALKS IN GENERAL.	Reduce number of accidents in residential and business areas (16). Separate pedestrians from traffic. Provide safer and more easily traveled areas for the elderly and the handicapped. Separate pedestrian area from roadway, Provide paved places for children to play (vs. in the road). Often funded by property owners.	May give pedestrians a false sense of security. May require a complicated political process to get installed. Difficult for handicapped to negotiate curbs. Exposed to weather: Snow removal problems, Cracking caused by severe weather requires maintenance.
SHOULDER IMPROVEMENTS.	Least expensive of the alternatives. Provides a multiple use facility. Conceivable for areas with low pedestrian volumes.	Pedestrians are not separated from traffic.
PATHWAYS.	Less expensive than permanent sidewalks.	Temporary. May need annual maintenance.

Figure 1-17. Sidewalks Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Locations where the roadway is not clearly delineated from the shoulder. School routes. Areas of retail, office, service, and institutional use. Areas with high pedestrian and vehicle volume. Locations with accidents involving pedestrians walking or standing in the road.	An overall planning strategy is necessary to determine policies on location of sidewalks, funding and design. Legal restrictions must be considered and regulations enacted. Funding can come from assessment of property owners, city funds or both. Locations for sidewalks can be determined through accident records, requests or complaints, or demonstration of apparent need. In designing sidewalks the following should be considered: – The needs of the elderly and handicapped: – 4–5 foot wide, uninterrupted, nonslip, smooth, low glare surface with curb cuts/ramps and careful placement of street furniture (1, 5). – Pedestrian flow and level of service. – Topography. – Potential drainage, litter, and snow removal/ storage problems. – Width should be at least 4-5 feet; intensely used shopping areas need 15-30 foot wide sidewalks (4).
All pedestrians.	Locations with low pedestrian volumes, especially rural roads.	The road edge might be marked with a painted line to delineate areas for vehicle traffic from those for pedestrian use.
All pedestrians.	Locations with moderate pedestrian volumes.	May be separated from the road by curb and drainage facilities.

1 foot = 0.3 metre

Figure 1-17. Sidewalks Countermeasure Matrix (continued)

	ADVANTAGES	DISADVANTAGES
SIDEWALK WIDENING.	Increases pedestrian space. Relieves pedestrian congestion. Provides an additional buffer zone between pedestrians and vehicles. Provides space for amenities. Eliminates visual obstruction by parked automobiles. Reduces the width of the roadway a pedestrian must cross. Improves the pedestrian walking environment.	Reduces vehicle travel lanes. Reduces parking space. High expense. Amenities can become barriers for the handicapped.
ARCADE SETBACK.	Provides shelter from weather. Doesn't reduce vehicle space. Relieves pedestrian congestion. Provides an additional buffer zone between pedestrians and vehicles. Provides space for amenities.	Requires cooperation of builders, developers, and other private interests. Reduces store frontage and sales space. High expense. May make pedestrians feel closed in.

Figure 1-17. Sidewalks Countermeasure Matrix (continued)

	TARGETS		IMPLEMENTATION CONSIDERATIONS
	PEOPLE	LOCATIONS	
	All pedestrians.	Locations with high pedestrian volumes. High retail areas in the CBD.	Alternative parking space must be available.
	All pedestrians.	Locations with high pedestrian volumes. High retail areas in the CBD.	

Figure 1-17. Sidewalks Countermeasure Matrix (continued)

Pertinent References – Sidewalks

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Signalization

Definition

Signals are electro-mechanical devices used for regulating, directing, or warning motorists and/or pedestrians.

Associated Behavioral and Accident Data

- Signals provide safer crossing areas for pedestrians by stopping those vehicles most likely to conflict with pedestrian flow and by telling pedestrians when it is safe to cross.
- There are conflicting views on whether pedestrian compliance is better at crossings with pedestrian signals or just traffic signals (3, 9).
- Many pedestrians, particularly children and the elderly, do not understand the meaning of traffic or pedestrian signals (12, 18).
- Right-turn-on-red has not been shown to increase pedestrian accidents (5, 8), but it does make the crossing situation more complicated.

Varieties of Signals or Signal Systems

- Traffic Signal: signal installed primarily for vehicular traffic control; pedestrians use the same phase and signals as the vehicles.
- Pedestrian Signal: a supplement to traffic control signals telling pedestrians when it is safe to start their crossing through the use of words or symbols; generally mounted at the far end of the crosswalk.

  Pedestrian signals can cycle with the traffic signal or be activated by a pedestrian-actuated pushbutton. Pedestrian signals have three types of phasing:

  - Shared Phase: pedestrian signals are timed with the traffic signal; pedestrians cross at the same time as vehicles moving parallel to them.
  - Delayed Phase: either the traffic or pedestrian signal is delayed to allow pedestrians to get out into the crosswalk before vehicles start, or to allow vehicles to turn before pedestrians start.
  - Separate Phase (Scramble or Barnes' Dance): all vehicles are stopped to allow pedestrians to cross unimpeded on all approaches and on the diagonal.

	ADVANTAGES	DISADVANTAGES
TRAFFIC SIGNALS.	Stop vehicles most likely to conflict with pedestrian flow. Create gaps in traffic flow. Pedestrians obey traffic signals more frequently than pedestrian signals (17). Can provide for the orderly movement of traffic. Can increase the traffic-handling capacity of intersections.	Pedestrians and vehicles are not physically separated, leading to possible conflicts. Signal timing may not be related to pedestrian flow, in particular that of the elderly and handicapped. More expensive than all other facilities except grade (vertical) separation and horizontally separated pedestrian environments. May cause pedestrian congestion on sidewalks and pedestrian delay at corners (4). Children have difficulty using them properly and need training (12). In rural and residential areas, most children don't wait for the light to cross (12). Suspension wire-mounted signals often cannot be seen by pedestrians standing on the corner. Pedestrians and drivers may disobey signals (5, 16).
PEDESTRIAN SIGNALS. IN GENERAL.	Warn pedestrians of an impending light change sooner than the vehicle amber signal. Tell pedestrian when it is safe for them to cross.	Lack of understanding of different meanings of steady and flashing WALK and flashing DONT WALK (14, 16). Younger pedestrians either disregard the signal, or overdepend on it (13). Pedestrians may feel overly safe from turning vehicles.
PEDESTRIAN-ACTUATED.	Respond to pedestrian needs and flow. Can give pedestrians a longer crossing cycle.	Cause additional vehicle delay because of longer cycle. Pedestrians often don't use the push button (10).

Figure 1-18. Signalization Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians. Motorists.	Streets with high vehicle and/or pedestrian volumes. School crossings. High accident intersections.	Warrants and design requirements are in the MUTCD (2). Location and design of signals must be uniform. Signal timing should also consider pedestrians, with special cycles where needed (e.g., areas with elderly or handicapped pedestrians). The shortest possible cycles should be used to accommodate waiting pedestrians and minimize vehicle delay. After waiting 30 seconds, pedestrians become impatient (7). The system must be as simple as possible. Complicated visual stimuli confuse drivers (14). Increasing turning prohibitions may reduce conflicts and accidents.
All pedestrians.	Locations with traffic signals. Locations with high pedestrian volumes. School crossings. Locations where traffic signals are not easily visible to pedestrians. Locations requiring a pedestrian clearance interval.	Design requirements and warrants are in the MUTCD (2). If pedestrians can see the traffic signal they are more likely to ignore the pedestrian signal. Many pedestrians don't understand flashing WALK, leading to a higher percentage of illegal crossings (9). Symbolic signals are understood as well as words by adults; children don't understand them as well as DONT WALK/WALK (14). Steady DONT WALK has about the same effect as flashing DONT WALK (14).
All pedestrians, particularly the handicapped, elderly or school children.	High pedestrian volume locations. Residential locations where there are large numbers of pedestrians during parts of the day or where pedestrians would have to wait a long time for a gap. Some school crossings.	Push buttons must be located so children and people in wheelchairs can reach them.

Figure 1-18. Signalization Countermeasure Matrix (continued)

SIGNALIZATION

	ADVANTAGES	DISADVANTAGES	
SEPARATED PHASE (SCRAMBLE).	Completely separates pedestrians and vehicles.	Can cause serious vehicle and pedestrian delay and backup.	

Figure 1-18. Signalization Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Areas of high conflict because of turning vehicles. Areas of high pedestrian volume. Small towns. *Not* at wide intersections.	The signals can be timed to give motorists a green light for several blocks to compensate for delay.

Figure 1-18. Signalization Countermeasure Matrix (continued)

Pertinent References – Signalization

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16. Sterling, C.F. An analysis of pedestrian reaction to the flashing WALK indication. *Traffic Engineering,* November 1974, *44*(14), 20.
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Signs and Markings

Definitions

- Signs: devices mounted on a fixed support, conveying a regulatory, warning or guiding message to pedestrians or motorists. Word or symbolic messages may be presented.
- Markings: regulatory, warning or guiding words, patterns, or lines painted on the pavement (for vehicles) or sidewalk curb (for pedestrians).

Associated Behavioral and Accident Considerations

- Warning signs and markings alert motorists and pedestrians to unexpected hazards.
- Regulatory signs and markings may give pedestrians a false sense of security.
- People tend to react to what they see on or beside the road rather than to what they read on a sign (5).
- Overuse or misuse of regulatory or warning signs/markings may cause people to ignore all signs or markings (8).

Varieties of Signs and Markings

- Regulatory: tell pedestrians and motorists what they may or may not do, based on the law.

  Examples: "Pedestrians Prohibited"
  "Cross Only at Crosswalks"
  "No Right Turn on Red"

- Warning: call the driver's/pedestrian's attention to conditions on or near a roadway that are potentially hazardous to pedestrians.

  Examples: "Caution, School Crossing"
  "Watch for Vehicles"

- Guide: provide information to help the pedestrian cross the street or use a pedestrian facility.

  Example: "For Extra Walk Time Push Button"

- Variable Message: electronic signs that can light up different messages according to need.

  Example: "Speed Limit____" (during school periods)

- Crosswalk Markings: painted lines delineating a pedestrian crosswalk. (See the section "Crosswalks" for elaboration of this topic.)
- Stop line: painted stripe indicating the place where vehicles should stop at a stop sign, traffic light or crosswalk.

SIGNS

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Inexpensive.	People have difficulty understanding them (4). Installation of new or novel signs requires an education and publicity program (7). Can be ineffective in urban areas because they have to compete with other visual objects (6). Tend to be ignored in rural areas (6). May be easily damaged.
REGULATORY.	Can tell people of regulations applying only at specific locations or times.	Regulations considered unnecessary or unwarranted will often be violated (2,14).
WARNING.	Can reduce pedestrian/vehicle conflicts (4). Give advance warning of schools. Make motorists more attentive in an area with visible children (11).	Excessive use of warning signs may cause motorists to ignore them (8). Pedestrians tend not to believe them and disregard them (12).

Figure 1-19. Signs Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Pedestrians. Motorists.	Preferably in locations with little visual clutter.	Excessive and unwarranted use of signs may cause disrespect for all signs (8). The MUTCD should be consulted and followed when installing signs. In particular, the following points are very important to safety: signs should (8): – be uniform and consistent in design and placement. – present a clear, simple and legible message. – fulfill a need as demonstrated through field studies or observation. – command attention and be conspicuous. – give the motorist or pedestrian adequate time to respond. – be visible at night through lighting or reflectorization. – be constantly maintained and upgraded as warranted. The use of symbols versus words on signs is not universally preferrable. Different age and cultural groups assign different meanings to the same signs/symbols (5,7).
Pedestrians. Motorists.	Locations where the particular regulation applies (8).	Detailed information in regulatory signs can be found in the MUTCD (8). Speed limit signs with flashing beacons are more effective than variable message or standard speed limit signs (15). "Walk On Left Facing Traffic" signs are effective in rural areas (1).
Pedestrians. Motorists.	Unexpected hazardous locations. Near schools. Locations where there might be unexpected pedestrian movements.	Detailed information on warning signs can be found in the MUTCD (8).

Figure 1-19. Signs Countermeasure Matrix (continued)

MARKINGS

	ADVANTAGES	DISADVANTAGES	
IN GENERAL.	Can warn pedestrians and drivers of hazards. Can channelize pedestrians and vehicles. Inexpensive. Can supplement the regulations or warnings of other devices. Do not divert the motorist's attention from the roadway (8).	Short durability, need continual maintenance. May be hard to see in the winter because of snow. May not be clearly visible when wet.	
STOPLINES.	Can increase the distance vehicles stop from the crosswalk (3).		

Figure 1-20. Markings Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Motorists. Pedestrians.	High hazard locations, that are not self-evident. Locations where vehicles or pedestrians must be channelized. Locations where sight distances are restricted. Locations where safety islands and road shoulders need delineation.	More detailed information on markings can be found in the MUTCD (8). The MUTCD should be consulted and followed when installing markings. In particular, the following points are very important to safety: markings should (8): – be uniform and consistent in design and placement. – present a clear, simple and legibile message. – fulfill a need as demonstrated through field studies or observation. – command attention and be conspicuous. – give the motorist or pedestrian adequate time to respond. – be visible at night through lighting or reflectorization. – be constantly maintained and upgraded as warranted. The use of symbols versus words on signs is not universally preferrable. Different age and cultural groups assign different meanings to the same signs/symbols (5,7).
Motorists.	Locations where it is important to indicate the point behind which vehicles must stop.	

Figure 1-20. Markings Countermeasure Matrix (continued)

Pertinent References – Signs and Markings

1. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
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Urban Pedestrian Environments (UPE)

Definition

At-grade environment partially or wholly separated from vehicular traffic; includes malls, auto-free zones and transitways located in urban business, commercial, industrial and residential areas.

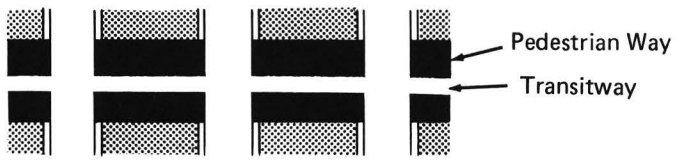
Considerations

- UPEs are usually initiated as part of an urban renewal or downtown economic revitalization process; however, pedestrian safety is a definite side benefit.
- Plans should be developed within the overall transportation and city planning system.
- Carefully planned temporary UPEs can be set up as part of a feasibility study to determine a more permanent need.
- Essential implementation and operational elements for a UPE are (3, 7, 8, 10):

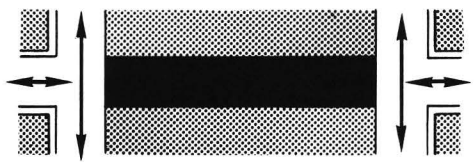
  Strong leadership,
  Time and money,
  Careful and thorough planning and feasibility studies, and
  Cooperation and involvement of the business community, government and the public.
- Possible funding sources are special assessment districts, revenue bonds, unallocated funds from the city budget, state grants, Federal grants and contributions.

Varieties of Urban Pedestrian Environments

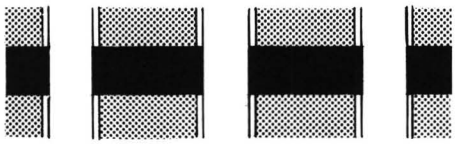
- Transitway: Street reserved for pedestrians and transit vehicles; all private vehicles are excluded except for emergency or temporary construction work vehicles. Transit lanes are set apart from pedestrian areas.



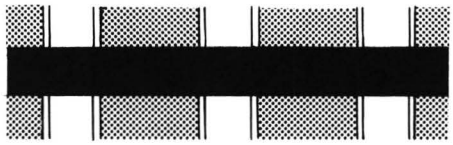
- Modified Street: Conventional street with one block closed to traffic for exclusive pedestrian movement.



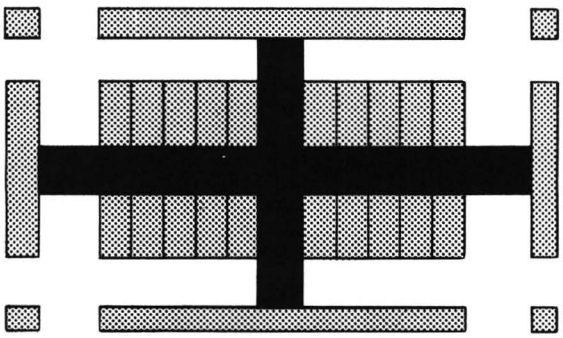
- Plaza or Interrupted Mall: Blocks of a retail street given over to exclusive pedestrian use, with cross streets left open to vehicular traffic.



- Continuous Mall: Multi-block pedestrian street from which all but emergency vehicles are excluded and which extends the full length of the shopping area without interruption.



- Displaced Sidewalk Grid: Horizontally displaced pedestrian walkways through alleys, arcades or lobbies within buildings.



- Below-Grade or Above-Grade Networks: (See the section on "Grade Separation.")

Pertinent References – Urban Pedestrian Environments

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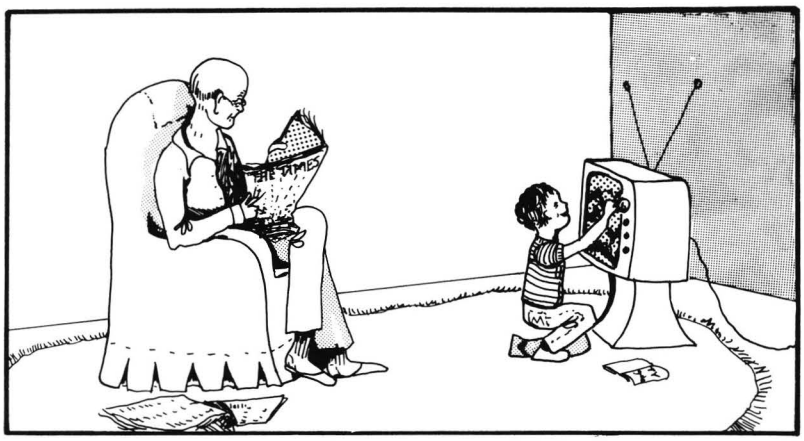
	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Provide greater separation of pedestrians and vehicles. Reduce pedestrian delays; relieve pedestrian congestion (12). May provide aesthetic and social enhancement of downtown area. No decrease and probable increase in economic viability of affected blocks (4, 11). Greater accessibility to retail merchants. Decrease noise and air pollution on affected street. Increase revenues, sales and land values (4, 8). Eliminate on-street servicing of stores. Can be developed in stages. May provide shelter for pedestrians. Can unify commercial or recreation areas (7, 9).	Generally high cost of installation, maintenance and operation. Vehicle traffic must be diverted to other streets. Maintenance (e.g., snow removal) problems. Reduce retail activity on nearby streets (9). Increase noise and air pollution on nearby streets. Disrupt utility and emergency services. Disrupt mail and goods delivery. May disrupt bus routes. Problems of street furniture placement for visually handicapped pedestrians (13). Potential legal problems (5). Parking problems. Security and policing problems.
TRANSITWAY.	Increases efficiency and time savings of mass transit (12).	Doesn't provide complete separation of pedestrians and vehicles.
PLAZA OR INTERRUPTED MALL.		Pedestrian-vehicle conflict is possible at cross streets.
DISPLACED SIDEWALK GRID.	Relieves vehicle congestion at intersections (9).	May cause midblock conflicts between pedestrians and vehicles (9).

Figure 1-21. Urban Pedestrian Environments Countermeasure Matrix

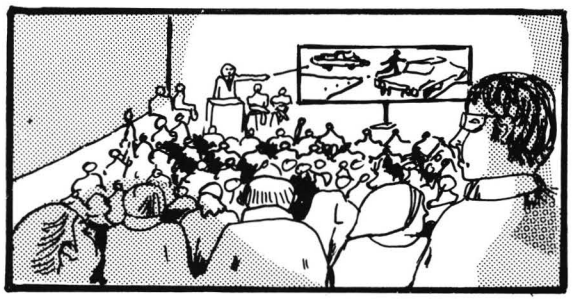
TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
All pedestrians.	Areas where few cars are currently traveling (narrow streets, trolley tracks). Areas of high pedestrian and vehicle activity (focal points). Major focal points of sales, transit or pedestrian activity.	Because urban pedestrian environments can affect a relatively large section of the central business district, feasibiltiy studies determining the political, business, and general public support are essential. Included in these evaluations should be: — Potential effects on traffic — Economic effects — Social effects. Successful implementation requires a great deal of cooperation and organization (6, 7). — A primary leadership group and working committees must coordinate and administer the process — Public and private interest can be developed through the media, informational meetings, pamphlets and displays — Management, financial, and scheduling plans should be arranged and followed. Periodic review sessions should be held to: — Consider and develop alternative concepts if necessary — Insure that all concerned parties have adequate opportunity to contribute as they see fit.
All pedestrians. Transit passengers.	Streets with high transit vehicle volumes.	Crosswalks must be provided for pedestrians.
All pedestrians.		Pedestrian-vehicle conflicts can be minimized through: — One way cross streets — Signals and warnings to the motorists such as signs, traffic bumps, or contrasting pavement at the mall crossings.
All pedestrians.	Blocks undergoing construction or repair. Between long blocks with high pedestrian concentrations.	Displaced grids should be planned before construction of the buildings on the block.

Figure 1-21. Urban Pedestrian Environments Countermeasure Matrix (continued)

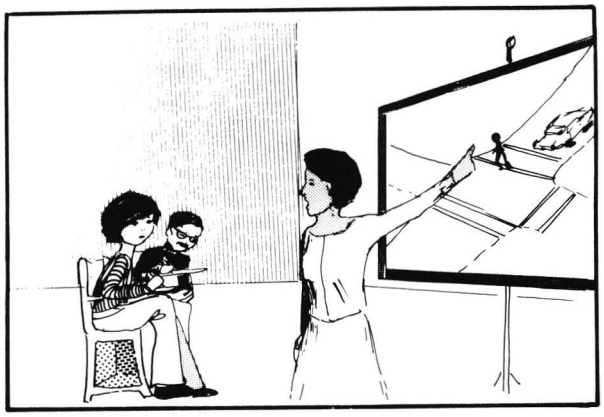
EDUCATION



Mass Media



Public meetings



Classroom

Education of Children

Associated Accident Data

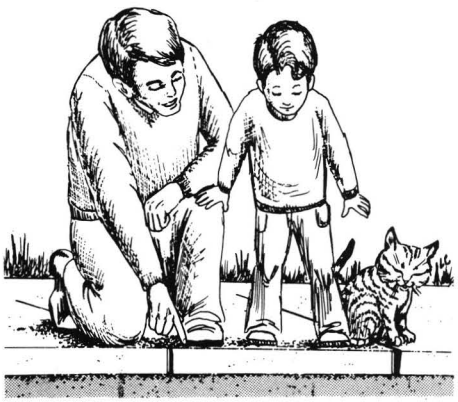
- 40-45 percent of all pedestrian casualties in the United States are children (20).
- Nearly 80 percent of all child pedestrian accidents are precipitated by unsafe or illegal actions by the child (5).
  - Most child pedestrian accidents are of the dart-out type and occur at nonintersections (16, 17, 30).
- Almost 75 percent of the pedestrian accidents involving children occur in residential areas at *other* than intersections (16,17).
- Few accidents involve children on their way to or from school; the majority occur near the child's home between 2 p.m. and 6 p.m. (16, 17, 23).
- Children in accidents come from homes with less parental supervision and fewer play facilities (23).

Associated Behavioral Data

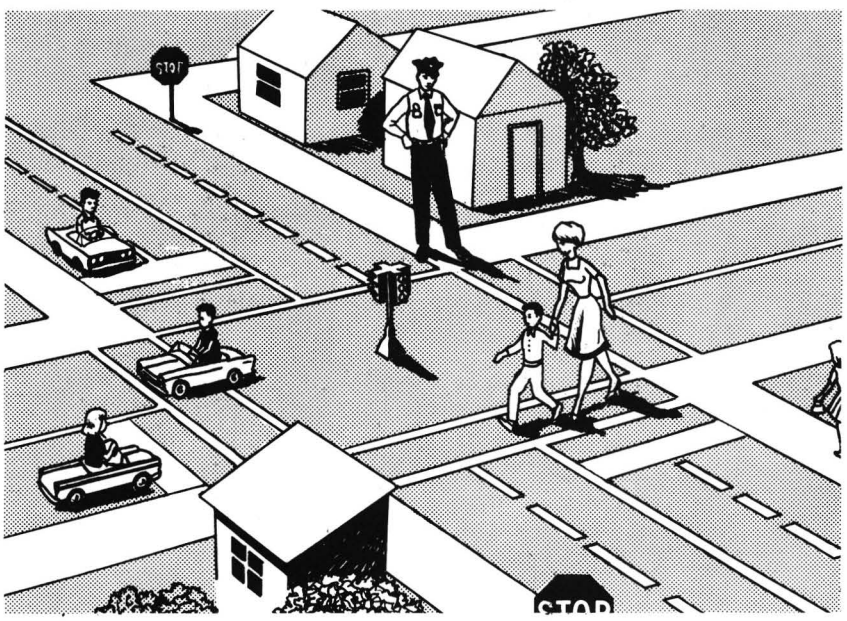
- Dart-out behaviors are exhibited by children from preschool to age thirteen, although they are less frequent with the older age groups (1).
- Children can be expected to do the unexpected in a traffic situation.
- Young children show the following forms of intellectual or physical immaturity:
  - Limited ability to deal with more than one thing at a time – improvable through training (8, 27).
  - Limited capability to judge vehicle velocity, distance, and safe gaps (25).
  - Inability to properly understand signs, many traffic terms, and signals; (a large number of children would cross on a red light) (22, 29).
  - Problems with sound localization and direction judgment (29).
  - Limited peripheral vision (29).
  - Greater difficulty to see over cars, and also to be seen, because of their smaller size.
- Drivers and children do not understand each other's behavior.
  - Drivers believe children will always stop and give cars the right of way (28, 30).
  - Children think adults will always be kind to them and that vehicles are capable of stopping instantly (29).
- A majority of children, whether walking or running, do *not* come to a complete stop before entering a street (13).
- Children should not be "overprotected" through overuse of pedestrian facilities. They need to learn how to cross safely at areas where there are no special facilities (1, 33).
- Parents should be encouraged to involve themselves in child safety through better supervision and by setting a good example (2).
- Warrants should be established and used to determine the type of countermeasures to use along a school route (patrols, adult guards, signals, police).
- Children need training to develop:
  - An ability to recognize traffic hazards.
  - Safe walking habits and practices.
  - Knowledge of why certain pedestrian practices are better than others.
  - Good attitudes as a pedestrian.
  - A growing ability to use good judgment and be self-protective.
  - A foundation of walking attitudes that later on will help develop good driving attitudes.

