FILE COPY

DOT HS-800 403

James F. Frank
COPY

PEDESTRIAN SAFETY
The Identification of Precipitating Factors and Possible Countermeasures

OPERATIONS RESEARCH, INCORPORATED
1400 SPRING STREET
SILVER SPRING, MARYLAND 20910

Final Report
January 1971
Contract No. FH-11-7312
Volume I of II

PREPARED FOR:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. FH-11-7312	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Pedestrian Safety: The Identification of Precipitating Factors and Possible Countermeasures Volume I and Volume II-Appendices		5. Report Date January 1971
		6. Performing Organization Code
7. Author(s) Monroe B. Snyder and Richard L. Knoblauch		8. Performing Organization Report No. FH-11-7312
9. Performing Organization Name and Address Operations Research, Inc. 1400 Spring Street Silver Spring, Maryland 20910		10. Work Unit No.
		11. Contract or Grant No. FH-11-7312
12. Sponsoring Agency Name and Address Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. Type of Report and Period Covered FINAL July 1969 through November 1970
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

The study objective was to identify causes and countermeasures relevant to pedestrian accidents. Behavioral and descriptive data were collected by interviews and on-scene observations for over 2,000 pedestrian accidents in 13 major cities. Subsequent analyses emphasized individual case causation and accident type classification relevant to countermeasure implementation. Cases were divided into accident types on the basis of causal factors and target groups, to provide a basis for countermeasure identification. The five most frequent types accounted for over 50% of the sample cases. Countermeasures relevant to each accident type are discussed.

17. Key Words Pedestrian(s) Accidents, pedestrian Countermeasures Accident causation, investigation	18. Distribution Statement General

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
none	none	350	

Form DOT F 1700.7 (8-69)

PREFACE

This document constitutes the final report under contract FH 11-7312. It is designed and organized, not only to meet contractual requirements and provide an archival record for the interested scientific community, but also to serve as an easily understandable source of information and guidance to various decision-makers whose actions can save lives and reduce pedestrian injuries.

Recognizing the wide variety of backgrounds and interests of the potential audience and the difficulty of preparing a single document to meet their varied needs, the decision was made to depart from the format and organization of the typical scientific report. Assuming different needs for different audiences, the report has been organized accordingly. Recognizing that not everyone will want to read the entire report, an attempt has been made to make it possible for individuals to easily identify and locate sections most relevant to their needs.

The Summary is recommended to everyone who is interested in the subject of this report. Certain decision-makers, for example, the mayor of a large city, may want to stop there and rely on others for a more detailed review.

The body of the report, Sections II through VI, focuses on an understanding of the pedestrian problem and possible corrective action. The project purpose, approach, and methods are presented in Section II only in enough detail to provide a meaningful context for Sections III through VI.

Those who wish to examine more closely the manner in which findings were developed, or who wish to examine some of the data in more detail, may refer to Volume II, Appendices.

The attention given to organization and presentation is motivated by the conviction that it is possible to reduce pedestrian deaths and injuries and that the information developed in this project can lead to that reduction if it is utilized by the appropriate decision-makers. The correctness of that conviction can only be tested if the decision-makers in our audience get the information and act on it.

ACKNOWLEDGEMENTS

Because of the broad scope of this project, many individuals were involved and contributed to its success. The continued support and assistance of Mr. Peter N. Ziegler of the National Highway Safety Bureau, who served as contract manager, deserves special note.

Mr. Waldorf Pletcher, Mr. Seymour Bergsman, Dr. Robert Knaff, and Dr. Leroy Dunn of the Federal Highway Administration and National Highway Safety Bureau provided useful reviews of project plans during various phases of the study.

Many police officers throughout the country contributed day-to-day assistance and cooperation throughout the data collection effort. Their efforts are sincerely appreciated as is the cooperation of the police chiefs and other police department officials in the following cities: Baltimore, Boston, Chicago, Denver, Houston, Los Angeles, New Orleans, New York, Philadelphia, Seattle, St. Louis, San Francisco, and Washington, D. C.

The project team for Operations Research, Inc. (ORI) was headed by Dr. Monroe B. Snyder, principal investigator, and Mr. Richard L. Knoblauch, assistant project director, authors of this report. Administrative support and guidance was provided by Dr. William J. Leininger, vice president and Mr. Gabriel Markisohn, program director. The following members of the technical staff contributed to the data collection and analysis effort: Mr. John Avila, Miss Margery Fisk, Miss Beverly Johns, Mr. William Liggett, Miss Suzanne Shaffer, and Mrs. Thomasina Theis. In addition, Mr. Bryan Robinson of Louis Berger, Inc. (a Leasco company) performed on-site engineering evaluations of selected sites.

The contribution of the accident investigation staff and approximately 2,000 citizens who supplied information is, of course, obvious. The former are identified in Appendix G; the latter must remain nameless.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

I. SUMMARY

INTRODUCTION AND PROJECT DESCRIPTION

Purpose

1.1 Pedestrian safety is a serious national and local problem. Each year about 350,000 pedestrians are struck by vehicles. Many are seriously injured; about 10,000 die. The problem is especially serious in urban areas where a large portion of traffic deaths are pedestrians. It is one of the leading causes of death in children.[1/]

1.2 This project was directed towards providing information to help answer two important and difficult questions.

a. What are the immediate causes of pedestrian accidents?

b. What action is possible to take to overcome or circumvent these causes and reduce pedestrian deaths and injuries?

1.3 The scope of the present study was limited to urban areas (where 85% of the pedestrian accidents occur) and crash causation (versus injury reduction).

Methods

1.4 Data were collected on a sample of 2,157 pedestrian accidents as they occurred in 13 major cities from the fall of 1969 through the summer of 1970. Cases were sampled from among the 13 cities roughly in proportion to the number of pedestrian accidents expected. The following main collection methods were used:

- Interview with participants and witnesses
- Police records
- On-scene observation.

1/ National Safety Council, Accident Facts, 1970 Edition, Chicago, Illinois.

Cases were initiated by either responding to police radio reports or by randomly sampling from recent police report forms. In addition, practically all fatal pedestrian cases that were available from the local police jurisdiction were covered.

1.5 The data collected was based on a conceptual model of pedestrian accidents focusing on the behavioral/event sequence preceding the crash and the factors that could directly influence that sequence. Emphasis was placed on securing quality data that would have maximum utility for countermeasure identification.

1.6 The analysis had two special features: (a) emphasis on case causation and (b) accident type classification relevant for countermeasure identification.

1.7 All data about each case were reviewed to determine whether there was sufficient direct evidence to support conclusions about the precipitating and/or predisposing factors that actually led to the crash. A rigorous frame of reference was established for drawing causal conclusions. Only if direct evidence was present in the case report could causality be attributed. Any reasonable doubt precluded judgment of causality. Mere presence of a previously hypothesized factor was not sufficient to conclude it "caused" the crash. If it was not possible to draw causal conclusions, the case made its contribution only through the statistical data analysis.

1.8 Ideally, each pedestrian accident can be assigned to a causal type along with other accidents which are similar with respect to three sets of features:

- Precipitating events (the specific nature of the failure in the function/event sequence that led to the collision)
- Predisposing factors (the specific environmental human or vehicle variables which actually influenced the function failure)
- Target groups (the human populations and/or kinds of physical locations involved in this type of accident).

1.9 The sample of cases were divided into types of pedestrian accidents on the basis of similarity of causes (and therefore likely countermeasure approaches). The circumstances and causes of the identified types of pedestrian accidents were systematically examined to determine those existing or innovative countermeasures that would have prevented the causal patterns found in those cases resulting in death or injury. Circumstances alone (e.g., nighttime accidents) were not considered as an adequate basis for a countermeasure recommendation. Every effort was made to produce countermeasures as specific as possible with respect to describing the action to be taken. Emphasis was placed on identifying countermeasures that are technically and administratively feasible. The project aimed at seeking out these solutions that have the best chance of actually achieving injury and fatality reduction within a few years.

FINDINGS AND RECOMMENDATIONS

Major Causal Types and Countermeasures

1.10 Although a number of distinct accident types were identified, the five most frequently noted can be expected to account for over 50% of the pedestrian accidents in urban areas similar to those studied. The basic descriptions are presented below followed by a summary note on the identified countermeasures that appear most promising for immediate accident reduction. A few less frequent accident types with direct solutions are also noted.

1.11 Dart-Out (First Half) (24%). A pedestrian, not in an intersection crosswalk, appears suddenly from the roadside. His quick appearance and short-time exposure to the driver are the critical factors. The pedestrian often may be running, and parked cars often obstruct vision, but neither need be present if the basic condition of sudden appearance to the driver's view is met. The prime example of the dart-out is a school-age child running out from between parked cars on his own block, in a residential area in the center city in the afternoon after school. He heads straight across the relatively narrow street, looking where he is going and is struck less than half way across. The driver, traveling at a normal rate of speed, did not have enough time to stop after detecting the child.

1.12 Dart-Out (Second Half) (9%). This is the same as the dart-out described for the first half above, except that the pedestrian covers half of a normal crossing before being struck. The distinction was made because of the possible differences in the opportunities or problems relative to driver detection and recognition of danger if the roadway is clear. However this type was assigned even if traffic obscured the driver's vision. It may be used even if the pedestrian crosses a medium-size median strip of a boulevard.

1.13 Intersection Dash (9%). This category covers cases similar to dart-outs with regard to pedestrian exposure to view, but the incident occurs in or near a marked or unmarked crosswalk at an intersection. Cases are included if the pedestrian is running across the intersection even though his exposure to possible driver view is not extremely short. (His speed will in effect limit his actual exposure to the driver.)

1.14 Multiple Threat (3%). The pedestrian is struck by car x after other cars blocking the vision of car x stopped in other lanes going the same direction, and avoided hitting the pedestrian. For example, cars in lanes one and two stop and permit the pedestrian to cross; car x in lane three going in the same direction hits the pedestrian as he steps out in front of the car in lane two. This classification is not used if the striking vehicle is going in the opposite direction from the stopping cars. (In that situation the stopping cars would not block the driver's vision.)

1.15 Vehicle Turn/Merge With Attention Conflict (7%). The driver is turning into or merging with traffic; the situation is such that he attends to auto traffic in one direction and hits the pedestrian who is in a different direction from his attention. A critical feature is that the attention conflict is built into the situation. Usually the driver directs his attention in a given direction to determine an acceptable gap into which he will enter.

1.16 Specific countermeasures were identified relevant to the above types. Among those appearing most appropriate for lower cost applications with short-term results were the following:

1.17 Street Parking Redeployment. This countermeasure is aimed primarily at the dart-outs but would influence the other two types as well. The objective is to use parking control to remove some of the visual obstruction, provide a partial barrier to physically control the pedestrian course, and increase the likelihood of detection. This countermeasure is suggested for consideration on certain residential streets, not main arteries. Its application is described for a one-way three-lane street with two lanes of parallel parking, but other existing situations could be modified to achieve the same result.

1.18 Two steps would be taken. First, parking would be removed from one side of the street, probably the left. Second, head-in diagonal parking would replace parallel parking on the right. (See Figure 5.5.)

1.19 In appropriate locations this would accomplish the following. Visual obstructions would be removed from the left side of the road giving the driver an increased view and more time to detect and react. The diagonal parking would provide a physical control that would tend to slow down the pedestrian as he ran across the street, but even more important, would angle him into traffic and direct his field of vision more in the direction of the threatening vehicles. Finally, he would be able to execute evasive action more readily than when crossing directly across the street. Approaching on the angle would let him change course to avoid, rather than having to stop.

1.20 Because this is an innovative countermeasure, it offers greater potential as a solution to a stubborn problem, and at the same time will evoke some resistance because it disturbs commonly accepted ways of handling on-street parking. Some legitimate questions can be raised which should be answered, relative to traffic flow, parking accidents and public acceptance.

1.21 Previous reported studies of diagonal parking have dealt with its use in business areas rather than the kind of application presented above. The data were gathered 20-35 years ago. (Changes in vehicle design and driving habits could change present day results.) Although most showed a reduction in parking accidents when parallel parking replaced diagonal, most studies had no controls or sufficient baseline data for drawing firm conclusions about the cause. The effect of parking redeployment on parking accidents can and should be determined. However, even if this countermeasure were to increase auto-auto accidents, it still might be worth it. (A trade of personal injury accidents for property damage accidents appears to be generally acceptable.)

1.22 Finally consider public reaction to moving or eliminating parking space. Two points are worth noting. First the change is for a commonly shared goal—the protection of children in the community. A change made to move commuters through a residential area produces a different reaction than a change suggested to protect the neighborhood children. Secondly, the use of diagonal parking on the remaining side minimizes parking space loss.

1.23 Careful application and site selection would be required. For example, a street with a row of large trees along the left side would not be appropriate for routine application because of the effect on vision. However, application on a careful systematic basis that will permit evaluation of effectiveness clearly seems warranted.

1.24 Meter Post Barrier. In commercial areas with on-street parking meters, small fences or railings extending out a few feet from either side of the meter post could combine with parked cars to form a barrier to prevent dart-outs. Two variations are possible. In one arrangement the barrier would be designed to permit a pedestrian to go between it and the car. He could exit between parked cars to the street; however, it would be difficult for him to run out between the parked cars. This arrangement would permit the driver to get out his side of the car and get to the sidewalk. In the second arrangement, the small barrier would be placed in such a manner that it would be extremely difficult, if not impossible, for a person to pass between it and a parked car. This would be more effective against dart-outs, since it would also eliminate the cases with short-time exposure that did not involve running. Drivers, however would not be able to get out their side (on a two-way street) and get to the curb without walking in the street for a distance. This might be viewed as an advantage if it induced drivers to slide over and exit on the curb side instead of the street side of the car, thus reducing street side accidents. Further design and study are needed to determine which option is best. (See Figure 5.)

1.25 Signal Retiming or Modification. One of the predisposing factors identified for the intersection dash was the inducement to risk taking coming from the traffic signal. The pedestrian is wrong to cross against the light. He should wait until he has the proper signal, but it is apparent that some will become impatient when they must wait. In some locations, longer than usual waiting periods are involved in order to move heavy traffic volumes. However, it must now be recognized that this may induce pedestrians to take risks because they are impatient. Standard time periods cannot be recommended on the basis of this study. The best specific treatment will depend on the individual nature of the intersection and its vehicle and pedestrian volumes. It is recommended that local traffic engineers review intersections with the longer pedestrian waiting periods, especially in commercial and multifamily dwelling areas surrounding the central business district, and consider the following possibilities:

- Resetting cycles to bring pedestrian waiting time in line with the norm, or lower if other considerations permit.

- If rush hour volumes do not permit complete retiming, reduce pedestrian waiting periods during non-peak hours. (Two-thirds of intersection dashes occurred before or after the 4:00 p.m. to 6:00 p.m. rush period.)
- Provide a signal indicating the waiting time remaining to green. This could be a numeric countdown signal giving the seconds remaining, but need not be; color codes or 10-second intervals could be used. Such a signal could be integrated with the wait-walk type pedestrian signals.

1.26 Stop Line Modification. This countermeasure is directed primarily at multiple threat accidents occurring at signalized intersections in commerical areas. In order to reduce the incidents where cars stopped at the stop line obscure the view from the striking car, a wide stop or limit line should be placed a number of feet prior to the crosswalk. Although specific design would depend on a number of factors at the particular location, the objective is to stop the cars far enough back so that a pedestrian in the walk is likely to be noticed by cars other than the ones facing him. The recommendation given by the Manual on Uniform Control Devices for a stop line about 4 feet in front of the nearest crosswalk may not go far enough.

1.27 This countermeasure might also be used at nonsignalized intersections, but the specific location of the stop line would have to consider the need for the driver to see cross traffic if it is not controlled.

1.28 Driver Procedures and Traffic Ordinance. This countermeasure is aimed at those multiple threat accidents that occur midblock or at noncontrolled intersections. Such accidents happen because some driver(s) yields to a pedestrian. The model traffic ordinance states that "whenever any vehicle is stopped at a marked crosswalk or at an unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle."[2/] A similar restriction probably applies in most cities that require a driver to yield to a pedestrian at other locations. The driver apparently fails to obey the overtaking and passing restriction because he is not aware of the pedestrian or the regulation.

1.29 The driver of the vehicle that has stopped is aware of the pedestrian and has demonstrated his willingness to follow the accepted procedure to assist the pedestrian. In such situations, he is a prime candidate for rendering assistance. This driver could further assist by warning drivers coming behind him by signaling them to stop. Any driver yielding to a pedestrian in the absence of a control device should be trained and required to signal any cars approaching from his rear to stop. This countermeasure calls for a combination of the

---

2/ American Automobile Association, Manual on Pedestrian Safety, Washington, D. C., 1969, Appendix B.

development of a standard hand signal (meaning more than just that the vehicle has stopped or is stopping); local ordinances, and appropriate public education and driver training so that drivers yielding to pedestrians protect them from overtaking vehicles.

1.30 Ordinances requiring drivers to stop and yield to a pedestrian in the roadway at any location are not recommended, but the study has not produced evidence to recommend their repeal where they exist.

1.31 Right Turn Attention Conflict Reduction. This countermeasure is aimed at the reduction of a portion of the accident type labeled vehicle turn/merge with attention conflict—specifically those involving right turns at nonsignalized intersections or at signalized intersections with right turn on red permitted.[3/] It involves the review of intersections in commercial areas with the objective of removing the basic attention conflict situation for the driver by selecting one of a number of possible actions. Those which may be considered are:

- Removal of right turn on red
- Signalization of intersection
- Control of cross traffic by stop sign
- Effect one-way traffic on street to right, coming from the right
- Pedestrian barrier if right turn on red needed
- Pedestrian-only signal phase.

1.32 The first two possibilities could remove the need for the driver to look to his left to identify an acceptable gap while turning right. The barrier in effect removes the crossing conflict and the pedestrian-only phase gives the pedestrian an opportunity to cross between the cars turning on the green and on the red. Once again the specific action requires location study.

1.33 Left Turn Attention Conflict Reduction. The problems and actions for left turn attention conflict reduction are the same as for the right turn with one difference. The left turn problem also includes the situation in which a driver is proceeding on the green and must select a gap in oncoming traffic in order to make his left turn. Additional actions to be considered are:

- Prohibition of left turns
- Use of left turn only arrow (protected from oncoming traffic)
- Use of leading or lagging green with notice to driver.

[3/] All-way-stop intersections are not a problem for this type.

1.34 Driver, Pedestrian and Public Education. This countermeasure involves only the presentation of specific information about the nature and extent of the major accident types described above and the most important specific steps for particular groups to take. The following areas would be covered.

- Driver search in danger areas
- Driver procedures - stopping for pedestrians
- Parent instruction to children
- Child sidewalk play
- Child trips to commercial areas
- Pedestrian attention to legal vehicle threats.

1.35 Conclusions Regarding Major Types. It is expected that these countermeasures can achieve a noticeable reduction in the estimated 150,000 accidents a year accounted for by the five accident types described above. The application of additional long-term countermeasures such as prohibition of on-street parking, off-street parking/play areas, sidewalk parks, and legal vehicle pedestrian conflict reduction would reduce the toll even more.

Accident Types Involving Salient Predisposing Factors

1.36 Four other accident types involved specific predisposing factors. They account for about 7% of the cases and offer possibilities for extreme reductions. The basic type descriptions and countermeasure recommendations for each follow.

1.37 Vendor-Ice Cream Truck (2%). The pedestrian is struck going to or from a vendor in a vehicle on the street. This is usually similar to a dart-out, with ice cream trucks being the most frequent attraction. This specific classification was given precedence over dart-out when assigning cases to types. The countermeasure is ice cream truck regulation and visual warning devices.

1.38 Pedestrian Exiting From Vehicle (1%). The pedestrian had been a passenger or driver and is struck as he exits from a vehicle; all vehicles are included. The countermeasures are vehicle exit visual warning devices, regulation of licensed public vehicles, and exit platform design. Parking redeployment, described earlier, would also help.

1.39 Bus Stop Related (3%). This type includes cases in which the location or design of the stop appears to be a major factor in the causation; e.g., the pedestrian crosses in front of the bus standing at a stop on the corner, and the bus blocks the view of cars. It does not include those cases that may be considered as exiting from a vehicle, nor does it include cases in which the stop is only an attraction or distraction. The countermeasure is location of bus stops at the far side of the intersection.

1.40 Backing Up (2%). The pedestrian is struck by a vehicle which is backing up. A case would not be so classified if the pedestrian were clearly aware of the movement of the vehicle; detection failure is important. This type was used even if the accident occurred off the street. The countermeasure is backup warning devices.

Other Accident Types and Countermeasures

1.41 Among the other specific accident types identified were the following (described in the body of the report):

- Pedestrian strikes vehicle
- Pedestrian waiting to cross in roadway
- Multiple pedestrian split
- Non pedestrian activity — not in roadway
- Off-street parking
- Freeway — from car
- Freeway — crossway
- Non pedestrian activity in roadway
- Pedestrian walking in roadway
- Working on vehicle
- Rear wheel: truck or bus
- Infrequent or unidentifiable patterns.

1.42 Among the countermeasures discussed for these types are:

- Intersection lighting and visual obstruction removal
- Provision of pedestrian pathways
- Parking lot design requirements
- Vehicle design — sun accessory
- Roadway worker protection requirements
- Freeway design for vehicle repair
- Freeway repair regulation and signing
- Freeway design —pedestrian crossing
- Driver training — freeway repair and emergency procedures

- Driver and pedestrian communication/ evaluation procedures and training
- Pedestrian and driver education - legal intersection conflicts.