Preschool Children: Sample Educational Programs

- Guidance by parents (especially important) or day care/nursery school personnel: setting a good example through proper actions in the traffic.



- AAA Booklets "Preschool Children in Traffic": These booklets assist parents, nursery school teachers and child care personnel in teaching rudimentary traffic safety information to young children. The booklets are written for different age groups (3)
- Safety Town: a miniaturized village with streets, sidewalks, buildings, and traffic control devices used for instructing small children in the basics of traffic operations. The town can either be fixed (in a shopping center or school area) or portable (14, 24).



- Traffic Safety Clubs (presently used in Japan and Great Britain): clubs in which parents and children learn about safety hazards and basic traffic rules; safety skills are developed through songs, games, group training and instruction of the parents (14, 24).
- Television: topical programs using safety films or combinations of films and explanations by safety personnel.

EDUCATION OF PRESCHOOL CHILDREN

	ADVANTAGES	DISADVANTAGES
PARENTAL GUIDANCE (USING AAA *PRESCHOOL CHILDREN IN TRAFFIC*).	May teach children not to dart out into traffic or play in the street. Help children learn by doing. Help children develop safe habits. Booklets are individualized for different age groups. Provide parents with a guide and materials for teaching their small children to deal with traffic.	Takes up parents' time. Depends on the motivation of parental or day care/nursery school personnel.
SAFETY TOWN.	Teach children responsibility for their actions. Teach children how to use traffic systems in a realistic, but safe environment. Children learn by doing. Community tends to be enthusiastic.	A location must be found either for storage or for permanent location. May be costly to build and operate. Needs organization and continuing management. May take police from other duties. Children may not relate them to traffic situations in the real world.
TRAFFIC SAFETY CLUBS	Directly educate small children. Indirectly benefit children by training parents.	Involve much planning and cooperation. Leaders must be trained. Clubs vary in quality of training.
TELEVISION PROGRAMS.	Young children are avid television watchers. Most homes have televisions. A time slot can be easily chosen to reach a majority of young children. Television stations are required to show a certain number of hours of public service shows and they are likely to be responsive to programs on child safety. Films are available through the local AAA clubs.	Requires contacts and planning. May be costly to produce. Safety shows may not be aired on prime time.

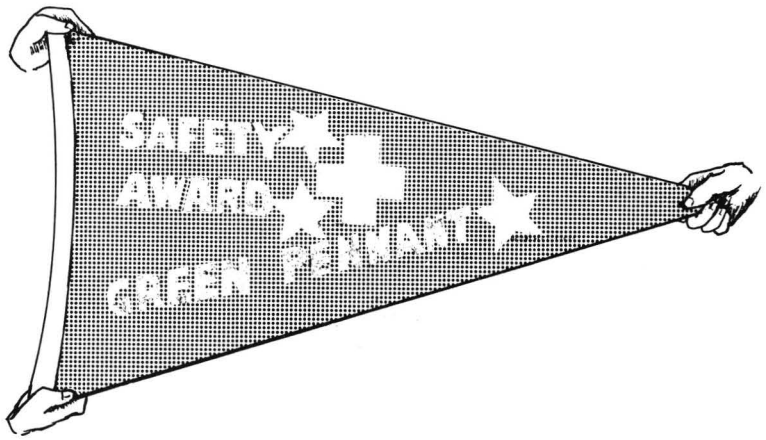
Figure 1-22. Education of Preschool Children Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Preschool children.	Neighborhood near the home or preschool. Areas where child walks or plays.	Adults should be informed of the necessity for preschool child safety. Follow-up training is necessary. Parents and nursery school personnel must be aware of the booklets, which are available through local AAA offices.
Preschool and elementary school children.	Locations accessible to many children.	Should be carefully planned and coordinated with the police department and other affected community groups. A citizen's group may sponsor the program.
Preschool children and their parents.	Neighborhood near the home. Areas where child plays.	Requires advance planning and preparation.
All children, especially those not in school.		A working relationship could be developed with local television stations or filmmakers. It might be useful to set up a special group concerned with safety messages on television. The local AAA office should be contacted about films.

Figure 1-22. Education of Preschool Children Countermeasure Matrix (continued)

Elementary School Children: Sample Educational Programs

- "Officer Friendly" (and similar programs): assembly or classroom programs given by the police or other safety officials. Such programs include talks, films and demonstrations about pedestrian, bicycle, school bus and other safety issues.
- Classroom demonstrations by members of the school safety patrol.
- Safety demonstrations by a magician using safety-related tricks to illustrate the message.
- Safety taught as part of the classroom curriculum. Several curriculum guides for such programs are available (6,7,12,27,32). These guides present numerous and varied approaches:
  - Rote learning of safety slogans or steps for crossing correctly.
  - Classroom lectures and discussions.
  - Use of activity cards or safety kits containing information sheets, quizzes, poster materials and visual aids.
  - Poster Contest: sponsored every year by the AAA and involving children in designing safety posters; can be incorporated into art classes.
  - Safe Route to School Program (discussed in the section "Child Protection").
  - Films, slides, models and simulators. Such materials could be provided through a centralized safety library.
  - Demonstrations or simulations. The results of pedestrian accidents are illustrated through a simulated crash of a vehicle and a safety cone dressed up as a (child) pedestrian.
  - On-site training or field trips to traffic facilities.
- Green Pennant Program: schools with an accident-free year are given a green pennant to put on their flagpole. For each subsequent accident-free year, a gold star is added to the pennant. These awards are highly publicized in the media. Schools that have a child pedestrian accident may not fly their pennant for a month and must remove one gold star. This applies to *any* pedestrian accident involving a child that attends that school.



- Programs to instruct parents.
  - Sending home pedestrian safety literature with school children or in packets sent with birth certificates of newborn babies (2).
  - Involving parents in the Safe Route to School Program.
  - PTA programs on pedestrian safety and on problems brought about by parents when they drive their children to school. Movies can be taken of this behavior and shown to the parents to demonstrate the danger.
- Classes for teachers on safety education included in college courses: requirement that teachers have a safety education course for certification.

Education Materials Available for Elementary School Children (Partial List)

- Pamphlets:*
  - Use Your Eyes: AAA
  - It Pays to Look Well: AAA
  - Run-Down Feeling: AAA
  - Headlights Bright: AAA
  - Parents Can Be Hazards: AAA
  - Play It Safe: National Safety Council
  - Accident Statistics Are People: City of San Jose, California
- Films (Current):*
  - Otto the Auto series: AAA
  - Can You Stop on a Dime? Los Angeles Police Department
  - The Talking Car (K-6): AAA
  - Street Talk (K-3): Ames Films
  - I'm No Fool as a Pedestrian (K-3): Walt Disney
  - WALK/DONT WALK: San Jose (California) Pedestrian Safety Project
  - Rock and Roll with the Safety Patrol: AAA

**Local* AAA clubs should be contacted about the availability of AAA films and pamphlets.

EDUCATION OF ELEMENTARY CHILDREN

	ADVANTAGES	DISADVANTAGES
OFFICER FRIENDLY.	Improves child/police relations. Children learn from an authority figure with experience in the area.	Quality of these programs varies according to the dedication and facilities of individual police departments. Takes police officers from other duties.
DEMONSTRATIONS BY PATROL.	Children learn more readily from their peers. The patrols can speak from experience.	Patrols must be trained to instruct. Patrols will miss their own classes.
EDUCATION WITHIN THE CURRICULUM.	Allows for more detailed follow-up. The subject can be covered more thoroughly. Can be woven into the regular curriculum.	Takes time from other classroom subjects. Teachers must be specially trained in the subject matter.
ROTE LEARNING.	Easy to do. Takes up little time. No special training needed for teacher.	Repetition lessens a child's ability to think for himself (10). Doesn't improve child's attitude to safety (10). Children don't understand their purpose and just go through the motions (10). Only cover simple traffic situations.
LECTURES.	Permit discussion and questions.	Classroom instruction is not as effective as instruction in a safety town situation for teaching children to cross properly at signals (9).
FILMS AND SLIDES.	Effective in teaching children the correct way to cross between parked vehicles (9). More effective way to train children to cross streets than classroom instruction (11).	May be expensive. Require audio-visual equipment.
MODELS AND SIMULATORS.	More effective in teaching children to cross streets safely than classroom instruction (11).	Expensive. Teacher must be trained to use it. Hard to build and operate.
DEMONSTRATIONS AND SIMULATIONS.	Effective in showing children the limitations of automobiles. Can make a vivid impression on children. Parents are enthusiastic about the program. Improve child/police relations.	Takes time from classes and police work, which may lead to school administration objections. Need time and materials to prepare.

Figure 1-23. Education of Elementary Children Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Elementary school children.	School.	Considerations for all education for programs for elementary school students are: – These educational program suggestions are not effective individually. They must be part of a coordinated program. – Effective traffic safety education programs must start early, at the preschool level. – Programs should be integrated and continue from preschool through high school, teaching children about all elements of transportation safety (pedestrian, bicycle, bus, and car). – Follow-up is essential. Children tend to forget what they have learned within several months. – Coordination is necessary in program development, curriculum planning and materials acquisition. Two possible methods of coordination are: – Local safety coordinator. – City, county or state library of safety materials and information. – Programs taking place away from the school (field trips and demonstrations) must provide for the safety of the students going to and while at the site. – Children need training to develop: – An ability to recognize traffic hazards. – Safe walking habits and practices. – Knowledge of why certain pedestrian practices are better than others. – Good attitudes as a pedestrian. – A growing ability to use good judgment and be self-protective. – A foundation of walking attitudes that later on will help develop good driving attitudes.
Elementary school children.	School.	
All school students.	School.	
Elementary school children.	School, at club meetings, and at home.	
All school students.	School and at club meetings.	
All school students.	School and at club meetings.	
All school students.	School and at club meetings.	
All school students.	School and at club meetings.	

Figure 1-23. Education of Elementary Children Countermeasure Matrix (continued)

EDUCATION OF ELEMENTARY CHILDREN

	ADVANTAGES	DISADVANTAGES
ON-SITE FIELD TRIPS.	Children learn by doing. Can increase correct crossing behavior (9). Can teach children to cross well away from parked vehicles (9). Can teach children how to cross correctly at traffic signals (10).	Involve more time than classroom instruction. Additional plans must be made to assure the safety of the children going to and while at the site.
GREEN PENNANT PROGRAM.	Involves the whole school and the community through the media. Publicizes pedestrian safety. Reminds students to act safely at all times, not just on the way to school. Provides motivation for students to act safely. Requires children to think about safety problems and express them.	Requires paperwork. Pennants and stars must be provided.

Figure 1-23. Education of Elementary Children Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Elementary school children.	Signalized intersections or crosswalks near the school.	
Elementary and Jr. High school students.	All schools.	

Figure 1-23. Education of Elementary Children Countermeasure Matrix (continued)

Junior and Senior High School: Sample Educational Programs

- Assemblies on pedestrian safety, including films and speeches, preferably by fellow students.
- Inclusion of data on pedestrian safety in driver education courses.
- Youth Traffic Court: made up of students to discipline fellow students violating safe walking, bicycling or driving regulations. Sentences may be sessions at violator's school and/or essays on traffic safety.
- Film contests.

EDUCATION OF JUNIOR AND SENIOR HIGH SCHOOL STUDENTS

	ADVANTAGES	DISADVANTAGES
ASSEMBLIES.	Reach a large group of students. Don't take much time out of the class schedule.	Are usually too large to permit questions and discussion. Usually have no follow up.
PEDESTRIAN SAFETY IN DRIVER EDUCATION COURSES.	Reaches a large group of students. Allows for questions and discussion. Doesn't take time from other classes. Information is presented in an opportune setting, i.e., students want to learn subject matter so they can get their license. Information is presented by an authority figure. Emphasizes need for drivers to watch out for pedestrians.	Takes time from the driver education curriculum. The teacher may not be enthusiastic about having to cover pedestrians and may present the information badly. Material must be prepared for inclusion in these courses.
YOUTH TRAFFIC COURT.	Peer pressure is very effective.	May present legal problems and in some states be illegal. Needs careful organization and great commitment of police and other law officials.

Figure 1-24. Education of Junior and Senior High School Students Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Junior and Senior High school students.	School and at club meetings.	Considerations for all Junior and Senior High school programs are: – These educational program suggestions are not effective individually. They must be part of a coordinated program. – Effective traffic safety education programs must start early, at the preschool level. – Programs should be integrated and continue from preschool through high school, teaching children about all elements of transportation safety (pedestrian, bicycle, bus, and car). – Follow-up is essential. Children tend to forget what they have learned within several months. – Coordination is necessary in program development, curriculum planning and materials acquisition. Two possible methods of coordination are: – Local safety coordinator. – City, county or state library of safety materials and information.
Senior High school students.	In driver education classes. While student is driving.	
Junior and Senior High school students.		

Figure 1-24. Education of Junior and Senior High School Students Countermeasure Matrix (continued)

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Education of the General Public

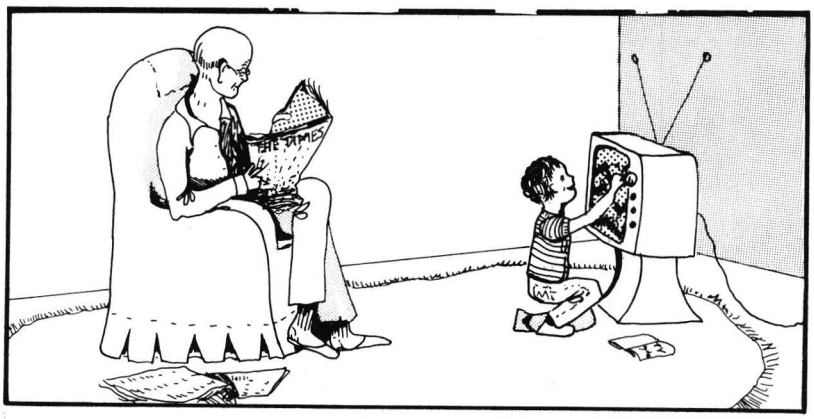
Associated Behavioral and Accident Considerations

- A majority of pedestrian accidents occurring involve a pedestrian who has committed some unsafe act (5).
  - A large percentage of adults involved in accidents appear suddenly in the street (7).
  - People may notice a safety problem, but they are unlikely to do anything about it, out of a feeling that accidents always happen to someone else.
  - Adults are inclined to take high risks by dodging between moving vehicles or by demanding a right-of-way irrespective of the speed and location of approaching vehicles (5).
- Many pedestrians do not know how to act safely in traffic or how to use traffic facilities.
  - About 35 percent of all adult pedestrians accidents occur at traffic signals (3).
- Teaching adults the correct use of roads is difficult because many adults are not psychologically attuned for more education (5).
  - Adults already have a base of safety knowledge. They need reminders and motivational messages.

Examples of Educational Programs

- Talks by police or safety officials to civic groups and special organizations.
  - Showing films of unsafe behavior.
  - Using safety topics in public assemblies.
  - Formation of a speakers bureau that can provide speakers to organizations.
- Community Action Programs: use of community organizations to construct and implement programs tailored to their specific needs.
  - Inclusion of interested community members on pedestrian committees.
- Use of the mass media:
  - Television: news spots explaining new changes; short action clips on safety activities; national programs explaining safety problems and solutions in depth (such as the National Safety Council's National Driver's Test, or National Disaster Survival Test programs).
  - Radio: short news items, public service spot announcements, talk shows to air problems, daily programs giving safety tips and pointing out hazards.

- Newspapers: well-timed press releases on changes or particular problems; pictures; feature stories; accident facts; editorials; articles written on a regular basis by safety personnel or police.



- Local magazines: pictures, articles, feature stories.
- Posters and advertisements in buses; bumper stickers.

- Circulation of literature explaining pedestrian rights and duties, traffic control devices, or relating accident statistics on hazards.
  - Development of special Braille materials for the blind.
- Release of newsletters or Critical Issue papers providing statements on official policies and their rationale to legislators and the media.
- Pedestrian safety lectures in driver education courses; license manuals explaining pedestrian rights, and pedestrian and vehicle limitations.
- Recognition and award ceremonies for safety-related activities.

EDUCATION OF THE GENERAL PUBLIC

VARIETY	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Teaches pedestrians how they can contribute to pedestrian safety by acting safely.	Long-term project. Must be continuous, well planned and coordinated.

Figure 1-25. Education of the General Public Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	

All pedestrians.		– Success of a public information/education program for adults depends on:
		  – Getting the public's attention.
		  – Choosing a simple, well-timed, realistic message appropriate for the target audience.
		  – Providing positive information, giving the pedestrian or driver ideas on what he can specifically do, rather than a list of "don'ts."
		  – A continuing campaign with follow-up and feedback.
		  – Support from law enforcement agencies.
		– The media are important allies. They can help launch new programs by generating public interest and acceptance, give free publicity, and be sponsors.
		– The limitations of the mass media as an educational tool must be considered if they are to be used effectively.
		  – The media cannot produce large behavior changes or sustain them after a campaign is over (4).
		  – The messages of the media in a safety campaign produce small changes in behavior. They more effectively reinforce learned safe behavior (4).
		– To be most effective, mass media presentations should:
		  – Be tied to the local situation and be timely.
		  – Be practical, factual, brief, clear and dramatic.
		  – Reach as many people as possible; for example, through a combination of radio and newspaper messages, or using more than one TV station (2).
		  – If funds are available, the services of an advertising firm may make messages more meaningful and penetrating.
		– Educational programs for adults might include:
		  – Information on the limitations of traffic engineering in preventing accidents, and the necessity for following warrants and making rational safety decisions instead of reacting to public demand based on emotional circumstances or political pressure.
		  – Information on the consequences of violations fines, court costs, possible loss in pay for time in court, parking fees, etc.
		  – Education of motorists about pedestrians safety.
		– Detailed information on organizing a public educational program is available from the American Automobile Association (1).

Figure 1-25. Education of the General Public Countermeasure Matrix (continued)

EDUCATION OF THE GENERAL PUBLIC

	ADVANTAGES	DISADVANTAGES
TALKS TO GROUPS	Reach a large number of people at one time. Allow for group discussion, questions and answers.	Don't reach a large percentage of the total population. Tend to be a one-time thing with no follow-up.
COMMUNITY ACTION GROUPS.	Gets the community involved and interested in pedestrian safety. May provide ideas on the most effective type of message to use.	May have organization and operation problems. Need strong leadership.
TELEVISION.	Reaches a very large audience. Traffic engineering changes and proper behavior patterns can be explained verbally and in pictures. Retention of messages which are both verbal and visual is high.	Members of the media must be carefully briefed and educated about the situation to ensure effective and accurate programs. Television production is very complicated. Can be costly.
RADIO.	Reaches a large audience. Can reach motorists when they are in their cars and may be most receptive to traffic safety messages.	Messages must be limited to short and simple news spots or safety tips.
NEWSPAPERS.	Can explain in words and pictures. Can cover a new development on a continuing basis. Can cover a subject more fully.	Reporters must be carefully briefed and educated on the situation to ensure effective and accurate articles.
POSTERS.	Inexpensive. Can reduce unsafe behavior if they are placed directly where the behavior occurs (4).	Limited ability to affect people's behavior (10).
CIRCULATION OF LITERATURE.	Sending leaflets home with children can bring about small changes in behavior (6). Many pamphlets are available from the local AAA clubs.	There is no guarantee people will read the materials or follow their advice. Many adults cannot read.

Figure 1-25. Education of the General Public Countermeasure Matrix (continued)

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Civic organizations. Clubs. Senior citizens groups.		Informed and willing speakers must be found. Groups must be contacted. A speakers outline or guide should be developed. Pamphlets should be available to hand out.
All pedestrians.		
All pedestrians. Elderly.		Most effective kinds of messages for television are (1): – News spots – Short action clips
All pedestrians. Motorists.		Most appropriate messages for radio are (1): – Short news items – Spot announcements – Talk show items
All pedestrians. Elderly (2).		Most effective messages for newspapers are (1): – Press releases – Pictures – Feature stories – Accident facts – Editorials – Columns
	Locations where unsafe behavior occurs.	
		A method for circulating literature must be determined for greatest efficiency.

Figure 1-25. Education of the General Public Countermeasure Matrix (continued)

Pertinent References – Education of the General Public

1. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
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Education of the Elderly

Associated Behavioral and Accident Considerations

- The elderly account for 70 percent of all pedestrian fatalities and nearly 50 percent of all pedestrian injuries (9).
- In 70 percent of the accidents involving the elderly, the pedestrian was at fault. (3).
- The elderly, as pedestrians, have a higher risk of accidents.
  - Many have never had a driver's license and don't know the limitations of vehicles.
  - They may have one or more of the following physical limitations: reduced vision or hearing, less accurate depth perception, decreased lateral field of vision, slower perception and response, or chronic illness.
  - They have problems understanding traffic control devices (9).
  - They are confused by traffic. Common behaviors range from timidity and fear to brashness and total contempt for traffic (9).

Examples of Educational Programs

- Safety courses made up of several sessions and using films, talks, group discussion and site visits (6).
- Talks to Senior Citizen's groups by police or safety officers at apartment buildings, housing developments or neighborhoods. Slides or films on the problems of the elderly may be used.
- Community Contact Program in which members of Senior Citizen's groups contact other elderly persons and provide them with safety materials.
- Special pamphlets written for the elderly, highlighting their particular problems and specific countermeasures (2).
- Subject areas for any of these forums could include:
  - The general pedestrian problem.
  - Problems of older pedestrians (vision or hearing losses, neuro-muscular deficiencies, alcohol and drugs, and mental or emotional problems).
  - Personal protection activities (behavioral changes, use of retroreflective materials at night).

EDUCATION OF THE ELDERLY

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	May reduce the overly high number of accidents involving elderly pedestrians.	Takes time and planning.
SAFETY COURSES.	Can cover large amounts of material. Allow discussion and questions.	The elderly may have trouble getting to the classes. May be costly.
TALKS.	Allow for discussion and questions. Involve less planning than a course.	Tend to be a one-time presentation with no follow-up.
COMMUNITY CONTACT.	Reach people who might not have any other opportunity to learn about safety. Personal contact.	Involves cooperation and commitment of Senior Citizen's groups.
PAMPHLETS.	Readily available. Inexpensive. Can present information tailored to the needs of the elderly.	Some of the elderly may have trouble reading.

Figure 1-26. Education of the Elderly Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
The elderly.		Education of the elderly should emphasize overcoming their limitations and breaking outdated habits. The elderly should be represented on safety committees. Specific guidelines on older adult pedestrian behavior are available from the local American Automobile Association office (2).
The elderly.	Public places. Senior citizen clubs.	Convenient locations must be found. Materials must be gathered and an instructor trained.
The elderly.	Apartment buildings. Housing developments. Senior citizen clubs.	Materials must be prepared carefully to provide maximum instruction in a short time.
The elderly.	Senior citizen clubs. Homes for the elderly.	
The elderly.		A pamphlet on the problems of elderly pedestrians and possible countermeasures has been published by the AAA (2). The locality may want to produce a pamphlet specifically identifying local problems and hazards.

Figure 1-26. Education of the Elderly Countermeasure Matrix (continued)

Pertinent References – Education of the Elderly

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2. American Automobile Association. *Older Adult Pedestrian Safety.* Washington, DC: American Automobile Association, 1965.
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9. Wiener, E.L. Why does a pedestrian cross the street? *Medicine, Science and the Law,* July 1967, 7(3), 117-122.

ENFORCEMENT

ENFORCEMENT

Enforcement

Definition

Programs aimed at encouraging obedience to pedestrian laws and pedestrian vehicle laws.

Associated Behavioral and Accident Data

- A large majority of pedestrian accidents are caused by the pedestrian's unsafe walking habits (2).
  - The most common violators are the young and the elderly -- the two groups overrepresented in accidents (2).
- There are conflicting views on the effectiveness of enforcement in increasing pedestrian safety.
  - There are no quantitative studies showing a reduction of pedestrian accidents in urban areas where there is a high level of pedestrian law enforcement (4,8).
  - There are also no quantitative studies which indicate that pedestrian law enforcement does not reduce accident rates.
- The majority of reprimanded or ticketed pedestrians will violate the law again at the first opportunity (11,12).
- Many motorists do not know pedestrian rights and laws.
- Safety officials in many cities consider enforcement to be one of the most important pedestrian countermeasures (9).
- 50 to 75 percent of fatal or severe injury accidents (vehicular and pedestrian) involve drivers who have been drinking (10).

ENFORCEMENT

	ADVANTAGES	DISADVANTAGES
PEDESTRIAN.	Enforcement campaigns can substantially reduce unlawful behavior (11). Cities with effective enforcement programs have shown the greatest reduction in pedestrian fatalities (13). Forces the pedestrian to exercise more care. Can help eliminate conflicts between pedestrians and motorists (1).	There is no quantitative data showing it reduces accidents. Violation behavior tends to be a habit and, therefore, is difficult to break (1,3). The effects of enforcement campaigns have been shown to be short lived. The campaign must be periodically reinforced (11). Possible lack of support from police patrols because: – It's poor public relations – Lack of government and police department policy – Courts don't back up pedestrian enforcement. Requires manpower.
MOTORIST.	Violation sentences or fines are stricter than those for pedestrians. Can take some of the dangerous drivers off the road. Motorist enforcement is already in effect and is understood by motorists.	Requires manpower and vehicles.

Figure 1-27. Enforcement Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Pedestrian law violators.	High hazard locations. Locations with high pedestrian and vehicle volumes. Locations with high accident rates.	Laws must be sensible, fair, clear, adequate for their purpose, and enforcable. Enforcement should go hand in hand with an education program. Laws must be made known to the public. Enforcement must be consistent, uniform, and long-term. Police should be briefed regularly on the pedestrian problem. Files should be kept on violators (1). Suitably strict sentences must be given, based on the severity of the behavior. Support of the courts in upholding citations is necessary. A peer group, citizen's arrest program may be effective. Required attendance at safety schools for flagrant and frequent violators is helpful. If a complete enforcement program is not feasible, selective enforcement at dangerous locations or at hazardous times of the day should be considered.
Motorist violators of pedestrian-related laws.	Locations with high accident rates. High hazard locations.	