Programmatic Recommendations

1.43 The Federal Government can contribute to the reduction of pedestrian accidents through development of standards and the support of specific areas of additional research and development. However, the greatest effort in countermeasure application must come at the local level. The findings of this project should be applied in local programs to:

- Determine the specific frequency of identifiable accident types in the city and the target areas in which they occur.
- Estimate the cost-effectiveness of various countermeasure combinations within local action constraints.
- Systematically apply these countermeasures and measure their impact in terms of the reduction in the accident types towards which they were directed and the resulting savings in lives and injuries.
- Establish a procedure for continual monitoring of pedestrian accidents to identify areas needing attention in the future.

1.44 All of these steps are currently within the state-of-the-art. Problems in establishing such a program will be more political and organizational than technical. Thus it is important that the public be informed of the nature and extent of the pedestrian accident problem and the countermeasures that can be applied.

II. PROJECT DESCRIPTION

INTRODUCTION

2.1 This section of the report summarizes the purpose, approach, and methods used in the project and provides the context for the consideration of the pedestrian safety problem and the action that can be taken. Additional details on the methodology may be found in Volume II, Appendices.

2.2 Pedestrian safety is a serious national and local problem. Each year about 350,000 pedestrians are struck by vehicles. Many are seriously injured; about 10,000 die. The problem is especially serious in urban areas where a large portion of traffic deaths are pedestrians. It is one of the leading causes of deaths in children, accounting for more than 1 out of every 10 deaths in children between 5 and 14 years of age. [1]

2.3 Some selected facts further illustrate the serious nature of this problem: [2]

- Pedestrian accidents account for 30% of the disabling motor vehicle injuries in the 0-4 and 5-14 age groups.
- A pedestrian in a traffic accident is 6 times more likely to die than a nonpedestrian in a traffic accident. [3]

1/ Accident Facts, 1970 Edition, National Safety Council, Chicago, Illinois.

2/ Unless otherwise noted, information is based on data from Accident Facts.

3/ Based on data from Manual on Pedestrian Safety, American Automobile Association, Washington, D.C., 1964.

- Pedestrian accidents account for 19% of all fatal motor vehicle accidents, 38% of urban fatal motor vehicle accidents, and 70% of the urban motor vehicle deaths in the 0-4 and 5-14 age ranges.
- Pedestrian deaths have increased 28% from 1958 to 1969.

2.4 Previous research on pedestrian accidents has focused on the collection of basic descriptive data (e.g., pedestrian, driver, and road characteristics) or examined the effect of a specific countermeasure (e.g., crosswalks, playgrounds). 4/ Such data combined with expert opinion and logic have been the basis for existing countermeasure recommendations (e.g., the use of reflectorized clothing has been suggested as a countermeasure for nighttime accidents). However, without a clear understanding of the nature of pedestrian accidents, ("how and why they happen") many safety personnel felt that few practical steps could be taken to make a noticeable impact. No previous studies have been found that identify causes of pedestrian accidents as a basis for countermeasure development.

PURPOSE

2.5 The project was directed towards providing information to help answer two important and difficult questions:

a. What are the immediate causes of pedestrian accidents?

b. What action is possible to take to overcome or circumvent these causes and reduce pedestrian deaths and injuries?

2.6 The scope of the present study was limited to urban areas and crash causation (versus injury reduction).

2.7 Figure 2.1 shows schematically how the present project fits in with the major steps towards the ultimate objective of pedestrian crash reduction.

2.8 This project is concerned with the first step of identifying causes and countermeasures. The next step will be to determine the needs in particular

---

4/ For a recent review of the literature, see B.M. Biehl, S.J. Older, and D.J. Griep, Pedestrian Safety, Organisation for Economic Cooperation and Development, Paris, 1970.

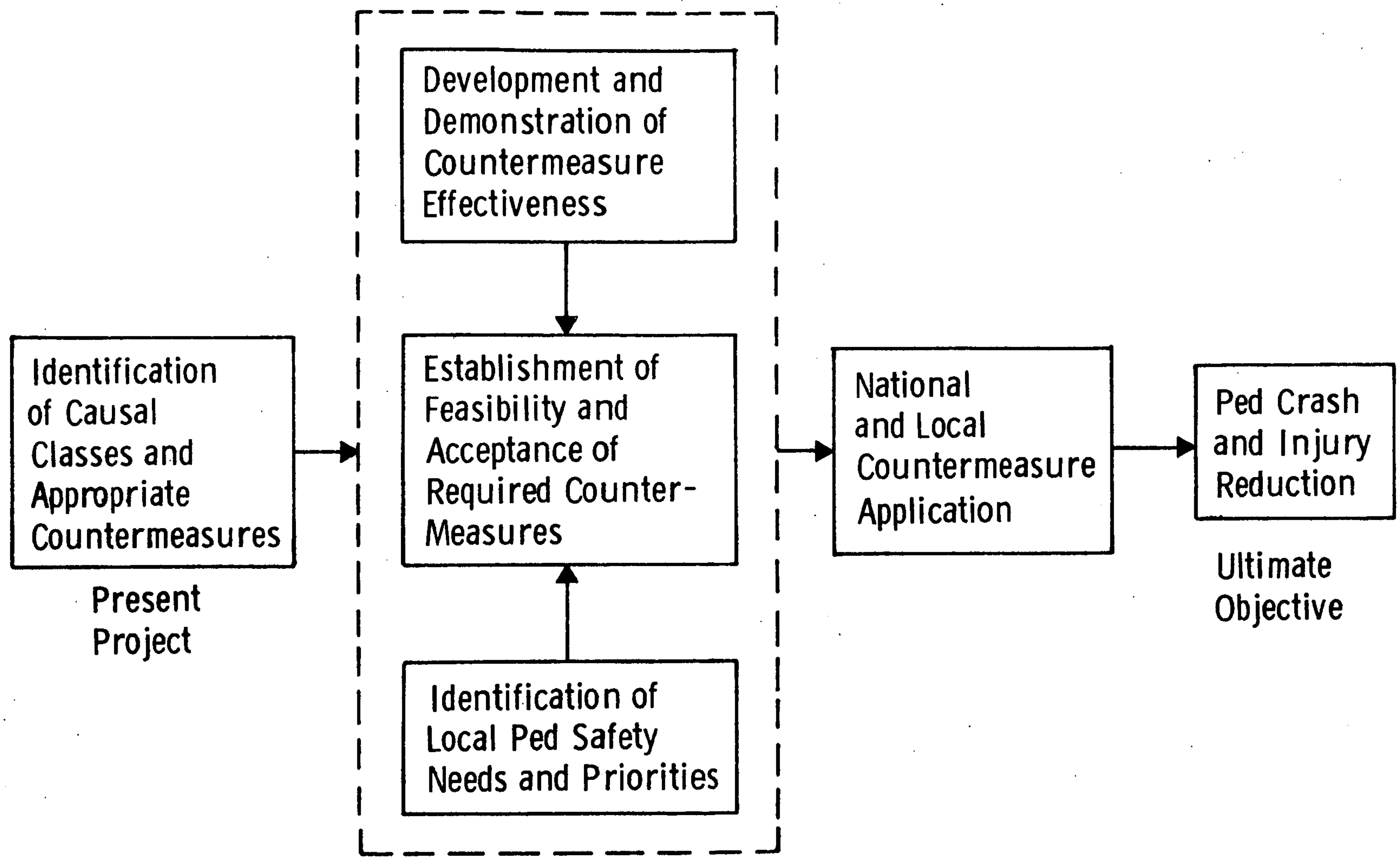

FIGURE 2.1 MAJOR STEPS REQUIRED

localities and to demonstrate the effectiveness of proposed countermeasures. This in turn should lead to a concerted effort at countermeasure application to reduce crashes and injuries.

APPROACH

2.9 The project approach can best be described by considering three main topics:

- Project data
- Analysis and interpretation of accident data
- Countermeasure considerations.

2.10 The basic thinking regarding these topics is presented here. The specific technical decisions resulting from this approach are presented in relevant sections in this report.

Project Data

2.11 The objective was to collect "quality data with utility for countermeasure identification." Five major guidelines influenced the data collection effort.

2.12 Emphasis on Behavioral Sequence Data. A multitude of data items can be collected about any accident. While no type of data was completely excluded from the study, the approach to meeting the project objectives was to concentrate on data involving the behavioral sequence preceding the collision—the actions and events that led to the crash. A conceptual model was developed, specifying the kinds of data needed to describe this sequence and also to indicate related data to help explain the sequence and/or develop countermeasures. Section III presents this conceptualization of the pedestrian accident process and the kinds of data needed.

2.13 Collection of Data From Primary Sources. Most data were secured directly from the primary parties to the accident, (drivers, pedestrians, and witnesses) and/or from observation by a project field investigator. Only a limited number of basic identification or special items (e.g., blood alcohol) were secured from records or reports by non-project personnel. Collection of data from primary sources permitted a more detailed, in-depth examination of items of interest. It also resulted in the need to use field investigators with formal training related to interviewing and interpersonal relations. This was seen as a critical aspect to secure high quality data under some difficult conditions.

2.14 Minimization of Data Time Lag. There are reasons to believe that data collected from individuals may tend to decrease in validity with the passage of time. Therefore, within practical limits, every effort was made to secure data as soon as possible after the crash, and on-the-scene immediately following the crash where feasible.

2.15 Maximum Coverage of Fatalities. Deaths represent the severest consequence of pedestrian accidents and, therefore, NHSB had specified that special attention be paid to fatalities. In general during the data collection effort, every pedestrian fatality report available from the jurisdictions covered was included as a case in this study. (See paragraph 2.31.)

2.16 Cost-Effective Allocation of Field Effort. In addition to the previously noted aspects of the approach, a desirable objective was to maximize the number of cases studied. At-the-scene coverage in some jurisdictions at certain times of the day would involve inordinate amounts of waiting time and thus reduce the total number of cases for the effort expended. Therefore the approach taken was to attempt at-the-scene investigation in those locations and at those times where the cost would be reasonable for the number of cases that could be expected to be investigated.

Analysis and Interpretation of Accident Data

2.17 The approach to analysis and interpretation was based on a consideration of project objectives—cause and countermeasure identification—and had two special features in addition to traditional approaches:

- Emphasis on case causation
- Classification of cases for countermeasure identification.

2.18 These features represented an attempt to effectively combine aspects of the "clinical" and "data association" approaches to analysis and interpretation. By the clinical approach is meant the collection of in-depth data about a single case sufficient to permit reasonable judgments and inferences to be made about the cause(s) of that particular case. This is a main feature of studies using "multidisciplinary teams" to study injury causation. The association approach means tabulating data about many cases so that frequently occurring (associated) items will become obvious, and under special circumstances statistical inferences can be drawn. Each of these approaches has its own advantages and limitations which will be considered here only as they relate to the two main features of analysis and interpretation of project data.

2.19 Emphasis on Case Causation. Each accident case studied had the potential of having sufficient data available to form the basis for conclusions concerning precipitating events that led directly to the crash. In some cases, sufficient information might also be available to draw inferences concerning predisposing factors further back in the causal chain (e.g., alcohol as a predisposing factor that led to pedestrian falling down in front of the bus).

2.20 Any attempt to summarize or tabulate data from more than one case will result in a loss of certain information. For example, if the results of two cases were tabulated, information would be lost relating to the relationships among different aspects of one case. Thus it was advantageous to draw causal conclusions about each case, based on all the available evidence, before summarizing findings. The approach followed was to review all data about each case to determine whether there was sufficient direct evidence to support conclusions about the precipitating and/or predisposing factors that actually led to the crash.

2.21 At this stage, only conclusions directly and obviously indicated by the data were permitted. If this was not possible, the case would have to make its contribution through the statistical data analysis.

2.22 Classification for Countermeasure Identification. The second salient feature of the analysis approach was the attempt to identify the various types of pedestrian accidents in a manner that would have maximum utility for countermeasure identification and action programs. The basic logic is that all pedestrian crashes obviously do not have the same set of causes and circumstances so as to be amenable to the same solutions (countermeasures). On the other hand, if progress is to be made in injury and crash reduction, countermeasures must be identified that apply to more than one case.

2.23 Thus the approach taken was to divide the universe of cases into types of pedestrian accidents on the basis of similarity of causes and therefore likely countermeasure approaches. A successful implementation of this approach would increase the efficiency of problem identification and countermeasure application in given locations, once the frequency of the various types was established. (The steps taken to achieve the objective of typing are described later.)

Countermeasure Considerations

2.24 The steps taken to identify pedestrian accident countermeasures were influenced by three main considerations: relevance, specificity, and feasibility.

2.25 Relevance to Case Data. Certain countermeasures can be suggested on the basis of a logical analysis of pedestrian accidents (e.g., barriers, reflective clothing). However, it was felt that the value of the project was to identify countermeasures that had direct relevance to the particular causal data found in this study. Thus the primary approach was to systematically examine the circumstances and causes of the identified types of pedestrian accidents to determine those existing or innovative countermeasures that would have prevented the causal patterns found in those cases resulting in death or injury or an accident. Circumstances alone (e.g., nighttime accidents) would not be considered as an adequate basis for a countermeasure recommendation.

2.26 Specificity. Every effort was made to produce countermeasures as specific as possible with respect to describing the action to be taken. For example, "training of pedestrians" as a countermeasure offers little guidance or direction. "Training of school-age pedestrians" is somewhat better. Better still would be the specification of the content to be taught to the particular group.

2.27 Feasibility. Emphasis was placed on identifying countermeasures that are technically and administratively feasible. Expensive, long-run countermeasures or those unlikely to gain political/public support should be noted, but not considered as adequate solutions. The project aimed at seeking out those solutions that have the best chance of actually achieving injury and fatality reduction within a few years.

METHODS

2.28 This portion of the report summarizes the steps taken to implement the project approach and reach the findings presented in this report. (A more detailed description is presented in Volume II.)

Specification of Data Items

2.29 The specific items of data to be collected about pedestrian accidents were chosen as a result of a systematic analysis of the pedestrian accident process, a review of previous accident investigation studies, and consultation with NHSB personnel. The kinds of accident information collected and their relation to a conceptualization of pedestrian crashes is shown in the models presented in Section III. (The items themselves are in Appendix B.) In general, data items fall into the categories shown in Table 2.1.

Sampling

2.30 Thirteen major cities were identified by NHSB. It was possible to investigate accidents in 12 of these. Milwaukee, Wisconsin, was not included because the police department did not want to participate. A substitute city was then selected. This purposeful sample of 13 cities, although restricted to those with populations of about half a million and over, covered a range of city characteristics. The sample cities comprise more than 10% of the national population and more than 12% of the national pedestrian injury accidents and fatalities. The list of cities and some descriptive data are shown in Table 2.2.

2.31 Within each city, accidents were selected from those reported to the city police department. In three of the larger cities, operational considerations resulted in a further restriction. In Los Angeles, only cases in the "metro area" were included. (Outlying areas within the city limits were not included.) In New York and Philadelphia, only cases investigated by the special accident investigation unit were sampled. This excluded all but fatalities and very serious injuries in those cities. In New York, because of the late start, not all fatals were covered; cases were randomly selected from those serious and fatal cases available.

TABLE 2.1

DATA TYPES (For Each Case)

1. IDENTIFICATION

   a. TIME AND PLACE
   b. OPERATOR CHARACTERISTICS
   c. PEDESTRIAN CHARACTERISTICS
   d. VEHICLE CHARACTERISTICS

2. BEHAVIORAL SEQUENCE

   a. PEDESTRIAN REPORT
   b. DRIVER REPORT
   c. WITNESS REPORT
   d. FIELD INVESTIGATOR REPORT

3. PARTICIPANT AND WITNESS ATTITUDE

   a. PEDESTRIAN
   b. DRIVER
   c. WITNESS

4. TRIP AND PRINCIPAL DESCRIPTION

   a. PEDESTRIAN
   b. DRIVER

5. REPORT AND WITNESS VALIDITY

   a. WITNESS DATA
   b. PEDESTRIAN VALIDITY
   c. DRIVER VALIDITY
   d. WITNESS VALIDITY

6. ENVIRONMENTAL OBSERVATION

   a. STABLE CONDITIONS
   b. TRAFFIC FLOW

7. CAUSAL CONCLUSIONS

   a. FIELD INVESTIGATOR CONCLUSIONS
   b. ANALYST CONCLUSIONS

8. COUNTERMEASURES

   ANALYST CONCLUSIONS

9. RESEARCH PROCEDURE INFORMATION

TABLE 2.2

POPULATION, PEDESTRIAN FATALITIES, AND PEDESTRIAN ACCIDENTS IN 13 STUDY CITIES

City	Population of 1960	Number of Pedestrian Accidents, 1968	Number of Pedestrian Fatalities, 1968
Baltimore	939,024	2,871	58
Boston	697,197	608	38
Chicago	3,550,404	8,674	151
Denver	493,887	464	27
Houston	938,219	830	49
Los Angeles	2,479,015	3,154	168
New Orleans	627,525	884	38
New York City	7,781,984	15,000	450
Philadelphia	2,002,512	4,472	104
San Francisco	740,316	1,446	36
Seattle	557,087	624	28
St. Louis	750,026	1,429	45
Washington, D.C.	763,956	2,097	50
Total	22,321,152	42,553	1,242

2.32 Cases were initiated by either or both of two methods depending on the local situation:

- On-scene-initiated (OSI) cases were selected by monitoring the police communications system during pre-selected hours and responding to the scene. In this mode, hours were assigned roughly in proportion to the number of accidents that were anticipated during that time period based on historical data. However, non-peak accident periods were not covered because of the cost of waiting involved.
- The second selection method involved a random selection of cases from recent police accident reports. In addition, as noted earlier, practically all pedestrian fatalities were selected.

2.33 Data collection started in the fall of 1969 and ended in the summer of 1970. (Local approval was not received from New York until the spring of 1970 and thus the sample from that city covered a shorter period.)

2.34 Cases were sampled from among the 13 cities roughly in proportion to the number of pedestrian accidents expected. The percentage of the total cases in 1968 that occurred in a given city determined the proportion of accident investigation effort assigned to that city. However, an upper limit of 30% and a lower limit of 4% of total project effort was set for any one city. (The lower limit was set because it was not feasible to conduct the study in a city with a smaller effort.)

Data Collection

2.35 Data were collected by three main methods: interview, police records, and on-scene observation.

2.36 In all cases an attempt was made to secure interviews from the driver, pedestrian, and two witnesses. Interviews were voluntary. Attempts were made to secure cooperation through explanation of the nature and purpose of the project and by providing anonymity where possible. However, a refusal, once made, was accepted. On-scene interviews were conducted after the police officers at the scene had completed their interview.

2.37 Other interviews were conducted under the best conditions and locations to minimize delay and maximize cooperation. They were at the hospital, at home, at work, or by telephone under special circumstances.

2.38 A limited number of basic data items were secured from a review of the police report.

2.39 On-scene observations were made either at the time of the accident or at about the same time of day and day of week as the accident when conditions were similar.

Data Processing and Analysis

2.40 Each case was reviewed and analyzed by the field investigator, who added his causal conclusions and countermeasure suggestions. Cases received at the ORI home office were processed so that participants and witnesses could not be identified from the case record.

2.41 Each case was reviewed by an analyst to check accuracy and to translate the findings into conclusions according to a scheme based on the conceptual models described in Section III of this report. Information included the "causal type" into which the case fell, the primary and secondary precipitating factors, predisposing factors, how the crash could have been avoided, and possible countermeasures.

2.42 A rigorous frame of reference was established for drawing causal conclusions. Only if direct evidence was present in the case report could causality be attributed. Any reasonable doubt precluded judgment of causality. Mere presence of a previously hypothesized factor was not sufficient to conclude it "caused" the crash. The causal conclusion section of every case was reviewed by the principal investigator or assistant project director.

2.43 Data were machine-processed to produce a variety of tabulations and cross-tabulations of interest. In addition a special branching program was developed to check on and supplement the clinical typing analysis. A branching program was also used to determine combinations of variables associated with various levels of accident severity.

III. CONCEPTUAL SYSTEMS MODELS

NEED AND PURPOSE OF THE MODELS

3.1 It is frequently stated that accident causation is a complex phenomenon involving many factors and interdependencies. A wide range of data could be collected about pedestrian accidents and analyzed in many different ways. Results about causation might be applied differently, depending on what aspect of the problem one attended to, or one's frame of reference.

3.2 It is believed that accident data collection, analysis, interpretation, and application of results can best be accomplished if based on a formal, explicit and rational analysis of both the subject of inquiry (i.e., pedestrian accidents) and the specific study objectives (i.e., identification of causal factors and possible countermeasures). The study objectives and their implications have already been discussed. This section presents models of pedestrian accidents, that is, simplified representations of pedestrian accidents that help to deal with the complexities of the subject. They are designed to help researchers and decision-makers visualize important components and how they may relate to each other. This in turn should provide a common and explicit basis for considering questions of data collection, analysis, interpretation, and, most important, application of results. The models are:

- Behavioral sequence model
- Causes and countermeasure model.

BEHAVIORAL SEQUENCE MODEL

3.3 The behavioral sequence model has two main features or components:

- The function/event sequence
- Influencing/predisposing factors.

The former deals with the sequence that leads to the pedestrian accident, while the latter deals with other factors which influence the behavior within the sequence.

The Function/Event Sequence

3.4 Since the ultimate purpose is the reduction of pedestrian-vehicle collisions,[1/] a logical approach is to examine the chain or sequence of events leading to the crash, in such a way as to determine what can be done to break or change the chain to avoid the crash. Working backwards from the collision of pedestrian and vehicle, it is possible to construct a sequence of events in terms general enough to apply to the whole class of pedestrian accidents, without losing the detail of analysis needed for understanding. While the specific events may vary from situation to situation, certain functions performed by the participant are always important and result in the particular events leading to the accident. Thus a set of "function/event" steps have been constructed that provide a framework for describing any particular pedestrian accident. Each step is identified in terms of a function or activity that should be performed by a participant, and its correct outcome. If the function is performed, either a successful or accident-precipitating result occurs. If it is not performed, an accident-precipitating event results. The basic functions are:

- Search
- Detection
- Evaluation
- Decision
- Human action
- Vehicle action.