Figure 1-27. Enforcement Countermeasure Matrix (continued)

Pertinent References – Enforcement

1. American Automobile Association. *Manual on Pedestrian Safety*. Washington, DC: American Automobile Association, 1964.
2. Crinion, J.D. As assessment of measures to reduce pedestrian accidents. *Papers Presented at the National Road Safety Symposium,* Canberra, Australia, March 1972. Canberra: Australian Government Publishing Service, 1972, 138-149.
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11. Wiener, E.L. The elderly pedestrian: Response to an enforcement campaign. *Traffic Safety,* December 1968, *12*(4), 100-110.
12. Wiener, E.L. Why does a pedestrian cross the street? *Medicine, Science and the Law,* July 1967. *7*(3), 117-122.
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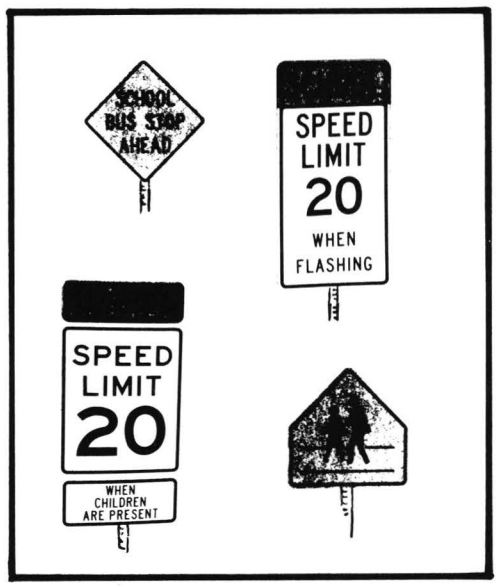
CHILD PROTECTION

Crossing guards



Warning signs

Safe route to school

General Considerations for Child Protection

Associated Accident Data

- 40-45 percent of all pedestrian casualties in the United States are children (9).
- Nearly 80 percent of all child pedestrian accidents are precipitated by unsafe or illegal actions by the child (3).
  - Most child pedestrian accidents are of the dart-out type and occur at nonintersections (7,8,14).
- Almost 75 percent of the pedestrian accidents involving children occur in residential areas at *other* than intersections (7,8).
- Few accidents involve children on their way to or from school; the majority occur near the child's home between 2 p.m. and 6 p.m. (7,8,10).
- Children in accidents come from homes with less parental supervision and fewer play facilities (10).

Associated Behavioral Data

- Dart-out behaviors are exhibited by children from preschool to age thirteen, although they are less frequent with the older age groups (1).
- Children can be expected to do the unexpected in a traffic situation.
- Young children show the following forms of intellectual or physical immaturity:
  - Limited ability to deal with more than one thing at a time – improvable through training (4,12).
  - Limited capability to judge vehicle velocity, distance, and safe gaps (11).
  - Inability to properly understand signs, many traffic terms, and signals; (a large number of children would cross on a red light) (10,13).
  - Problems with sound localization and direction judgment (13).
  - Limited peripheral vision (13).
  - Greater difficulty to see over cars, and also to be seen, because of their smaller size.
- Drivers and children do not understand each other's behavior.
  - Drivers believe children will always stop and give cars the right of way (12,14).
  - Children think adults will always be kind to them and that vehicles are capable of stopping instantly (13).
- A majority of children, whether walking or running, do *not* come to a complete stop before entering a street (6).
- Children should not be "overprotected" through overuse of pedestrian facilities. They need to learn how to cross safely at areas where there are no special facilities (1,15).
- Parents should be encouraged to involve themselves in child safety through better supervision and by setting a good example (2).
- Warrants should be established and used to determine the type of countermeasures to use along a school route (patrols, adult guards, signals, police).

Pertinent References – General Considerations for Child Protection

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15. Yaksich, S., Jr. The pedestrian's role in traffic control. Paper presented at the Tenth Pan American Highway Congress, Montevideo, Uruguay, February 1967.

Preschool Child Safety Countermeasures

Definition

Countermeasures for children aged two to six.

Associated Behavioral and Accident Data

- The majority of preschool child pedestrian accidents occur at midblock when children run into the street (5,6).
- Young children show immature behavior in traffic, have little understanding of safety devices, have limited peripheral vision and ability to localize sounds, and have limited coordination (7).
- If young children have no other play areas or backyards, they will play in the street.

Varieties of Countermeasures

- Supervision:
  - The key to preschoolers' safety is parental or adult supervision while children are playing or walking near the street (2).
  - Parents should set a good example by walking safely.
  - Children must be carefully supervised while crossing streets with an adult, as they do not pay attention to crossing safety when with an adult (4).
- Provision of play areas in backyards or in the neighborhood.
  - Development of play and recreation areas in congested high accident areas has significantly reduced accidents (3).
- Improvement of visibility of small children.
  - Dressing them in bright, contrasting colors in the day and garments with retroreflective material at night.
  - Removal of trees and shrubs that obscure children from a driver's view.
  - Use of noncontiguous sidewalks (separated from the roadway) with an area between the curb and sidewalks.
  - Prohibition of street parking.
- Warning drivers of the presence of small children through the use of approved signing methods.
- Regulation of vehicle speeds.

Pertinent References – Preschool Child Safety Countermeasures

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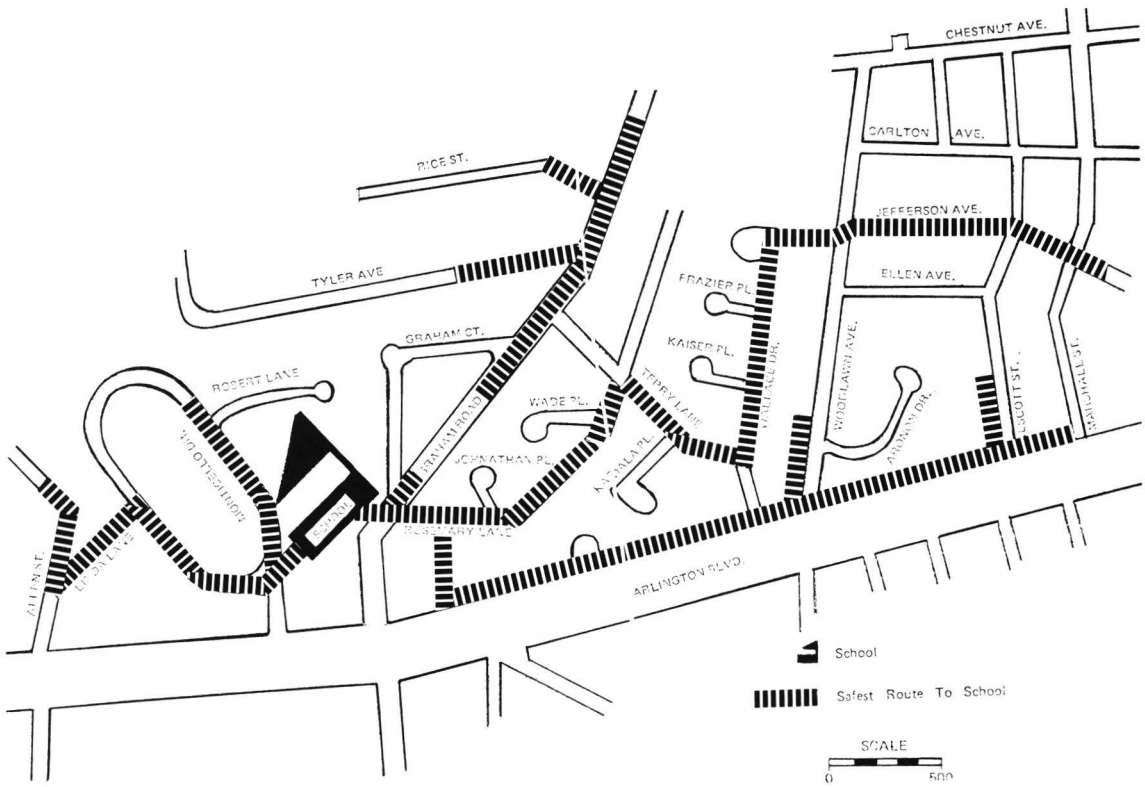
Safe Route to School Program

Definition

A program that establishes, organizes, and operates safe routes for children to use when travelling between home and school. Simple maps are drawn up showing streets, the school, and the suggested route.

Associated Behavioral and Accident Data

- During the first two years of school (ages 5-6), a child's accident risk rises (1).
- The Safe Route to School Program can involve children in planning their own routes and gives them a safe route to take, stressing hazards and proper crossing practices (3).



SAFE ROUTE TO SCHOOL PROGRAM

	ADVANTAGES	DISADVANTAGES
IN GENERAL	Identifies the safest route for children to follow between home and school. Teaches children about hazards and safe walking practices. May foster improved school/community cooperation. Provides for the most effective use of protective measures such as traffic control devices, adult crossing guards and school patrols (8). Provides a basis for engineering studies of traffic control needs (8). Indicates priorities for sidewalk construction (8).	Involves extensive planning and ongoing commitment. It may be difficult to get teachers, parents and the community interested and involved. Expensive; must be continually updated. The safest routes are not always the shortest. Children prefer the shortest routes and use shortcuts (5).

Figure 1-28. Safe Route to School Program Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
School children, especially those in the lower grades.	School areas where children walk to school.	It is absolutely necessary to have community and school support. Parents should play a large role in school route planning as children will follow routes prescribed by their parents (7). Parents should walk the route with their child. The program must be maintained through review of routes and possible replanning. The traffic engineering department should study the routes to see if changes are needed. Routes may be marked by use of marked crosswalks. Additional data on the steps and criteria for planning a safe-route program are available (2, 6, 8).

Figure 1-28. Safe Route to School Program Countermeasure Matrix (continued)

Pertinent References – Safe Route to School Program

1. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
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3. American Automobile Association. *The Young Pedestrian.* Washington, DC: American Automobile Association, 1965.
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School Bus Routing and Patrols

Definitions

- School Bus Routing: determination of safe and efficient school bus routes and stops.
- School Bus Patrols: student patrols trained to maintain order on buses and at bus stops.

Associated Behavioral and Accident Data

- Up to 65 percent of fatal accidents involving school buses also involved young pedestrians approaching or leaving a loading zone (4).
- School bus mirrors have not been found adequate in preventing some accidents involving the bus and discharged passengers (3).
- Bus Patrols are helpful in maintaining order, and preventing accidents to riders on buses and those crossing roadways (1) .

SCHOOL BUS ROUTING AND PATROLS

	ADVANTAGES	DISADVANTAGES
ROUTING.	Provides safe, efficient and economical bus routes (4). May reduce accidents involving school buses and child pedestrians (4). Helps determine the hazards at or on the way to bus stops (4). Bus routing is already done at some level in all communities.	Expensive.
PATROLS.	Maintain order at bus stops and on buses. Help children safely cross streets at bus stops. Can be tied in to the crossing guard program. Make sure children are away from the bus before it starts. Help children learn safe bus passenger behavior.	Parents may be reluctant to allow their child to be a patrol. Need special training.

Figure 1-29. School Bus Routing and Patrols Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
School bus passengers.	Areas where safety or distance require busing of children to school.	Routes should be planned to reduce the need for children to cross major streets or unsignalized intersections on their way to or from a bus stop (2). School bus routing involves (4): — Determination of transportation needs — Preparation of a school district map — Determination of hazardous locations — Development of routes and schedules — Continual reevaluation and modification.
School bus passengers.	On school buses.	The school bus patrol program can be part of the crossing patrol program. (See the section on "School Crossing Guards.") Details on school bus patrols are available from the AAA (1). Contact the local AAA office.

Figure 1-29. School Bus Routing and Patrols Countermeasure Matrix (continued)

Pertinent References – School Bus Routing and Patrols

1. American Automobile Association. *School Bus Patrols.* Washington, DC: American Automobile Association, 1942.
2. National Highway Traffic Safety Administration. *Highway Safety Program Manual. Volume 14. Pedestrian Safety.* Washington, DC: U.S. Government Printing Office, November 1974.
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School Crossing Guards

Definition

Trained parents, police, or older children who instruct, direct, and control students at street crossings.

Associated Behavioral and Accident Data

- During the first two years (ages 5-6) of school, a child's degree of risk and accident frequency rises (3).
- Very few accidents occur at school crossings (3).
- Communities with student or adult guards have reported large decreases in elementary school child accidents (2,3,8).
- Children tend to obey an authority figure.

Varieties of Crossing Guards

- Student Patrols: trained boys and girls who control other children and choose safe gaps in vehicle traffic during which they can cross; or who control children at bus stops. They are often appointed on the basis of scholastic merit. (School Bus Patrols are discussed in the section "School Bus Routing and Patrols.")
- Adult Crossing Guards: paid, uniformed community members, often retirees or housewives, trained to stop traffic, if necessary, to help children across streets.
- Police Guards: members of the police department who stop traffic to allow school children to cross.

SCHOOL CROSSING GUARDS

	ADVANTAGES	DISADVANTAGES
IN GENERAL.	Can substantially reduce school crossing accidents. High user compliance. Children feel safer at intersections with guards (7). A majority of drivers notice guards (7). Help children learn safe behavior by enforcing it.	Possible organizational problems. Guards must be trained and supervised; without proper training, they may encourage improper behavior.
STUDENT PATROLS.	Children controlled by patrols can develop a keen road sense (5). Help children develop a sense of responsibility and self-reliance (5). Children are eager to belong if being a patrol member is regarded as an honor. Cost-effective. Peer pressure is a strong incentive for correct behavior.	Possible organizational and (class) scheduling problems. Patrol members miss classes. Require extensive planning, coordination and training. Incentive must be provided to patrols.
ADULT CROSSING GUARDS.	Can stop the traffic to allow children to cross. Can instruct young children in safe walking habits.	Must be paid. Possible conflict over jurisdiction or organization required to pay salaries. Require training and supervision. Potential insurance liability problems. Uniforms must be provided. Possible reliability or absenteeism problems. Recruitment problems.
POLICE GUARDS.	Can stop the traffic to allow children to cross. Are more highly respected than other guards. Improve police/child relations. Already have training in traffic control.	Expensive. Takes officers away from other duties.

Figure 1-30. School Crossing Guards Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
School children.	School crossings with small vehicle gaps and high vehicle speeds. Locations with limited sight distance. Locations with high volumes of turning traffic. Arterials with high volumes of pedestrians.	A successful student or adult guard program requires the cooperation and authorization of the schools, the community and the police department. Media coverage draws attention to pedestrian safety and the existence of school crossing guards. Crosswalks should be marked at controlled intersections to mark the preferred route. Sources of detailed plans for school patrol or adult guard organization are the Institute of Traffic Engineers and the AAA (1, 2, 6).
School children.	Crossings near schools with natural gaps in traffic. School bus stops.	A school official or teacher should be responsible for operation of the student patrol. Civic and service organizations may provide support, funds, or uniforms if asked. A method for appointing patrols must be developed. Scholastic standing may not be the best determinant of a child's ability to be a good patrol.
School children.	Locations with few safe gaps in vehicle traffic. Areas needing additional protection.	The police department should be responsible for adult guards and police guards.
School children.	Locations with few safe gaps in vehicle traffic. Hazardous locations. In emergency situations.	

Figure 1-30. School Crossing Guards Countermeasure Matrix (continued)

Pertinent References – Crossing Guards

1. American Automobile Association. *Adult School Crossing Guards: A Guide to Selection, Training and Warrants for Operation.* Washington, DC: American Automobile Association, n.d.
2. American Automobile Association. *Handbook: How to Organize and Supervise a School Safety Patrol.* Washington, DC: American Automobile Association, 1966.
3. American Automobile Association. *Manual on Pedestrian Safety.* Washington, DC: American Automobile Association, 1964.
4. American Automobile Association. *School Bus Patrols.* Washington, DC: American Automobile Association, 1965.
5. Crinion, J.D. An assessment of measures to reduce pedestrian accidents. *Papers Presented at the National Road Safety Symposium,* Canberra, Australia, March 1972. Canberra: Australian Government Publishing Service, 1972, 138-149.
6. Institute of Traffic Engineers. *A Program for School Crossing Protection.* Washington, DC: Institute of Traffic Engineers, 1971.
7. Shinder, A., Robertson, H., & Reiss, M. School trip safety and urban play areas. Volume V: Guidelines for the development of safe walking trips and school maps. Prepared by BioTechnology, Inc., for the Federal Highway Administration, November 1975.
8. Vallette, G.R., & McDivitt, J.A. Model pedestrian safety program. Interim report. Volume II: Review of operational experience. Prepared by BioTechnology, Inc., for the Federal Highway Administration, March 1977.
9. Walton, G.T. School crossing guard index. *ITE Technical Notes,* March 1977, *2*(1), 13-14.
10. Washington State Superintendent of Public Instruction. Safety patrol manual. Washington State Superintendent of Public Instruction, Olympia, 1974.

Play Streets

Definition

Residential streets, usually in high density urban environments, closed to through traffic during specified hours in the summer to permit a supervised or general program of recreational activities to take place.

Associated Behavioral and Accident Data

- Children playing in urban streets are the most highly represented group in pedestrian accident statistics (3).
- The major cause of child pedestrian accidents is the child darting-out into the street (3).
- The majority of accidents involving children occur in residential areas, near the child's home (1).
- Children involved in accidents tend to live in areas with few play facilities (4).
- Development of play and recreation areas in congested, high accident areas has significantly reduced the frequency of child pedestrian accidents (2).

PLAY STREETS

	ADVANTAGES	DISADVANTAGES
IN GENERAL	Completely separate children from vehicular traffic. Can reduce accidents involving children playing in or darting out into the street (4). Inexpensive compared to the alternatives (parks and playgrounds). Provide safe places for children to play.	Reduce available parking space. Vehicle circulation is reduced. Adult commitment and time is needed. Official city approval is required.

Figure 1-31. Play Streets Countermeasure Matrix

TARGETS		IMPLEMENTATION CONSIDERATIONS
PEOPLE	LOCATIONS	
Children.	Streets in which children are already playing. One-way streets. Residential areas.	*Successful* play streets have (5): – Community support and a continuation of community activities at times when the street is open to traffic. – A sponsoring organization (Police, Recreation Departments). – A majority of residents in favor of the play street. – Commitment from adults to supervise the play street. Streets can be marked for games and equipment provided for group games. The streets may be closed using police barricades, strings and signs, or signs alone. (More information can be found in the section "Barriers.") Further information on play streets and their design is available from the U. S. Federal Highway Administration (4, 5).

Figure 1-31. Play Streets Countermeasure Matrix (continued)

Pertinent References – Play Streets

1. American Automobile Association. *Manual on Pedestrian Safety*. Washington, DC: American Automobile Association, 1964.
2. Bartholomew, W.M. Pedestrian accidents in service areas of selected city recreation facilities. *Traffic Safety Research Review,* December 1967, *11*(4), 117-120.
3. Knoblauch, R.L. Urban pedestrian accident countermeasures experimental evaluation. Volume II: Accident studies. Prepared by BioTechnology, Inc., for the National Highway Traffic Safety Administration and Federal Highway Administration, February 1975.
4. Reiss, M.L., & Shinder, A.E. School trip safety and urban play areas. Volume III: A survey of the characteristics of the urban play street. Prepared by BioTechnology, Inc., for the Federal Highway Administration, November 1975.
5. Reiss, M.L., & Shinder, A.E. School trip safety and urban play areas. Volume VII: Guidelines for the creation and operation of urban play streets. Prepared by BioTechnology, Inc., for the Federal Highway Administration, November 1975.

Other Countermeasures for School Children

Parking Prohibitions

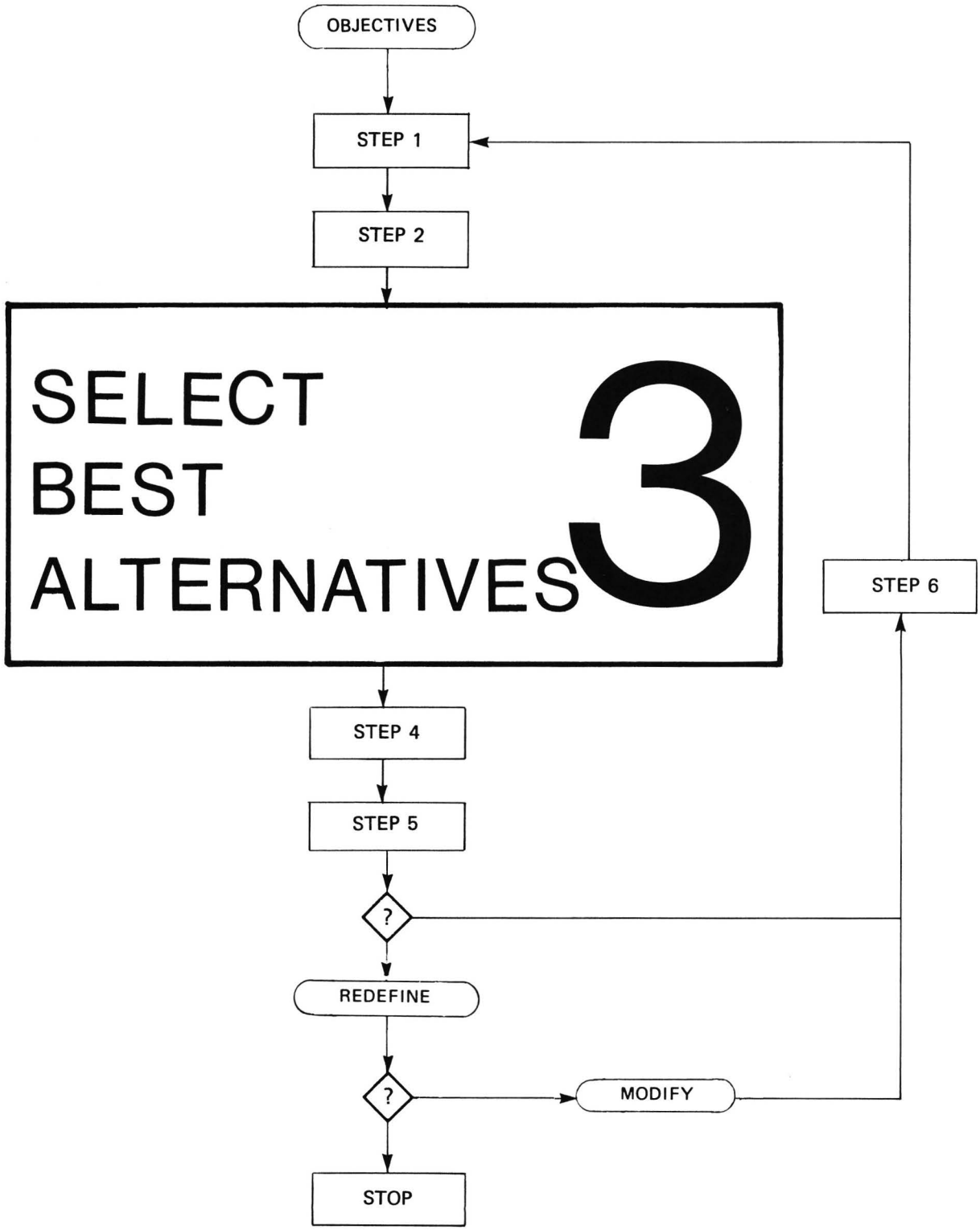
Prohibition of parking near intersections and on the school side of streets adjacent to the school during school trip hours.

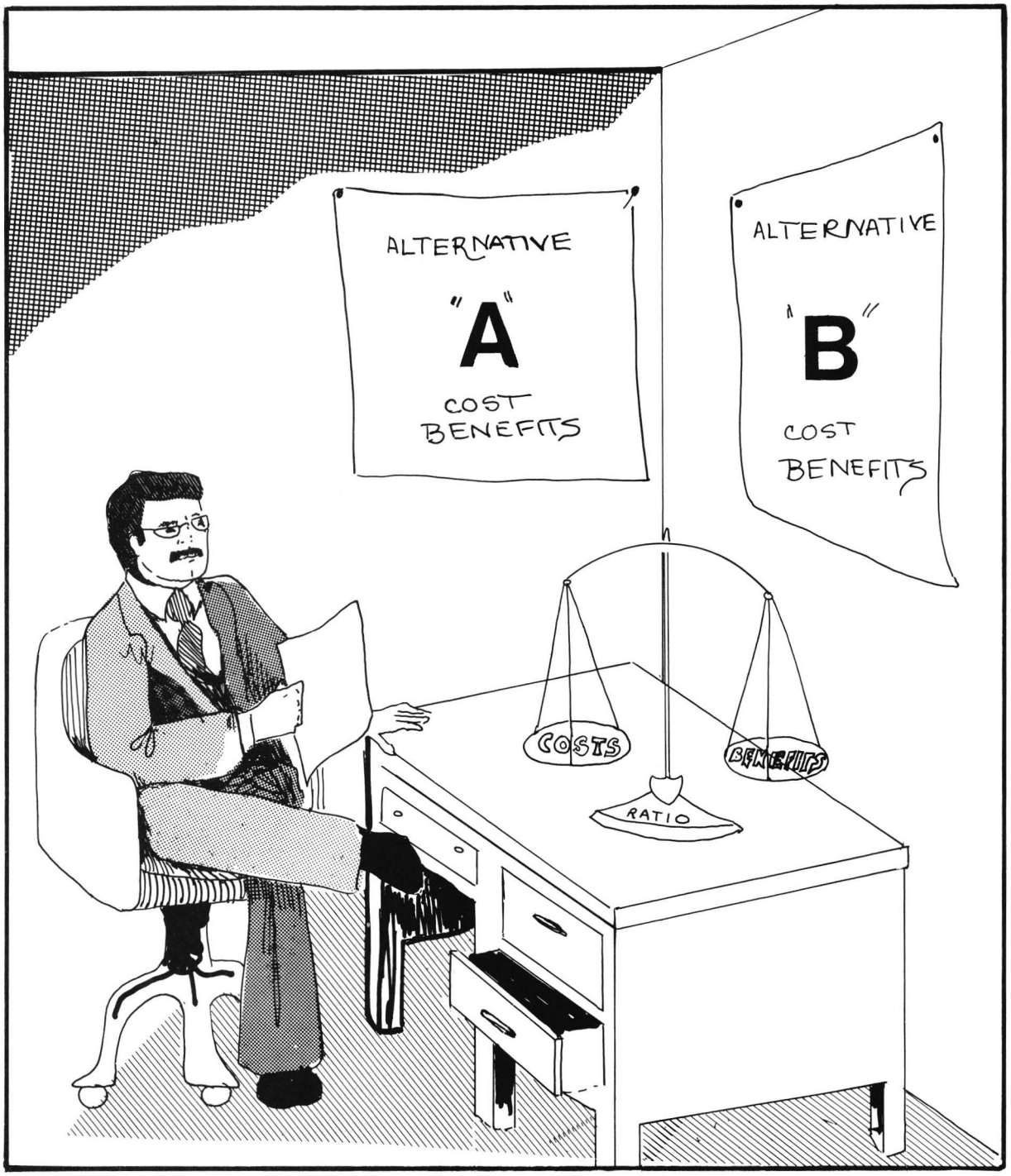
- School parking and loading facilities must be provided for parents and school buses.
- Parents must be educated to drive and park safely near schools (see "Education of Children").