Figure 3.1 presents the basic behavioral sequence in terms of these functions and their possible outcomes, for both pedestrian and driver/vehicle components. The sequence in this figure begins after the selection and implementation of the collision course. The collision course is defined as the course of the participant which, if continued, will bring him in contact with the other participant. The fact that it is a collision course need not be known to the participant at the time.

1/ Injury reduction as opposed to crash reduction is not ruled out as a complementary approach although its payoff in pedestrian accidents is open to question.

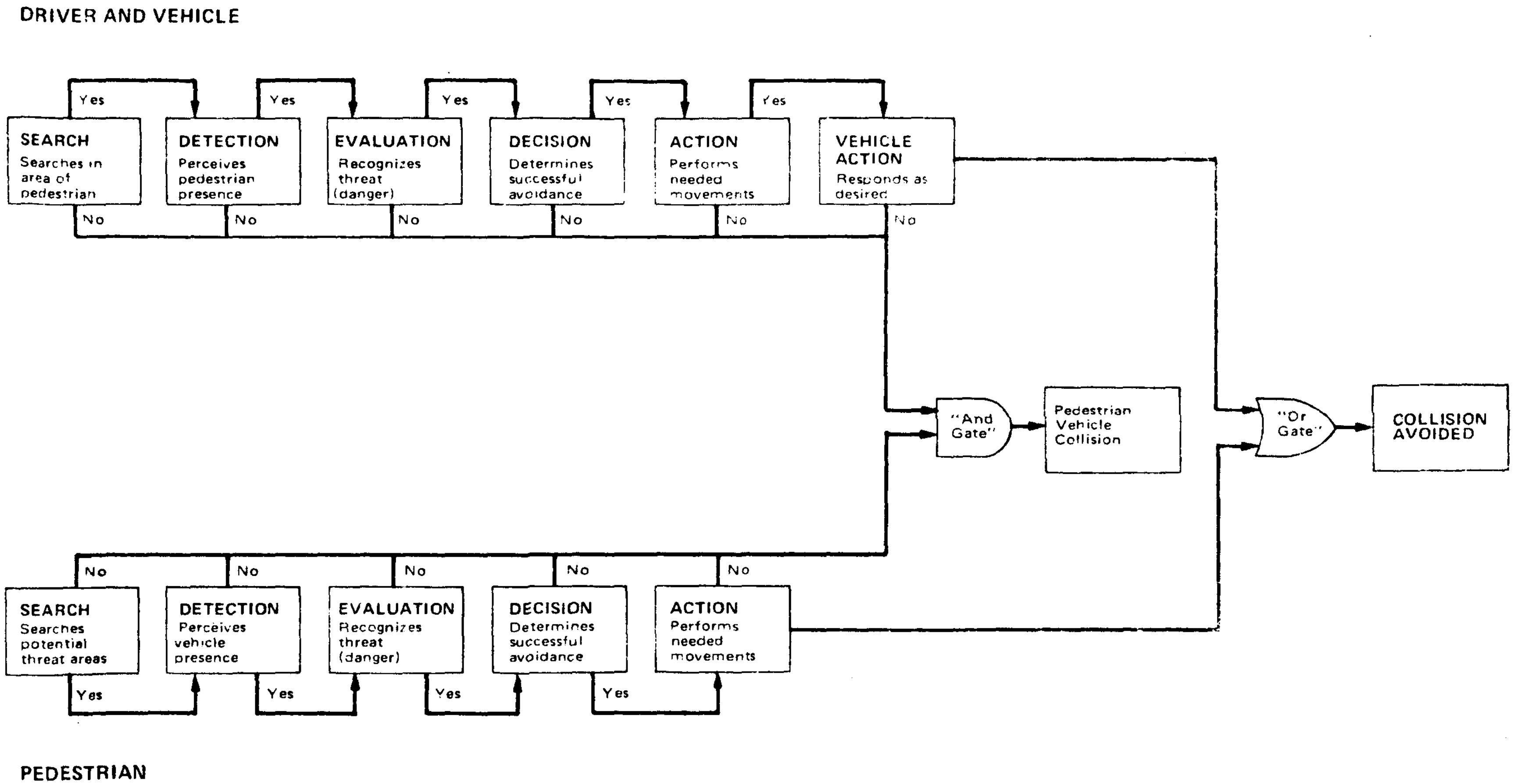

FIGURE 3.1. GENERALIZED FUNCTION EVENT SEQUENCE

3.5 In Figure 3.1 each step for each participant is indicated by a rectangle labeled by the name of the function and the desired or successful outcome. The lines labeled yes or no following the functions indicate what sequence is followed if the function is performed successfully or not. Two points about the sequence and its outcome should be noted: (a) once one step is not performed adequately, the following steps will not be, and (b) if either pedestrian or vehicle chain is completed successfully the collision is avoided.

3.6 The steps in the driver sequence can be summarily described as follows:

- Search refers to the focus of the driver's attention and his behavior that influence his perception of the environment. This deals mainly with where he is looking.

- Detection refers to his actual perception of the environment. Successful detection means that he is aware of the pedestrian.

- Evaluation refers to his evaluation of what he has perceived (the pedestrian and his surroundings); and, if "successful," results in a recognition of the threat of a collision and the need for action to avoid it.

- Decision refers to the determination of the action necessary to avoid a collision.

- Human action refers to the motor behavior of the driver to implement his avoidance decision.

- Vehicle action refers to the response of the vehicle to the motor behavior of the driver.

3.7 The sequence for the pedestrian is the same, except for the exclusion of the vehicle action.

3.8 It is obvious that a failure at any step results in nonperformance of the remaining steps. For example if the driver fails to detect the pedestrian, he will fail to recognize the need to avoid him, fail to decide how to do it, and fail to take the action needed to change the vehicle course.

3.9 Timing is also important; a delay in detection for example, may leave inadequate time for the required avoidance action. Failure at any step, or poor performance resulting in a time delay which precludes successful completion of the chain, is considered to be a precipitating "cause" of the collision. However, it is well-recognized that many factors may influence this sequence of functions and thus, indirectly, the occurrence of a collision. These factors are considered next.

Influencing/Predisposing Factors

3.10 Discussions of crash causation commonly deal with three main areas: the driver, the vehicle, and the roadway. This general approach to the grouping of factors is useful in considering variables which influence the function/event sequence, provided two modifications are made: (a) "the driver" includes both the driver and the pedestrian and (b) "the roadway" is considered in the broadest sense of the total environment. Thus four main classes of predisposing or influencing factors are identified:

a. Driver factors

b. Pedestrian factors

c. Vehicle factors

d. Environmental factors.

3.11 To understand the causes of crashes, one must know which of the specific variables in these groups influence the function/events in the behavior sequence, and in what ways. Figure 3.2 schematically portrays the relationship of these factors to the function/event sequence. Within each major class (e.g., pedestrian, driver), variables of interest can be thought of as directly influencing (a) perception, (b) evaluation and decision, (c) human motor behavior, and (d) vehicle action. If variables within a major class do not influence any of these then they are not of interest in the determination of causation.

3.12 Figure 3.2 also indicates the need to consider (a) the precollision cours of the participants as an influence on the function/event sequence and (b) the fact that the course of one participant becomes part of the environment for the other participant. Although it is not detailed in Figure 3.2, the "selection and implementation of the precollision course" encapsulates a function/event sequence, from search to action, which is influenced by the same groups of predisposing factors as the sequence involved in the collision course.

CAUSES AND COUNTERMEASURES MODEL

3.13 The behavioral sequence model presented a structure for viewing the types of events and factors involved in pedestrian crashes and some of the ways in which they relate to each other. It can be used as a frame of reference for describing a single crash, or for indicating what kinds of function failures or predisposing factors are most frequent.

3.14 However, the identification of causes must be carried to a more detailed and specific level if it is to be a useful foundation for countermeasure identification. The complexities of various possible combinations of specific

2/ Some other descriptive variables may still be of interest when considering countermeasures.

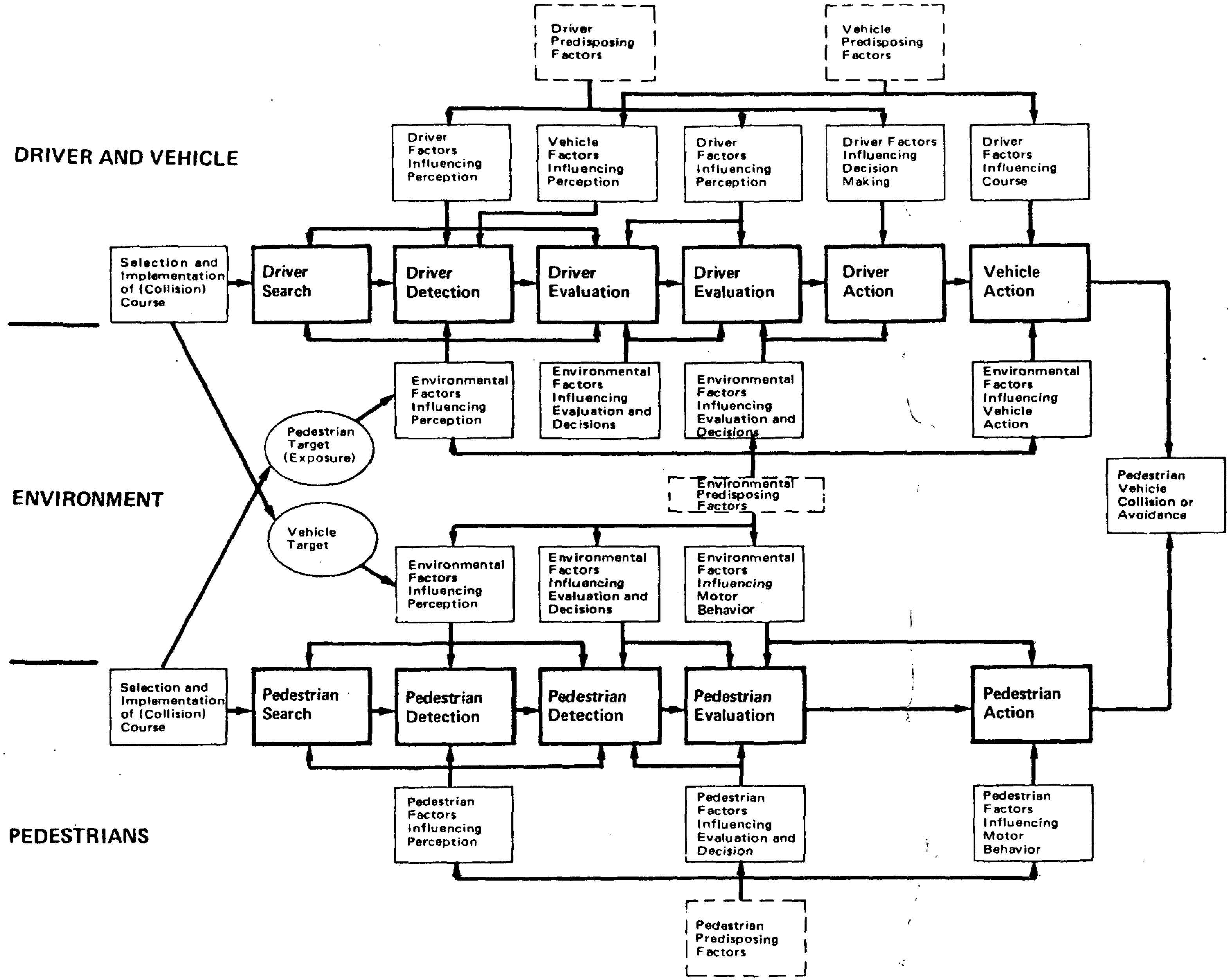

FIGURE 3.2. RELATIONSHIP OF INFLUENCING/PREDISPOSING FACTORS TO FUNCTION/EVENT SEQUENCE

causal variables leads to the need for an additional frame of reference or model to assist in organizing accident and causal data so that they are useful for determining specific corrective actions that can be taken. This section addresses that need by presenting a further conceptualization of (a) causal types and (b) countermeasure approaches.

Causal Types

3.15 A basic assumption is that all pedestrian accidents are not alike in terms of causes. Furthermore, even though a given countermeasure may work against crashes with different combinations of causal factors, a study of the combination of causal factors is the best way to determine appropriate countermeasures.

3.16 It is believed that similarities and differences among the population of pedestrian accidents are such that a finite number of different types can be identified, each of which will be amenable to different (but perhaps overlapping) countermeasures. In other words, in order to identify countermeasures pedestrian accidents should be broken down into different types primarily on the basis of cause. Each such grouping is designated as a "causal type."

3.17 Ideally, each pedestrian accident can be assigned to a causal type along with other accidents which are similar with respect to three sets of features:

- Precipitating events
- Predisposing factors
- Target groups.

3.18 Precipitating events refer to the specific nature of the failure in the function/event sequence that led to the collision.

3.19 Predisposing factors refer to the specific environmental, human or vehic variables which actually influenced the function failure.

3.20 Precipitating factors are those actions, decisions and events that lead directly and immediately to a crash, while predisposing factors are those which, in advance, created a susceptibility, inclination or disposition towards a crash.

3.21 Target groups refer to the human populations and/or kinds of physical locations involved in this type of accident.

3.22 The relationship among these three aspects of a causal type is shown schematically in Figure 3.3. It should be noted that, ideally, for a given accident type, the predisposing factors must be environmental, human or vehicle conditions that actually led to the function failure, while target group variables include environmental, human, or vehicle conditions that are only associated with involvement. The usefulness of this distinction will become apparent when considering the countermeasure approaches.

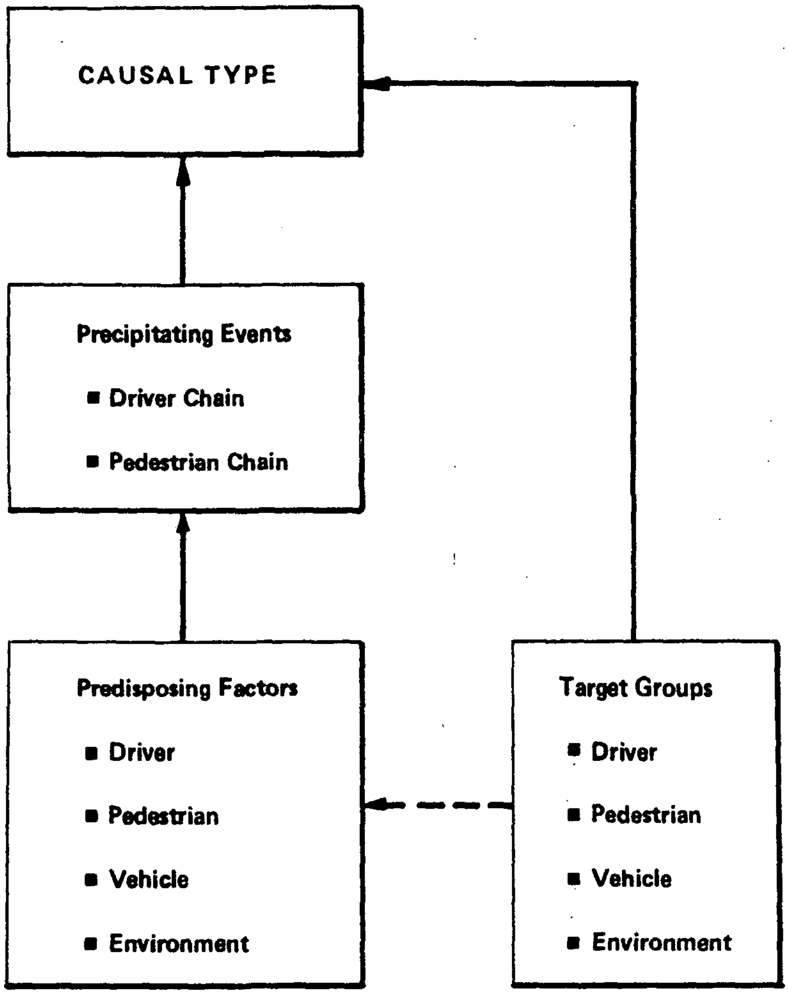

FIGURE 3.3. ASPECTS OF CAUSAL TYPE

Countermeasure Approaches

3.23 The identification of possible countermeasures requires at least three elements:

a. Identification of the specific problem to be counteracted (precipitating factors)

b. Identification or narrowing of the target affected by the problem

c. Identification of the specific actions that can be taken to reduce or eliminate the occurrence of the precipitating events or to prevent them from resulting in a crash.

3.24 Items a and b can be provided by classification by causal types. The third step can be approached in two basis ways:

- Match existing recommended countermeasures with causal types to determine their applicability
- Analytically review causal types to identify potential new countermeasures.

3.25 An analytical review of a given causal type aimed at identifying new countermeasures can be conducted, based on a simple countermeasure model. Countermeasures can operate in three basic ways:

a. Reduce or eliminate the predisposing factors that led to the precipitating event (functional failure), e.g., alcohol control.

b. Reduce or eliminate the precipitating event (functional failure) directly.

c. Interpose a countermeasure so that the precipitating action no longer leads to a crash.

3.26 These three approaches accept the status quo with regard to locomotion and course selection. A fourth approach, normally much more expensive or politically unfeasible, is to control the situation so that the collision course cannot be selected.

IMPLICATIONS AND APPLICATIONS

3.27 The models presented here have identified: (a) major aspects of the pedestrian accident process; (b) a manner in which these different aspects may be grouped in order to understand accidents with common causal patterns; and (c) the ways in which these patterns may be reviewed to identify possible countermeasures.

3.28 More specifically the models may be applied as follows:

- The function/event sequence of the behavior sequence model identifies the primary data items to be studied in depth to determine precipitating factors.
- The influencing/predisposing factors of the behavior sequence model identify the areas for collection of additional data useful in understanding causation.
- The causes and countermeasures model indicates a way of organizing information about a set of crashes that is useful for countermeasure selection, and identifies the analytical steps necessary to identify relevant countermeasures.

3.29 These models imply both the need for the approach to the project described in Section II and provide the basis for specifying specific items of data and analysis.

IV. GENERAL PEDESTRIAN ISSUES

INTRODUCTION

4.1 This section presents findings of the study related to general issues and questions about pedestrian accidents. Selected data are presented here to add to the general understanding of the nature of the problem. (Additional detail is provided in Volume II, Appendices.) For the most part these data are of a descriptive nature, or deal with general causal factors. The description of specific causal types most relevant to countermeasure design is presented in Section V.

BASIC DESCRIPTIVE DATA

4.2 In reviewing the descriptive data, it should be noted that the sampling approach was aimed at collecting quality, in-depth data, rather than an exact probability sample to permit precise estimates of descriptive parameters.

4.3 The sampling procedure was expected to result in a slight overrepresentation of fatalities and peak afternoon time periods, and a slight underrepresentation of accidents in outlying areas. However, where study data could be compared with previous studies, the two sets were generally consistent.

Time

4.4 At the initiation of the study, available historical data were secured from participating cities relative to the time of day during which pedestrian accidents were reported. These data showed a striking and consistently heavy pattern of incidents in the late afternoon.

4.5 Although there are differences among cities relative to the time of onset or moderation of the peak period, the 3:00-6:00 p.m. period was included in all cities. The percentage of all motor vehicle accidents occurring during this time period is also high, but the percentage of pedestrian accidents occurring is higher than the percentage of all motor vehicle accidents during the period.

4.6 A smaller proportion of pedestrian accidents than all motor vehicle accidents occurred during other periods, especially in the early morning. One might suspect that the ratio of pedestrians to drivers is lower at that time. Figure 4.1 shows the distribution of pedestrian accidents over the 24-hour period in two cities (based on all cases in a recent year) as well as for the cases covered in this study.

Age

4.7 Research conducted prior to the present study identified the heavy involvement of children and the high fatality rate for older pedestrians. About half the pedestrian fatalities were over 45 years old and 30% were over 65. The 5- to 9-year age had the highest injury rate (number of injuries/number of persons in that age group)—much higher than even the older age groups.[1/]

4.8 The data collected in this study are consistent with prior findings. Of the pedestrians studied, 10% were between 1 and 4 years of age, 30% were between 5 and 9, and 11% were between 10 and 14.

4.9 Each five year age group from 30 on, contributed about 3% of the cases.[2/] Thus the 60-80 age groups contributed 13% of the cases. However, they accounted for 32% of the fatalities. Over 50% of the fatalities occurred in the over-40 group. The under-15 group, which contributed half of the total cases, accounted for 25% of the fatalities.

4.10 With respect to driver age, the ORI sample was distributed across age groups remarkably like all licensed drivers. There was a slightly higher representation in the ORI sample of the 19-30 range which might be explained by the likelihood that this group does more driving. These data do not necessarily mean that drivers in all age groups are involved at the same rate per hours driven.

Location and Area

4.11 Pin maps, if kept by city police, and discussions with police traffic or records personnel, indicated that the high incidence areas for pedestrian accidents are in the center city outside of the central business district. Such areas have been characterized as crowded, high-crime slums and ghettos.

[1/] American Automobile Association, Manual on Pedestrian Safety, Washington, D.C., 1964.

[2/] Percentages are based on the number of cases for which data are available. Unless otherwise noted, this procedure is followed throughout the text. Tables in Volume II give additional detail on the number of cases on which percentages are based.