School Site Selection

Selection of new school sites should include assistance from planners, traffic engineers, and police, and must consider loading, parking, and child pedestrian safety.

- Consider off-street parking.
- Design should emphasize safe access and circulation of pedestrians.


OBJECTIVES
STEP 1
STEP 2
SELECT BEST ALTERNATIVES
3
STEP 6
STEP 4
STEP 5
?
REDEFINE
?
MODIFY
STOP



BENEFIT - COST

STEP 3: SELECT THE BEST ALTERNATIVE (BENEFIT-COST ANALYSIS)

Step 1 of this Pedestrian Safety Program described procedures to help identify problems in terms of behavioral and accident types. Step 2 listed numerous countermeasures known to be effective against particular safety problems. From these two steps you have identified one or more countermeasures which may solve a particular problem or problem area. The next step is to select that countermeasure which will yield the highest anticipated benefits for the lowest anticipated costs (Benefit-Cost Analysis).

The term Benefit-Cost Analysis refers to methods which measure the anticipated impacts of proposed courses of action in quantifiable terms. Both benefits and costs are assigned values. Often, although it is certainly not required, these values are stated in monetary units.

The relationship between benefits and costs can be expressed as a ratio:

$$\rho = \frac{B}{C}$$

where

B = the present value of all expected benefits (e.g., pedestrian accident rate or severity reduction).

C = the present value of all expected costs (e.g. implementation, operation costs, vehicle delay).

The result of this analysis will identify that alternative giving the greatest total benefit for the least total cost – the alternative with the largest Benefit-Cost Ratio.

Background

Historically, Benefit-Cost Analysis and its related proecdures (Cost Effectiveness, Cost-Benefit, etc.) have met with considerable controversy. One primary problem area pertains to what are the best units of measurement of the various benefits and costs.* Most costs can be described in monetary values (e.g. construction costs, manpower requirements, gasoline costs of vehicle delay). However, there are additional "costs" that cannot be easily expressed in terms of dollars (e.g. time delays, environmental costs). Table 3-1 lists likely cost variables, and their common measurement units, which can be incurred during the installation and operation of pedestrian facilities.

*Benefit-Cost Analyses are most meaningful if the total costs and total benefits are described using the same terminology. That way, comparisons can be more readily seen.

Table 3-1

Sample Categories of Costs Incurred
in Pedestrian Facility Installation and Operation

Cost Categories	Unit of Measurement
Design costs	Dollars
Construction costs (including manpower)	Dollars
Annual maintenance and operating costs	Dollars
Vehicle delay	Dollars
Vehicle delay	Time
Pedestrian delay	Time
Implementation	Time
Ecological costs	
Air pollution	Parts per million
Noise pollution	Decibels
Visual pollution	Subjective
Cost of an Accident	Dollars

The problem is even more severe in identifying benefits. Very few of the potential benefit variables (see Table 3-2) are readily quantifiable, let alone in monetary terms. One of the greatest problems in highway safety Benefit-Cost Analysis is in determining a valid and legitimate monetary value of a human life in a fatal accident, or a particular injury level in a nonfatal accident.

Table 3-2

Sample Categories of Benefits Received
from Pedestrian Facility Installation and Operation

Benefit Category	Unit of Measurement
Accident frequency reduction	Numerical
Accident severity reduction	Numerical
Facility life expectancy	Time
Vehicle delay reduction	Dollars
Vehicle delay reduction	Time
Pedestrian delay reduction	Time
Economic impact	Dollars
Social impact	Subjective
Convenience	Subjective
Ecological impacts	
Air pollution reduction	Parts per million
Noise pollution reduction	Decibels
Aesthetic impact	Subjective

To combat this problem, Step 3 describes a variation of Benefit-Cost Analysis, different from traditional analyses in that monetary values are not directly used in the comparison. Instead, a "Value Rating," based on the local situation, is assigned to each cost and benefit variable.

Value Rating System Method

The methodology of the Value Rating System is a six-step process. Two additional analysis options can also be used if warranted.

Step A: List all cost and all benefit variables for the alternatives under consideration.

Step B: Determine realistic ranges for each of the cost and benefit variables.

Step C: Convert the anticipated outcome level (expected cost or benefit) of each variable of each alternative to a Value Rating using the appropriate Value Rating scale. Sum the cost and benefit Value Ratings for each alternative.

Step D: Determine each alternative's Benefit-Cost Ratio.

Step E: Consider constraints (goals and limitations).

Step F: Select alternative(s) meeting these constraints.

Analysis Option 1: Sensitivity Analysis.

Analysis Option 2: Variable Priority Weighting.

To facilitate the understanding of this method, the explanation will be made through an example. In this example, four possible actions (Alternatives A, B, C and D) have been identified that are relevant to some problem. *Note that the numerical values and ranges used in this example are arbitrary and are examples only.*

- Step A: List all cost and all benefit variables for the alternatives under consideration.

Tables 3-1 and 3-2 listed some of the possible cost and benefit variables which relate to pedestrian facility installation and operation. Of course, not all of the variables will be applicable to every alternative. Likewise, additional variables not listed can be considered for other problem alternatives. The variables identified here are examples, and you should expand or edit the list according to your own locality's situation.

- Step B: Determine realistic ranges for each of the cost and benefit variables.

The process of evaluation in the Value Rating System converts the anticipated level of a cost or benefit variable to a "neutral" number. Because this outcome amount (e.g. Construction Cost) will vary between alternatives, a range of possibilities for each variable should be identified. In this example, Alternative A will cost $10,000 to construct, Alternative B $1000, and Alternative C $20,000. Alternative D, the "Take No Action' Alternative, would have no cost. Therefore, the range for the variable "Construction Cost" could be from less than $1000 (<$1000) to greater than $25,000.

Similarly, a range for each benefit variable should be listed. For example, Life Expectancy of an installed countermeasure may range from <2 years to 20+ years.

The Value Ratings for each variable are determined by a point scale from 0-100. Tables 3-3 (Costs) and 3-4 (Benefits) illustrate the listing of the variable ranges. The 0-100 Value Rating Scale is at the left of each table. Because some of the variables are not commonly evaluated in numerical terms, the 100-point scale is supplemented by a five-division subjective "Poor-Excellent" scale. Thus, nonnumerical variables such as Visual Pollution, can be assigned a Value Rating based on its subjective evaluation (e.g. Poor, or Much additional Visual Pollution resulting from a countermeasure's installation, equals 10 points).

- Step C: Convert the anticipated outcome level (expected cost or benefit) of each variable of each alternative to a Value Rating using the appropriate scale. Determine the Total Cost Value Rating and Total Benefit Value Rating for each alternative.

Once the range has been established for each cost and benefit variable, the anticipated levels of each variable for each alternative can be converted to Value Ratings. Table 3-5 gives example cost and benefit levels for the four alternatives. Using Tables 3-3 and 3-4, these benefits and costs are converted to the Value Ratings shown in Table 3-6.

The Total Benefit Value Rating for a particular alternative is determined by adding the Value Ratings of the individual benefit variables for that alternative and dividing by the number of variables. That is:

$$B = \frac{V_1+V_2+V_3+\ldots}{N}$$

where

B = Total Benefit Value Rating for that alternative
$V_1, V_2 \ldots$ = Individual Value Ratings for the benefit variables
N = Number of benefit variables considered for that alternative

Table 3-3

Value Rating of Pedestrian Facility Costs*

Value Rating Scale / Cost Variables	Design Costs ($)	Construction Costs ($)	Annual Maintenance & Operation Costs ($)	Implement. Time (Mo.)	% Increase Total Vehicle Delay	% Increase Total Pedestrian Delay	Increase Visual Pollution	% Increase Noise Pollution	% Increase Air Pollution
0	5000+	25,000+	2000+	10+	10+	10+		10+	10+
10 Poor (10) (Much)	4500	22,500	1800	9	9	9	P (Much)	9	9
20	4000	20,000	1600	8	8	8		8	8
30 Fair (30)	3500	17,500	1400	7	7	7	F	7	7
40	3000	15,000	1200	6	6	6		6	6
50 Average (50)	2500	12,500	1000	5	5	5	A	5	5
60	2000	10,000	800	4	4	4		4	4
70 Good (70)	1500	7,500	600	3	3	3	G	3	3
80	1000	5,000	400	2	2	2		2	2
90 Excellent (90) (None)	500	2,500	200	1	1	1	E (None)	1	1
100	< 500	< 2500	< 200	< 1	< 1	< 1		< 1	< 1

*NOTE: The numerical values and ranges for each variable and in each cell of the table are arbitrary and are example values only. Each locality should list variables and ranges appropriate to its own situation.

Table 3-4

Value Rating of Pedestrian Facility Benefits*

Value Rating Scale / Benefit Variables	% Acc. Reduction (Total)	% Acc. Reduction (Fatals)	% Decrease in Injury Severity	Life (yrs.) Expectancy	Economic Impact	Social Impact	Implement. Time (Mo.)	Resultant Flow Level of Service	Aesthetic Value	% Dec. Vehicle Delay (Total)	% Dec. Ped. Delay (Total)	% Dec. Noise Pollution
0	<5	<5	<5	<2			10+			<2	<2	<5
10 — Poor (10) (Low)	5	5	5	2	P	P	9	P	P	2	2	7
20	10	10	10	4			8			4	4	9
30 — Fair (30) (Low-Average)	15	15	15	6	F	F	7	F	F	6	6	11
40	20	20	20	8			6			8	8	13
50 — Average (50) (Average)	25	25	25	10	A	A	5	A	A	10	10	15
60	30	30	30	12			4			12	12	17
70 — Good (70) (High-Average)	35	35	35	14	G	G	3	G	G	14	14	19
80	40	40	40	16			2			16	16	21
90 — Excellent (90) (High)	45	45	45	18	E	E	1	E	E	18	18	23
100	50+	50+	50+	20+			<1			20+	20+	25+

*NOTE: The numerical values and ranges for each variable and in each cell of the table are arbitrary and are *example values only*. Each locality should list variables and ranges appropriate to its own situation.

Table 3-5

Example: Benefits and Costs of Four Action Alternatives

Benefits	Alternative A	Alternative B	Alternative C	Alternative D
Accident Reduction	15%	20%	45%	0%
Fatality Reduction	10%	25%	45%	0%
Injury Severity Reduction	20%	15%	30%	0%
Life Expectancy	3 Yr.	6 Yr.	10 Yr.	N/A
Economic Impact	N/A	N/A	High	N/A
Social Impact	Average	Average	High	High
Implementation	4 Mo.	5 Mo.	10 + Mo.	N/A
Level of Service	Low Average	Average	Low Average	Average
Aesthetic Value	Low Average	Low	High	High
Vehicle Delay Decrease	N/A	N/A	N/A	0%
Pedestrian Delay Decrease	N/A	N/A	N/A	0%
Noise Pollution Reduction	7%	N/A	15%	N/A
Costs				
Design Cost	$2000	$400	$5000	$0
Construction	$10,000	$1000	$20,000	$0
Maintenance	$1000	$2100	$600	$300
Implementation	4 Mo.	5 Mo.	10 + Mo.	N/A
Vehicle Delay Increase	2%	2%	5%	0%
Pedestrian Delay Increase	1%	1%	3%	0%
Visual Pollution Increase	A (Average)	E (None)	E (None)	E (None)
Noise Pollution Increase	N/A	2%	N/A	N/A
Air Pollution Increase	N/A	N/A	N/A	N/A

Table 3-6

Example: Value Ratings of Four Action Alternatives

Benefits	Alternative A	Alternative B	Alternative C	Alternative D
Accident Reduction	30	40	90	0
Fatality Reduction	20	50	90	0
Injury Severity Reduction	40	30	60	0
Life Expectancy	15	30	50	–
Economic Impact	–	–	90	–
Social Impact	50	50	90	90
Implementation	60	50	0	–
Level of Service	30	50	30	50
Aesthetic Value	30	10	90	90
Vehicle Delay Decrease	–	–	–	0
Pedestrian Delay Decrease	–	–	–	0
Noise Pollution Reduction	10	–	50	–
Total	285 (N=9)	310 (N=8)	640 (N=10)	230 (N=8)
Costs				
Design Costs	60	100	0	100
Construction	60	100	20	100
Maintenance	50	10	70	85
Implementation	60	50	0	–
Vehicle Delay Increase	80	80	50	100
Pedestrian Delay Increase	90	90	70	100
Visual Pollution Increase	50	90	90	90
Noise Pollution Increase	–	80	–	–
Air Pollution Increase	–	–	–	–
Total	450 (N=7)	600 (N=8)	300 (N=7)	575 (N=6)

Similarly, the Total Cost Value Rating for a particular alternative is obtained by adding the individual cost variables' Value Ratings and dividing by the number of variables:

$$C = \frac{V_1 + V_2 + V_3 + \ldots}{N}$$

where:

C	=	Total Cost Value Rating for that alternative
$V_1, V_2 \ldots$	=	Individual Value Ratings for the cost variables
N	=	Number of cost variables considered for that alternative

For the four alternatives in this example, the Total Cost and Total Benefit Value Ratings are:

	Benefits	Costs
Alternative A	$\frac{285}{9} = 31.7$	$\frac{450}{7} = 64.3$
Alternative B	$\frac{310}{8} = 38.8$	$\frac{600}{8} = 75.0$
Alternative C	$\frac{640}{10} = 64.0$	$\frac{300}{7} = 42.9$
Alternative D	$\frac{230}{8} = 28.8$	$\frac{575}{6} = 95.8$

- Step D: Determine each alternative's Benefit-Cost Ratio.

The Benefit-Cost Ratio is expressed as

$$\rho = \frac{B}{C}$$

where:

B = the Total Benefit Value Rating for an alternative

C = the Total Cost Value Rating for the same alternative

In this example, the four Ratios are:

Alternative A: $\rho = \frac{B}{C} = \frac{31.7}{64.3} = .49$

Alternative B: $\rho = \frac{B}{C} = \frac{38.8}{75.0} = .51$

Alternative C: $\rho = \frac{B}{C} = \frac{64.0}{42.9} = 1.49$

Alternative D: $\rho = \frac{B}{C} = \frac{28.8}{95.8} = .30$

It must be realized that this ratio is *not* a measure of the relative quality of particular alternatives. That is, a countermeasure with a ratio of 2.0 is not twice as good as another with a ratio of 1.0. In addition, because this method does not deal with monetary values, it is *not* necessary for the ratio to be greater than 1.0 in order for an alternative to be acceptable. The B-C Ratio is simply a numerical statement of the benefits expected versus the costs outlayed.

After determining each alternative's Benefit-Cost Rating, they should be evaluated in sequence, starting with the one with the highest Ratio. The highest rated alternative should be the one selected.

In the example, Alternative C obviously has the highest B-C Ratio and, if there are no constraints, would be the facility to select. However, constraints (e.g., cost limitations, and/or desired minimum benefit levels) will affect whether or not the highest rated alternative will be the one implemented. Step E discusses constraint consideration.

- Step E: Consider constraints (goals and limitations).

Constraints are desired or required prerequisites which a solution to a particular problem must meet. Possible cost-variable constraints are the total funds available or the immediacy that the problem solution must be installed. Example benefit-variable constraints are a minimum desired level of accident or injury severity reduction, or no additional visual pollution at the installation site.

For this example, the constraints are:

- Construction costs cannot exceed $10,000.
- It must be totally implemented within 6 months.
- Vehicle delay increases cannot exceed 3 percent.

- Expected fatality reduction must be at least 10 percent.
- Its unattended life expectancy must be 3 or more years.

Step F describes the method of final alternative selection.

- Step F: Select highest rated alternative meeting the constraints.

After the Benefit-Cost Ratio for each alternative has been calculated, the alternative with the largest Ratio *and* meeting the constraints should be selected for implementation.

In this example, Alternative C has the highest B-C Ratio (return on investment). However, its high design, construction and maintenance costs, and long implementation time do not meet the stated constraints. On the other hand, it has a very high anticipated accident reduction level, positive effects on the local economy, and aesthetic value. In a case where one alternative has such a higher B-C Ratio but does not meet the initial constraints, it may be appropriate to try to meet those constraints (e.g. find the extra money, or be less concerned about the implementation time).

Alternative D, the "Take No Action" alternative, also does not meet all the stated constraints – specifically the desired 10 percent reduction in accident fatalities. Although this alternative is certainly a feasible choice, and incurs practically no costs, the expected benefits are minimal as well. In some situations, the No Action Alternative may be better than the Do Something Alternatives if the constraints are met.

Both Alternatives A and B meet the stated constraints in this example. Assuming that no additional constraints are added when only these two alternatives are left, the choice is Alternative B, which has the higher Value Rating Ratio (.49 vs. .51).

Subjectivity Problems with Benefit-Cost Analysis

Although Benefit-Cost Analyses use numbers a great deal, in reality they are very subjective. The anticipated benefits of a countermeasure are only guesses of what will occur in the future. Although past experience may help generate estimates with greater accuracy, the figures are still conjectures for the specific location under consideration.

Certainly the most useful tool for a Benefit-Cost Analyst/Decision Maker to have is a method which accurately forecasts the future. However, numerous unknowns about future events present some level of uncertainty and risk in making such predictions. In estimating the anticipated outcome levels of individual benefit and cost variables, the analyst *must* use sound and well-based judgment. A thorough understanding of the variables and their potential effects is a prerequisite for accurate forecasting.

Similarly, in developing the scales for the Value Rating conversion tables, realistic and sound ranges must be used. The range must be such that small incremental changes in the outcome estimate of a variable will not *drastically* change the final Value Rating. At the same time, the range *should* permit large variations in individual variables to be reflected in the final total Value Rating for the alternative.

Accurate forecasting through sound rational judgment must be supplemented by professional integrity on the part of the B-C Analyst. Whenever a quantitative analysis is being made, the outcome is directly affected by the data input. It is imperative that the numbers used reflect reality, and not personal biases, as much as possible. An alternative selection based on incorrect data may not be effective and certainly will waste time and funds. Verifying the numerical values to be used in the analysis is more important than the mathematical computations themselves.

Several techniques enabling a decision maker to better guess possible future situations are available. Sensitivity Analysis forecasts several futures for individual events (variables). It is not a required step in a Benefit-Cost Analysis, but can give a better indication of what alternative to select. Analysis Option 1 describes this technique.

- Analysis Option 1: Use Sensitivity Analysis if desired.

Sensitivity Analysis is a technique allowing estimation of more than one possible future condition for any or all variables for one or all alternatives. Instead of one "best guess" level for a variable, three estimates are made: an optimistic, a pessimistic, and a midrange level. The Total Benefit or Total Cost Value Rating and the Benefit-Cost Ratio are then recomputed for that alternative for each of the three estimates, and the alternatives are again compared. It is possible that the most advantageous alternative will change depending on whether optimistic or pessimistic conditions occur.

The decision maker-analyst must decide which of the possible future environments for a variable is the most likely, rather than one "best guess" outcome. That decision will identify which alternative is selected. Of course, if the same alternative comes out ahead through all conditions, then the decision is much easier to make.

In the example, say that Alternatives A and B have midrange Life Expectancies of 3 years and 6 years (the previous calculation). However, optimistic and pessimistic Life Expectancy estimates and the equivalent Value Ratings may be the following:

Life Expectancy	Alternative A	Alternative B
Optimistic	6 (= 30)	10 (= 50)
Midrange (Earlier calculation)	3 (= 15)	6 (= 30)
Pessimistic	1 (= 0)	2 (= 10)

Recomputing the Benefit-Cost Ratio under these possible Life Expectancy conditions, the new Ratios are:

B-C Ratio	Alternative A	Alternative B
Optimistic	.52	.55
Midrange (Earlier calculation)	.49	.51
Pessimistic	.47	.48

It can be seen that the optimistic Alternative A has a better B-C Ratio than both the midrange and pessimistic Alternative B, and that the midrange Alternative A is better than the pessimistic Alternative B.

Note that Sensitivity Analysis can become very mathematically complex. If every Benefit and Cost variable is assigned three values and all possible combinations (using some optimistic, or some pessimistic, or some midrange levels, etc.) are tested, a computer would be absolutely required. This technique should only be used when it is truly difficult to determine the one likely "best guess" for a variable. Of course, it is possible that a pessimistic occurrence of one variable may cause an optimistic occurrence of another variable. Variable interrelationships must be watched when using Sensitivity Analysis.

This discussion has so far assumed that all the cost and benefit variables are of equal importance. In reality, each locality has a different set of priorities based on budgetary, accident rate and other criteria. The second analysis option presents a technique for emphasizing and deemphasizing variables if desired.

- Analysis Option 2: Use Variable Priority Weighting if desired.

A benefit and cost Variable Weighting scheme is recommended when the most important variables to a decision making process should be maximized and variables of lesser importance to the individual locality minimized. To use this technique, a mathematical Weighting Factor is assigned to each variable. The Factor value, from 0 to 1, is multiplied with the Value Rating of that variable. A weight of 1 gives full value to the variable; a weight of 0 eliminates the variable. Mathematically, the Weighting Factor procedure is stated as:

$$B = W_1V_1 + W_2V_2 + W_3V_3 + \ldots$$

where:

B	=	Total Benefit Value (as above).
$V_1, V_2 \ldots$	=	Individual Values for the benefit variables (as above).
$W_1, W_2 \ldots$	=	Individual Weighting Factors for the associated benefit variables.

Similarly:

$$C = W_1V_1 + W_2V_2 + W_3V_3 + \ldots$$

where:

C = Total Cost Value (as above).

$V_1, V_2 \ldots$ = Individual Values for the cost variables (as above).

$W_1, W_2 \ldots$ = Individual Weighting Factors for the associated cost variables.

Selection of the Weighting Factors is somewhat arbitrary. If it is not possible to determine which variables are more important than others, no weighting should be used.

Using the data from the example, *possible* Variable Priorities might be as follows (Table 3-7):

Table 3-7

Example: Priority Weights for Benefit and Cost Variables

Benefits	Weight	Costs	Weight
Accident Reduction	1.0	Design Costs	1.0
Fatality Reduction	1.0	Construction Costs	1.0
Injury Severity Reduction	1.0	Maintenance	1.0
Life Expectancy	.8	Implementation	.2
Economic Impact	.7	Vehicle Delay Increase	.6
Social Impact	.2	Pedestrian Delay Increase	.6
Implementation	.2	Visual Pollution	.2
Level of Service	.4	Noise Pollution	.7
Aesthetic Value	.2	Air Pollution	.5
Vehicle Delay Decrease	.6		
Pedestrian Delay Decrease	.6		
Noise Pollution	.4		

Note: The numerical values are arbitrary and are *example values* only. Each locality should list priorities appropriate to its own goals and limitations.

Using the Value Ratings from Table 3-6, the Total Benefit and Total Cost Value Ratings can be recalculated (Table 3-8).

Table 3-8

Example: Recalculated Value Ratings of
Four Action Alternatives Using Variable Priority Weighting

Benefits	Alternative A	Alternative B	Alternative C	Alternative D
Accident Reduction	30 (1.0) = 30	40 (1.0) = 40	90 (1.0) = 90	0 (1.0) = 0
Fatality Reduction	20 (1.0) = 20	50 (1.0) = 50	90 (1.0) = 90	0 (1.0) = 0
Injury Severity Reduction	40 (1.0) = 40	30 (1.0) = 30	60 (1.0) = 60	0 (1.0) = 0
Life Expectancy	15 (.8) = 12	30 (.8) = 24	50 (.8) = 40	–
Economic Impact	–	–	90 (.7) = 63	–
Social Impact	50 (.2) = 10	50 (.2) = 10	90 (.2) = 18	90 (.2) = 18
Implementation	60 (.2) = 12	50 (.2) = 10	0 (.2) = 0	–
Level of Service	30 (.4) = 12	50 (.4) = 20	30 (.4) = 12	50 (.4) = 20
Aesthetic Value	30 (.2) = 6	10 (.2) = 2	90 (.2) = 18	90 (.2) = 18
Vehicle Delay Decrease	–	–	–	0 (.6) = 0
Pedestrian Delay Decrease	–	–	–	0 (.6) = 0
Noise Pollution	10 (.4) = 4	–	50 (.4) = 20	–
Total (= B)	146 (N=9)	186 (N=8)	411 (N=10)	56 (N=8)
Costs				
Design Costs	60 (1.0) = 60	100 (1.0) = 100	0 (1.0) = 0	100 (1.0) = 100
Construction	60 (1.0) = 60	100 (1.0) = 100	20 (1.0) = 20	100 (1.0) = 100
Maintenance	50 (1.0) = 50	10 (1.0) = 10	70 (1.0) = 70	85 (1.0) = 85
Implementation	60 (.2) = 12	50 (.2) = 10	0 (.2) = 0	–
Vehicle Delay Increase	80 (.6) = 48	80 (.6) = 48	50 (.6) = 30	100 (.6) = 60
Pedestrian Delay Increase	90 (.6) = 54	90 (.6) = 54	70 (.6) = 42	100 (.6) = 60
Visual Pollution	50 (.2) = 10	90 (.2) = 18	90 (.2) = 18	90 (.2) = 18
Noise Pollution	–	80 (.7) = 56	–	–
Air Pollution	–	–	–	–
Total (= C)	294 (N=7)	396 (N=8)	180 (N=7)	423 (N=6)

Using these new values and the procedures in Step C, the Total Beneift and Total Cost Value Ratings for the four alternatives are:

	Benefit	Cost
Alternative A	16.2	42.0
Alternative B	23.3	49.5
Alternative C	41.1	25.7
Alternative D	7.0	70.5

The Benefit-Cost Ratios for the four alternatives are:

Alternative A = .39
Alternative B = .47
Alternative C = 1.60
Alternative D = .10

Referring back to Step D, it can be seen that the sequence for considering alternatives has not changed. The high-to-low sequence both with and without Variable Priority Weighting is C-B-A-D. However, the Priority Weighting values can affect the Benefit-Cost Ratio and, therefore, the possible best alternative.

Summary

Benefit-Cost Analysis is an important decision-making tool because it provides a technique to make Alternative selections based on mathematical analysis. This is not to say that B-C Analysis should be the only basis for selecting an alternative. Political and public demand, historical precedent, and your specific situation have roles to play. However, a quantitative analysis provides the element for more rational, and subsequently justifiable, decisions.

Rational decision making is particularly necessary because of the great demand for safety improvement funds at all levels of government – a demand which is expected to increase in the future. The method outlined in Step 3 (and illustrated in Figure 3-1) is conducive to use at all governmental levels. (See Appendix E for a specific discussion of its use at the state level.)

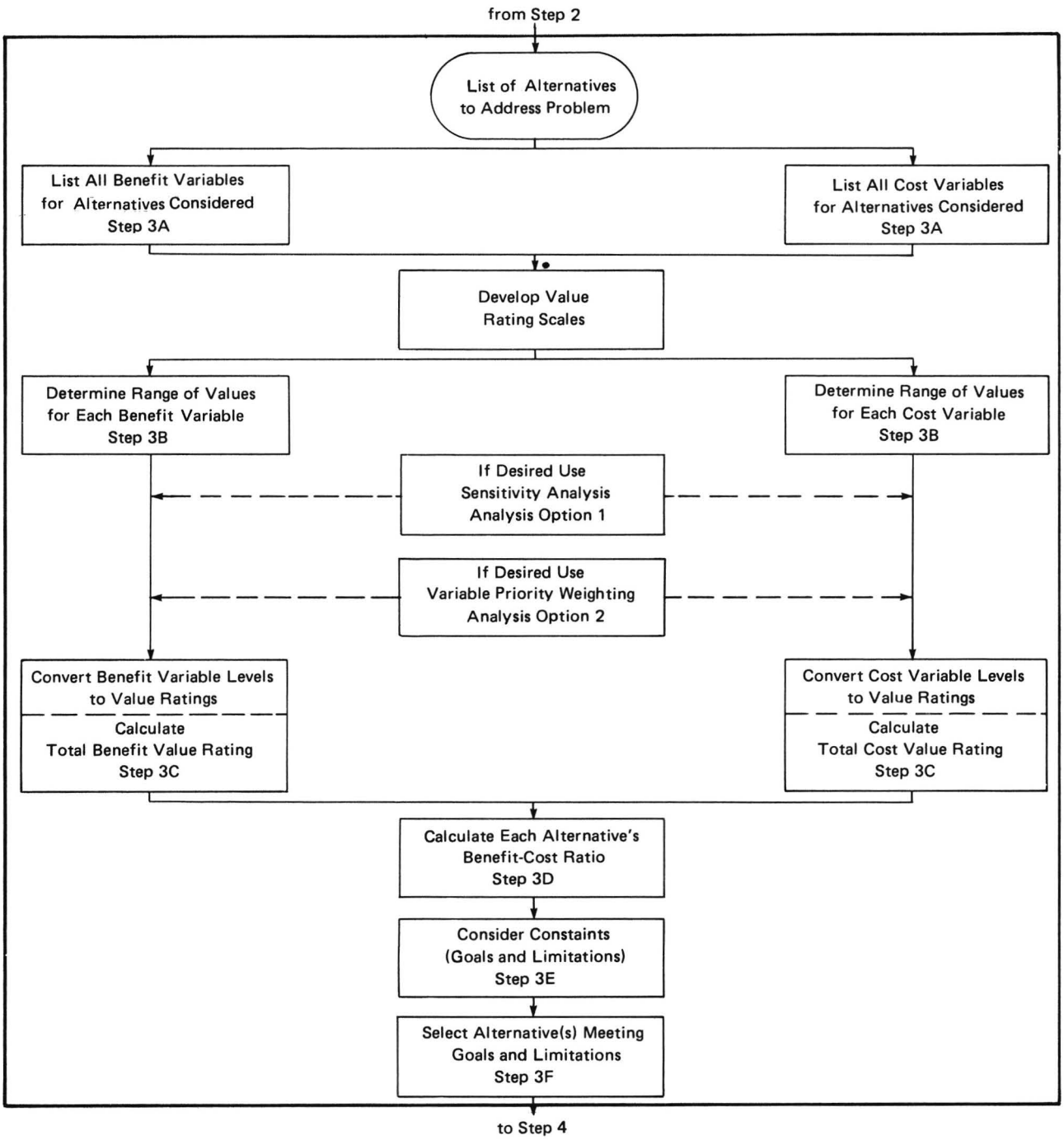


Figure 3-1. Step 3: Select Best Alternative (Benefit-Cost Analysis) Outline.

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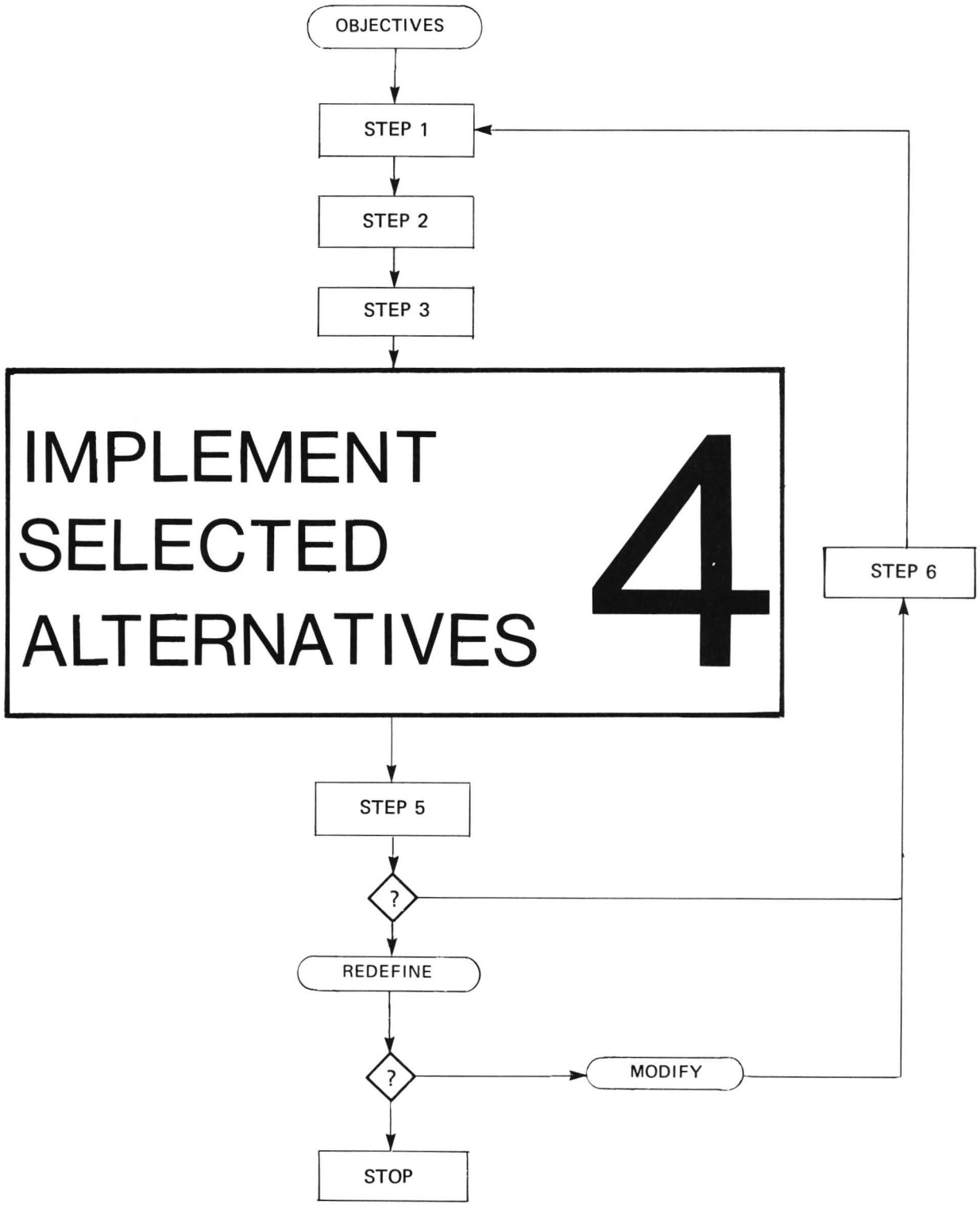
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MODIFY
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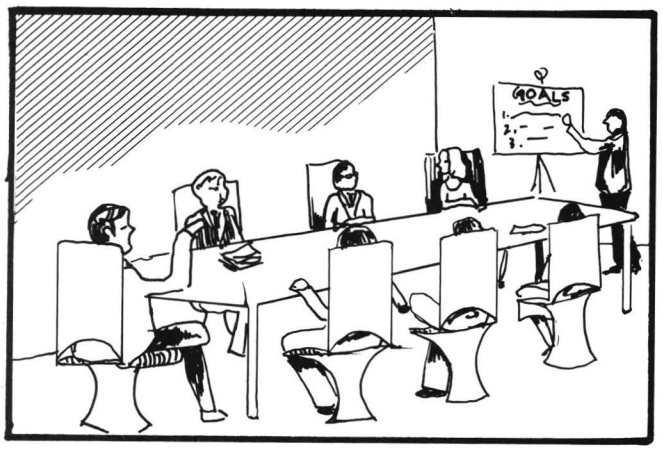
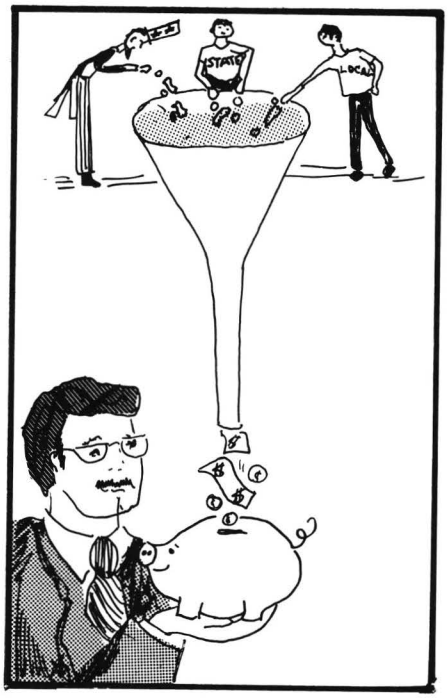
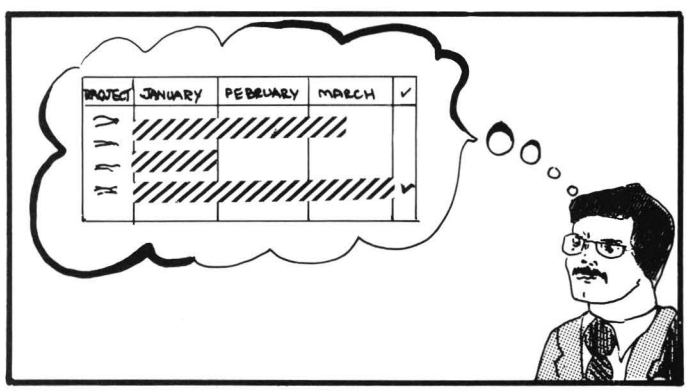


Policy goals and objectives

Support



Funding



Scheduling

STEP 4: IMPLEMENT SELECTED ALTERNATIVE

Once a countermeasure has been selected, the next step is to see that it gets implemented. The tasks of successful implementation are:

- establishing policy goals and objectives.
- coordinating safety efforts.
- establishing and maintaining support.
- obtaining financial resources.
- prioritizing and scheduling projects.

Establishing Policy Goals and Objectives

The goals and objectives of pedestrian programs will vary from one jurisdiction to another. However, common to all those interested in pedestrian safety should be:

- reduce the frequency of pedestrian accidents.
- reduce the injury severity of pedestrian accidents.

It is vital that these goals be written in a policy statement. Formulation of such a statement is a means of communicating the desired safety program to those who will implement it. Local priorities, goals and objectives should be plainly stated in this statement.

Establishing these goals and objectives should be done in the form of specific performance statements: that is, descriptions of activities which affected organizations must perform, the costs involved, and the schedule for doing them. This technique is known as Management by Objectives (MBO). Program goals and objectives stated in performance terms are relatively easy to track and monitor. Because of this, the program's effectiveness can be more readily evaluated (see Step 5: Evaluation).

Coordinating Safety Efforts

One of the major problem areas of pedestrian safety in general is the multitude of agencies sharing the responsibility for pedestrian affairs. This is true at all levels of government. At the local level, the agencies specifically involved will vary from jurisdiction to jurisdiction. Usually involved are the traffic engineering, police, planning and zoning, housing and urban renewal, parks and public works departments, and the schools. Having so many agencies involved can readily lead to duplication of efforts or to inaction. Most *successful* safety programs have one individual or group responsible for coordinating the total pedestrian safety program.

Each of the above named agencies has as its *primary* focus something other than the pedestrian. There must be an organization that directly represents pedestrian interests. Three possible answers to this problem are:

- Mayor's Task Force for Pedestrian Safety.
- Bureau of Pedestrian Affairs.
- Pedestrian Safety Coordinator.

The idea behind each of these organizational structures is to have one central driving force backing pedestrian programs. One or more of the other agencies will get involved in the physical implementation, maintenance and operation as appropriate. However, this focal group or individual should be coordinating all these efforts.

Mayor's Pedestrian Safety Task Force. This is a non- or semiprofessional group of citizens, businessmen, city officials, and representatives of special-interest pedestrian groups (e.g., the elderly, children, walking/jogging clubs). The group acts as a "buffer" between citizens directly affected by a safety program and the agency responsible for its implementation and operation. Its primary task is to screen and shunt complaints from citizens to the appropriate agency for further study, recommendation and action.

Bureau of Pedestrian Affairs. This group is more professionally oriented and can be established as an agency on its own. It has the same duties as the Task Force, *plus* it would be responsible for:

- maintaining and publishing pedestrian accident statistics.
- overseeing the installation of facilities.
- initiating proposals for pedestrian-related improvements.

Pedestrian Safety Coordinator. This possibility focuses the duties of pedestrian safety on one individual. The Pedestrian Safety Coordinator's job can be one of the tasks of a Traffic Safety Coordinator, depending on the extent of the pedestrian and other safety problems. The duties of this individual include all those of the Task Force and the Bureau.

Establishing and Maintaining Support

No matter which type of organizational structure is selected, coordinating and actively dealing with numerous people in various departments is an essential task of the safety coordination effort. A successful pedestrian safety program requires the support of all involved governmental agencies, the media, schools, businessmen and especially, the public at large.

Because pedestrian safety programs require so much support, it is essential that the Program Coordinator have the authority to deal effectively with the heads of agencies and the public in

general. If this person is not perceived as a high level official, successful project implementation may not be feasible.

The single most important criteria for implementation is probably the perceived value of the project by the affected citizenry. Without acceptance at the most local level – the implementation site – it is doubtful than any safety program countermeasure will be effective. Regardless of the technical merit a facility might have, if it is not supported by the community it is doomed to failure.

The nature of pedestrian safety projects, particularly within a city's business district, requires that planning and implementation involve input from a number of affected participants. As a minimum, the following individuals or groups should be consulted prior to finalizing any plans:

- affected pedestrians.
- affected merchants.
- affected motorists.
- affected residents.
- local management.

Enthusiasm for the *total* local pedestrian safety program generally must come from the upper levels of the locality's political system. One way to generate such enthusiasm occurs when a good program becomes publicized – either locally (within the state) or nationally. While this is difficult to initiate, there is a means already available to accomplish this – the American Automobile Association's Pedestrian Safety Inventory. The national AAA, through the local Automobile Clubs, annually surveys the pedestrian programs in over 2,000 American communities. Cities, counties, and states voluntarily fill out a two-page questionnaire describing their pedestrian safety efforts for the previous year. Awards are given to localities with outstanding safety programs and/or low accident occurrence. Historically, one of the side benefits of this program is that it forces a locality to become aware of its total pedestrian safety efforts. The AAA's responses to a locality indicate how its program compared to other cities of a similar size. On numerous occassions, poor showings by a community have caused local officials to initiate better pedestrian-oriented efforts.

Obtaining Financial Resources

Many options are available for funding individual pedestrian projects. These options will vary depending on the scope and target subjects of the project. Appendix C: Potential Funding Sources, provides a list of some of the sources and funds that are or have been available for pedestrian-related projects. Whether there are currently available funds can be determined by contacting the appropriate organization.

The first step in acquiring any Federal aid is to gain the support of the local government for the proposed project. The second step is to contact the local and state organization(s) which have the responsibility for distributing these funds. States should contact the Federal agency's regional or divisional office. Although obtaining funds may seem like an impossible task, knowledge of the types of funds available, their sources, and who to contact can readily make more monies available at the local level.

One of the necessary ingredients in obtaining funds is the ability to demonstrate a need, or to show that previously used funds have created a safer pedestrian environment. The development of rational data using Step 1 techniques is a major step in this direction.

Prioritizing and Scheduling Projects

Time is a critical factor after a problem area has been identified. In order to keep the problem from increasing in magnitude, it is desirable to implement the appropriate safety countermeasures as soon as possible. Two elements play a role in applying solutions: which pedestrian problems should be addressed first; and where do pedestrian problems fit into the total transportation picture.

Prioritizing Safety Hazards. Although this manual is addressing the pedestrian safety issue, it is recognized that there exist problem areas in the nonpedestrian traffic picture as well. The limited funds that are available must be split between pedestrian and nonpedestrian problem solutions. To determine where the most benefit will result, both within and between these two categories, a Hazard Prioritization process must be used.

Hazard Prioritization is a technique for evaluating the degree of hazard associated with a particular problem area. Each location is rated using three elements:

- Severity: the degree of the problem if left unattended (Nuisance, Marginal, Critical, Catastrophic).
- Probability: the likelihood of an accident if no solution is implemented (Unlikely, Probable, Considerable, Imminent).
- Cost: the cost of the implemented solution (Prohibitive, Extreme, Significant, Nominal).

Each problem area should be described using these three elements. A card, such as the example illustrated in Figure 4-1, can be used to facilitate this technique. Problem areas are prioritized according to their severity, probability and cost. Catastrophic-Imminent-Nominal problems should be addressed first because the greatest benefit for the least cost can be expected. Catastrophic-Imminent-Significant problems would be addressed next. After all Catastrophic-Imminent problems are considered, Catastrophic-Considerable-Nominal problems should be turned to. The last problems to be addressed would be Nuisance-Unlikely-Prohibitive.

HAZARD ANALYSIS CARD

Prepared by _____ Date _____

Hazard Description _____

Departments:

Severity	Probability	Cost	Action
O Nuisance	O Unlikely	O Prohibitive	O Defer
O Marginal	O Probable	O Extreme	O Analysis
O Critical	O Considerable	O Significant	O Immediate
O Catastrophic	O Imminent	O Nominal	Date _____

Figure 4-1. Example Hazard Prioritization Card (From Brown, 1976).

Prioritization using this technique can establish a sequence for addressing pedestrian problems alone, and for inserting these problem areas into the total transportation systems management program. This is useful when exclusive funds for pedestrian problem solutions are available, and when pedestrian problems must be considered as part of the total transportation safety effort.

Scheduling. For every project, the plan of action should be put on a time schedule from conception to operation. Time schedules allow managers to plan manpower and funding allocations. Schedules can be used as a tool in spreading the costs of a program out over a period of years. For example, if you want to install pedestrian signals at 30 intersections, rather than install all 30 signals in one year, you can phase the project out for 5 years at a fraction of the initial cost. This would then allow simultaneous initiation of another project which can also be phased out over time.

In addition, when the specific goals and objectives are established in association with a schedule for meeting them, there is a constantly available tool for evaluating how the safety program in general and in detail is progressing. The next step (Step 5: Evaluation) further discusses this use of project and program scheduling.

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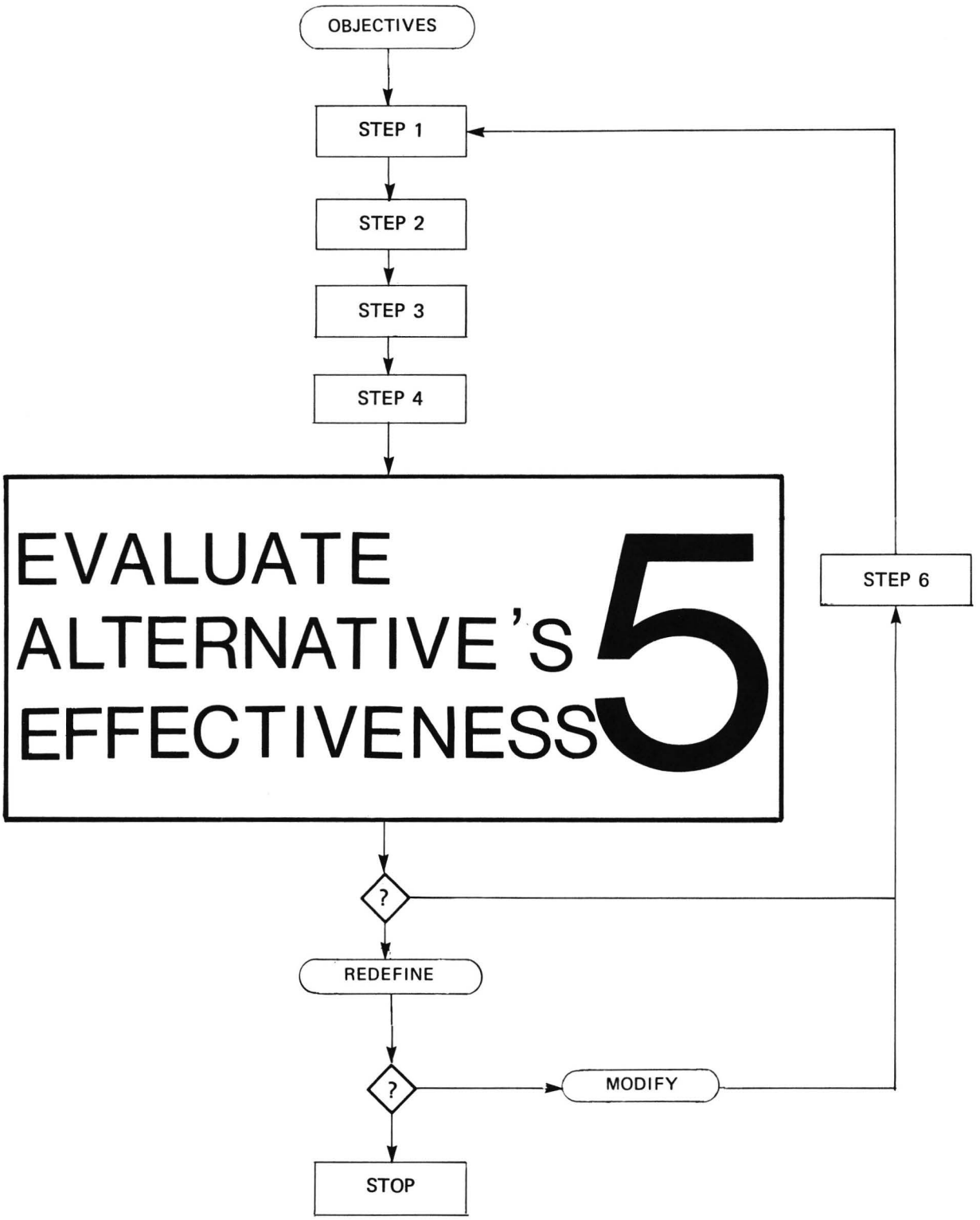
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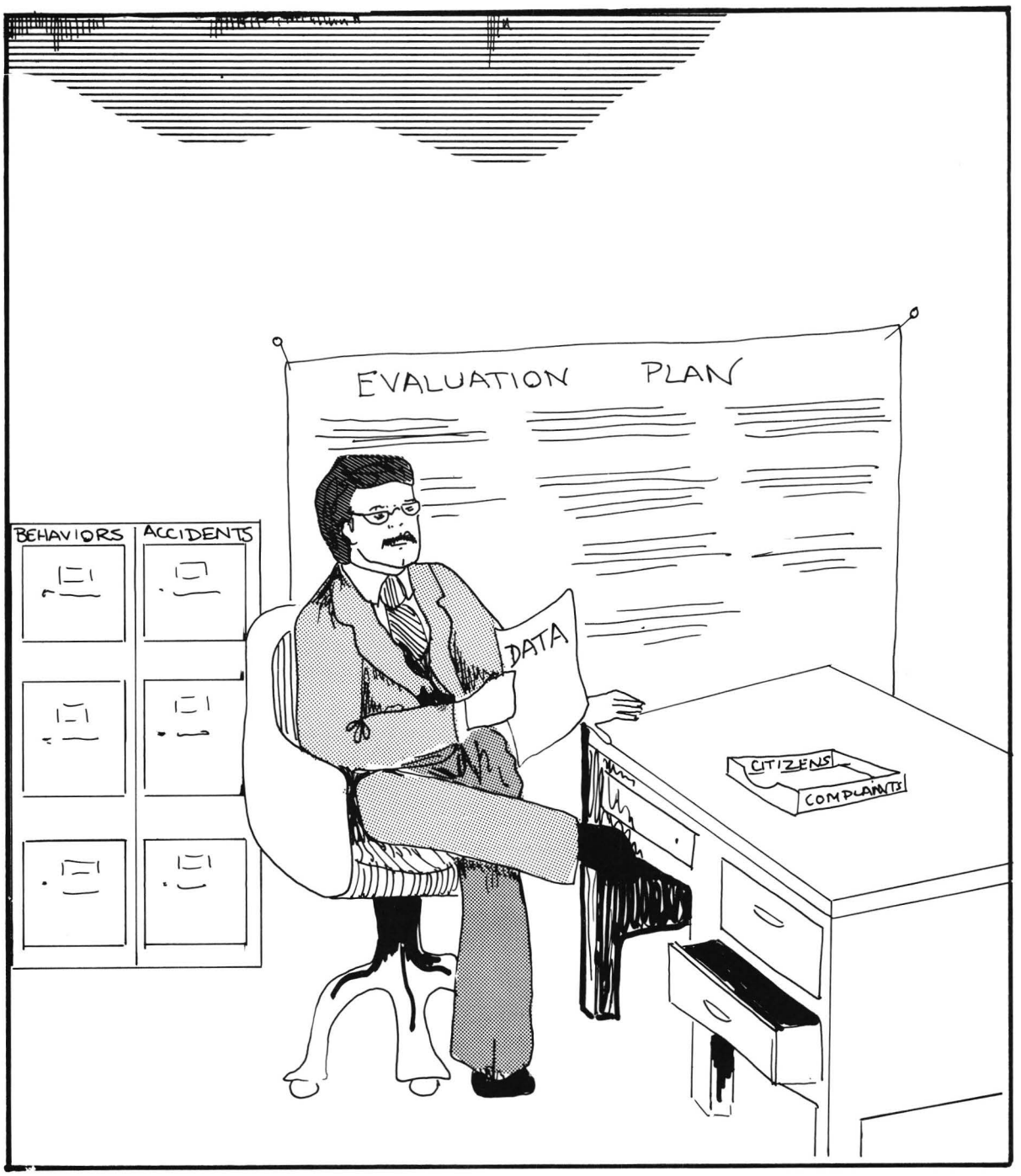
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ACCIDENTS
DATA
CITIZENS
COMPLAINTS

EVALUATION

STEP 5: EVALUATE ALTERNATIVE'S EFFECTIVENESS

This Step provides general guidelines for the process of evaluating whether an implemented alternative is having the desired effects on pedestrian safety. Evaluation often sounds straightforward and relatively easy when described on paper. In fact, it can become very complicated. Relatively few people have extensive experience as valid highway safety program evaluators. *Before attempting the design or execution of an evaluation, supplement this Step with one or more of the references listed, or the experience of a local statistics or experimental design expert.*

Although the evaluation process is being discussed at the end of this *Users' Manual*, it must be considered and planned from the initial stages of the safety program. Evaluation is intimately connected with the program's goals and purposes. A second reason for initiating the evaluation process early is that data on the behavioral situation before an alternative is installed should be collected.