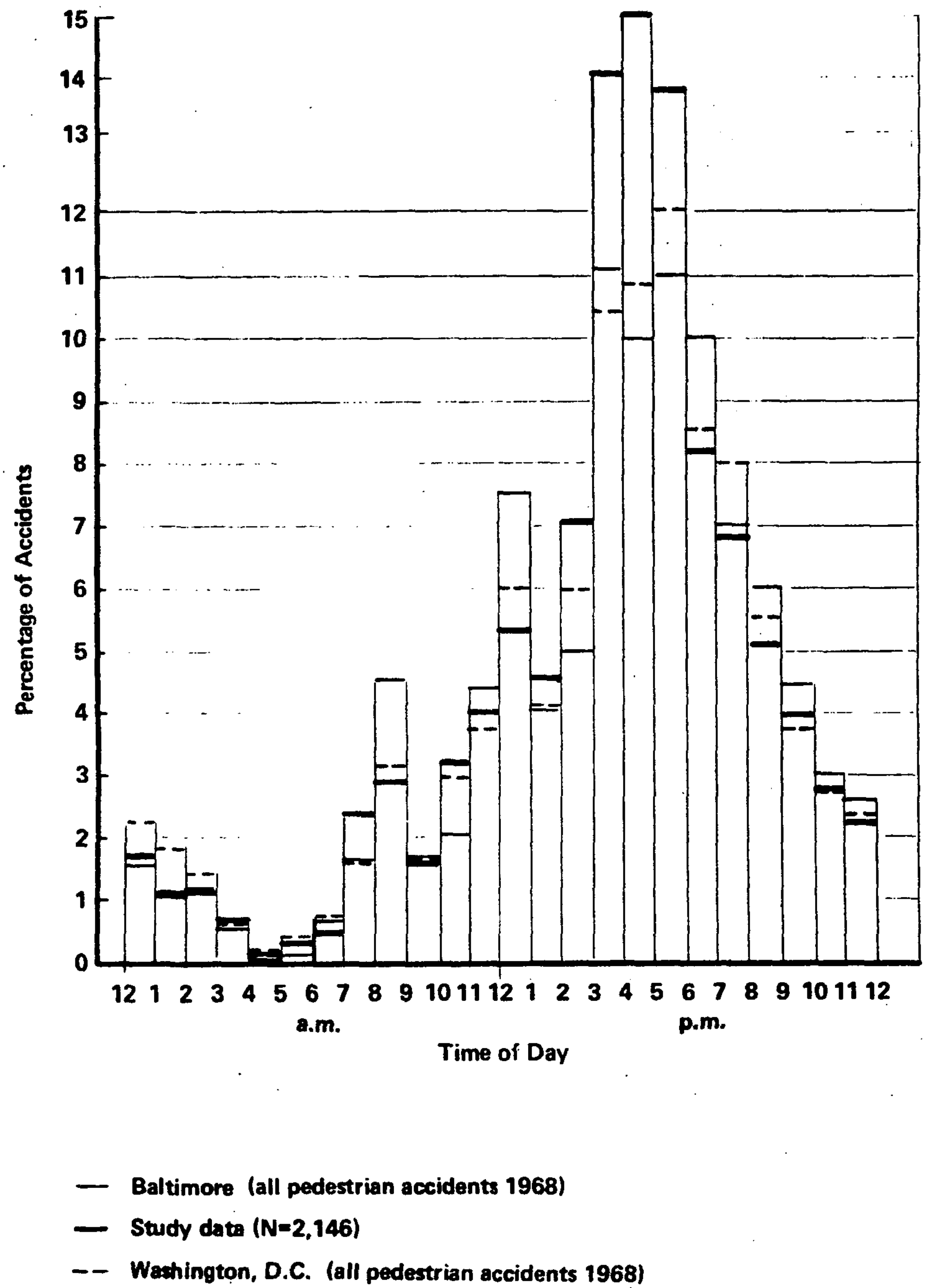

FIGURE 4.1. DISTRIBUTION OF PEDESTRIAN ACCIDENTS BY TIME OF DAY

4.12 For some cities, the sample cases in the ORI study were plotted on a street map and compared to public housing areas, urban renewal areas, or areas commonly known as slums or ghetto areas. Again, these areas corresponded to the high incidence pedestrian accident areas.

4.13 Relatively few accidents in the sample came from the central business district. (In two of the smaller cities, with high use of pedestrian signals downtown, no central business district pedestrian accidents were found in the study sample during the 10 month period.)

4.14 About half the accidents occurred in residential areas, 7% in mixed commercial-residential and 40% in primarily commercial areas. Only 2% occurred in school areas.

4.15 About half the accidents studied occurred at or near intersections. Traffic flow was generally normal (56%) or light (27%).

4.16 Most accidents, 78%, occurred on two-way streets. Crossing distances were generally not too great—57% were less than 40 feet. Average speed of vehicles during times that accidents occurred was not high (95% were under 35 mph and 58% were under 25 mph).

GENERAL CAUSATION DATA

Alcohol

4.17 Two kinds of data concerning alcohol were available for most cases One was an indication of alcohol presence for the driver or pedestrian. This information was secured from the police accident report. (Blood alcohol levels (BAL) were available too infrequently to warrant their tabulation. When BAL was determined, it was usually in a district attorney's or coroner's file with restricted access.) The second was a judgment as to whether or not the entire case record supported the conclusion that alcohol was a predisposing factor that led to the precipitating causal event.

4.18 The presence of alcohol was noted in about 2% of the drivers and 4% of the pedestrians in the sample. Alcohol as a predisposing factor was noted about the same percentage of the time; however, these cases were not all the same cases for which the police had detected alcohol. There was about a 60% overlap for drivers and a 75% overlap for pedestrians between police detection and a "predisposing" judgment. In addition some cases not reported on the police record as indicating the presence of alcohol were judged to have alcohol as a predisposing cause based on other evidence.

4.19 Compared to the most widely circulated figures on alcohol involvement in traffic accidents, these figures appear low. Part of the reason may be poor measurement—the data available were based on observation rather than blood levels. However, there are other reasons to expect a lower rate in this sample. Most pedestrian accidents occur earlier in the day than the "prime drinking hours" and high alcohol involvement periods.

4.20 Furthermore, the higher percentages reported usually refer to the percent of fatal traffic accidents. The rates for alcohol presence and predisposition were higher in the ORI sample of fatal cases (in the 6-8% range for both pedestrians and drivers as compared to the 2-4% range reported earlier for all sample cases). Furthermore, it should be noted that most of the pedestrians struck were below the normal age for alcohol consumption.

4.21 Finally, the preceding figures refer to individuals and not accidents. Since the number of cases in which alcohol involvement for both pedestrians and drivers was noted is small (about .3%), the rate per accident is almost the sum of the two (6.1%).

Physical Limitations

4.22 Physical limitations have an obvious potential for contributing to pedestrian accidents. There was at least one case of a functionally blind person being struck, and one involving a woman in a wheel chair. The rate of physical limitations present increases with advancing age for both drivers and pedestrians. The under-45 groups in the sample are usually in the 3% to 10% range for presence of some limitation, while the 60 and over groups tend to be in the 25-40% range.

4.23 For those cases with data on physical restrictions (n≅1,500), 90% of drivers and 90% of pedestrians have none. In 3.6% and .6% of the cases, pedestrian old age and driver old age, respectively, were judged to be predisposing factors. In 1.8% and .8% of the cases, other pedestrian and driver human factors (excluding alcohol) were judged to be predisposing.

Severity of Injury

4.24 For obvious reasons, safety personnel tend to give special attention to crashes that result in a pedestrian fatality. A comparison of the findings for fatal cases with nonfatal cases showed some expected differences.

4.25 The fatal group contains a higher proportion of older pedestrians: 37% of the fatals and 8% of the nonfatals are over 60 years of age; 28% of the fatals are under 15, while more than 53% of the nonfatals are under 15.

4.26 The fatal group contained a higher proportion of cases with higher pre-involvement vehicle speeds—15% of the fatal cases involved speeds over 40, while only 1% of the nonfatal cases involved such speeds.

4.27 There were also differences with respect to the time of day and presence of alcohol. Of the fatal cases, 44% occurred during non-daylight hours while only 24% of the nonfatal cases occurred then; 7% of the fatal cases and 3% of the nonfatals occurred where there was no street lighting. Alcohol was reported as present or not known for the pedestrian in 8% and 37% of the fatal cases respectively; comparable figures for the nonfatals were 4% and 6%.

4.28 Somewhat similar results occurred with regard to presence of alcohol in the driver. The fatal group reported 8% affirmative and 14% not known, while the nonfatal group reported 2% affirmative and 11% not known.

4.29 The type of area (residential, commerical, etc.) and the type of location (intersection versus midblock) were about the same for the two groups.

4.30 Although there are higher proportions of older people, alcohol involvements, high speeds, and nighttime accidents in the fatal group, fatality reduction cannot be limited to attending to those groups. Looking at the problem from another point of view, 56% of the fatalities occurred during the daytime, 28% of the fatalities were under 14 and 63% were under 60. In 77% of the fatal cases pre-involvement vehicle speed was 30 mph or less. Finally, fatalities resulted from practically all of the various accident types discussed in Section V.

4.31 The major behavioral items (direction and object of attention, movement and recognition of danger) reported for fatally injured pedestrians were about the same as found in the total sample.

Precipitating Factors

4.32 For each case, up to three primary precipitating factors were identified. A classification of precipitating factors was developed from the behavior sequence model with details added from specifics in the case reports. Each precipitating factor identified the nature of the failure in the function/event sequence plus further detail when feasible (e.g., driver detection failure due to parked cars). Table 4.1 lists the specific factors and the number of times each was identified as being a primary precipitating factor in a given case. The percentage figures refer to the percent of the total sample (n = 2,158) to which each factor applied.

4.33 Table 4.2 presents similar information in summary form by totaling the identified specific factors within "factor groups." Each factor group is associated with a given behavior/event block in the conceptual model, e.g., driver detection. In Table 4.2, the percentages refer to the percentage of total specific factor identifications that occurred within a given factor group.

4.34 The following explanation of some of the groups of factors should aid in interpreting these tables.

4.35 Pedestrian Course Factors. This refers to courses (speed, direction) that were of a high risk nature in the particular case situation. For example, a pedestrian crossing a fenced freeway would be in a very unexpected, unusual place and therefore not anticipated by drivers attending to traffic. It should be noted that when a running pedestrian presented a short time exposure to the driver, only the latter factor was identified. Those with "pedestrian course running" mean the swift movement rather than the short time exposure was important.

4.36 Pedestrian Search Failures. This means the pedestrian did not conduct an adequate search of the area, whereas a pedestrian detection failure means that he searched in appropriate directions but did not detect, perhaps because of a visual obstruction. In a number of cases it was possible to determine that the pedestrian did not detect the presence of the vehicle, but it was not possible to tell whether or not he did conduct an adequate search. Thus the broader factor,

TABLE 4.1

FREQUENCY OF PRIMARY PRECIPITATING FACTORS

System Failure Description	Cases in Which Factor Was Identified	
	Percent	No.
(01) Ped course (risk taking), high exposure to vehicles	3.80	81
(02) Ped course (risk taking), poor target, slow speed	1.20	26
(03) Ped course (risk taking), poor target, short-time exposure	31.40	67
(04) Ped course (risk taking), poor target, unexpected or unusual place	3.00	64
(05) Ped course (risk taking), poor target, running	9.90	214
(06) Ped course (risk taking), poor target, crossing against light	6.50	141
(07) Ped course (risk taking), poor target, back to traffic	0	1
(08) Ped course (risk taking), poor target, poor location, sitting on curb	0.05	1
Total ped course failures = 1,206		
(10) Ped search, and detection, not further specified (NSF)	14.10	304
(11) Ped search, overload	0.20	5
(12) Ped search, distraction (NSF)	5.70	122
(13) Ped search, inattention	13.00	281
(14) Ped search, inadequate search	10.70	231
(1F) Ped search, distraction, traffic signal	0.50	10
(1G) Ped search, distraction, traffic during first half of crossing	1.10	24
(1H) Ped search, distraction, traffic during second half of crossing	0.60	13

TABLE 4.1 (Cont)

System Failure Description	Cases in Which Factor Was Identified	
	Percent	No.
(1J) Ped search, distraction, hostile person or animal	1.30	27
(1K) Ped search, distraction, play activity	4.60	99
Total ped search failures = 1,161		
(15) Ped detection, not explainable, adequate search but detection failure	1.30	29
(16) Ped detection, perceptual interference, parked car	5.40	115
(17) Ped detection, perceptual interference, traffic	0.70	16
(18) Ped detection, perceptual interference, post	0.30	6
(19) Ped detection, perceptual interference, street furniture	0.05	1
(1A) Ped detection, perceptual interference, building	0.10	3
(1B) Ped detection, perceptual interference, sun	0.05	1
(1C) Ped detection, perceptual interference, poor lighting	0.10	3
(1D) Ped detection, perceptual interference, standing traffic	2.10	46
(1E) Ped detection, perceptual interference, stopped bus	0.80	8
Total ped detection failures = 238		
(21) Ped evaluation, misperception of driver's intent	3.40	77

TABLE 4.1 (Cont)

System Failure Description	Cases in Which Factor Was Identified	
	Percent	No.
(22) Ped evaluation, poor prediction of vehicle/ped path	3.4	81
Total ped evaluation failures = 238		
(31) Ped decision and avoidance intent	0.8	17
(32) Ped avoidance action, environment	0.2	4
(33) Ped avoidance action, self-limits	0.7	15
Total ped avoidance action failures = 36		
(41) Driver course (risk taking), limitation of avoidance response, speed	4.9	106
(42) Driver course (risk taking), unexpected course, attempt to beat light	0.9	20
(43) Driver course (risk taking), unexpected course, run stop sign	0.5	11
(44) Driver course (risk taking), unexpected course, run red light	1.9	40
(45) Driver course (risk taking), unexpected course, wrong side of road	0.2	4
Total driver course failures = 181		
(5U) Driver search (and detection), not further specified	8.6	185
(51) Driver search, overload	0.6	14
(52) Driver search, distraction	3.9	85
(53) Driver search, inattention	4.0	86
(54) Driver search, inadequate search	6.5	140
Total driver search failures = 510		

TABLE 4.1 (Cont)

System Failure Description	Cases in Which Factor Was Identified	
	Percent	No.
(55) Driver detection, perceptual interference, parked cars	6.0	130
(56) Driver detection, perceptual interference, traffic	1.4	31
(57) Driver detection, perceptual interference, posts	0.5	10
(58) Driver detection, perceptual interference, street furniture	0.2	4
(59) Driver detection, perceptual interference, buildings	0.3	6
(5A) Driver detection, perceptual interference, sun	0.9	20
(5B) Driver detection, perceptual interference, poor lighting	0.9	19
(5C) Driver detection, perceptual interference, standing traffic	2.2	48
(5D) Driver detection, perceptual interference, stopped bus	0.9	19
(5E) Driver detection, perceptual interference, blinding headlight	0.1	3
(5F) Driver detection, perceptual interference, trees	0	0
(5G) Driver detection, perceptual interference, splashed water	0.05	1
(5H) Driver detection, perceptual interference, snow on windshield	0.05	1
Total Driver Detection Failure = 292		
(71) Driver evaluation, misperception of ped's intent	2.7	58

TABLE 4.1 (Cont)

System Failure Description	Cases in Which Factor Was Identified	
	Percent	No.
(72) Driver evaluation, poor prediction ped/ vehicle path	1.1	24
Total driver evaluation failures = 82		
(5X) Driver lost control of vehicle, (NFS)*	3.5	75
(61) Driver and pedestrian interaction, failure to match evasive action	0.4	9
Total system failures identified =3,948		

* Not further specified.

TABLE 4.2

FREQUENCY OF PRIMARY PRECIPITATING FACTOR IDENTIFICATIONS
WITHIN FACTOR GROUPS
(N = 2,147 cases)

Factor Group	Number of Times Selected	Percent of Factors Selected
Ped course	1,206	30.6
Ped search and detection	1,166	29.4
Ped detection	238	6.0
Ped evaluation	158	4.0
Ped decision	17	.4
Ped action	19	.5
Driver course	181	4.6
Driver search and detection	510	12.9
Driver detection	292	7.4
Driver evaluation	82	2.1
Driver control-action	75	1.9
Driver and ped interaction	9	.2
Total	3,953	100%

pedestrian search and detection failure, not further specified (NFS), had to be used. In Table 4.2 this factor is grouped in with the search failures.

4.37 Some of the specific types of search failures should be noted. Inattention means he was not paying particular attention to anything, while inadequate search means he conducted a search that was not sufficiently thorough or complete. Overload means that there were so many inputs that he could not adequately search and attend to them all, while distraction means that his search was focused on something other than the vehicle that hit him.

4.38 The other pedestrian factors are self-explanatory. Driver factors have similar meanings. Driver and pedestrian evasive action failure to match indicates that both parties changed course to avoid the crash but cancelled each other out.

4.39 Tables 4.1 and 4.2 show the high incidence of risky pedestrian courses, along with driver and pedestrian search and detection failures. Many fewer accidents were caused by failures by one of the parties to evaluate the threat or act appropriately once he had detected the other party. It should be noted that each specific factor in Table 4.1 was identified as a primary factor in some accidents and that these tables illustrate relative incidence.

4.40 The same list of factors was used to select "secondary" precipitating factors — events which were judged to be of secondary importance in a particular case, or whose contribution was not as strongly established as that of the primary precipitating factor. Driver detection and pedestrian detection factors were identified most often.

4.41 Combinations of Precipitating Factors. Although causal patterns are treated in the discussion of specific types (Section V), some data on combinations of primary precipitating factors occurring within the total sample may be of interest. In just over half the cases two primary precipitating factors were identified. The other half was split almost equally between cases in which either one or three primary precipitating factors were identified.

4.42 When only one primary factor was identified, 60% of the time it was a pedestrian factor. When two or three factors were identified, 75% and 68% of the factors were pedestrian factors.

4.43 There were many combinations of specific precipitating factors that could and did occur. It appears that there are many combinations of precipitating events that can lead to a pedestrian crash. The combination of specific factors which occurred in about 1% or more of the cases are listed in Table 4.3. Table 4.4 presents data concerning combinations of factors from a slightly different viewpoint. It indicates the frequency with which any specific factor in a given group was identified in combination with any specific factor in another given factor group (e.g., the frequency with which specific driver search factors and specific pedestrian search factors were identified in the same case).

Predisposing Factors

4.44 It was noted earlier that predisposing factors increase the likelihood of an accident in advance although they do not lead directly and necessarily to the accident. Table 4.5 shows the frequency of such factors identified as contributing to the cases studied. An identification as a predisposing factor in this study means more than presence or association; it means that the factor was judged to contribute to the accident.

4.45 The largest single group of predisposing factors were "environmental," mostly because of the heavy incidence of parked cars that interfere with vision. The second largest set of predisposing factors results in a heavy exposure of the pedestrian to threatening vehicles. The exposure comes mainly from engineering that permits pedestrian-vehicle conflicts[3] of from young children who are unattended or improperly supervised. (The "unattended child" category was used only for preschool-age children.) The third largest set involved pedestrian human factors, mainly old age and alcohol, which were judged to have contributed to the precipitating events.

Conclusion

4.46 The preceding review of selected data was designed to provide a basic description of various aspects of pedestrian accidents and give a general indication of the causal factors that were identified in this study. The purpose has been to provide a basic perspective and an indication of some of the salient problems. With this background, it is now appropriate to turn to more direct presentations of causal patterns and the possible countermeasures that can be employed.

3/ For example, an uncontrolled intersection, or a signalized intersection in which cars are given a green signal to turn on a course that crosses the pedestrian path at a time when the pedestrian has a green signal.

TABLE 4.3

COMBINATIONS OF SPECIFIC PRIMARY PRECIPITATING FACTORS

Combination	No.	Description	% of 1,667[1]
03	47	Pedestrian course, poor target, short-time exposure	2.8
0310	66	Pedestrian course, short-time exposure, pedestrian search and detection failure, not further specified (NFS)[2]	4.0
0312	16	Pedestrian course, short-time exposure, pedestrian search, distraction	0.9
0313	82	Pedestrian course, short-time exposure, inattention, not attending to anything	4.9
0314	37	Pedestrian course, short-time exposure, inadequate search	2.2
0316	23	Pedestrian course, short-time exposure, pedestrian visual, parked car	1.4
031K	23	Pedestrian course, short-time exposure, pedestrian distraction, play activity	1.4
0355	15	Pedestrian course, short-time exposure, driver visual, parked car	0.9
031055	17	Pedestrian course, short-time exposure, pedestrian search and detection, NFS, driver visual, parked car	1.0
03105U	14	Pedestrian course, short-time exposure, pedestrian search and detection, NFS, driver search and detection, NFS	0.8
031655	41	Pedestrian course, short-time exposure, pedestrian detection, visual, parked car, driver visual, parked car	2.4
05	17	Pedestrian course, poor target, running	1.0
0513	15	Pedestrian course, running, pedestrian search, inattention	0.9
0514	16	Pedestrian course, running, pedestrian search, inadequate search	0.9
0510	20	Pedestrian course, running, pedestrian search and detection failure, NFS	1.2

TABLE 4.3 (Cont)

Combination	No.	Description	% of 1,667
105U	31	Pedestrian search and detection failure, NFS; driver search and detection failure, NFS	1.9
12	23	Pedestrian search, distraction	1.4
13	24	Pedestrian search, inattention, not attending to anything	1.4
14	41	Pedestrian search, inadequate search	2.4
1454	21	Pedestrian search, inadequate search; driver search and detection, inadequate search	1.3
54	21	Driver search and detection, inadequate search	1.3
5U	35	Driver search and detection failure, NFS	2.1
5X	25	Driver control of vehicle, lost control, NFS	1.5
99	66	Insufficient information	4

1/ Total of 1,667 cases with either one, two, or three precipitating factors given.

2/ Not further specified.

TABLE 4.4

COMBINATIONS OF PRIMARY PRECIPITATING FACTOR GROUPS

Combinations of Factor Groups	% [2/]	No.
Ped course, ped search, driver detection	13.6	294
Ped course, ped search	11.3	245
Ped search, driver search	9.9	214
No factors identified	8.1	176
Ped course, ped search, driver search	6.3	136
Ped course, ped detection, driver detection	5.7	123
Ped search, driver detection	3.9	84
Driver search	3.6	77
Ped course	3.7	81
Ped search	3.6	77
Ped evaluation, driver search	2.4	53
Ped search, driver course, driver search	1.7	37
Ped course, driver detection	1.7	36
Ped course, driver search	1.6	35
Driver evaluation	1.5	33
Ped course, ped search, driver control action	1.3	29
Ped course, ped search, driver course	1.3	28
Driver course	1.2	25
Ped detection, driver detection	1.2	25
Ped search, driver control action	1.1	23
Ped search, driver detection	1.1	23

1/ In at least 10% of the sample of N=2,157.

2/ Percentage of all cases (N=2,157) that had the indicated combination of factors.

TABLE 4.5

FREQUENCY OF PREDISPOSING FACTORS

Predisposing Factors	Cases in Which Factor Was Identified	
	%	No.
Limitations on driver's search, vehicle projections	.8	21
Inducement to risk - signal timing	2.3	50
Heavy exposure, high risk, traffic control, ped vehicle turns	6.8	146
Heavy exposure, high risk, traffic control, ped vehicle conflicts	2.4	51
Heavy exposure, high risk, traffic control, safety zone design	.6	12
Heavy exposure, high risk, adult supervision of children - improperly supervised	6.9	148
Heavy exposure, high risk, adult supervision of children - unattended	6.5	140
Total heavy exp, high risk factors = 497		
Pedestrian human factors, alcohol	3.8	81
Pedestrian human factors, old age	3.6	78
Pedestrian human factors, NFS	1.9	40
Pedestrian human factors, narcotics, drugs	.05	1
Total ped human factors = 200		
Driver human factors, alcohol	2.0	44
Driver human factors, NFS	.9	19
Driver human factors, old age	.6	13
Total driver human factors = 76		

TABLE 4.5 (Cont)

Predisposing Factors	Cases in Which Factor Was Identified	
	%	No.
Environment - parked cars	21.2	457
Environment - weather, visibility	3.1	66
Environment - weather, slippery conditions	2.4	51
Environment - control, domestic animals	.1	2
Environment - streetcar tracks	.1	2
Total environmental factors = 578		
Vehicle condition - poor brakes	.3	7
Vehicle condition - NFS	.1	2
Vehicle design - NFS	.05	1
Total vehicular factors = 10		

V. CRASH CAUSATION AND COUNTERMEASURES

INTRODUCTION

Objectives

5.1 The objectives of this section are first to present an organized description of pedestrian accidents in order to provide a clear delineation of the problems that must be overcome, and second to present possible countermeasures or solutions. The primary manner in which these will be achieved is through the presentation of an organized structure of accident types that were developed using the methods and procedures described in Section II.

5.2 Data collected during the present study were directed at determining causal factors amenable to countermeasures. An attempt was made to isolate types of pedestrian accidents which involved different causal patterns and countermeasures. Special attention was given to the behavioral precollision sequence of events so as to be able to identify precipitating factors. Ideally, one should also know the predisposing factors which increased the probability of the precipitating events, and the target population (people or locations) towards which countermeasures should be directed. Each pedestrian accident type may be considered as a problem to be solved. For each problem both old and innovative countermeasures are considered.

Causal Types

5.3 All cases were assigned a specific type designation. As an aid to considering the action that might be taken, types have been grouped under the following headings:

- Typical pedestrian situation—dart-outs and dashes
- Other typical pedestrian situations

- Situations with specific predisposing factors
- Nonstreet locations
- Atypical pedestrian activity
- Miscellaneous
- Atypical causes—not pedestrian countermeasure corrective
- Causes not studied
- Infrequent or unidentifiable pattern.

5.4 Most of the cases studied were identified as types falling within the first two groups. The "atypical causes—not pedestrian countermeasure corrective" and the "causes not studied" groups include cases that either fall beyond the scope of pedestrian safety or could not be studied. For these groups, only a minimum report will be given. For other groups, the specific causal types will be considered individually under the group headings. Table 5.1 lists all the specific types and percent of sample cases falling within them.[1/]

Countermeasures

5.5 As indicated in Section II, specific countermeasures were identified by reviewing the causal patterns and targets associated with given accident types. While attention is focused on the specific countermeasures that are appropriate for given accident types, it is useful to note that countermeasures fall into five general classes with respect to the general nature of the action to be taken.

5.6 Class I—Vehicle Characteristics. Countermeasures in this class reduce crashes by modifying the vehicle itself.

5.7 Class II—Traffic Engineering and Regulation. This class includes engineering and control changes that modify the movements of vehicles and people or aspects of the physical environment. Only short-term projects without major construction are included.

5.8 Class III—Urban Development. Major physical changes in the urban environment fall in this class. Construction of highways, buildings, parks, etc., is included.

5.9 Class IV—Education, Enforcement and Public Information. This class includes all measures designed to change behavior by providing information, rewards,or punishment.

5.10 Class V—Other. This class includes any other specific steps that could be taken, such as modification of emergency vehicle response procedures.

1/ Any extrapolation from these and other percentages must, of course, take into consideration the nature of the study sample. (See Section IV and Appendix D.)

Table 5.1

FREQUENCY OF ACCIDENT TYPES
(N = 2,147)

Accident Type	Percent	No.
A1 Dart-outs and dashes		
(01) Dart-out first half	24.1	518
(02) Dart-out second half	8.9	193
(10) Pedestrian strikes vehicle	4.0	86
(27) Intersection dash	8.4	180
Total	45.5	980
A2 Other typical pedestrian situations		
(07) Multiple threat situation	3.2	69
(14) Pedestrian waiting to cross in roadway	0.6	14
(24) Vehicle turn/merge with attention conflict	6.4	137
(26) Multiple pedestrian split	0.3	7
Total	10.5	227
B Situations with specific predisposing factors		
(06) Vendor-ice cream truck	1.5	32
(20) Pedestrian exiting from vehicle	0.9	19
(23) Bus stop related	2.6	56
(29) Backing up	1.7	37
Total	6.7	144
C Non-street locations		
(09) Non-pedestrian activity not in roadway	0.9	19
(15) Freeway-expressway—from car	0.2	4
(16) Freeway-expressway—crossing	1.1	23
(25) Off-street parking	0.9	19
Total	3.1	65
D Atypical pedestrian activity		
(08) Non-pedestrian activity in roadway	2.2	48
(21) Pedestrian walking in roadway	1.1	24
(31) Working on vehicle	0.3	6
Total	3.6	78

Table 5.1 (Cont)

Accident Type	Percent	No.
E Miscellaneous		
(13) Rear wheel: truck or bus	0.5	10
(19) Weird	1.2	26
Total	1.7	36
F Atypical causes—not pedestrian countermeasure corrective		
(03) Precipitated by illegal antisocial act to pedestrian	1.1	24
(04) Precipitated by illegal antisocial act by pedestrian	0.9	19
(05) Hot pursuit	0.1	2
(18) Result of auto-auto crash	2.6	55
(22) Driverless vehicle	0.4	9
Total	5.1	109
G Causes not studied		
(11) Inadequate information: non-fatal	2.6	56
(12) Inadequate information: fatal	0.8	17
(17) Ped operating bike or cart	2.2	47
Total	5.6	120
H Infrequent or unidentifiable pattern	17.4	374
Total, All Cases	100.0	2,147

Organization of Cause and Countermeasure Information

5.11 The remainder of this section will present information by accident type following the accident type groupings noted previously. For each type, two kinds of information will be presented:

- Basic type description
- Summary data .

A countermeasure discussion will be presented at the end of each applicable group of accident types.

TYPICAL PEDESTRIAN SITUATIONS—DART-OUTS AND DASHES

5.12 This group includes the following types and covers about 45% of the sample cases. The code numbers precede the title and the percent of the sample follows, i.e.,

(01) Dart-out first half (24%)

(02) Dart-out second half (9%)

(27) Intersection dash (8%)

(10) Ped strikes vehicle (4%) .

Dart-Out First Half (01)

5.13 Basic Type Description. A pedestrian, not in an intersection crosswalk, appears suddenly from the roadside. His quick appearance and short-time exposure to the driver are the critical factors. The pedestrian may often be running, and parked cars often obstruct vision, but neither need be present if the basic condition of sudden appearance to the driver's view is met.

5.14 The prime example of the dart-out is a school-age child running out from between parked cars on his own block, in a residential area in the center city in the afternoon after school. He heads straight across the relatively narrow street, looking where he is going and is struck less than half way across. The driver, traveling at a normal rate of speed, did not have enough time to stop after detecting the child. Other variations, such as a 79-year-old pedestrian, may occur, but the above example was a recurring pattern that was noticed by many field investigators.

5.15 Summary Data. The most frequent primary precipitating factor identified for this type was "(03) ped course—risk taking-short-term exposure" which means that the pedestrian course of movement caused a short-term exposure to the driver and precipitated the crash.[2]

---

[2] If running was important only insofar as it caused a short-time exposure, it was included in "03 short-time exposure"; the "05 running" code meant that more than a short-time exposure problem was contributed by the running.

5.16 This accounted for more than 35% of the primary precipitating factors identified for cases in this type.[3] The following factors together accounted for another 45% of the primary precipitating factors identified.

(10) Ped search and detection failure—NFS

(13) Ped search—inattention

(14) Ped search—inadequate search

(1K) Ped search—distraction, play activity

(16) Ped detection—visual—parked cars

(55) Driver detection—visual—parked cars.

5.17 The last two failures (16 and 55) also accounted for almost 70% of the secondary precipitating factors identified in these cases.

5.18 Although this type accounted for about a quarter of the total sample, it included from one half to two-thirds of the cases in which the following were primary precipitating factors: (10) ped course—short-time exposure, (16) ped detection—parked cars, and (55) driver detection-parked cars. This type also included about three-fourths of all the cases in which the latter two (16 and 55) were identified as secondary precipitating factors.

5.19 The most frequently noted predisposing factor was parked cars. It accounted for over 60% of the predisposing factors identified for type 01 dart-out, while unattended children and improperly supervised children each accounted for about 15% of the predisposing factors for this type. About 55% of the cases in the total study sample in which unattended children or improperly supervised children was a predisposing factor fell into this type (01) as did 70% of the total cases in which parked cars were a factor. Thus these factors account for most of the predisposing factors within the type and most of the cases with these factors fall into this type.

5.20 A review of the behaviors involved showed that most pedestrians were looking straight ahead (72%), were not observing traffic (75%), were running (79%), and did not recognize the need for evasive action (76%) or recognized it just prior to impact (15%). The most frequent objects of attention specified were friends or family (29%) or play (23%).[4]

3/ As noted earlier, each case could have up to three primary precipitating, three secondary precipitating, and three predisposing factors identified.

4/ As indicated earlier, unless noted otherwise, percentages are based on the case for which data were available on a given item. Detailed results appear in Volume II, Appendices.

5.21 The type 01 drivers were also looking ahead (66%) or engaged in general search activity (23%). Most (76%) were proceeding at sustained speed. Some (16%) did not recognize the need for evasive action. A significant proportion (38%) recognized the need just after the pedestrian began his collision course while about the same number (43%) recognized the need just prior to impact.

5.22 Almost 90% of the type 01 dart-out pedestrians were under 14; about half of the incidents happened between 3:00 p.m. and 6:00 p.m., while 78% were between 2:00 p.m. and 9:00 p.m.; 80% were in the daytime. The crashes took place in residential areas (72%) and did not involve high speeds (85% below 30 mph pre-involvement). Most of the time the pedestrian was struck within two blocks of his home (65%), crossing a street less than 40 feet wide (74%).

5.23 Alcohol presence was not detected (93% "no" for pedestrians and 92% "no" for drivers). Almost half the injuries were below the moderate level; however, 16% of the fatalities and 24% of the serious injuries in the total study were 01 dart-outs. Figure 5.1 illustrates the causal pattern for dart-out first half.

Dart-Out Second Half (02)

5.24 Basic Type Description. This is the same as the dart-out described for the first half above, except that the pedestrian covers half of a normal crossing before being struck. The distinction is made because of the possible differences in the opportunities or problems relative to driver detection and recognition of danger if the roadway is clear. However this code is used even if traffic obscured the driver's vision. This code may be used even if the pedestrian crosses a medium-size median strip of a boulevard.

5.25 Summary Data. The most frequently identified primary precipitating factors identified for (02) dart-out second half were:

(03) Ped course—risk taking—short-time exposure

(04) Ped course—risk taking—running

(10) Ped search and detection failure—NFS

(13) Ped search—inattention

(14) Ped search—inadequate.

5.26 The first two accounted for 37% of the total primary factor identifications for this type, while all five accounted for 59%. Running is of interest because it is identified more often as a primary factor than it is in the first half dart-out. More than 30% of the total sample cases in which running was a primary precipitating factor were (02) dart-outs second half.

5.27 The four most important secondary precipitating factors were:

(55) Driver detection—visual—parked cars

(56) Driver detection—traffic

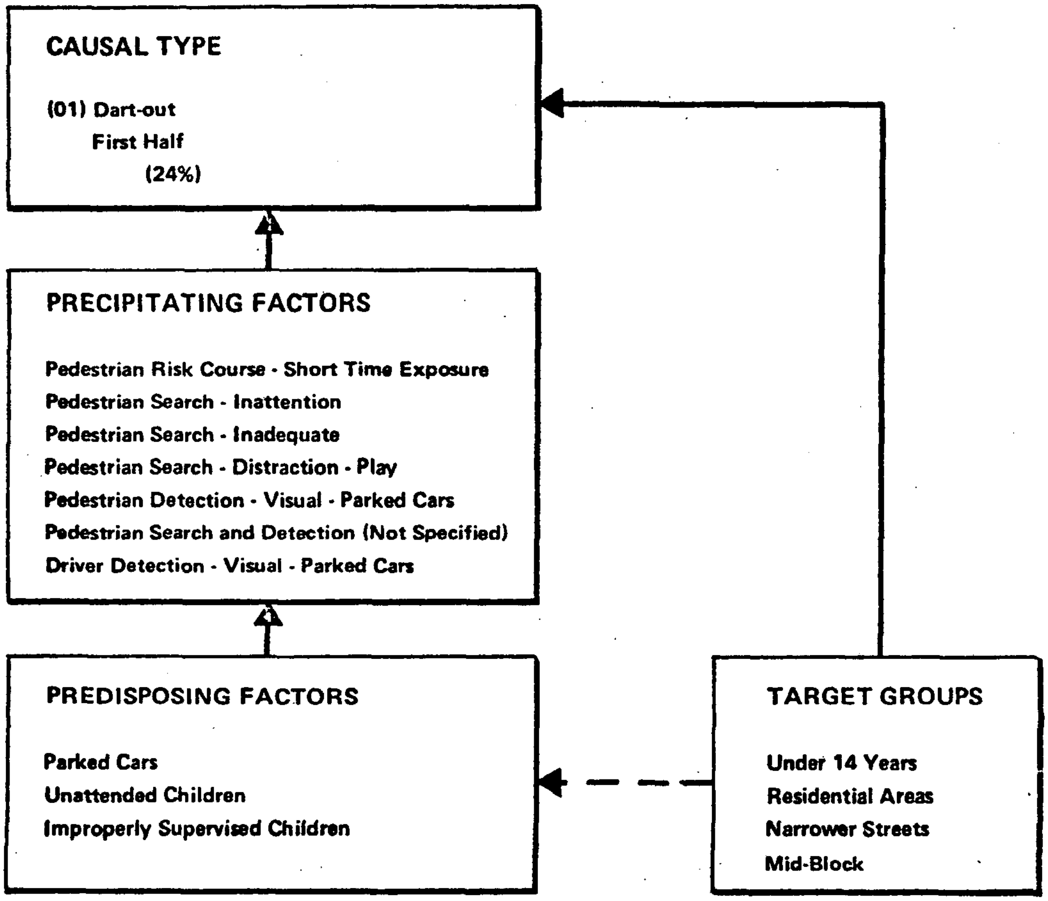

FIGURE 5.1. CAUSAL PATTERN—DART-OUT FIRST HALF

(50) Driver detection—standing traffic

(16) Pedestrian detection—parked cars.

43% of the total cases which identified (56) driver detection—traffic as a secondary factor fell into (02) dart-out second half.

5.28 Predisposing factors most noted were the same as for (01) dart-outs, i.e., parked cars, unattended and improperly supervised children. In addition, (61) weather—visibility was noted. Although dart-out second half accounted for about 9% of the total sample, 15% of the sample cases with a weather visibility predisposing factor were in this type.

5.29 Pedestrian behavior was in general similar to that for first half dart-outs except a larger proportion was watching traffic (39% as compared to 75% for first half dart-outs were not watching traffic). Also a higher proportion (25%) of second half dart-outs recognized the need for evasive action just prior to impact, and a smaller proportion did not recognize the need at all—although 64% of the second half dart-outs still did not recognize the need at all.

5.30 The basic characteristics of the situation were very similar to the (01) dart-out but not quite as extreme. For example, 77% of the pedestrians were under 14 (versus 87%); 69% of the cases had speeds below 25 mph (versus 85%); 52% were in residential areas (versus 72%); 74% were midblock (versus 87%); and 72% were in the daytime (versus 80%). Differences were greater with respect to specific location; 34% of the streets were under 40 feet across (versus 74% for first half dart-outs) and 17% of the pedestrians were 10 or more blocks from home (versus 5% for the first half dart-outs).

5.31 Thus the second half dart-out is generally similar to the first half dart-out, but his running and driver detection failures as a result of traffic come into play more often, and the accidents happen on wider nonresidential streets as well as on the narrower residential streets. The pedestrian may be watching traffic, although he still does not detect in time. Figure 5.2 illustrates the causal pattern for dart-out second half.

Intersection Dash (27)

5.32 Basic Type Description. This category covers cases similar to dart-outs with regard to pedestrian exposure to view, but the incident occurs in a marked or unmarked crosswalk at an intersection. Cases are included if the pedestrian is running across the intersection even though his exposure to possible driver view is not extremely short. (His speed will in effect limit his actual exposure to the driver.)

5.33 Summary Data. Three factors accounted for 44% of the primary precipitating factors identified for cases in this type:

(03) Ped course—risk taking—short-time exposure

(05) Ped course—risk taking—running

(06) Ped course—risk taking—crossing against signal.

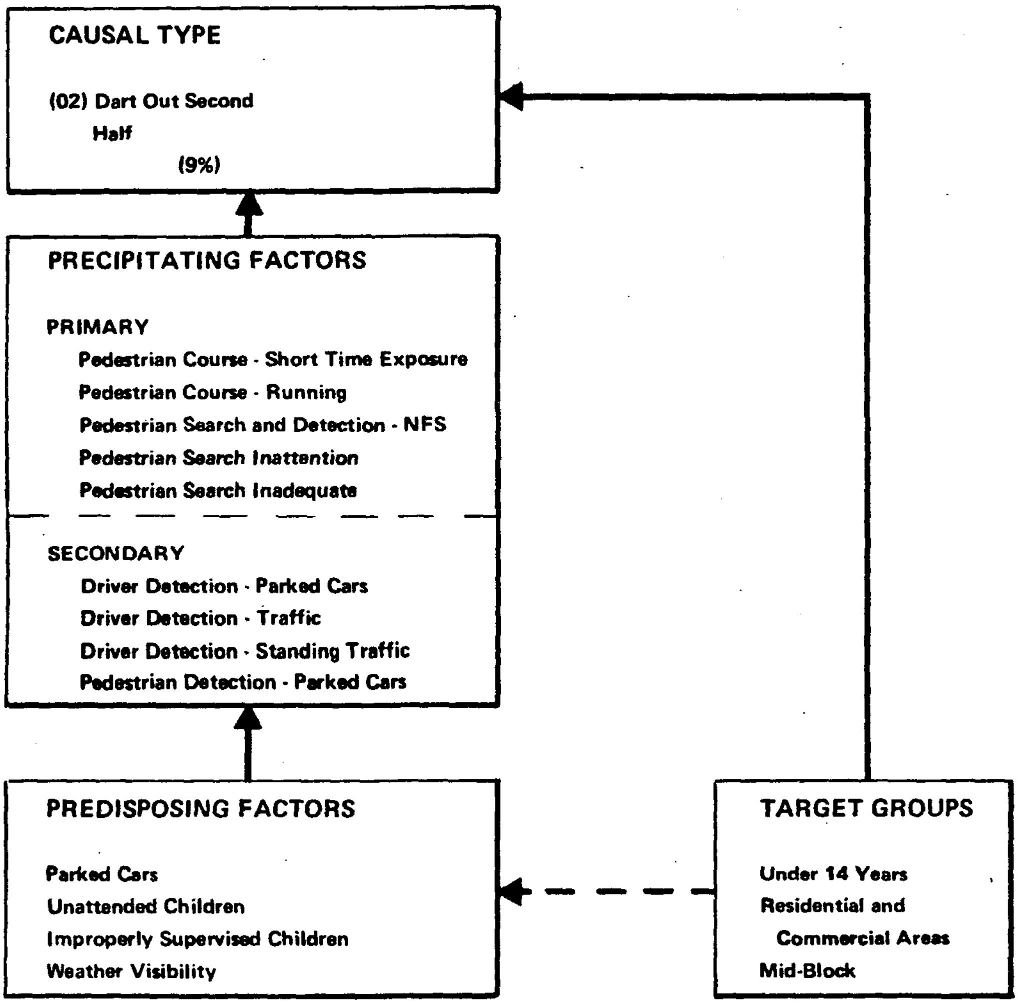

FIGURE 5.2. CAUSAL PATTERN—DART-OUT SECOND HALF

5.34 Short-time exposure and running were important in the dart-outs as well as in the intersection dash. 40% of the cases in which crossing against the light was a primary factor fell into type 27 intersection dash.