Specifically, evaluation is intended to determine:

- whether or not the program is fulfilling the goals it is designed to accomplish.
- how efficiently the program is accomplishing its stated goals.
- if the program is producing results contrary to its goals.

These purposes imply an often overlooked but important reason for evaluation. While a particular countermeasure may have positive effects on pedestrian safety, it could simultaneously be negatively affecting other conditions. Also, if a facility is having only a small beneficial effect, evaluation might indicate that the dollars being used to maintain that countermeasure could be used for an alternative with a greater benefit.

There are three types of evaluation.

- Type I: Expert, but nonquantitative Judgment. This type has the least value and should be used only as a last resort for minor projects It will not be further considered in this manual.
- Type II: Programmatic Evaluation. This deals with the operation and management of a pedestrian safety program.
- Type III: Effectiveness Evaluation. This type evaluates the effect or noneffect that an installed countermeasure is having and is of the greatest concern.

Programmatic Evaluation

As was mentioned in Step 4, one of the necessary processes in safety program implementation is to establish definitive policy goals and objectives. Management of a program designed around such goals should be evaluated in terms of stated program activities (planning, development, implementation, operation, etc). Goals and objectives stated in performance terms are relatively easy to track and monitor. This is known as Management by Objectives (MBO).

The large majority of MBOs are quantifiable or observable, Table 5-1 presents a partial list of measures typically found in MBO programs. Many localities may need only a small number of measures to follow program performance; larger programs require complete project documentation. As the program evolves and changes, the measures of evaluation (e.g., cost, schedule) can be modified. The product of Programmatic Evaluation should be clear and timely awareness of program status and progress relative to established objectives.

Table 5-1

Typical Programmatic Evaluation Measures

Cost
Operating expenses (rent, supplies)
Labor
Countermeasure (design, accident records, data processing)
Evaluation (collection, accident records, data processing)
Equipment (data collection devices, furniture)
Schedule
Create program and evaluation plan
Identify problem locations
Create countermeasures
Arrange funding
Design facility
Implement (construct) countermeasure(s)
Collect before and after data
Evaluate effectiveness
Maintain facility
Other Activities
Public involvement
Volunteer activities
Promotion
Personnel productivity

Effectiveness Evaluation

The most difficult to obtain, but most useful evaluation data concern the effectiveness of an implemented countermeasure. These data are the basis for the expansion, contraction, redirection or modification of the safety program. Several substeps must be performed to accomplish Effectiveness Evaluation. These are:

Step A: Develop Evaluation Plan

- A.1: Determine countermeasure goals and corresponding measures of effectiveness (MOEs)
- A.2: Select an experimental design
- A.3: Prepare a data collection plan
- A.4: Determine the statistical analysis

Step B: Conduct Evaluation

- B.1: Assemble equipment and train personnel
- B.2: Collect data

Step C: Analyze and Interpret the Data

- C.1: Reduce data
- C.2: Perform statistical analyses
- C.3: Report findings

These substeps are discussed in detail below:

- Step A: Develop Evaluation Plan.

The goals of all pedestrian safety programs will ultimately relate to accident occurrence as a measure of pedestrian safety. However, because they occur infrequently, accidents are a very poor criterion measure. In addition, individual countermeasures are not designed to impact on all Accident Types. Specific facilities are designed to eliminate or change particular (pedestrian or driver) behaviors which are accident Causal Factors. If accident data are not adequate to demonstrate a countermeasure's effectiveness within the first two years after installation, a related measure should be considered. Also, although accident data are the ultimate criteria, they are subject to Regression to the Mean phenomena.* Therefore, the first step in developing the evaluation plan is to determine appropriate *non*accident Measures of Effectiveness.

*Regression to the Mean refers to the tendency of any extreme data to be less extreme in succeeding time periods. If there were five accidents at an intersection in one year, the best prediction for the following year would be a number less than five. This is due to random fluctuation, but is often interpreted as the positive impact of a countermeasure.

Step A.1: Select Measures of Effectiveness (MOEs). MOEs are the Dependent Variables (behaviors resulting from a facility installation) that indicate the effect of a countermeasure in terms of a stated criteria. The criteria to be used should reflect the Accident Type addressed by the facility – that is, the Causal Factors.

The general Causal Factors criteria were discussed in Step 1 in connection with the Accident Typology (Tables 1-1 to 1-3). Additional data that should be collected are listed in Table 5-2. Other factors to be considered in the selection of MOEs are:

- The measure must be valid in terms of relating to the stated criterion; it must measure what it is supposed to measure.
- A valid measure must be sensitive enough to discriminate between performance changes in the Before and After conditions.
- The measure must be obtainable, in a technical sense, and in terms of cost, manpower and resources.
- The measure must be reliable; it must be measuring the same phenomena every time it is used.

Table 5-2

Summary List of Measures of Effectiveness

Accidents	Behaviors	Operations
Number of accidents	Pedestrian compliance (with signals, crosswalks)	Vehicle volumes
Number of accidents by causal type	Inadequate looking	Vehicle speed
Number of accidents by facility	Pedestrian hesitation/backup	Turn counts
Fatalities	Pedestrian conflict with thru or turning vehicles	Pedestrian volume
Injuries		Pedestrian delay
Accident Rate		
Accident Risk		

Step A.2: Select Experimental Design. The Experimental Design is the method to be used to evaluate the data. Several Experimental Designs are available for use in highway safety evaluation. Many are used inappropriately, particularly when accidents are a criterion measure. Because of the regression to the mean problem, use of a control group or site is mandatory with accident MOEs. When only behavioral and operational measures are used, some form of Before-After design can be substituted.

–Before-After Design. In this design, two measurements are taken, one before and one after the alternative is implemented. Effectiveness is defined as the difference in these two measurements

over time as determined by appropriate statistical tests. Implicit in all of the Before-After type designs is that the Before data must be collected prior to the installation or initiation of a countermeasure program. It is essential that planning ahead be done to ensure that appropriate Before data are obtained.

While this design is straightforward and easily applied, it does have its shortcomings. The design implicitly assumes that: if the countermeasure had not been implemented, the Before measurement would have continued at the same level; and if a behavioral change is seen after the implementation, it is attributable to the countermeasure. Both of these assumptions could be wrong.

—Before-After Design with Control Site(s). The Before-After Design is vulnerable to changes that occur during the time it takes to complete the study (e.g., in traffic volumes or composition). These changes *can* affect the outcome of the statistical analysis resulting in erroneous conclusions. Therefore, it is essential that the effects of such variables be minimized as much as possible. The Before-After with Control Site is similar to the Before-After except that two (or more) *comparable* sites are identified for comparison. Identical measurements are taken at both sites before and after installation of the countermeasure, which is done at only one site. The other site is used as a control.

This type of design overcomes the deficiencies of the simple Before-After Design. Behavioral or operational changes at the test site are compared to the Before and After measurements at the control site. In this way, variables that change over time will appear at both sites and are thus accounted for in the evaluation.

While this design is more logically correct, it is the most difficult study to conduct. The test and control sites *must* be behaviorally and operationally similar. Finding a control site similar to the test site is difficult and time consuming. In addition, it will take more time and money to collect and analyze the data.

In view of the difficulties associated with the latter design, the simple Before-After technique often must be used. However, to overcome the inherent deficiencies, data collection periods must be scheduled to control the influence of other variables. To compare Before-After data, it is necessary to assure that the only thing which has changed over time is the treatment. Table 5-3 lists examples of variables which need to be controlled to achieve this assurance.

Table 5-3
Typical Control Variables

Weather Conditions	Time of Day
Level of Illumination	Day of Week
Traffic Volume	Season
Traffic Mix	User Age and Sex
User Familiarity/Unfamiliarity	Pedestrian Volume

Step A.3: Prepare Data Collection Plan. The third step in developing an evaluation plan is to prepare a detailed data collection plan spelling out specific data needs, sample size required, data collection procedures, and schedules. The need for early evaluation planning is best illustrated here because comparable Before and After data must be collected. If the data collection is not planned until the countermeasure is installed, incompatible and virtually useless data will result.

–Data Needs. The selected MOEs from Step A.1 will determine the types of data needed. Having established a particular MOE of interest (e.g., pedestrian compliance), describe the exact type of data needed and the location(s) where it should be collected (e.g., crossing all legs of the intersection).

–Sample Size and Sampling Plan. To satisfy statistical requirements, it is necessary that a sufficient sample size be obtained. Formulae are available in several of the references (4,5,7) and basic statistical textbooks for determining sample size requirements. Suggested minimums for some typical measurements are seen in Table 5-4.

Table 5-4

Suggested Minimum Sample Sizes

Measure	Minimum Sample Size (Observations)
Speeds	100 (each vehicle type)
Pedestrian-Vehicle Conflicts	30 (each type)
Pedestrian Surveys	100
Pedestrian Compliance	50 pedestrians

Table 5-5 shows the type of impact a countermeasure must have for various accident frequencies to show statistical significance. It is apparent that a large accident base is required if accidents alone are to be used as an MOE. Accident data should be supplemented with behavioral and operational effectiveness measures.

The sampling plan should indicate whether to take measurements at random or at some predetermined interval. This will be dictated by the MOE, (for example, only the lead vehicle of a platoon if speed is the MOE. For pedestrian compliance or similar MOEs, it may be more appropriate to observe *all* pedestrians, but for only a certain 15-minute period of each hour.)

Table 5-5

Approximate Degree of Project Impact Needed
to Claim Statistical Significance
for Selected Baseline Accident Rates

Average Number of Accidents Base Period*	1	2	3	4	5	6	7	8	9	10
Percent Reduction Needed	95	85	73.3	67.5	62	56.7	54.3	51.3	48.9	46
Average Number of Accidents After Implementation	.05	.3	.8	1.3	1.9	2.6	3.2	3.9	4.9	5.4

Average Number of Accidents Base Period	11	12	13	14	15	16	17	18	19	20
Percent Reduction Needed	44.5	42.5	41.5	40	38.7	37.5	36.4	35.6	34.7	34
Average Number of Accidents After Implementation	6.1	6.9	7.6	8.4	9.2	10.0	10.8	11.6	12.4	13.2

Average Number of Accidents Base Period	25	30	35	40	50	60	70	80	90	100
Percent Reduction Needed	31.2	30	28.6	25	24	21.7	20	18.8	17.8	16
Average Number of Accidents After Implementation	17	21	25	30	38	47	56	65	74	84

*Based on 3.5 year average with no trend in crashes.
(Adopted from NHTSA, 1977).

–Techniques. Having established the data needs, determine which data collection methods are most appropriate. Appendix B: Data Collection Techniques, contains descriptions of several procedures for collecting data. Consider using techniques which record several measures. (For example, vehicle speed, headway, gap, erratic maneuvers, pedestrian conflicts and behavior, travel paths and other data can be simultaneously collected using time-lapse photography.)

–Schedules. Determine how long it will take to collect the amount of data required. Plan the dates of the Before and After data collections. Allow a sufficient Acclimation Period after installation of the treatment to eliminate novelty effects. The acclimation period depends on the size of the change and the MOE being used. Accident data require at least one year and preferable longer. As a rule of thumb, thirty days for acclimation of MOEs other than accident data is sufficient.

The periods of data collection must be the same for each evaluation. That is, at one site before and after countermeasure implementation, data must be collected on the same day of the week, time of day, and season to avoid confounding variables (e.g. volume differences between day and night, or rush- and nonrush-hour traffic). Any deviations from the established schedule in the Before study must be repeated in the After study at both the control and implemented sites.

Step A.4: Determine the Statistical Analysis. The final element of the evaluation plan is the statistical analysis plan. Because, in most cases, Before and After data will be compared, appropriate statistical analyses are required to determine if the change is due to the treatment or chance alone. In most cases, one of three types of data will be collected.

–Continuous. Data that have no distinct intervals between possible values are continuous. Analysis of these data can be expressed as means (averages), percentile, standard deviation, or variance. Examples include vehicle speed and lateral placement.

–Dichotomous or Count. Data that are identified by the occurrence or nonoccurrence of a behavior are dichotomous. Analysis is generally in terms of the number or percentage of individuals performing an identified behavior. Examples include pedestrian compliance or pedestrian-vehicle conflicts.

–Rare Event. Behaviors that occur very infrequently (e.g. accidents) are Rare Event Data.

The actual statistical analysis performed will depend on the type of data collected. Table 5-6 presents combinations of types of data, recommended statistical tests, and comments regarding the output or use of the test.

Table 5-6

Sample Applications of Statistical Techniques *

Data Type	Recommended Tests	Comment
Continuous	t-test for difference in means F-test for difference in variances	Powerful because it uses mean and variance. Assumes data are normally distributed and samples are independent. Sample size of 30 or more required.
Continuous—more than two variables to be tested	Analysis of Variance	Gives both significance of each variable and interaction between variables.
Dichotomous (percentage)	Z-test for proportions	Used for comparing two proportions.
Dichotomous or categorical data (numerical)	Chi square (χ^2) test	Used when comparing more than two numbers; e.g., 2 x 2 or larger contingency table. Particularly useful for testing cross-tabulated questionnaire data.
Rare event data	Poisson distribution Chi-square test	Used for testing the significance of accident reduction.

*For further elaboration, see statistical texts and/or References 2,5,7.

- Step B: Conduct the Evaluation.

Step B.1: Assemble Equipment and Train Personnel. Executing the Evaluation Plan for data collection should be straightforward if the plan is comprehensive. However, there are several logistical and operational matters that should be planned in detail to insure that this effort runs smoothly and the resulting data are reliable.

–Equipment. All required equipment should be assembled and checked to insure that it is in working order. The type and make of equipment should be the same throughout the evaluation.

–Data Collection Forms. All forms should be prepared in advance, making sure that they are understood and ample space has been provided for recording the data.

–Personnel. The same people should be used throughout the evaluation. This is particularly important if visual observations are being made. Consistency between observers is difficult to achieve and usually involves lengthy training. Familiarize *all* personnel with the data collection equipment and recording forms.

Brief personnel on how to handle contingencies (e.g., how hard must it rain before the data collection is canceled). If interviews are to be conducted, use role-playing to train interviewers stressing the importance of asking the questions exactly the same way each time.

–Procedures. Prepare a set of instructions for the data collection personnel indicating exactly how, when and where the data are to be collected. Pilot test all data collection procedures prior to the start of both the Before and After studies.

Step B.2: Collect Data. Data collection should be as inconspicuous as possible. Evidence of unusual vehicles, traffic counters or radar will modify driver and pedestrian behavior and confound the effects being measured. Adhere rigorously to schedules and sampling plans. Document in detail any deviations from the schedule. If filming is used, develop films of the Before data prior to implementing the countermeasure. Prevent intervening changes (e.g., construction) at the study sites during the evaluation.

- Step C: Analyze and Interpret the Data.

Step C.1: Reduce Data and Perform Statistical Analyses. The raw field data are reduced to a form suitable for the application of statistical tests. These processes include calculating means, standard deviations, percentiles and percentages.

The statistical tests that will normally be used were listed in Table 5-6. Some discussion on the application of these tests is presented here. More detailed information should be obtained from a statistics textbook or one of the other sources identified in Appendix D: Evaluation Resources.

Statistical analysis is a mathematical procedure that quantitatively determines the likelihood that an observed change was elicited by the installation of the countermeasure or was purely by chance. It must be realized that testing for statistical significance is only a decision tool. It does not demonstrate the practical importance of the difference. For example, a new flashing signal may have a statistically significant effect on traffic speed. However, the cost of the signal versus the value of the speed reduction must still be addressed with benefit and cost data. There are situations where the difference between the two sets of measures may be highly significant but of no practical value. When interpreting test results, both issues must be considered.

Statistical significance is designated by the probability that an observed event (behavior change) is due to the implementation of a facility rather than random, chance fluctuations of the data. Convention generally calls for a 95 percent confidence level (.05 Level of Significance [LOS]; or 19-1 odds that it is not due to chance), or even a 99 percent level (.01 LOS; 99-1 odds). However, a 90 percent (.10 LOS; 9-1 odds) may be more appropriate in some situations. Deciding which significance level to use should be based on the seriousness of the implications of the findings and the concern over the possibility of falsely thinking a significant change has occurred.

–Continuous Data Analysis. For this type of data the test of significance most frequently used is the t-test for differences in means (averages). For example, to determine if the difference in mean speed is significant, apply the following equation:

$$t = \frac{\bar{X}_A - \bar{X}_B}{\sqrt{\frac{S_A^2}{N_A} + \frac{S_B^2}{N_B}}}$$

where

X_A = mean of the After speeds

X_B = mean of the Before speeds

S_A^2 = standard deviation of After speeds

S_B^2 = standard deviation of Before speeds

N_A = number of speed measurements After

N_B = number of speed measurements Before

The calculated value of t is compared to a given critical value of t (in any basic statistics book) to determine the significance of the difference between the two means. If the calculated t value is equal to or greater than the critical value, the countermeasure elicited a statistically significant change (here, a speed reduction).

—Dichotomous Data Analysis. These data are usually tabulated as proportions of the total. A z-test can be used to test the hypothesis that two sample proportions are equal when each is estimated from a large number of observations. Implementation of a countermeasure means predicting that it will bring about a reduction in (for example, pedestrian-vehicle conflicts) or that the hypothesis stated above is false.

The z-value can be obtained directly using the following formula:

$$Z = \frac{N_A n_B - N_B n_A}{\sqrt{\frac{N_B N_A n(N-n)}{N}}}$$

where:

n_B = pedestrian-vehicle conflicts Before

n_A = pedestrian-vehicle conflicts After

N_B = turning traffic volume Before

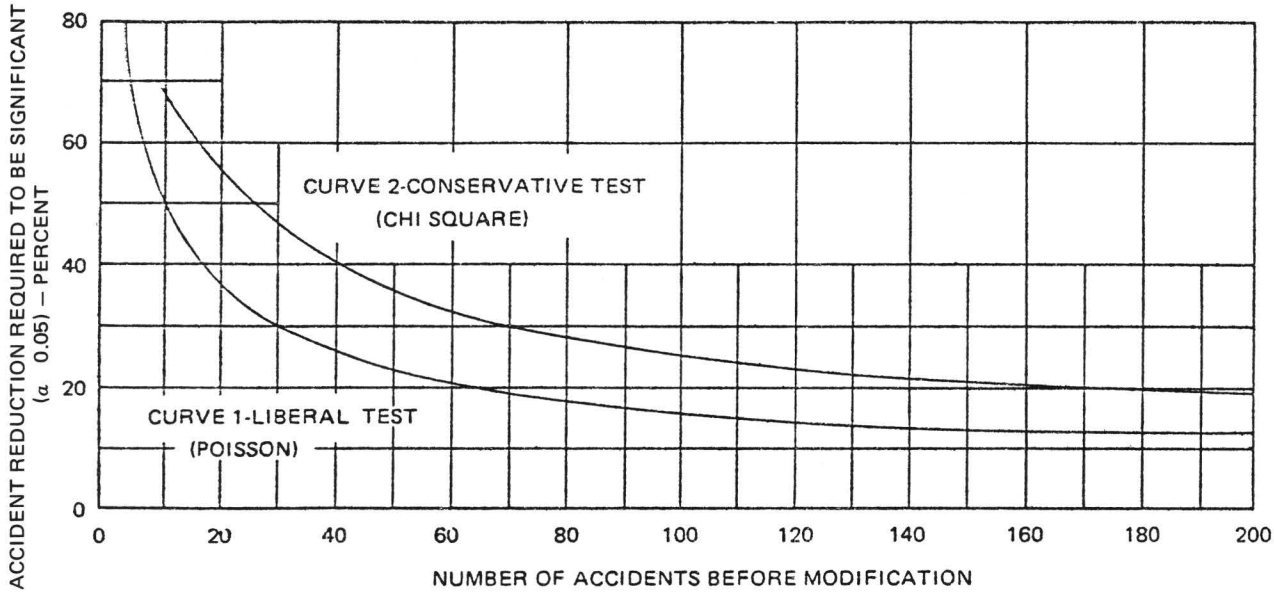
N_A = turning traffic volume After

$n = n_B + n_A$

$N = N_B + N_A$

The calculated z statistic is compared to a given critical z value (in any basic statistics book) for a level of significance. If the calculated z value is equal to or greater than the critical value, the countermeasure brought about a statistically significant reduction.

—Rare Events Data Analysis. Occasionally, it may be possible to use accident data before and after the implementation as a measure of effectiveness. If so, a convenient significance test for accident reduction is performed by use of the curves in Figure 5-1. The two curves represent two limits which can be applied to determine whether there is a significant reduction in accidents. The accident data base used for this evaluation may be either the entire sample or if large enough, only a group of Accident Types which the treatment is aimed to reduce (e.g., Dart-out Accidents).



(From Michaels, 1966).

Figure 5-1. Curve of Significance Test for Rare Event Data

The value to enter on the vertical axis is determined by the following equation:

$$\% \text{ Reduction} = \frac{\text{\# Accidents Before} - \text{\# Accidents After}}{\text{\# Accidents Before}} \times 100$$

If the traffic volumes changed significantly during the study period, substitute an accident rate (No. of accidents x 100 million total vehicles miles of travel) for the number of accidents in the above equation. Two to three years of accident data should be available as Before data to establish an average or stable condition. *Note*: If the location was selected because of an accident rate (or number) much higher than in previous years, other MOEs should be considered.

If the intersection point on the graph is above the upper curve, there is a 95 percent confidence that the countermeasure brought about an accident reduction. If the point falls below the lower curve, any reduction found can be attributable to chance. Values falling between the curves are strongly suggestive of a significant improvement, but additional data should be collected to be certain.

Step C.2: Report Findings and Recommendations. Two objectives should be met in reporting findings: clearly present the conclusions reached, including any recommendations for future study; and document all relevant aspects of the evaluation and data analysis procedures. Use graphic presentation of statistical facts and figures to emphasize critical results.

The report should contain sufficient details of all aspects of the procedure to enable others to assess the applicability to their particular situation.

Pertinent References – Evaluation

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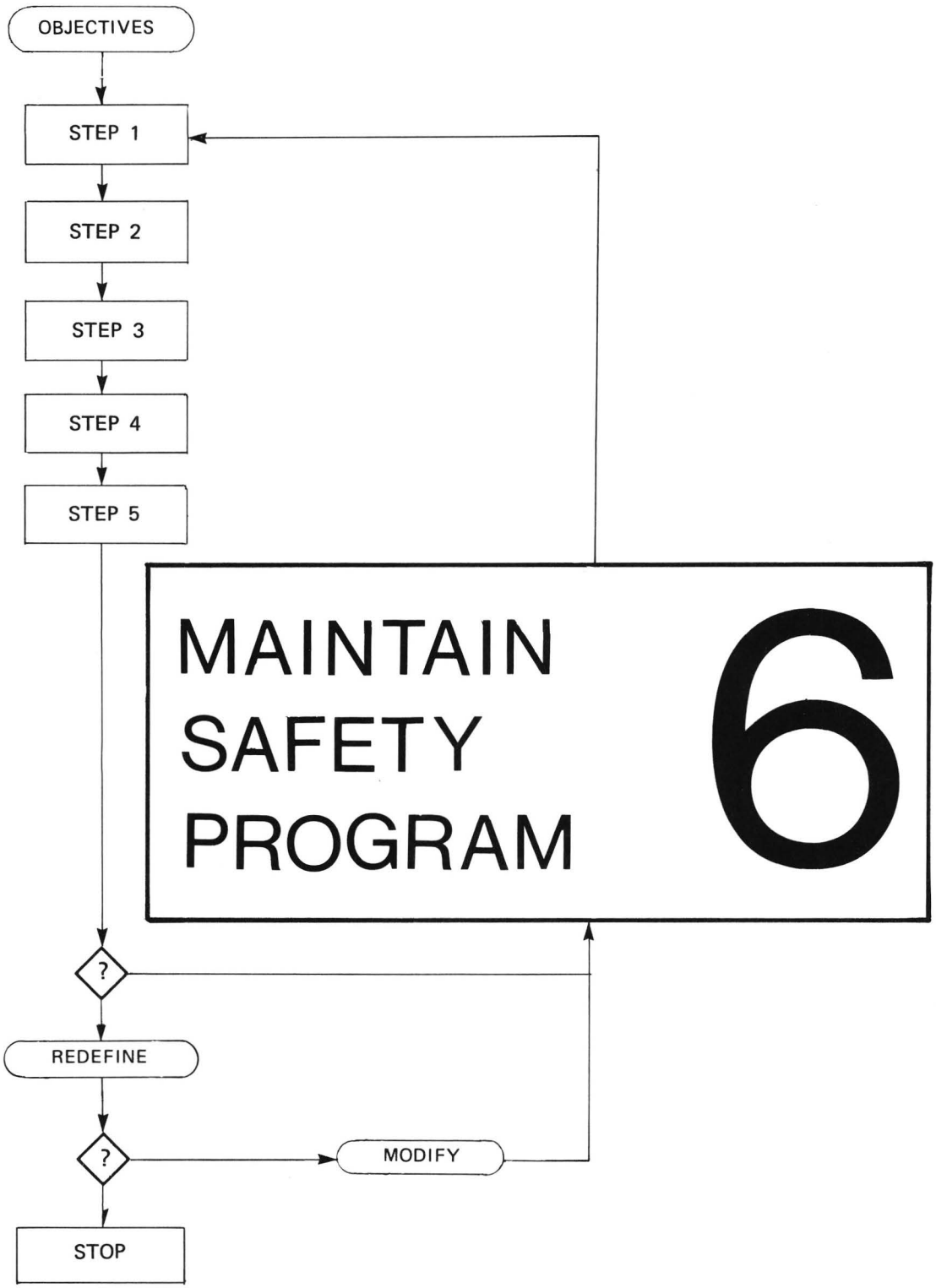
OBJECTIVES
STEP 1
STEP 2
STEP 3
STEP 4
STEP 5
MAINTAIN SAFETY PROGRAM
6
?
REDEFINE
?
MODIFY
STOP

DON'T STOP NOW

STEP 6: MAINTAIN THE PEDESTRIAN SAFETY PROGRAM

The first five steps of the Model Pedestrian Safety Program have presented:

- procedures for identifying and determining the pedestrian safety problem.
- ideas for resolving problem areas.
- a method to rationally select the best alternative.
- recommendations to ensure viable implementation.
- techniques for evaluating the effectiveness of implemented alternatives.