5.35 Four other factors accounted for an additional 27% of the primary precipitating factors identified for intersection dash cases:

(10) Ped search and detection—NFS

(13) Ped search—inattention

(14) Ped search—inadequate search

(50) Driver search and detection—NFS.

5.36 Although it was a low frequency factor in the total sample, it should be noted that 30% of the cases identifying "(41) Driver course—risk taking—attempt to beat signal," fell into this type. Secondary factors worth noting were:

(50) Driver search and detection—NFS

(41) Driver risk taking—course—speed

(55) Driver detection—parked cars

(56) Driver detection—traffic.

5.37 Predisposing factors noted most frequently included the child supervision and parked car factors noted in the dart-outs, and

- Inducement to risk taking—signal timing
- Pedestrian vehicle conflicts.

30% of the cases in which the former were noted fell into this type.

5.38 The major pedestrian behavioral items reported followed a similar pattern to the dart-outs, except that only 26% were specifically not attending to traffic as compared to about 75% for the dart-outs. A smaller proportion of drivers (61%) were proceeding at sustained speed than for the dart-outs (76%), as might be expected because of the intersection location.

5.39 Although most pedestrians (64%) were under 14 years of age, 30% were over 20, compared to 10% for first half dart-outs and 19% for second half dart-outs. Time of day distribution was similar to the dart-outs, with heavy afternoon peaks, but it should be noted that 18% occurred between 11:00 a.m. and 2:00 p.m. The most striking difference between the dart-outs is that 49% of the intersection dashes occured in commerical areas. Speeds were low (75% pre-involvement speed under 30 mph) and daytime accidents were the rule (77%). Figure 5.3 illustrates the causal pattern for intersection dash.

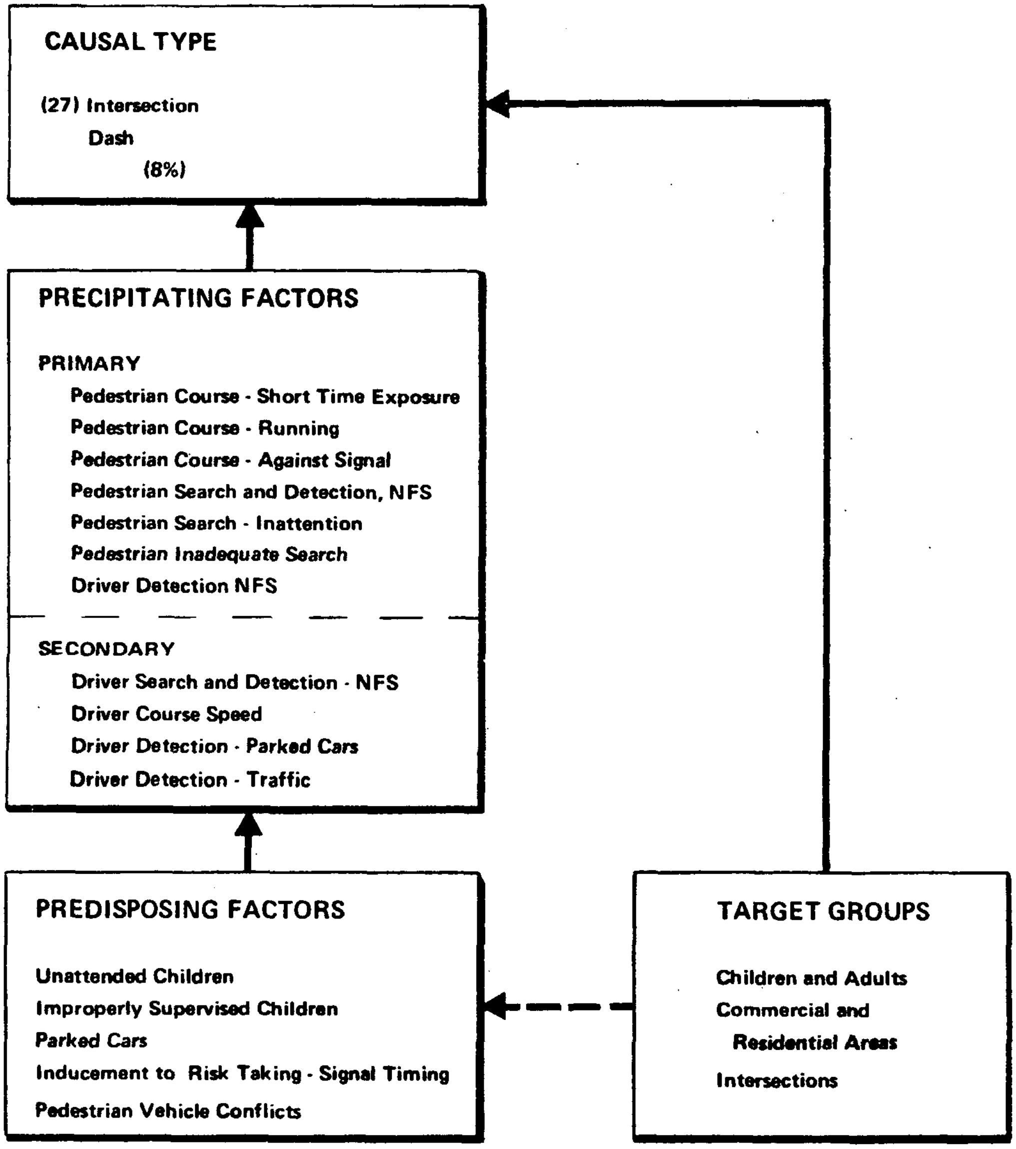

FIGURE 5.3. CAUSAL PATTERN—INTERSECTION DASH

Pedestrian Strikes Vehicle (10)

5.40 Basic Type Description. This classification covers crashes not covered by other clear types (e.g., dart-out), in which it has been determined that the pedestrian ran or walked into the car.

5.41 Summary Data. The factors identified most often as primary precipitating factors were:

(05) Ped course—risk taking—running

(10) Ped search and detection—NFS

(13) Ped search—inattention

(14) Ped search—inadequate search

(1K) Ped search—distraction—play.

The first three accounted for 36% of the primary factor identifications and the last two for another 13%. (03) Ped short-time exposure and (1k) ped search—distraction—play activity accounted for another 10% of the primary factor identifications. Although unexplainable pedestrian search and detection failures constituted a small proportion of the primary identifications, 21% of the cases to which it applied in the total sample fell in this type (which had 4% of the total). Secondary precipitating factors were not noted very often. The most frequent were pedestrian detection—vision—parked cars and driver detection—vision—parked cars.

5.42 *Predisposing factors most often identified were unattended children,* parked cars, and three "pedestrian human factors" (the condition of the pedestrian), old age, alcohol and "not further specified." The latter means that some condition was detected but could not be defined or was one of a number of miscellaneous conditions such as mental deficiency.

5.43 The major behavioral items reported for this type are somewhat different in extent from the other types in this group. For pedestrian direction of attention, straight ahead was given in 50% of the reported cases as opposed to 65-75% in the other dart-outs and dashes. While 50% were not paying attention to traffic, 15% observed the collision vehicle and 23% observed other threatening vehicles. Only 46% were running. Most (74%) did not recognize the need for evasive action; 18% did just prior to impact.

5.44 Compared with the dart-outs, drivers were more often looking to one or both sides (27%), proceeding with special caution (28%), paying attention to the future victims (39%), and recognized the need for evasive action (51%). In fact, 27% recognized the need just after the pedestrian started on the collision course.

5.45 Although as usual, most pedestrians were under 14 years of age (62%), 15% were 60 or over. Although there was a 43% peak period between 3:00 p.m. and 6:00 p.m., there were none between midnight and 6:00 a.m., and 20% were between 6:00 a.m. and 1:00 p.m. Eighty percent were daytime accidents and half were in residential areas. More than half (58%) were at or near intersections. Only 15% had pre-involvement speeds over 30 mph. While 12% resulted in no injury, 11% were serious or fatal and 23% resulted in moderate injuries. Figure 5.4 illustrates the causal pattern for pedestrian strikes vehicle.

<u>Countermeasure Discussion—Typical Pedestrian Situations, Dart-Outs and Dashes</u>

5.46 The types of pedestrian accidents described in this group present a difficult and important problem which accounts for about 45% of the cases. If the studv sample is representative of urban accidents, there will be about 135,000 accidents of such types during the next year. Two common reactions to the problem nave been: (a) teach kids not to run into the street, and (b) nothing can be done.

5.47 The analysis of the problem has shown that the main items to be attacked and overcome are:

- A risky pedestrian course - exposing him to view briefly
- Failure of the pedestrian to search and detect
- Parked cars which interfere with driver and pedestrian vision.

5.48 Countermeasures can aim at modifying the course, or given the risky course, increase the likelihood of detection. Possible approaches to achieve these objectives are as follows:

- <u>Course modification</u>
  - Physical obstructions
  - Human supervision
  - Alternate activity location.
- <u>Detection improvement</u>
  - Modify human behavior
  - Remove physical obstructions
  - Provide warning.

Keeping other aspects of the causal type in mind, possible countermeasures that work towards one or more of the above approaches have been identified and are presented below. Each countermeasure applies to one or more of the accident types described above. Some will also influence types to be discussed later, although the major impact will be on the typical pedestrian situations, dart-outs and dashes.

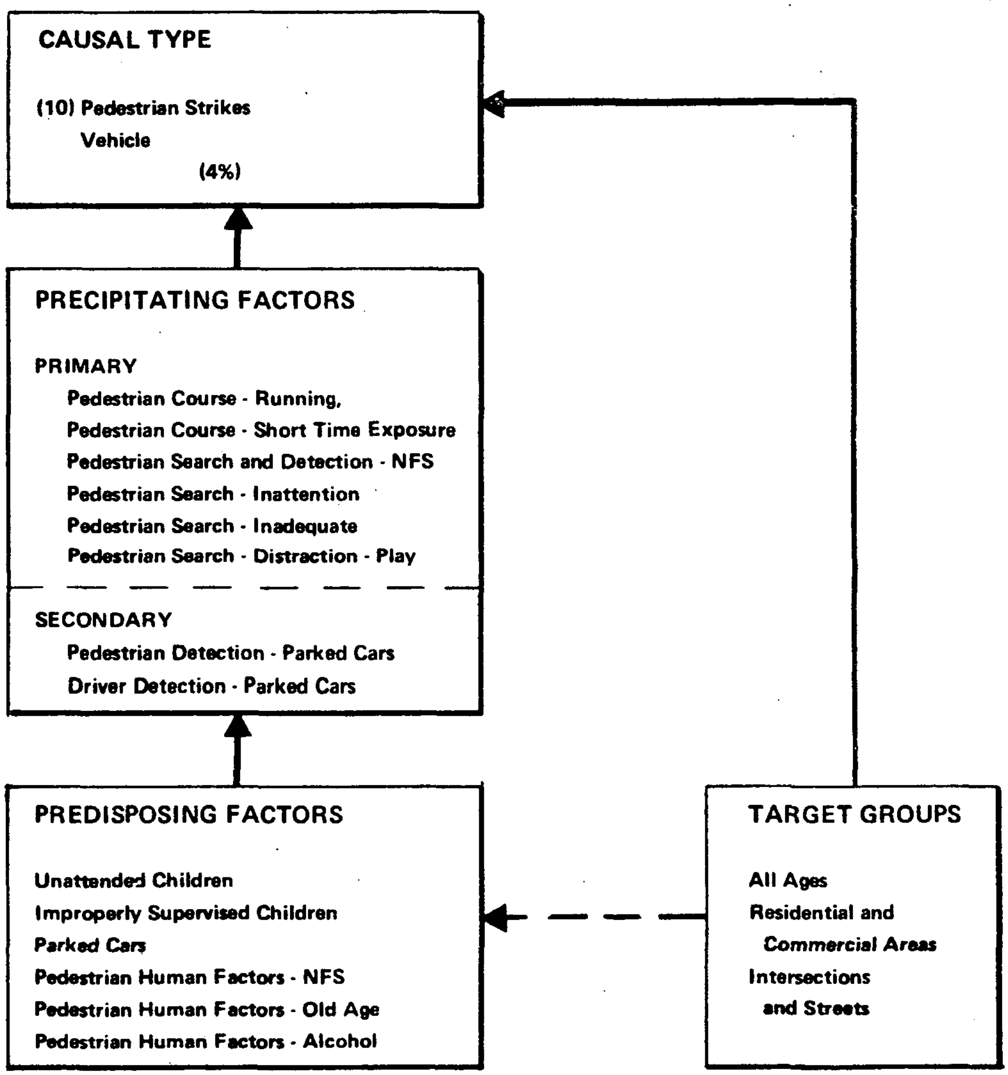

FIGURE 5.4. CAUSAL PATTERN—PEDESTRIAN STRIKES VEHICLE

5.49 Street Parking Redeployment. This countermeasure is aimed primarily at the dart-outs but would influence the other two types as well. The objective is to use parking control to remove some of the visual obstruction, provide a partial barrier to physically control the pedestrian course, and increase the likelihood of detection. This countermeasure is suggested for consideration on certain residential streets, not main arteries. Its application is described for a one-way three-lane street with two lanes of parallel parking, but other existing situations could be modified to achieve the same result.

5.50 Two steps would be taken. First, parking would be removed from one side of the street, preferably the left. Second, head-in diagonal parking would replace parallel parking on the right. (See Figure 5.5.)

5.51 In appropriate locations this would accomplish the following. Visual obstructions would be removed from the left side of the road giving the driver an increased view and more time to detect and react. The diagonal parking would provide a physical control that would tend to slow down the pedestrian as he ran across the street, but even more important, would angle him into traffic and direct his field of vision more in the direction of the threatening vehicles. Finally, he would be able to execute evasive action more readily than when crossing directly across the street. Approaching on the angle would let him change course to avoid, rather than having to stop.

5.52 Because this is an innovative countermeasure, it offers greater potential as a solution to a stubborn problem, and at the same time will evoke some resistance because it disturbs commonly accepted ways of handling on-street parking. Some legitimate questions can be raised which should be answered. Some are discussed here.

5.53 First, consider the effect on traffic flow. It would probably delay traffic flow on main thoroughfares, but it was not designed to be used there. It is designed for the more lightly traveled, slower moving residential street.

5.54 Secondly, consider the effect on vehicle accidents caused by backing out of diagonal spaces. It is often said that diagonal parking produces more accidents than parallel parking, and that is why traffic engineers went about eliminating it in the 1940's. Secondary references have been found that state evidence exists, but it is apparently old or undocumented.

5.55 As this report is written, sufficient information has not been found to determine the relevance of past data to this suggestion. (If data were collected on a change in a main thoroughfare in 1935, one could question its relevance.) Even if this countermeasure were to increase auto-auto accidents, it still might be worth it. (A trade of personal injury accidents for property damage accidents appears to be generally acceptable.)

5.56 Finally consider public reaction to moving or eliminating parking space. Two points are worth noting. First the change is for a commonly shared goal—the protection of children in the community. A change made to move commuters

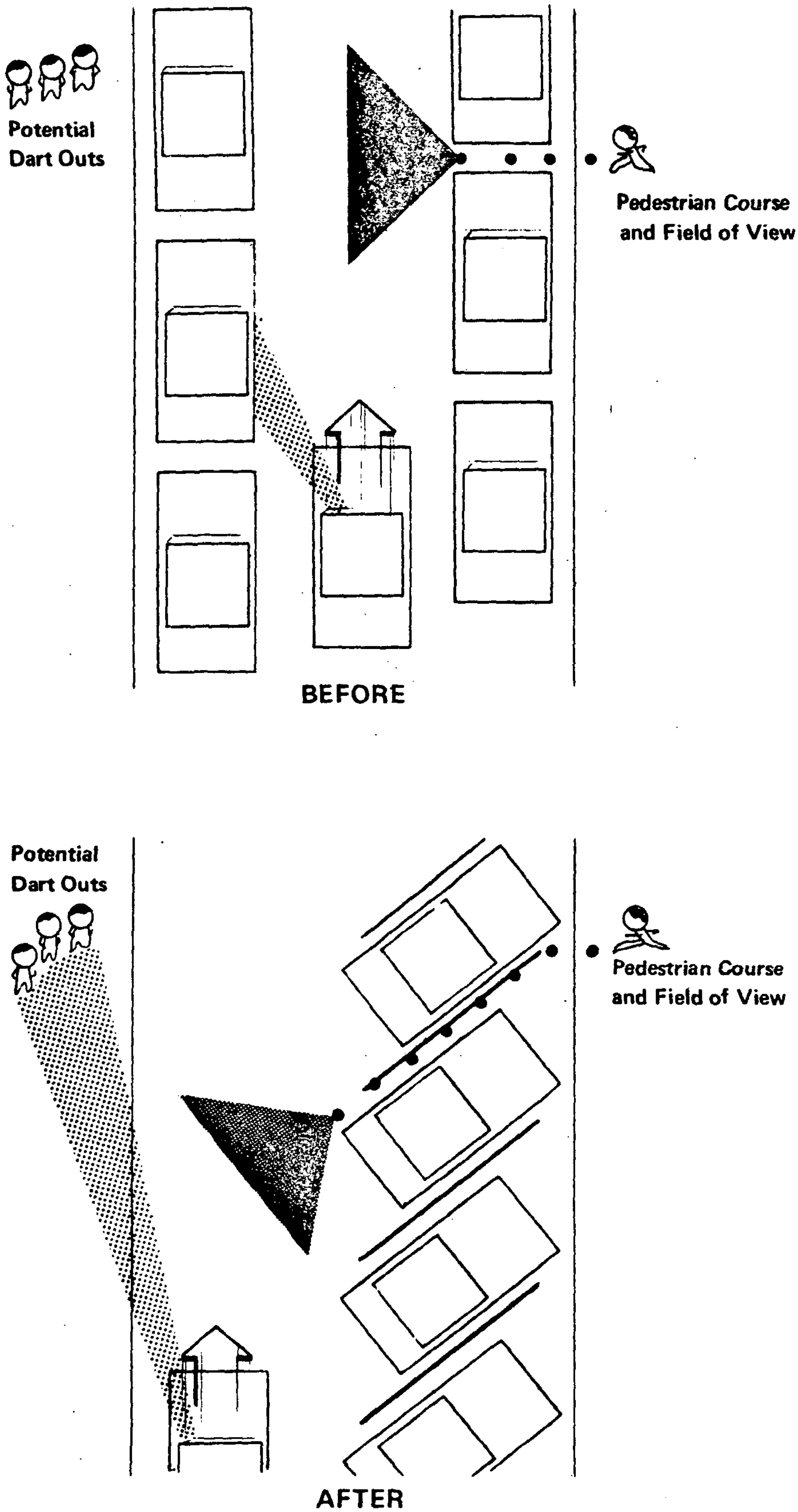

FIGURE 5.5. ILLUSTRATIVE EXAMPLE OF PARKING REDEPLOYMENT

through a residential area produces a different reaction than a change suggested to protect the neighborhood children. Secondly, the use of diagonal parking on the remaining side minimizes parking space loss.

5.57 Careful application and site selection would be required. For example, a street with a row of large trees along the left side would not be appropriate for routine application because of the effect on vision. However, application on a careful systematic basis that will permit evaluation of effectiveness clearly seems warranted.

5.58 Prohibition of On-Street Parking. This countermeasure appears likely to be effective, but not likely to be feasible, except in certain cases. It would reduce dart-outs and to a lesser extent intersection dashes. The areas that would benefit most, the crowded center city areas, have the worst parking situation and highest on-street parking requirements. Off-street facilities would have to be provided. (This is discussed later.)

5.59 However, in new developments or areas being redeveloped, such a prohibition is feasible and desirable. If on-street parking were banned in an area before building planning began, off-street spaces would be provided. In new residential areas, builders would be more likely to provide longer driveways. Building codes to support private provision of parking would help.

5.60 Off-Street Parking/Play Areas. This countermeasure is aimed primarily at the reduction of dart-outs. In selected center city blocks, old buildings or vacant lots could be converted to off-street parking, and on-street parking could be banned on that block. A variation would be the public construction of a one- or two-story garage with the roof being used as a fenced-in play area. Special care would be needed in the design of vehicle and pedestrian exits and entrances.

5.61 Sidewalk Parks. This countermeasure is aimed primarily at the reduction of dart-outs. Streets which are adequate in width from curb to building line could be improved by providing a park type area physically separated from vehicle traffic. Physical barriers by themselves are unattractive and politically unfeasible. However, a park fence with a park is something different. The objective would be to provide small play areas for preschool and primary grade children (e.g., a concrete pipe fixed in cement) that would still permit pedestrian traffic. Shrubs and trees would make the fence more acceptable.

5.62 This measure could only be used in some locations and not others. In some places, the street would be wide enough to take a few feet to add to the park. Consideration should be given to a midblock crossing designed to prevent dart-outs, if easily viewed from vehicles and adequately identified. If the park can be extended to the end of the block and around the corner, the design of exits can reduce the probability of intersection dashes.

5.63 Meter Post Barrier. In commercial areas with on-street parking meters, small fences or railings extending out a few feet from either side of the meter post could combine with parked cars to form a barrier to prevent dart-outs. Two variations are possible. In one arrangement the barrier would be designed to permit a pedestrian to go between it and the car. He could exit between parked cars to the street; however it would be difficult for him to run out between the parked cars. This arrangement would permit the driver to get out his side of the car and get to the sidewalk. In the second arrangement, the small barrier would be placed in such a manner that it would be extremely difficult, if not impossible, for a person to pass between it and a parked car. This would be more effective against dart-outs, since it would also eliminate the cases with short-time exposure that did not involve running. Drivers, however would not be able to get out their side (on a two-way street) and get to the curb without walking in the street for a distance. This might be viewed as an advantage if it induced drivers to slide over and exit on the curb side instead of the street side of the car, thus reducing street side accidents. Further design and study are needed to determine which option is best.

5.64 Signal Retiming or Modification. One of the predisposing factors identified for the intersection dash was the inducement to risk taking coming from the traffic signal. The pedestrian is wrong to cross against the light. He should wait until he has the proper signal, but it is apparent that some will become impatient when they must wait. In some locations, longer than usual waiting periods are involved in order to move heavy traffic volumes. However, it must now be recognized that this may induce pedestrians to take risks because they are impatient. Standard time periods cannot be recommended on the basis of this study. The best specific treatment will depend on the individual nature of the intersection and its vehicle and pedestrian volumes. It is recommended that local traffic engineers review intersections with the longer pedestrian waiting periods, especially in commercial and multifamily dwelling areas surrounding the central business district, and consider the following possibilities:

- Resetting cycles to bring pedestrian waiting time in line with the norm, or lower if other considerations permit.
- If rush hour volumes do not permit complete retiming, reduce pedestrian waiting periods during non-peak hours. (Two-thirds of intersection dashes occurred before or after the 4:00 p.m. to 6:00 p.m. rush period.)
- Provide a signal indicating the waiting time remaining to green. This could be a numeric countdown signal giving the seconds remaining, but need not be; color codes or 10-second intervals could be used. Such a signal could be integrated with the wait-walk type pedestrian signals.

5 65 Conflict Reduction. Legal vehicle-pedestrian conflicts at signalized intersections were a predisposing factor in some intersection dashes (i.e., a vehicle turning on the green would be in conflict with a pedestrian crossing with the green). The reduction of such conflicts would be desirable from the standpoint of pedestrian safety. Some of the ways to achieve conflict reduction might slow traffic movement, but some would speed it. Again the specific technique should be chosen by the local traffic engineer after considering vehicle movement and vehicle safety characteristics. The possibilities include:

- Pedestrian only signal phases
- Pedestrian walk signals leading vehicle turn signals (would still have problem, but for a shorter time)
- Elimination of turns
- Conversion to one-way streets.

While some of the steps listed involve wider considerations, their positive contributions to pedestrian safety deserves greater attention.

5.66 Specific Driver Training. Driver training should be expanded to include two areas relevant to avoiding dart-out and dash type accidents. First, there should be concise coverage of basic information about the accident types included in this group so that drivers will be aware of the extent of the problem, the patterns of pedestrian behavior they may expect, and the times and locations in which they may be expected. All this is directed at improving "normal" driver search and detection of the dart-out and dash types. In addition, the second area would deal specifically with recognition of potential "pedestrian strikes vehicle" cases and the use of the horn to induce evasive action by the pedestrian.

5.67 Specific Adult Education. Adult education on the nature and seriousness of the problem with respect to types in this group can do two things. First, it can help develop the motivation for individual action and enlist the community support to implement other countermeasures. Secondly, it can provide specific suggestions to parents about (a) the manner of preschool-age child pedestrian supervision required and (b) instructions for parents to give school-age children going on specific pedestrian trips. (The former is directed at certain dart-outs and the latter is directed primarily at intersection dashes.)

5.68 Specific Preschool and Primary Grade Education. Preschool education, whether face-to-face, or by public television should focus on sidewalk play activity in relation to pedestrian accidents. Rather than how to cross the street, the more important message is how to play (to keep from running into the street and becoming a dart-out). At school age, additional emphasis can be put on purposeful trip making and problems in commercial areas (related to dart-outs and intersection dashes).

5.69 Other Countermeasure Considerations. The preceding discussion has identified particular countermeasures relevant to the prevention of the accident types described in this section. Discussion of relative priorities and effectiveness will be discussed in Section VI.

OTHER TYPICAL PEDESTRIAN SITUATIONS

5.70 This group includes the following accident types and accounts for 11% of the total sample:

(07) Multiple threat situation	(3.2%)
(14) Pedestrian waiting to cross	(.6%)
(24) Vehicle turn/merge with attention conflict	(6.4%)
(26) Multiple pedestrian split	(.3%).

Although they account for fewer cases than the first group discussed, if the study sample is representative of urban pedestrian accidents, about 33,000 such accident types would occur each year.

Multiple Threat (07)

5.71 Basic Type Description. The pedestrian is struck by car x after other cars blocking the vision of car x stopped in other lanes, going the same direction, and avoided hitting the pedestrian. For example, cars in lanes one and two stop and permit the pedestrian to cross; car x in lane three going in the same direction hits the pedestrian as he steps out in front of the car in lane two. This classification is not used if the striking vehicle is going in the opposite direction from the stopping cars. (In that situation the stopping cars would not block the driver's vision.)

5.72 Summary Data. The primary precipitating factors were:

(5C) Driver detection—standing traffic

(1D) Ped detection—standing traffic

(03) Ped course—short-time exposure

(05) Ped course—running

(14) Ped—inadequate search.

5.73 The first three accounted for half of the primary factor identifications and the other two for an additional 13%. Most of the total sample cases involving the first two failures fell in this type. The same two accounted for over half of the secondary precipitating factor identifications, and again about half of the cases in the total sample identifying them as secondary factors fell in this type. Although this type represented 3.2% of the total sample, 20% of the cases identifying driver detection—traffic as a primary factor and 10% identifying it as a secondary factor also fell in this type. There were few predisposing indications, with 14% of the total sample showing inducement to risk taking—signal time falling into this type.

5.74 Most pedestrians were watching traffic but not the collision vehicle. Forty-two percent were running and 42% were walking normally. More than 60% of the pedestrians were in a crosswalk. More than half did not recognize the need for evasive action; 38% did just prior to impact.

5.75 Most drivers were looking ahead (74%) proceeding at sustained speed (58%) prior to the accident. However, 19% were slowing down, 14% were stopped or proceeding from a stop and 11% were accelerating. Twenty-one percent did not recognize the need for evasive action, and 63% did just prior to impact.

5.76 Pedestrian age was spread out; 39% were under 15, 32% were between 15 and 35, and 20% were over 60. Most incidents occurred in daytime (84%), in commerical areas (65%), and at intersections (80%). Fifty-three percent of the locations had no traffic control, while 7% had a stop sign and 38% had a traffic signal. Speeds were not high (88% under 30 mph). Figure 5.6 illustrates the causal pattern for multiple threat.

<u>Pedestrian Waiting to Cross (14)</u>

5.77 <u>Basic Type Description</u>. The pedestrian is <u>not</u> moving, but is standing in the roadway waiting to cross.

5.78 <u>Summary Data</u>. The primary driver factor was inattention, but detection failure due to posts, parked cars, and poor lighting also occurred. Pedestrian failures were due mainly to risky courses—unusual places or heavy exposure to vehicles, and detection failures due to distraction. Detection failures due to environmental objects and poor prediction of vehicle-pedestrian paths were also noted. The predisposing factors were pedestrian-vehicle conflicts, driver alcohol, and other human factors.

5.79 Most pedestrians were attending to moving traffic or another potentially threatening vehicle and did not recognize the need for evasive action. A number of drivers were attending to parking or a traffic signal. Most were proceeding at sustained speed and recognized the need for action just prior to impact.

5.80 Eighty-five percent of the pedestrians were over 15 years old, and 63% were between 20 and 45 years of age. Half the incidents occurred between 5:00 p.m. and 9:00 p.m. Although half were in daylight hours, many were at dusk or in the dark with no lighting. Sixty-five percent were in commercial areas; residential one family or multifamily areas were hardly involved. Figure 5.7 illustrates the causal pattern for pedestrian waiting to cross.

<u>Vehicle Turn/Merge With Attention Conflict (24)</u>

5.81 <u>Basic Type Description</u>. The driver is turning into or merging with traffic; the situation is such that he attends to auto traffic in one direction and hits the pedestrian who is in a different direction from his attention. A critical feature is that the attention conflict is built into the situation. Usually the driver directs his attention in a given direction to determine an acceptable gap into which he will enter.

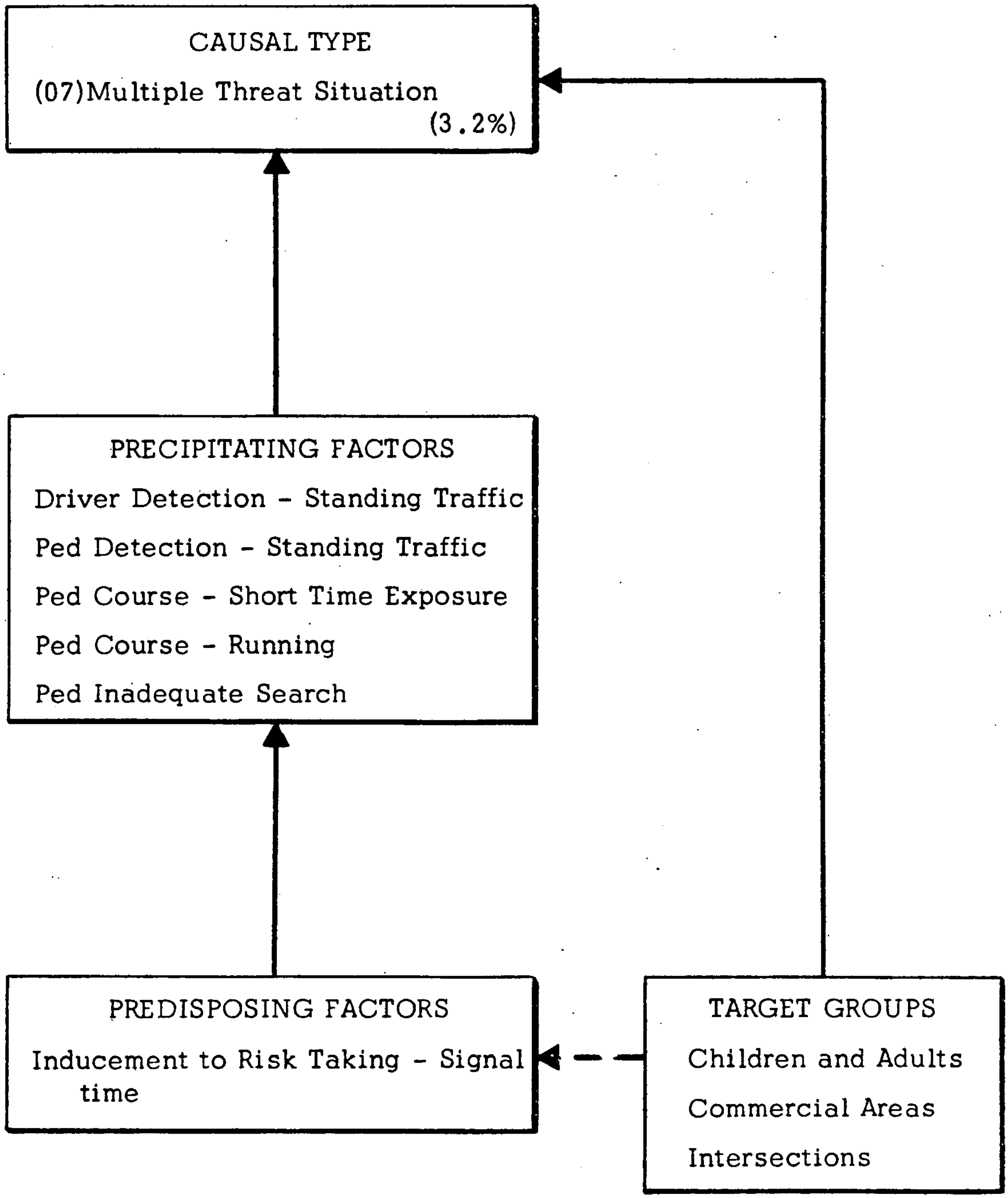

FIGURE 5.6. CAUSAL PATTERN—MULTIPLE THREAT SITUATION

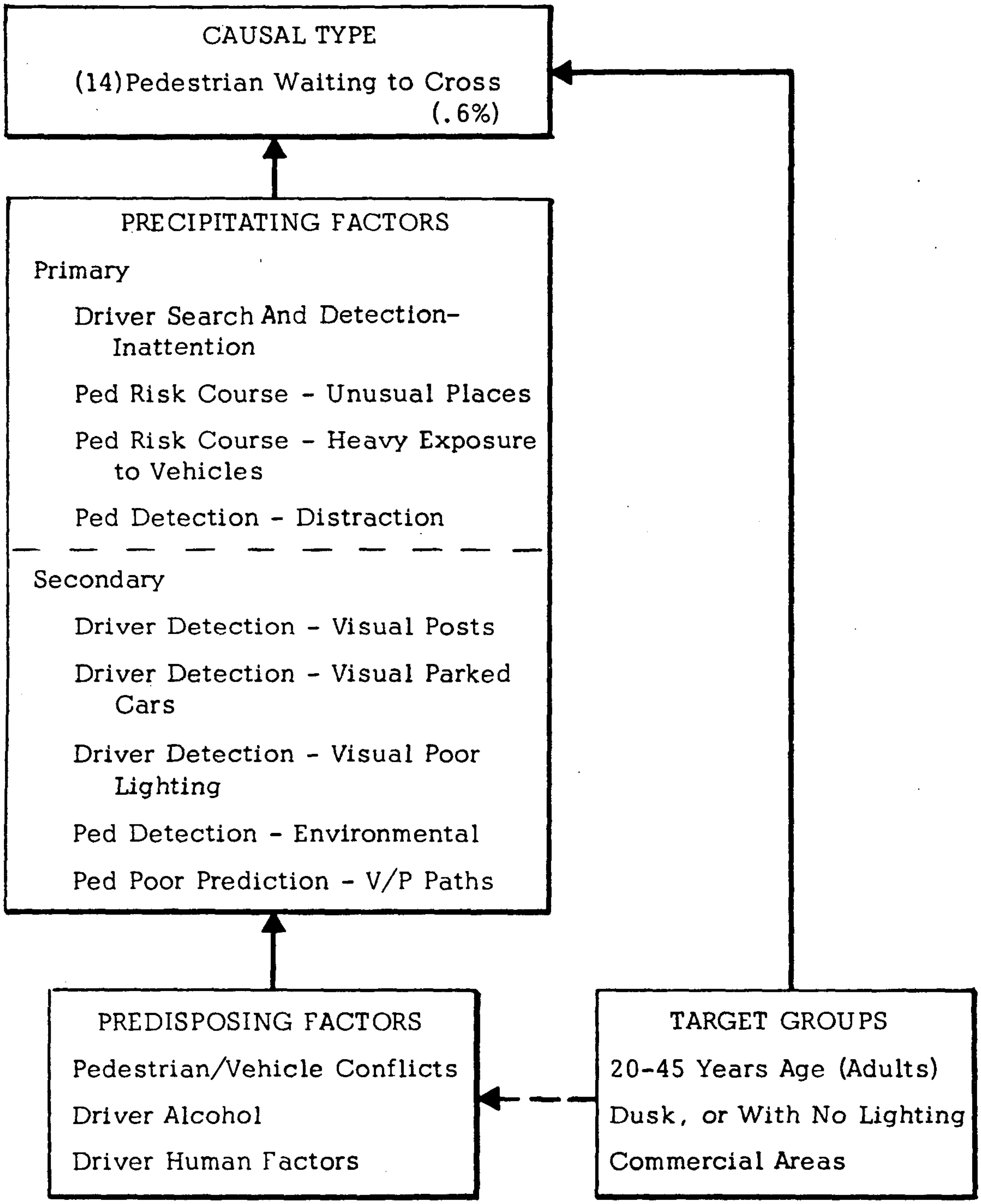

FIGURE 5.7. CAUSAL PATTERN—PEDESTRIAN WAITING TO CROSS

5.82 Summary Data. Three driver search factors accounted for 40% of the primary precipitating factors: overload, inadequate search, or not further specified. Although this type represents 6% of the sample, 21-27% of the cases in which each of those factors was identified fell into this type. Pedestrian search failures accounted for another 22% of the primary factor identifications—inattention, inadequate search, and not further specified. The last two also accounted for 20% of the secondary precipitating factors. Pedestrian misperception of driver intent also played a part, accounting for 6% of the primary and 11% of the secondary precipitating factor identifications.

5.83 Although they were relatively low frequency factors, 43% of the total sample cases indicating driver search overload, and 40% of the total sample cases indicating detection failure as a result of perceptual interference by the sun fell into this type. Although infrequent, 50% of the cases in which slow pedestrian speed was a secondary factor fell in this group.

5.84 The striking predisposing factor was heavy exposure—pedestrian-vehicle turns which accounted for two-thirds of the predisposing factors identified. Over 70% of the cases for which this factor was identified fell into this type. Pedestrian—vehicle legal conflicts were also noted, as were pedestrian human factors—old age and weather-visibility, which together accounted for another 17% of the predisposing identifications.

5.85 Most of the pedestrians were looking straight ahead (82%) and were walking normally (72%). Although 31% were not attending to traffic, 37% attended to the collision vehicle, and 29% to moving, standing, or other potentially threatening vehicles. Twenty-eight percent were attending to a traffic signal. More than half did not recognize the need for evasive action.

5.86 Drivers were directing their attention to one side or the other (32% right, 30% left), were attending to turning the corner (87%) and moving traffic (34%). Forty-two percent did not recognize the need for evasive action.

5.87 Pedestrian age was strikingly different from the typical pattern as were some other characteristics. Only 5% of the pedestrians were under 15 years, while more than half were 55 or over. Although 60% of the cases occurred between 1:00 p.m. and 8:00 p.m., they were spread much more evenly than usual over the normal waking hours. Seventy-one percent were during daylight hours, 73% were in commercial areas, and practically all were at intersections.

5.88 Of special interest is the finding that 55% of the cases occurred at locations with red, green, amber signals, and an additional 23% occurred at signalized locations where right turn on red was permitted. Pre-involvement speeds were quite low—83% were 15 mph or less. Figure 5.8 illustrates the causal pattern for vehicle turn/merge conflict with attention conflict.

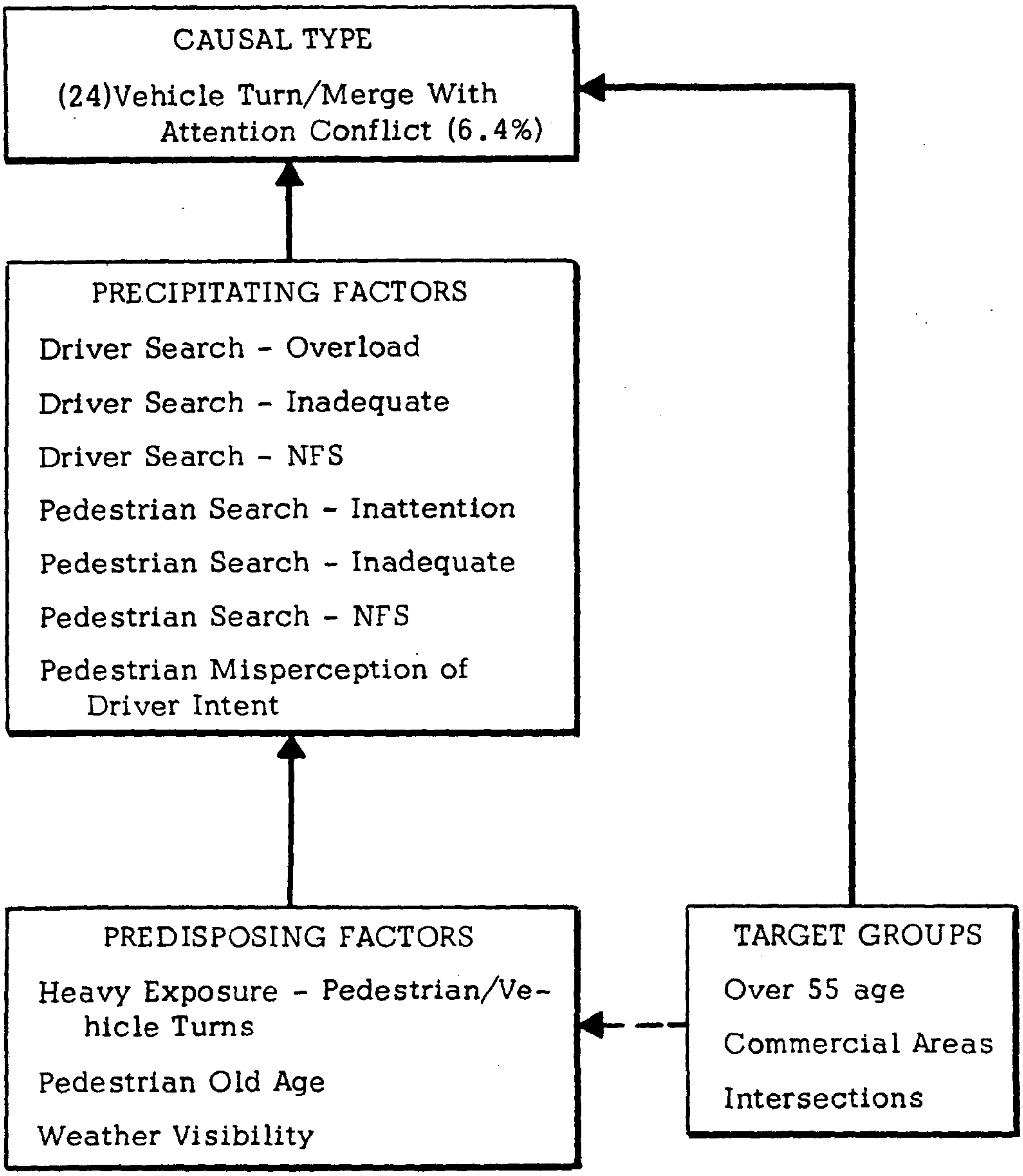

FIGURE 5.8. CAUSAL PATTERN—VEHICLE TURN/MERGE WITH ATTENTION CONFLICT

Multiple Pedestrian Split (26)

5.89 Basic Type Description. More than one pedestrian is present in a group. A major causal factor is different actions by the pedestrians, resulting in the driver's hitting at least one of the multiple targets; usually he will hit one, trying to avoid the others.