These five steps do not end your safety program.

Although one or more problems may have been corrected with one cycle through these steps, other problem areas will continually flare-up. Only through constant watch will these be identified on a timely basis. Early detection can mean prompt reaction, keeping the problem at a minimal level.

A *successful* pedestrian safety program is a never-ending loop. Step 6: Maintain the Pedestrian Safety Program, is not so much a definitive step as a feedback movement returning to Step 1. In actuality, there are few procedural differences between Steps 5 and 1. Although the discussion deals primarily with the statistical aspects of evaluation, the data used in the evaluative process in Step 5 are the same data used in Step 1 to identify the problem – accident and behavioral analyses. This is useful because the existence of new problems might be detected during the process of evaluating the effects of a previously implemented facility.*

Because there will always be pedestrian-vehicle interactions, the *potential* for accidents is quite high. Although your locality may not have a pedestrian safety problem at present, it does not take many collisions to greatly increase the accident rate.

The traffic situation can be viewed as a "pressure cooker" (see Figure 6-1). Envisioning the contents of the pot as the interactions of pedestrians and vehicles, without constant watch of the situation (the lid), these interactions can become too intense and "boil over" into accidents, injuries and fatalities. With a tight lid (Complete Program), the contents are kept under control. The Complete Safety Program begins with a return to Step 1 and recycling through the Model Pedestrian Safety Program again and again. Quick identification of problems and timely selection and implementation of solutions is a must for a long-term safe environment for pedestrians.

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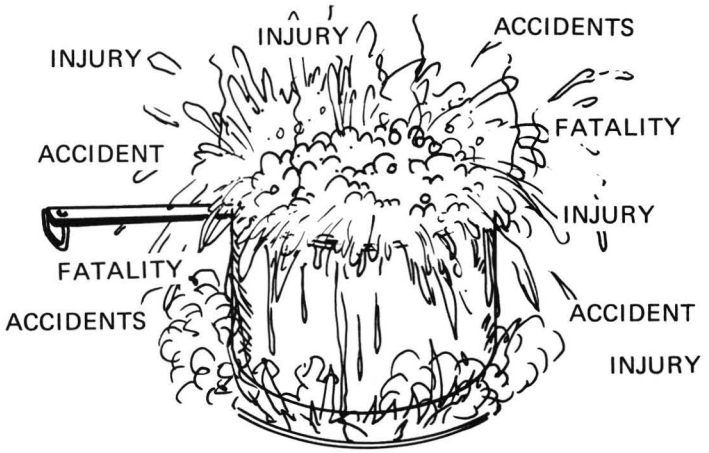
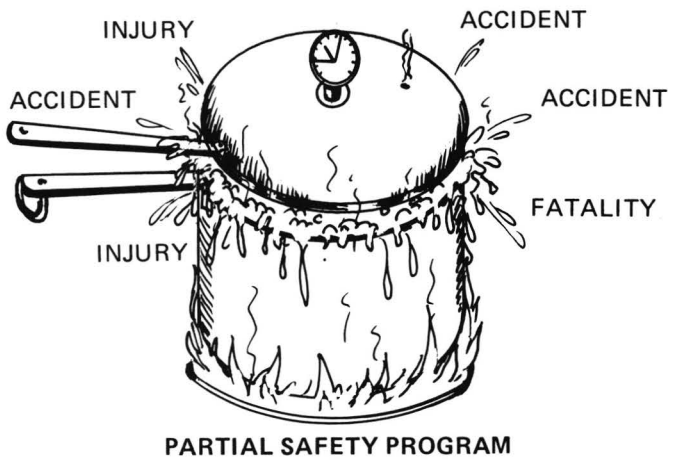
*Even at one implemented location, the process of making a safer situation for pedestrians may have negative effects on other traffic. Part of the Evaluation – Problem Identification process is to check out these possible unfavorable effects resulting from earlier implementations.





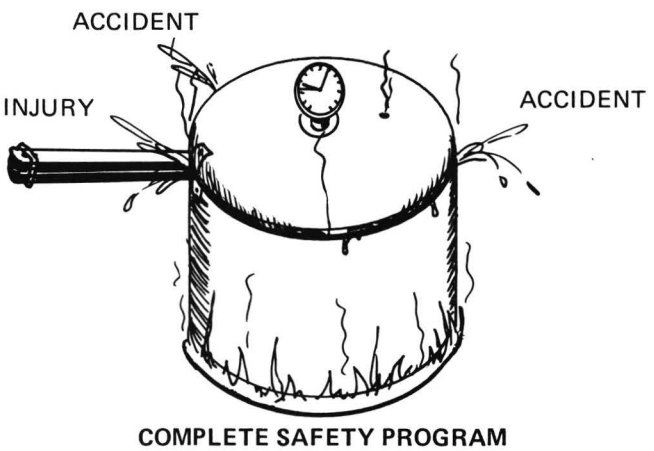
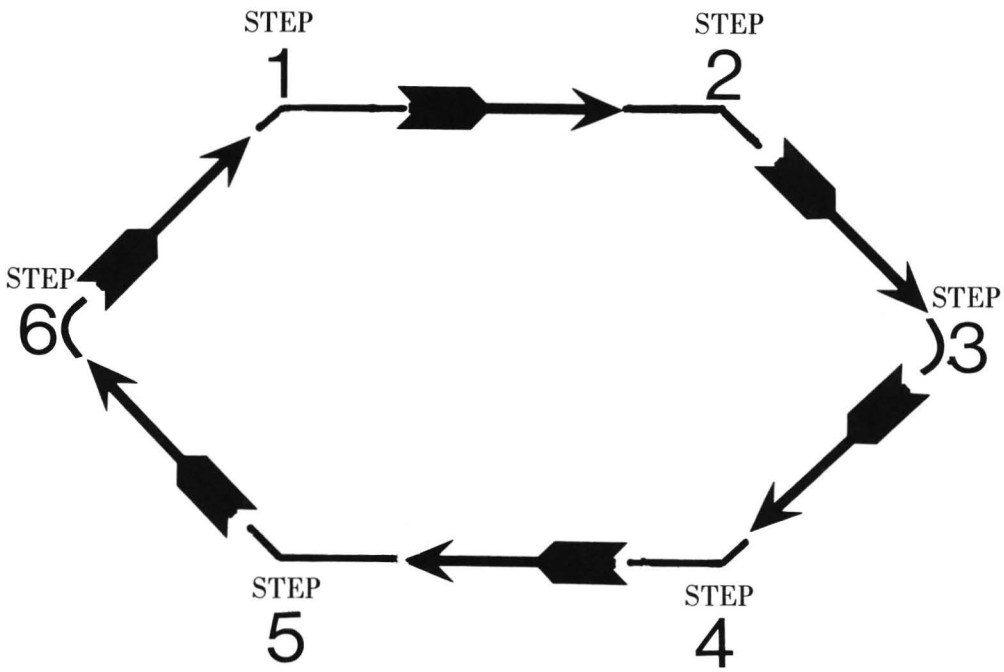


Figure 6-1. Three Levels of Safety Programs and Their Results.



PROGRAM MAINTENANCE

APPENDIX A

GLOSSARY OF TERMS

Step 1: Identify Extent of Problem

Accident:	collision or crash involving a pedestrian and a vehicle.
Accident Reconstruction:	the process of determining the behavioral sequence of events which occurred immediately preceding, during and after the collision.
Accident Typology:	grouping of pedestrian accidents by critical behavioral and locational descriptors. Each Accident Causal Type has one or more countermeasures which addresses one or more of the critical descriptors.
Activity Sampling:	collection of nonaccident behavioral data. Because accidents occur infrequently, activity sampling is used as a shorter-term evaluation tool of the effectiveness of a countermeasure installation.
Causal Factors:	individual behaviors along the accident Events Sequence. Five behaviors describe the general activities needed to be performed by a pedestrian or driver/vehicle in order to avoid an accident. They are: search, detection, evaluation, decision, and action. The behaviors identify focal points for countermeasure solutions to interrupt the sequence leading to a crash.
Causal Type:	definition of a pedestrian accident using one or more critical behavioral, locational or populational critical descriptors. Each Causal Type is described by its Precipitating Event(s), Predisposing Factor(s), and/or Target Group(s).
Events Sequence:	the series of behaviors performed by the pedestrian and driver which result in a fatal or nonfatal collision. The Events Sequence is made up of the series of Causal Factors.
Hazardous Location:	street, intersection, neighborhood, or locality where pedestrian accidents frequently occur; or where pedestrians/drivers are continually performing unsafe behaviors increasing their potential for accident involvement; or where site geometrics (conditions) inhibit safety and thereby increase the likelihood of a collision occurring.
Involvement Ratio:	the frequency or percentage of a particular behavior/accident type relative to the total population present.
Master Coding Form:	accident data collection sheet listing all the data relevant to determination of the Accident Type. Data are obtained from the standard (police) report and a Supplemental Data Form.
Nonaccident Behavioral Analysis	collection of data on the population of pedestrians and drivers *not* involved in pedestrian accidents.

Precipitating Events: specific nature of the failure in the Event Sequence that leads to a collision; factors leading directly and immediately to a crash.

Predisposing Factors: specific environmental, human or vehicle variables which *actually influence* the collision. Factors which, in advance, create a susceptability, inclination or disposition toward a crash.

Supplemental Data Form: accident data collection sheet used to record all data pertinent to Pedestrian Accident Type identification but *not* appearing on the standard report form.

Target Group: subpopulations and/or types of locations involved in a particular accident type, or at whom a specific countermeasure solution is aimed.

Barriers: chains, fences or similar devices separating pedestrian and vehicular traffic.

- Pedestrian
  - Median Barriers: located along a median or area separating opposing traffic lanes preventing pedestrians from crossing at nonintersection locations. Usually constructed using chain link fencing.
  - Roadside Barriers: located alongside a highway or freeway to prevent pedestrians from crossing the road. Generally made with chain link fencing.
  - Sidewalk Barriers: located along or near the edge of a sidewalk to channel pedestrians to crosswalks or grade-separated facilities, or to impede their crossing at hazardous locations. Common construction materials include chain link fencing, pipe and chain/cable, planters or other sidewalk furniture, and hedges.
- Vehicle
  - Median Barriers: guardrails, concrete barriers, fences, or hedges used to separate opposing lanes of traffic.
  - Shoulder Barriers: guardrails or other barriers used to separate vehicle and pedestrian traffic.
  - Street Closure Barriers: concrete, wood or live plant barriers used to prevent vehicles from entering particular streets or blocks.

Bus Stop Relocation: moving a transit or school bus stop from the nearside to the far side of an intersection.

Countermeasure: solution to a pedestrian safety problem.

Crosswalks: the portion of the roadway designated for pedestrians to cross the street.

- Unmarked Crosswalk: the portion of a roadway at an intersection included within the prolongation of the boundary lines of sidewalks or pathways used by pedestrians; does not include the prolongation of alley lines.
- Marked Crosswalk: part of the road distinctly indicated for pedestrians by lines or other markings on the road surface.
- Midblock Crosswalk: a marked crosswalk located between intersections; possibly with a pedestrian-actuated signal.

Diagonal Parking: situation in which vehicles may park only head-in at an angle. (In this context as a pedestrian safety countermeasure, parking is prohibited on the opposite side of the street.)

Emergency Medical Services: facilities which increase the likelihood of an accident participant's survival through rapid and expert attention to their injuries and timely transport to hospital or other medical services.

Enforcement: programs aimed at encouraging obedience to pedestrian laws and pedestrian-related vehicle laws.

Grade Separation: a facility allowing free-flowing, noninteracting, generally perpendicular flow of pedestrians and vehicles. Grade-separated facilities are located one or more levels above or below ground (vehicle) level.

- Below-Grade Networks: extensive underground walkways that carry pedestrians perpendicular and parallel to the vehicles flowing above them.
- Elevated Walkways: "sidewalks" located above ground level. They run generally parallel to the vehicle direction of flow, and can be free-standing or part of an adjacent building (e.g., as an arcade).
- Overpass/Bridge: above-ground passageway or bridge over a roadway. Both ends of the overpass are at grade level, with stairs or ramps taking the pedestrian up over the roadway.
- Skyways/Skywalks: generally enclosed crossovers one or more levels above ground level. Both ends of the skywalk are above grade level.
- Underpass/Tunnel: the same as an overpass, except that the stairs or ramps lead down to an underground passage. Both ends are at grade level.

Handicapped, Facilities for the: traffic engineering devices that aid those with physical disabilities (e.g. blindness, deafness, loss of limb).

- Audio Signals: pedestrian signals augmented with bells, horns, buzzers or clicking sounds to indicate when the WALK signal is on.
- Combination Audio and Tactile Signals: small vibrating boxes located on signal posts which give off a clicking sound so they can be easily located.
- Crosswalk-Related Guidestrips: raised markings of epoxy and gravel that can be felt by a blind person with a cane and used as a guide to cross the street.
- Curb Ramps: sloped structures for pedestrians which cut through a curb or build up to the curb from street level.
- Sidewalk-Related Guidestrips: tactile strips located along the edge of a walkway to guide blind pedestrians.

- Tactile Signals: devices keyed to the signal that vibrate to let the blind touching the device know when they can cross.

Level of Service: a qualitative measure of the operating conditions on a pedestrian walkway. The level of service is affected by pedestrian volume and speed, interruptions, freedom to maneuver, safety, comfort and convenience.

Lighting: the use of lights to illuminate roads, sidewalks and crosswalks.

Markings: regulatory, warning or guiding words, patterns or lines painted on the pavement (for vehicles) or sidewalk curb (for pedestrians).

- Crosswalk Markings: painted lines delineating a pedestrian crosswalk.
- Stop line: painted stripe indicating the place where vehicles should stop at a stop sign, traffic light or crosswalk.

One-Way Street: street on which vehicles may travel in only one direction.

Play Streets: residential streets, usually in high density urban environments, closed to through traffic during specified hours in the summer to permit a supervised or general program of recreational activities to take place.

Retroreflective Materials: materials which reflect light from headlights back to the driver. They are composed of millions of tiny glass beads or microscopic plastic prisms bonded to cloth or to a material that can be transferred to cloth and worn by pedestrians.

Safe Route to School Program: a program that establishes, organizes, and operates safe routes for children to use when travelling between home and school. Simple maps are drawn up showing streets, the school, and the suggested route.

Safety Island: pedestrian refuge area between opposing traffic lanes or within an intersection; includes islands originally installed to channel vehicle traffic, but used by pedestrians.

- Loading Islands: raised islands serving as refuges for loading and unloading passengers from transit vehicles.
- Raised Islands/Medians: islands raised above the level of the road and designated with a curb.
- Roadway-level Islands: islands marked on the road with paint, raised markers, or other distinguishing material.

Safety Town: a miniaturized village with streets, sidewalks, buildings and traffic control devices used for instructing small children in the basics of traffic operations.

School Bus Patrols: student patrols trained to maintain order on buses and at bus stops.

School Bus Routing: determination of safe and efficient school bus routes and stops.

School Crossing Guards: trained community members, police, or older children who instruct, direct, and control students at street crossings.

- Adult Crossing Guards: paid, uniformed community members trained to stop traffic, if necessary, to help children across streets.
- Police Guards: members of the police department who stop traffic to allow school children to cross.
- Student Patrols: trained boys and girls who control other children at crossings and choose safe gaps in vehicle traffic during which they can cross.

Sidewalks: at-grade areas for pedestrian travel; includes walkways between the curb lines or edge of a roadway and the adjacent property lines.

- Pathway: temporary gravel or asphalt walkway along the roadside.
- Permanent Sidewalk: concrete walkway separated from the road by a curb or gutter.
- Shoulder Improvements: area adjacent to the roadway that has been cleared of physical obstructions for use by pedestrians.
- Widened Sidewalk: walkway that has been widened by reducing the street area (generally the parking lane).

Signals: electro-mechanical devices used for regulating, directing, or warning motorists and/or pedestrians.

- Pedestrian Signal: a supplement to traffic control signals telling pedestrians when it is safe to start their crossing through the use of words or symbols.
  - Delayed Phase: either the traffic or pedestrian signal is delayed to allow pedestrians to get out into the crosswalk before vehicles start, or to allow vehicles to turn before pedestrians start.
  - Separate Phase (Scramble or Barnes' Dance): all vehicles are stopped to allow pedestrians to cross unimpeded on all approaches and on the diagonal.
  - Shared Phase: pedestrian signals are timed with the traffic signal; pedestrians cross at the same time as vehicles moving parallel to them.
- Traffic Signal: device designed primarily for vehicular traffic control; pedestrians use the same phase and signals as the vehicles.

Signs: devices mounted on a fixed support, conveying a regulatory, warning or guiding message to pedestrians or motorists.

- Variable Message: electronic signs that can light up different messages according to need.

Urban-Pedestrian Environment: at-grade environment partially or wholly separated from vehicular traffic; includes malls, auto-free zones and transitways located in urban business, commercial, industrial and residential areas.

- Continuous Mall: multi-block pedestrian street from which all but emergency vehicles are excluded and which extends the full length of a shopping area without interruption.
- Displaced Sidewalk Grid: horizontally displaced pedestrian walkways through alleys, arcades or lobbies within buildings.
- Modified Street: conventional street with one block closed to traffic for exclusive pedestrian movement.
- Plaza or Interrupted Mall: blocks of a retail street given over to exclusive pedestrian use, with cross streets left open to vehicular traffic.
- Transitway: street reserved for pedestrians and transit vehicles; all private vehicles are excluded except for emergency or temporary construction work vehicles. Bus transit lanes are set apart from pedestrian areas.

Step 3: Benefit-Cost Analysis

Alternative: accident countermeasure; solution to a problem. Benefit-Cost Analysis compares the relative effects of one or more potential problem solutions.

Benefit: the *positive* effects resulting from the installation and operation of a pedestrian safety countermeasure.

Benefit-Cost Analysis: a mathematical procedure which analyzes and compares the anticipated benefits of a safety facility with the anticipated costs. The alternative with the highest Benefit-Cost Ratio *and* meeting the constraints is selected for implementation.

Benefit-Cost Ratio: mathematical expression of the relationship between the Total Benefits and Total Costs anticipated for an alternative. Alternatives are considered in order of highest-to-lowest B-C Ratio.

Cost: the *negative* aspects of the installation and operation of a pedestrian safety countermeasure.

Constraint: a prerequisite goal or limitation that an alternative must meet in order to be implemented. Constraints can be related to benefits (e.g. a desired 10 percent reduction in the accident rate), or to costs (e.g. $10,000 maximum construction cost).

Sensitivity Analysis: mathematical technique allowing Benefit-Cost Analyses considering more than one possible future condition for any or all variables for one or all alternatives. The task of the decision maker-analyst is to decide which of the possible future environments is the most likely.

Value Rating: a "neutral" number representing the anticipated level of a benefit or cost variable. The range of possible variable levels is matched to a 0-100 point Value Rating Scale. The anticipated level of the individual variable is converted to the appropriate Value Rating.

- **Benefit Variable Value Rating:** the Value Rating of an individual benefit variable.
- **Cost Variable Value Rating:** the Value Rating of an individual cost variable.
- **Total Benefit Value Rating:** the summation of all the individual Benefit Variable Value Ratings divided by the number of benefit variables for that alternative.

- **Total Cost Value Rating:** the summation of all the individual Cost Variable Value Ratings divided by the number of cost variables for that alternative.

Variable: individual benefit or cost item expected to influence or be influenced by an alternative.

Variable Priority Weighting: mathematical procedure which deemphasizes individual benefit or cost variables (thereby emphasizing other variables) during the B-C Analysis.

Weighting Factor: a number, from 0 and 1, multiplied with an individual variable's Value Rating. A weight of 1 gives full value to the variable; a weight of 0 eliminates the variable from further consideration for that analysis.

Acclimation Period: transition period after implementation of a facility during which users' behaviors are initially being affected. The length of this period will depend on the size of the change and the measure of effectiveness (MOE) being evaluated.

Before-After Design: experimental design in which two measurements are taken at a site, one before and one after implementation of an alternative at that site. The effect of the countermeasure is calculated as the difference between these two measurements.

Before-After with Control Site(s): similar to the Before-After except that two (or more) *comparable* sites are identified for data comparison. Identical data are taken at both sites before and after installation.

Continuous Data: data that have no distinct intervals between possible measurements. Analysis of these data can be expressed as means, percentiles, standard deviation, or variance. Examples include vehicle speed and lateral placement.

Control Site/Group: location similar in design and operation, or subpopulation of people demographically similar, to the location/group affected by implementation of an alternative. Data are collected before and after installation at the problem site.

Dependent Variable: the behavioral item(s) (Causal Factor) expected to be affected by installation of a countermeasure; the Measure of Effectiveness (MOE) for a particular evaluation.

Dichotomous Data: data identified by the occurrence or nonoccurrence of a behavior (i.e. "yes" or "no" type answer). Analysis is generally in terms of the number or percentage of individuals performing an identified behavior. Examples include pedestrian compliance or pedestrian-vehicle conflicts.

Effectiveness Evaluation: data concerning the safety consequences of the implementation of a countermeasure.

Experimental Design: the method of collecting data for evaluation.

Independent Variable: behavioral item(s) not expected to be affected by a particular countermeasure.

Mean:	average.
Measure of Effectiveness (MOE):	the dependent variable(s) that indicate the effect of a countermeasure.
Novelty Effect:	behavioral changes elicited immediately after the installation of a countermeasure. These are usually short-lived phenomena occurring during the Acclimation Period (e.g. pedestrians going out of their way to use a crossover just to check it out). More long-term effects will be seen after the novelty wears off.
Programmatic Evaluation:	evaluation of the overall safety program goals and objectives (versus individual facility implementations) in terms of performance activities (planning and development, operation, etc.).
Regression to the Mean:	statistical phenomenon in which any extreme data tend to become less extreme in succeeding time periods. (E.g., short-term reductions in accident rates are often interpreted as the positive effect of a countermeasure, but are frequently due to random fluctuation of the data.)
Rare Event Data:	behaviors that occur very infrequently (e.g. accidents).
Statistical Significance:	mathematical expression of the degree of certainty that an observed event (behavior change) is due to the implemented facility rather than chance. While convention usually calls for the .05 (95 percent confidence) or the .01 (99 percent confidence) level, a .10 level may be more appropriate in some situations.
Variable:	individual behavior (Causal Factor) expected to be influenced by a countermeasure (dependent variable) or not influenced (independent).

APPENDIX B
DATA COLLECTION TECHNIQUES

Several techniques are available to collect nonaccident behavioral data. This appendix discusses manual and photographic methods of data collection. Each of these has advantages and disadvantages. Descriptions and sample data forms for the two techniques are provided.

The most direct method of assessing pedestrian and vehicle behaviors is to count the frequency of occurrence of each defined behavior. This leads to the first step of behavioral analysis that *must* be accomplished: operationally define the events to be measured. This means specifying the *observable* elements necessary to define the event. The best operational definitions are those simple enough to completely describe the behavior *and* be understood by all potential users. (For example, an operational definition of Aborted Crossing might be: "Ped. returns to curb after having both feet in roadway.") The definition should also reflect the method of data collection to be used. (An example of an operational definition for Running might be: Crossing an entire traffic lane in three or less frames of film [$\geqslant$6.6 feet*per second].") Such a concise statement of the elements used to define a behavior is invaluable for comparing the results of different studies – e.g., between localities in a state.

Observation of behaviors at a site generally involves evaluating individual and group behaviors, and the dynamics of pedestrian-vehicle interactions. These data can be collected by manual or filming techniques.

*1 foot = .30 metre

Data Collection by Manual Methods

Manual collection of data is done using one or more observers in the field recording behaviors of interest. Table B-1 gives examples of items which can be recorded using manual methods. There are two common procedures used in manual data collection: the "paper and pencil technique" and tape recording observations for later transferral to data forms. In the first procedure, data are recorded on paper as they are being observed in the field. In the second, the observer simply talks into a recorder; the data are put down on paper after returning to the office. For both techniques, data forms must be developed from which the data can be analyzed. Figures B-1 to B-4 illustrate possible designs of forms useful for collecting manual data.

It should be apparent that manual data collection is best suited for rather simple tallies of non-complex behaviors. Sophisticated behavioral analysis and collection of more than a very few different behaviors is virtually impossible. This is because data collection using manual techniques occurs in realtime. That is, once the behavior occurs, it cannot be seen again. If more detailed data are desired, photographic techniques should be considered.

Table B-1

Sample Manual Observation Data Items

Data Item	Definition	Purpose	Data Collection Procedures
Traffic Flow Tallies	A measure of vehicular volume and turning activity	To characterize the "level of service" of the streets comprising the site in order to determine possible interactions with, and effects of, the countermeasures	Manual counts taken during one green light interval per intersection leg or for a random one-minute interval at nonsignalized intersections
Pedestrian Flow Tallies	A measure of pedestrian usage of marked and unmarked crosswalks	To characterize the "level of service" of the site and the direction of pedestrian movement in order to determine possible interactions with, and effects of, the countermeasures	Manual counts taken for five minutes at each corner of an intersection starting with the onset of the green light (or walk signal) if present
Timing of Light Signals	A measure of traffic and pedestrian light signal intervals	To characterize the signal timing and thus determine its possible affect on traffic and pedestrian flow	Manual timing of all light signals (vehicular and pedestrian) at an intersection

(From Berger, 1975)

DATA FORM 7
PEDESTRIAN FLOW TALLIES

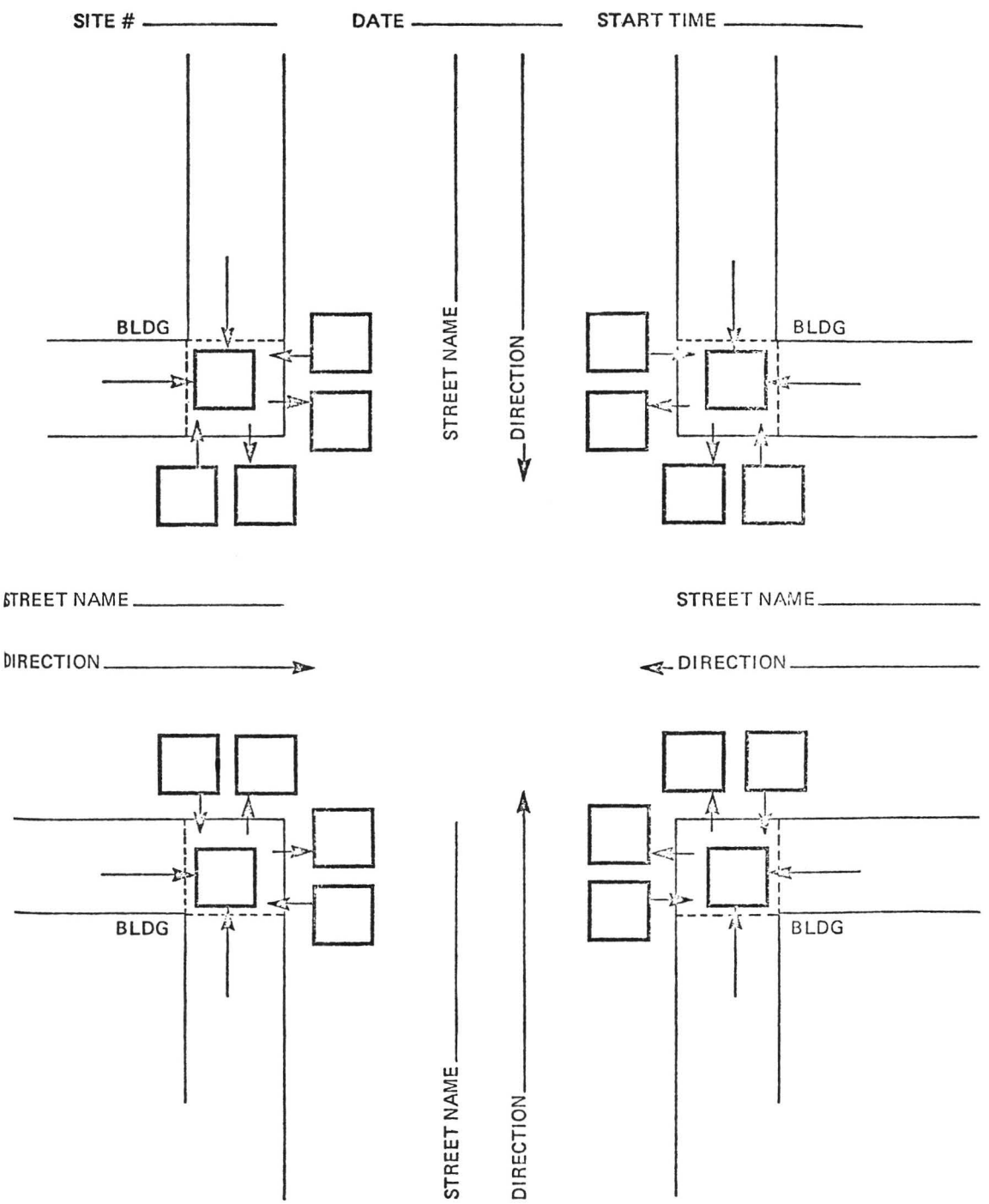


Figure B-1. Example Pedestrian Flow Data Collection Form.

Form 3 - Pedestrian Observations at Study Walk

Committee Member _____

Study Phase: A____ B____ Using: Flash____ Steady____ clearance

Location: _____ and _____ Streets

Time (10 minute intervals)	1 Walk	2 Don't Walk (Flash)	3 Don't Walk (Steady)	4 Veh. Red	5 Veh. Green
TOTALS					

Number of Peds who left curb during these intervals (see note)

NOTE: Peds in Columns 4 & 5 also appear in Column 3.

Vehicle volume rate (hourly)

Figure B-2. Example Pedestrian Data Collection Form.

INTERSECTION _____ DATE _____ CODER _____

PERIOD AND LEG	COUNTS			
	B	RTV	MV	TV
1 A	#P =			
	#T =			
1 B				
1 C				
1 D				
2 A				
2 B				
2 C				
2 D				
3 A				
3 B				
3 C				
3 D				
4 A				
4 B				
4 C				
4 D				

B = Momentary reversal in pedestrian direction of travel in the traffic lane or hesitation, in response to a vehicle in a traffic lane.

RVT = Running in a traffic lane in response to TV

TV = Number of turning vehicles involved coming within 20 feet of a pedestrian (in path of vehicle).

MV = Thru vehicle moving thru the crosswalk whicle pedestrian is in a traffic lane (any one vehicle and/or any one pedestrian may be counted only once)

KEY: #P = Number of pedestrians
#T = Number of times per pedestrian (multiples)

Figure B-3. Example Pedestrian Data Collection Form.

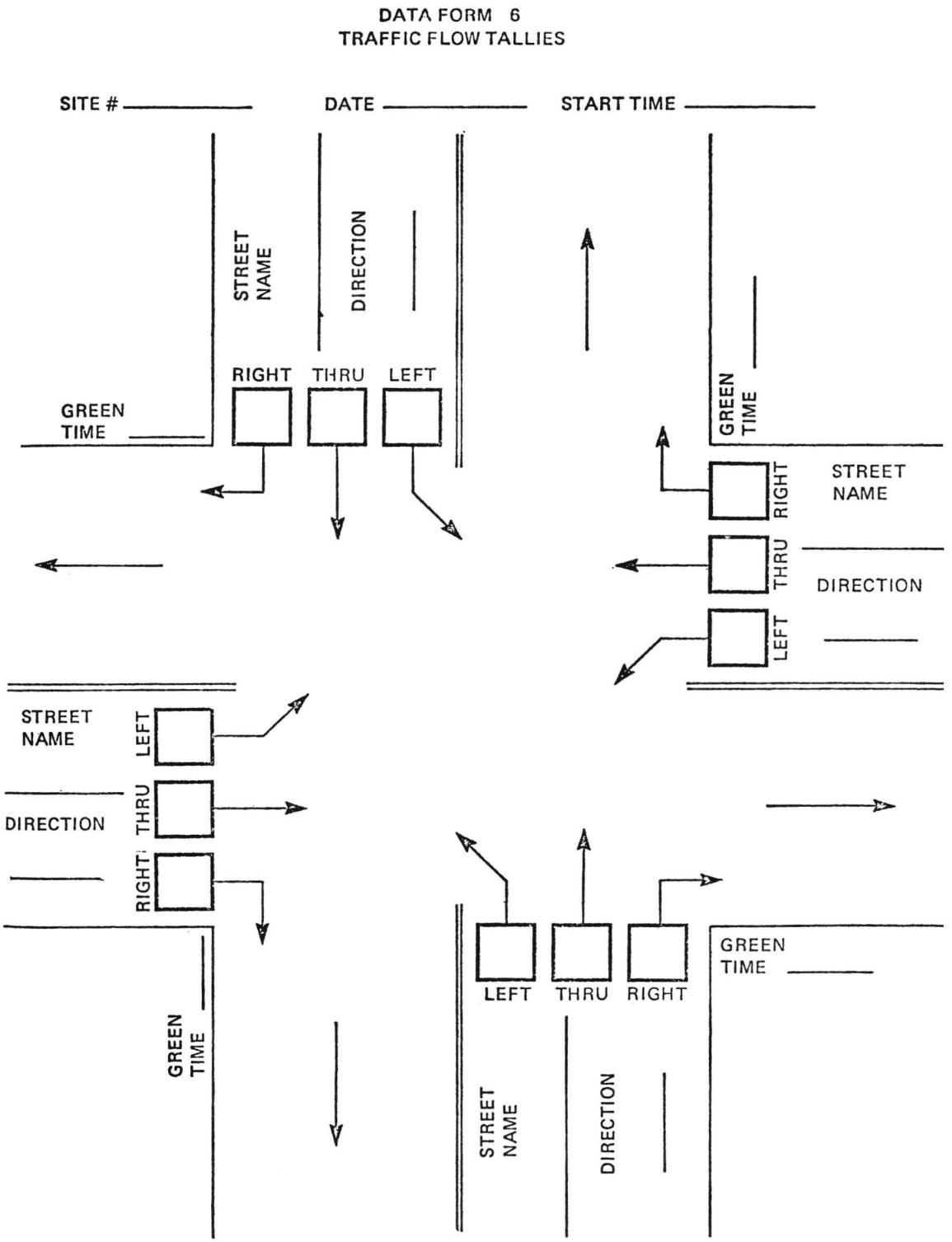


Figure B-4. Example Traffic Flow Data Collection Form.

Data Collection by Photographic Methods

Because of the rapidity with which pedestrian and vehicle behaviors occur in a natural setting, it is often impossible to observe and record all individual behaviors which may be significant. One way around this problem is to record the behaviors on film and analyze them at a slower pace.

Filming of behaviors can be done using realtime or time-lapse photography. Realtime photography is generally taken at 18 film frames per second (fps). Because normal projection speed is 18 fps, the data on the film is seen at the same speed at which it occurred. Time-lapse photography, when projected at normal speed, speeds up or slows down the actual action. For data analysis, films are usually projected at slow rates so that numerous behavioral actions can be recorded. Table B-2 gives examples of items which can be recorded using photographic techniques. Figures B-5 and B-6 illustrate sample recording forms for transferring film data to paper for evaluation.

Table B-2

Sample Photographic Data Items

Data Item	Definition	Purpose	Data Collection Procedures
Behavioral Sequence Records (BSR)	A detailed description of the entire crossing episode of a pedestrian	To reveal the crossing characteristics of pedestrians that perform undesired actions (e.g., midblock crossing, against signal, etc.)	Simultaneous filming (18 fps) and manual recording
Pedestrian Activity Sampling (PAS)	A record of pedestrian behaviors in a defined area of the roadway	To characterize pedestrian activities as a) hazardous, and b) countermeasure specific (e.g., sudden appearances, intersection runs, etc.)	Time-lapse photography of the area under study (2 fps)
Traffic Behavior (TB)	A measure of vehicle speed and headway within the site area by lane	To characterize vehicle behavior in order to determine possible interactions with, and effects of, the countermeasures	Film records of vehicles traversing a standard measurement area (18 fps)

(From Berger, 1972)

PAS FILM SCORING – MIDBLOCK COUNTERMEASURES

Site # _____ **Source of Information:** Film ☐ Forms ☐

Date _____ **Phase:** B ☐ A_1 ☐ A_2 ☐ P ☐

Control/Experimental **Data Mode:** 1 ☐ 2 ☐

Scorer's Initials _____

Countermeasure: Median Barrier/Midblock Crosswalk/Diagonal Parking/Meter Post Barrier

Definitions:

Pedestrian: Individual whose entire crossing is on film (curb to curb) as long as he enters roadway more than 20 feet from nearest intersection crosswalk.

Abort: Ped. returns to the curb after having had both feet in roadway.

Trapped on Median: Ped. hesitates or stops while on median waiting for the passage of at least one vehicle.

Bus Stop Related: Ped. crosses in front of stopped bus (at bus stop) into traffic lane.

Vehicle Overtaking: Ped. enters roadway and moves in front of stopped or standing vehicle (not a parked vehicle) into lane of traffic moving in the same direction.

Walking on Median: Two or more steps parallel to the roadway while on the median.

Veh. Induced Hesitation: Ped. hesitates or stops in roadway (parking or thru traffic lane) waiting for the passage of at least one vehicle; (no forward motion for at least one frame of film).

Backup Movement: Momentary reversal in ped. direction of travel (parking or thru traffic lane), i.e. 1 or more steps in opposite direction.

In Front of Parked Vehicle: Ped. enters roadway between vehicles parked less than one car length apart or within one car length in front of a parked vehicle.

Running: Traversing a ten foot lane in 3 frames of film or less (> 6.6 feet/second).

Running into: Ped. meets running requirements in initial (curb) lane.

Running in: Ped. meets running requirements after passing initial (curb) lane.

Sudden Appearance: Ped. runs into roadway from between parked vehicles or within one car length in front of a parked vehicle.

Running into 2nd Half: Ped. runs into second half of roadway.

Note: Sudden Appearances will be double-coded under Running into Roadway, In Front of Parked Vehicles as well as Sudden Appearance.

PAS PERIOD								
TOTAL PEDESTRIANS								
Hazard A								
Hazard B								
Hazard C								
Abort								
Trapped on Median								
Bus Stop Related								
Vehicle Overtaking								
Walking on Median								
Veh. Induced Hesitation (Traffic Lane)								
Veh. Induced Hesitation (Parking Lane)								
Backup Movement (Traffic Lane)								
Backup Movement (Parking Lane)								
In Front of Parked Vehicles								
Running into Roadway								
Running in Roadway								
Sudden Appearance								
Running into 2nd Half								
Site Specific								

1 foot = .30 metre

Figure B-5. Example Pedestrian Film Data Collection Form.

PAS FILM SCORING—INTERSECT[illegible] COUNTERMEASURES

Site # _____
Date _____
Control/Experimental
Scorer's Initials _____

Source of Information: Film ☐ Forms ☐
Phase: B ☐ A_1 ☐ A_2 ☐ P ☐
Data Mode: 1 ☐ 2 ☐

Countermeasure: Preventive Markings/Crosswalk Set-Back/Stop Line Relocation/Bus Stop Relocation
Definitions:

Pedestrian: Individual whose entire crossing is on film (curb to curb).
Abort: Ped. returns to the curb after having had both feet in roadway.
Turning Conflict—1: Number of turning vehicles involved in Type 3 conflicts.
Turning Conflict—2: Number of pedestrians whose flow is interrupted (hesitation) by turning traffic.
Turning Conflict—3: Number of pedestrians who pass within one car length in front of a turning vehicle.
Trapped on Median: Ped. hesitates or stops while on median waiting for the passage of at least one vehicle.
Leaving Crosswalk: Ped. leaves crosswalk area into a traffic lane.
Outside of Crosswalk: Ped. crosses all traffic lanes outside of painted crosswalk.
Bus Stop Related: Ped. crosses in front of stopped bus (at bus stop) against the signal.
Vehicle Overtaking: Ped. enters roadway and moves in front of stopped or standing vehicle (not a parked vehicle) into a lane of traffic moving in the same direction (against signal).
Crossing Against Light: Entry into and exit from roadway while vehicles are still moving and/or making a complete crossing before waiting peds. start across.
Crossing ½ Way Against Light: Vehicle passes ped. as he gets to center line; stopped vehicle begins to move before ped. has taken 2 steps beyond center line of 2nd half of roadway.
Veh. Induced Hesitation: Ped. hesitates or stops in roadway (parking or thru traffic lane) waiting for the passage of at least one vehicle; (no forward motion for at least one frame of film).
Backup Movement: Momentary reversal in ped. direction of travel (parking or thru traffic lane); i.e. 1 or more steps in opposite direction.
Running: Traversing a ten foot lane in 3 frames of film or less (> 6.6 feet/second).
Running into: Ped. meets running requirements in initial (curb) lane.
Running in: Ped. meets running requirements after passing initial (curb) lane.
Intersection Run: Running into (1st or 2nd half of) roadway against the light signal.
Note: Intersection Run will be double-coded under Running in/into Roadway, Crossing Against the Light as well as Intersection Run.

PAS PERIOD								
TOTAL PEDESTRIANS								
Hazard A								
Hazard B								
Hazard C								
Abort								
Turning Conflict—1								
Turning Conflict—2								
Turning Conflict—3								
Trapped on Median								
Leaving Crosswalk								
Outside of Crosswalk								
Bus Stop Related								
Vehicle Overtaking								
Crossing Against Light								
Crossing 1/2 Way Against Light								
Veh. Induced Hesitation (Traffic Lane)								
Veh. Induced Hesitation (Parking Lane)								
Backup Movement (Traffic Lane)								
Backup Movement (Parking Lane)								
Running into Roadway								
Running in Roadway								
Intersection Run—1st Half								
Intersection Run—2nd Half								
Total Number Turning Vehicles								
Site Specific								

1 foot = .30 metre

Figure B-6. Example Pedestrian Film Data Collection Form.

Methodology Selection

Photographic data collection can become very expensive. The long-term usefulness of the data must be considered when selecting one or the other technique. Advantages and disadvantages of the photographic and manual data collection methods are listed in Table B-3.

Table B-3

Advantages and Disadvantages
of Manual and Photographic Data Collection Methods

METHOD	ADVANTAGES	DISADVANTAGES
Manual Recording	Data are immediately available for analysis. Less expensive.	Less detailed or fewer behaviors can be recorded per data collector. Behaviors not observed when they occur cannot be recovered.
Photography	Provides a permanent record of the behaviors being recorded. Allows more complete and detailed behavioral analysis. Does not interrupt or disturb the behaviors being observed. Allows for evaluation of variables whose values are constantly changing (e.g., traffic density). Behaviors not originally the subject of study can be evaluated at a later time. Does not require large numbers of people to collect numerous data behaviors. Projection at speeds faster or slower than the rate of filming can provide evaluative data not observable in realtime. Projection in reverse allows tracing of behavior patterns.	Expensive Do not allow immediate analysis of the data after it is recorded. Some photographic skill is required. Limited field of view due to camera and lens system design; complete behavioral patterns may not be recorded. Film has to be viewed time data are needed. It may be difficult to trace individuals in crowded situations. Usually allow daytime data collection only. Suitable camera location must be found. Film can be lost by the processor.

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APPENDIX C

POTENTIAL FUNDING SOURCES

This appendix is a partial list of the funds and their sources that are or have been available for pedestrian-related projects. To check on the availability of Federal funds, your locality should go through the state offices (e.g., Governor's Office for Highway Safety, State Transportation Department) to the regional/divisional office of the Federal agency.

Department of Transportation

Federal Highway Administration

- Federal-aid Interstate Funds may be used for up to 90% of the cost of planning, construction and improvement of pedestrian facilities.
- Federal-aid Primary, Secondary and Urban funds may be used for up to 70% of the above costs.

  All Federal-aid funds may be used off the respective system for pedestrian facilities to serve pedestrians which would otherwise use a Federal-aid route. However, the amount which can be expended for independent facilities is limited to $2.5 million or a lesser amount so that $45 million nationally is not exceeded.

  These funds may be used for:

  1. Grading, drainage, paving, barriers, landscaping, and structures necessary to accommodate the number and type of users of a facility.
  2. Fixed source lighting where appropriate.
  3. Right-of-way (land acquisition and relocation assistance) on independent walkway and bikeway projects.
  4. Curb-cut ramps on new or existing facilities, including ramps required for access by the physically handicapped.
  5. Walkway and bikeway grade separations where:
     a. vehicular speeds and crossing volumes justify the cost, and the walkway or bikeway cannot be rerouted;
     b. the separation is necessary because the highway has complete control of access.
  6. Traffic control devices including signs, signals, and pavement markings.
  7. Supplementary features such as shelters, parking, storage facilities, and comfort stations.
  8. Walks, barrriers, and additional widths and lengths on bridges necessary for walkways and bikeways for route continuity.

Projects using Interstate, Primary and Secondary System funds are selected by the State transportation agency. Projects using Urban System funds are for urban areas of a population of 5,000 or more and are selected by local jurisdiction officials acting through metropolitan planning organizations (MPO), with the concurrence of the State transportation agency.

- Highway Planning and Research (HPR) Funds cover up to 80 percent of the cost for planning and research activities on projects anywhere within a State. These projects are selected by the State transportation agency.
- Planning (PL) Funds are for planning and research activities in urban areas with a population of 50,000 or greater. These projects are selected by metropolitan planning organizations (MPO).
- Highway Safety (Sec. 402) Funds administered by the Federal Highway Administration may be used for accident data collection and analysis, and planning and evaluation of pedestrian related facilities.

National Highway Traffic Safety Administration

- Planning and Research Funds: help cover the cost for planning and research activities; demonstration grants.

Urban Mass Transportation Administration

- Demonstration grants, technical, and feasibility studies. Projects must be related to general urban development and include substantial transit improvement.

Department of the Interior

Bureau of Outdoor Recreation

- Community Development Funds: cover 50 percent of the costs of building parks and open spaces (could include malls).

Department of Commerce

Economic Development Administration

- Funds to pay work projects for the unemployed – have them work on constructing malls, walkways, etc.

Department of Housing and Urban Development

- Urban Beautification Program (1965): assist in mall development.

Other Federal Funds

- Revenue Sharing

State Funds

- Matching funds for community development
- Spot Safety Improvement Programs (Highway Department): to eliminate hazards at high accident locations.
- Funds to reduce unemployment.

Local Funding Sources

- Special assessments.
- Voluntary assessment.
- Revenue bonds.
- City Budget: improvement and maintenace, general revenue, capital construction funds.
- School district assessment.
- Gas or Special Sales Tax.
- Contributions.

APPENDIX D

EVALUATION RESOURCES

The process of experimental design and statistical analysis of behavioral or accident data is admittedly complicated. Often it will be expedient to obtain outside (your agency or organization) specialized expertise. The following are several types of institutions/organizations/individuals who might be available within your locality.

Government Agencies

Federal Highway Administration Regional Offices

National Highway Traffic Safety Administration Regional Offices

Regional offices rarely have evaluation specialists on staff. However, regional officials are quite cognizant of the evaluation or statistical experts available within the region and will help guide you to adequate resources.

Governor's Highway Safety Coordinator/Director

Again there is rarely an evaluation expert on staff but a willingness to tell you about existing resources is prevelant.

Universities/Colleges

Highway Research Centers and Traffic Safety Centers

Several universities have transportation and/or highway centers experienced in either evaluation or accident analysis. Prominent examples are:

Highway Safety Research Center, University of North Carolina
Highway Safety Research Institute, University of Michigan
Texas Transportation Institute, Texas A&M University
Transportation Institute, Pennsylvania State University
Highway Traffic Safety Center, Michigan State University
Transportation Institute, Northwestern University
Institute for Transportation and Traffic Engineering, University of California, Berkeley

Safety Departments

Some universities have academic programs focusing on safety. The faculty usually will serve or can recommend individuals as consultants. The department may contract to perform evaluation services. Examples of these departments are:

Safety Department, Central Missouri State University.
Safety Center, University of Southern California.

Social Science Departments

A school which offers training in human factors/engineering psychology/applied experimental psychology may have faculty who can aid in experimental design, data analysis and behavioral performance measures; for example, the Human Factors Laboratory, University of South Dakota. Any faculty trained in quantitative psychology and with experience in applied research can assist in experimental design and statistical analysis.

Consulting Firms or Individuals

There are a number of companies (both profit and nonprofit) who have corporate and staff experience in evaluation or accident analysis. These organizations are best found by looking at current literature in the highway safety field. A similar statement applies equally to individual consultants. However you will most often find out about individuals by talking with regional officials or others intimately involved in highway safety.

APPENDIX E

STATE USE OF THE MODEL PEDESTRIAN SAFETY PROGRAM

The primary emphasis in this *Users' Manual* has been toward the local level – cities and counties of all sizes. That does *not* mean that it is nonapplicable at a state level. This appendix discusses how a state Department of Transportation, Traffic Safety Office, Governor's Safety Representatives, or other organization can use this manual. Primary among these is the impetus the state can provide to local levels to enhance their pedestrian safety programs.

Step 1: Identify the Pedestrian Safety Problem (Accident Investigation)

In most states, all localities use the same or very similar accident report. That is, the report forms for City A, City F, County M, and the State Police are basically the same. This is imperative if valid and reliable cross-jurisdictional accident comparisons are to be made. In order to obtain the required behavioral data for Accident Type identification, and still allow cross-locality comparisons, statewide coordination is again necessary. The Supplemental Data Form should be developed at the state level and distributed, with instructions, to local communities.

One of the data analysis techniques discussed in the text is the use of pin maps. As was stated, these provide a rapid, visual view of the pedestrian (and total) accident situation. Recommendations that they be required by all municipalities should be considered. In addition, the State could use this technique as well. The visual impact provided by pin maps can supplement the statistical reports of the statewide accident problem.

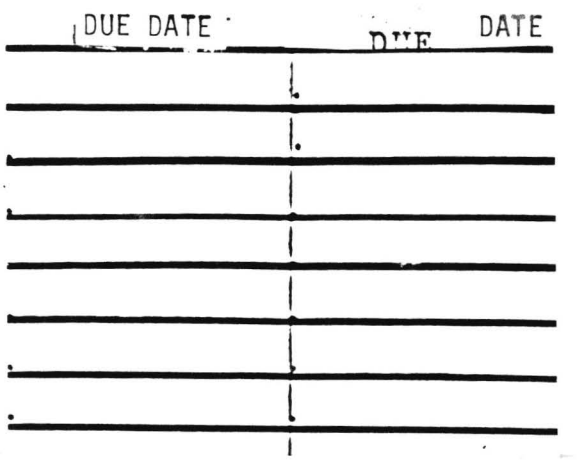
Step 3: Select Best Alternative (Benefit-Cost Analysis)

As written, Step 3 addresses the selection of a best alternative for a local-level problem. However, funding decisions at the state level are likely to be more complex than those in the local municipality. Whether the state has funds of its own or is shunting Federal funds for safety programs, the objective is always to see the maximum benefit return for the funds allocated. The Benefit-Cost Analysis described can be applied to selecting which localities (alternatives) get what levels of funding.

In doing this, some of the Benefit and Cost Variables will be different from those used at the local level; others are sure to remain the same. For example, the anticipated level of accident or severity reduction for a given level of funding are must Benefit Variables. The use that a locality will make of the funds (i.e. implementation costs) are important Cost Variables. Other variables might be the severity of a municipality's problems, weighing them against the severity of another's safety problems.

Step 4: Implementation

Of prime importance is the support the state can give to local jurisdictions to initiate or enhance a pedestrian safety program. This does not necessarily have to be financial support. Technical (engineering, managerial, or statistical) and, to some extent, moral support are also necessary.



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