5.90 Summary Data. The precipitating situation is described by the type description. Although the number of cases was small, an analysis of specific precipitating factors indicated the following factors: pedestrian short-time exposure or slow speed, pedestrian search failures, pedestrian misperception of driver intent or poor prediction of the vehicle-pedestrian path, driver search overload or distraction, poor prediction by driver of vehicle-pedestrian path, and driver and pedestrian failure to match evasive action. It appears that the pedestrian search failure or misperception of the driver intent or vehicle path leads to his risky course, which is different from his companion pedestrians. The driver is either distracted by the other pedestrians, cannot cope with all the inputs, or does not expect the action. In some cases the misperception of intention carries on to a failure to match evasive action.

5.91 No predisposing factors were identified. The small sample makes specific behavior analysis tenuous. Most pedestrians were running. They did not seem to be attending to traffic. The drivers were proceeding normally at sustained speed and looking ahead. Most pedestrians and drivers recognized the need for evasive action.

5.92 Pedestrians were mainly older children and teenagers. The accidents happened mainly in late afternoon and early evening, in commercial areas and near intersections.

5.93 Speeds were more often over 30 mph. This is a very distinct accident type with respect to the events and actions leading to it. It was recognized early in the study as a unique pattern, but resulted in few cases. Figure 5.9 illustrates the causal pattern for multiple pedestrian split.

Countermeasure Discussion - Other Typical Pedestrian Situations

5.94 The types in this group are distinct from each other and there is less overlap in the influence of potential countermeasures. That is, most of the measures identified here apply to just one of the four types described previously.

5.95 Stop Line Modification. This countermeasure is directed primarily at multiple threat accidents occurring at signalized intersections in commercial areas. In order to reduce the incidents where cars stopped at the stop line obscure the view from the striking car, a wide stop or limit line should be placed a number of feet prior to the crosswalk. Although specific design would depend on a number of factors at the particular location, the objective is to stop the cars far enough back so that a pedestrian in the walk is likely to be noticed by cars other than the ones facing him. The recommendation given by the Manual on Uniform Control Devices for a stop line about 4 feet in front of the nearest crosswalk may not go far enough.

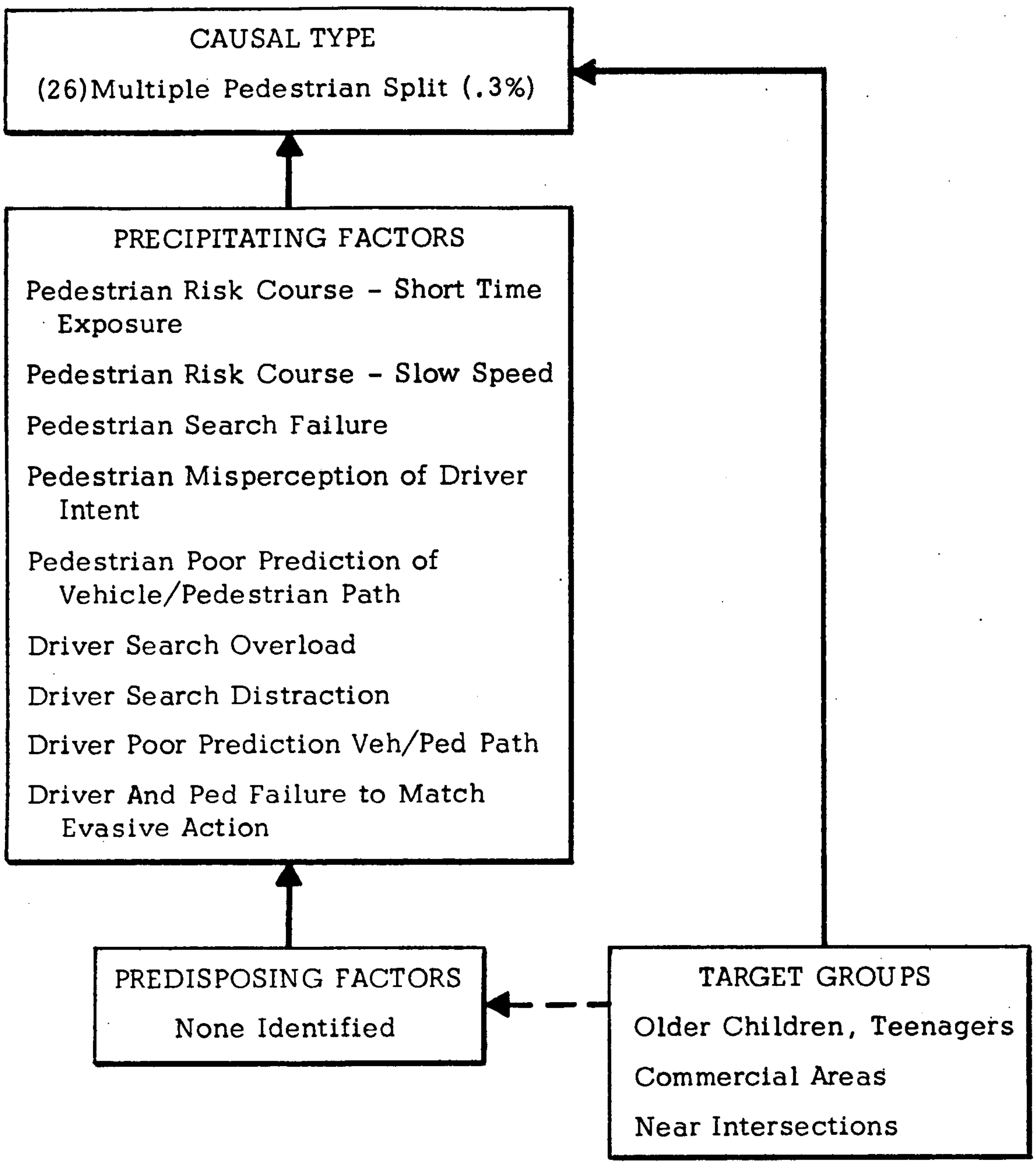

FIGURE 5.9. CAUSAL PATTERN—MULTIPLE PEDESTRIAN SPLIT

5.96 This countermeasure might also be used at nonsignalized intersections, but the specific location of the stop line would have to consider the need for the driver to see cross traffic if it is not controlled.

5.97 Driver Procedures and Traffic Ordinance. This countermeasure is aimed at those multiple threat accidents that occur midblock or at noncontrolled intersections. Such accidents happen because some driver(s) yields to a pedestrian. The model traffic ordinance states that "whenever any vehicle is stopped at a marked crosswalk or at an unmarked crosswalk at an intersection to permit a pedestrian to cross the roadway, the driver of any other vehicle approaching from the rear shall not overtake and pass such stopped vehicle."[5/] A similar restriction probably applies in most cities that require a driver to yield to a pedestrian at other locations. The driver apparently fails to obey the overtaking and passing restriction because he is not aware of the pedestrian.

5.98 The driver of the vehicle that has stopped is aware of the pedestrian and has demonstrated his willingness to follow the accepted procedure to assist the pedestrian. In such situations, he is a prime candidate for rendering assistance. This driver could further assist by warning drivers coming behind him by signaling them to stop. Any driver yielding to a pedestrian in the absence of a control device should be trained and required to signal any cars approaching from his rear to stop. This countermeasure calls for a combination of the development of a standard hand signal (meaning more than just that the vehicle has stopped or is stopping); local ordinances, and appropriate public education and driver training so that drivers yielding to pedestrians protect them from overtaking vehicles.

5.99 Ordinances requiring drivers to stop and yield to a pedestrian in the roadway at any location are not recommended, but the study has not produced evidence to recommend their repeal where they exist.

5.100 Intersection Lighting and Removal of Visual Obstructions. Although the improvement of lighting at intersections is a general countermeasure that would be expected to reduce various nighttime accidents, it is noted here because it is about the only feasible action to take to reduce type (14) - pedestrian waiting to cross accidents.

5.101 It is recommended that special attention be given to provide adequate illumination of the intersection crossings in commercial, and mixed commercial-residential areas as well as apartment areas from which people are likely to walk to social activities. At the same time that sites are reviewed for adequacy of lighting, visual obstructions such as sign posts and street parking near intersections should be identified and removed or relocated when possible.

5/ American Automobile Association, Manual on Pedestrian Safety, Washington, D. C., 1969, Appendix B.

5.102 Right Turn Attention Conflict Reduction. This countermeasure is aimed at the reduction of a portion of the accident type labeled vehicle turn/merge with attention conflict—specifically those involving right turns at nonsignalized intersections or at signalized intersections with right turn on red permitted.[6/] It involves the review of intersections in commercial areas with the objective of removing the basic attention conflict situation for the driver by selecting one of a number of possible actions. Those which may be considered are:

- Removal of right turn on red
- Signalization of intersection
- Control of cross traffic by stop sign
- Effect one-way traffic on street to right, coming from the right
- Pedestrian barrier if right turn on red needed
- Pedestrian—only signal phase.

5.103 The first two possibilities could remove the need for the driver to look to his left to identify an acceptable gap while turning right. The barrier in effect removes the crossing conflict and the pedestrian-only phase gives the pedestrian an opportunity to cross between the cars turning on the green and on the red. Once again the specific action requires location study.

5.104 Left Turn Attention Conflict Reduction. The problems and actions for left turn attention conflict reduction are the same as for the right turn with one difference. The left turn problem also includes the situation in which a driver is proceeding on the green and must select a gap in oncoming traffic in order to make his left turn. Additional actions to be considered are:

- Prohibition of left turns
- Use of left turn only arrow (protected from oncoming traffic)
- Use of leading or lagging green with notice to driver.

5.105 Pedestrian and Driver Education—Legal Intersection Conflicts. This countermeasure involves the provision of specific information about the nature of the vehicle turn/merge conflict type and other legal turn conflicts along with the correct search pattern for the pedestrian and driver. A particular objective would be to get pedestrians to attend to the potential turning vehicle threat.

5.106 Vehicle Design—Sun Accessory. Although a more general countermeasure, this is noted here because a large proportion of the cases where the sun was a

---

6/ All-way-stop intersections are not a problem for this type.

precipitating factor fell into the vehicle turn/merge conflict type. It is suggested that the feasibility of providing better protection against being blinded by the direct sun through redesigned visors or windshields be investigated. It appears that the need may vary with geographic location and might only require selective application.

SITUATIONS WITH SPECIFIC PREDISPOSING FACTORS

5.107 This group includes the following four types that account for 7% of the cases in the study sample and an estimated 21,000 urban pedestrian accidents a year.

(06) Vendor—ice cream truck	(1.5%)
(20) Ped exiting from vehicle	(.9%)
(23) Bus stop related	(2.6%)
(29) Backing-up	(1.7%).

5.108 Each represents a relatively small proportion of the sample, primarily because each is related to a very specific situation. However, analysis is simpler and countermeasures can be directly aimed at a specific problem.

Vendor—Ice Cream Truck

5.109 Basic Type Description. The pedestrian is struck going to or from a vendor in a vehicle on the street. This is usually similar to a dart-out, with ice cream trucks being the most frequent attraction. This more specific classification is given precedence over dart-out when assigning cases to types.

5.110 Summary Data. This type is really a special instance of a dart-out. The causal pattern is almost identical and need not be repeated here. Age and time of day are even more restricted to children and afternoon and early evening. Seventy percent of the pedestrians were between 5 and 9 years old. Almost 20% of the incidents occurred at or near intersections and 6% were near schools. All cases resulted in injury.

Pedestrian Exiting From Vehicle (20)

5.111 Basic Type Description. The pedestrian had been a passenger or driver and is struck as he exits from a vehicle; all vehicles are included.

5.112 Summary Data. The primary precipitating factors were pedestrian course—short-time exposure and pedestrian search—inattention. Most pedestrians (60 to 70%) were looking ahead, not attending to traffic, and did not recognize the need for evasive action.

5.113 Most drivers (65%) were proceeding at sustained speed and recognized the need for action either after the pedestrian began his collision course (38%) or just prior to impact (50%).

5.114 Most (58%) of the pedestrians were between 15 and 39. All but 16% were struck during three main traveling periods: 8:00-9:00 a.m., 11:00 a.m.-2:00 p.m., and 3:00-6:00 p.m. The two highest incidence areas were commercial (22%) and residential one family (39%). Multifamily (11%) and apartment areas (17%) were involved to a lesser extent. Most (78%) were midblock accidents. Various vehicles were involved.

Bus Stop Related (23)

5.115 Basic Type Description. This type does not include those cases that may be considered as exiting from a vehicle, type (13), nor does it include cases that may be described as rear-wheel truck or bus (described later). It does include all other cases whose occurrence revolves around a bus (taxi, trolley, etc.) stop, unless the stop is only an attraction or distraction. In other words, the location or design of the stop appears to be a major factor in the causation; e.g., the pedestrian crosses in front of the bus standing at a stop on the corner, and the bus blocks the view of cars.

5.116 Summary Data. The primary precipitating factors identified were:

(03) Ped course—short-time exposure

(13) Ped search—inattention

(06) Ped course—against signal

(1E) Ped detection—vision—stopped bus

(5D) Driver detection—vision—stopped bus.

5.117 As might be expected, 74-78% of the cases with the last two as primary factors were included in this type, as were more than 25% of the cases in which those two were a secondary factor.

5.118 Most pedestrians were either attending to the bus (67%) or not attending to traffic (19%). About one-third were walking normally and one-third were running, while 10% were walking rapidly. 56% did not recognize the need for evasive action; 30% did just prior to impact. The drivers' recognition of the need was about the same. About 35% were proceeding at sustained speed, while an equal number were proceeding from a stop, and others were more often slowing than accelerating.

5.119 All age groups were involved although the 5 to 14 group contributed about 30%. Most (75%) accidents occurred during daylight hours with major peaks at 8:00-9:00 a.m., 12:00-1:00 p.m., 3:00-4:00 p.m., and 5:00-6:00 p.m. Commercial (62%) and one-family residential (16%) areas were most involved. Over 88% were at intersections.

Backing Up (29)

5.120 Basic Type Description. The pedestrian is struck by a vehicle which is backing up. A case would not be so classified if the pedestrian were clearly aware of the movement of the vehicle; detection failure is important. This type is used even if the accident occurs off the street.

5.121 Summary Data. The precipitating factors identified all related to driver or pedestrian search factors with driver inadequate search being the most frequent.

5.122 More than 50% of the pedestrians were walking normally and 75% did not recognize the need for evasive action. The drivers were backing up and most (70%) were directing their attention to the rear; 81% did not recognize the need for evasive action.

5.123 Pedestrian ages were distributed across the entire range but there were only 3% in the 10-19 group and 42% were 50 years of age or over. The incidents were relatively evenly distributed from 10:00 a.m. to 8:00 p.m.. Forty-six percent occurred in commercial areas, while various residential and mixed commercial-residential areas accounted for about the same amount. Slightly more than half (53%) were at or near intersections. Only 7% had pre-involvement speeds over 10 mph.

Countermeasure Discussion - Situations With Specific Predisposing Factors

5.124 Ice Cream Truck Regulation and Warning Device. It is suggested that ice cream trucks and other street vendors that serve as an attraction to children be equipped with a visual warning device. The device could be two alternating amber lights, similar to the school bus type with a warning sign between them (e.g., watch children). It could be installed on top of the vehicle with the requirement that it be activated whenever the vehicle is stopped for vending.

5.125 Bus Stop Relocation. It is suggested that bus stops be located at the far side of the intersection so as to minimize visual interference. It should be noted that one city in the study had no bus stop related accidents. Upon investigation it was determined that over 90% of its bus stops had already been relocated to the far side.

5.126 Backup Warning Devices. It is suggested that all new vehicles be equipped with an auditory warning device that is activated when the car is in reverse, as are backup lights. A pulse type "beep" signal similar to that used on many construction vehicles appears most effective. Frequency requirements should be set considering the pattern of hearing loss that accompanies old age. In addition, consideration should be given to the placement of backup lights so that they too can be more effective as a warning during daylight hours.

5.127 Vehicle Exit Platforms and Regulation. Localities should review exit arrangements for public transportation vehicles. Exit areas should (at a minimum) be arranged to provide railing so that an exiting passenger cannot proceed into a vehicle path. Regulation of public licensed vehicles to require street side departure also seems feasible.

5.128 Vehicular Exit Warning Devices. As an aid to driver detection of pedestrians exiting from vehicles, a visual signal is desirable. However, it appears appropriate to keep the warning at a relatively moderate level. It is suggested that a red light be placed on or near the vehicle door so that it will be visible from the rear when the door is partially opened. The light would be designed to activate as the door opens. A device such as this has been included in some American cars, combined with the white "courtesy light" in the door. Such a device would call attention to the coming threat and/or provide the driver with additional time in which to react.

NONSTREET LOCATIONS

5.129 This group involves the following four specific types:

(09) Nonped activity, not in roadway (.9%)

(15) Freeway/expressway—from car (.2%)

(16) Freeway/expressway—crossing (1.1%)

(25) Off-street parking or loading. (.9%)

These types constitute 3% of the sample, but it should be noted that freeway incidents were under-represented since they were not covered by a number of police departments that assisted in case location (see Section II for sampling).

Nonpedestrian Activity, Not in Roadway(09)

5.130 Basic Type Description. The victim is not engaged in an activity that would classify him as a pedestrian and he is not in the roadway when struck, e.g., he might be mowing the lawn.

5.131 Summary Data. The primary precipitating factors were driver vehicle control, lost control—NFS, and driver course—speed. Perhaps these would have been single vehicle crashes if a pedestrian had not been there. Driver human factors NFS was the main predisposing factor; 15% of all cases in which this was a factor fell into the type (09) category, and type (09) accidents accounted for 1% of the sample. Weather, alcohol, and defective brakes were also noted.

5.132 In general, pedestrians were engaged in some specific activity and were not moving; 20% recognized the need for evasive action just after the driver began his collision course. Most incidents occurred either between 4:00 a.m. and 7:00 a.m. or between 3:00 p.m. and 9:00 p.m. They happened in all kinds of areas, but mainly at or near intersections. A range of speeds (15-50 mph) were involved. The pedestrians involved were generally under 35 years old and distributed evenly within that age range. In about 20% of the cases pedestrian alcohol presence was reported as unknown.

Freeway/Expressway—From Car (15)

5.133 Basic Type Description. The pedestrian had been a driver or passenger and exited from a car on the freeway.

5.134 Summary Data. Pedestrian course items accounted for about 60% of the primary precipitating factors: high exposure to vehicles, short-time exposure, and unexpected, unusual place. Pedestrian search factors were also noted. The one case in which splashed water on the windshield blocked the driver's vision was also in this type. Driver course—speed, and driver detection failure due to traffic, were the secondary factors. Pedestrian old age, and weather—slippery conditions, were noted as predisposing factors. The pedestrians were not attending to traffic; rather they were working or looking at some roadside object. None recognized the need for evasive action. The drivers were proceeding at sustained speeds and recognized the need for evasive action either just prior to impact or just after the pedestrian began his collision course.

Freeway/Expressway—Crossing (16)

5.135 Basic Type Description. The victim is a true pedestrian going somewhere and crossing the freeway. He was not a passenger or driver who exited from a car on the freeway.

5.136 Summary Data. Pedestrian course, heavy exposure to vehicles, and unexpected, unusual place accounted for most of the primary precipitating factors. Pedestrian's poor prediction of vehicle-pedestrian path interaction was also involved. Pedestrian human factors—alcohol accounted for many of the predisposing factor identifications. Driver alcohol, pedestrian human factors, unattended children, and weather—visibility were also noted as predisposing.

5.137 Behavioral data were sparse, but it appears that more than half the pedestrians were running and did not recognize the need for evasive action. On the other hand, most drivers were proceeding at sustained speeds and recognized the need for evasive action just after the pedestrian began his collision course.

5.138 Accidents occurred at various times of the day and involved pedestrians at various ages over 5. They were in or near open or mixed residential/commercial areas and involved high speeds, high severity of injurity, and a higher alcohol involvement for pedestrians and drivers.

Off-Street Parking or Loading (25)

5.139 Basic Type Description. The accident occurs in an off-street parking or loading area. Backing up accidents as described above are not included. Pedestrians exiting from vehicles are not included.

5.140 Summary Data. A wide variety of specific factors were identified, indicating the many failures that could lead to an off-street accident—

unexpected appearance of the pedestrian, driver and pedestrian search failures, detection failures due to parked cars, posts and poor lighting, as well as misperception of the intent of the other party were all cited. Among the predisposing factors were driver human factors—alcohol, and pedestrian human factors—old age. More than half the pedestrians did not recognize the need for evasive action. About half the drivers were attending to a particular maneuver and did not recognize the need for evasive action.

5.141 About 40% of the pedestrians were between 10 and 25 years old, and 40% were between 45 and 75 years old. About 75% of the incidents occurred in commercial areas during daylight hours. Most speeds were low. For 78% of the pedestrians and 67% of the drivers alcohol presence was not indicated; thus probable alcohol involvement appears higher than for many other accident types.

Countermeasures—Nonstreet Locations

5.142 Freeway Design For Vehicle Repair. This countermeasure is directed at freeway drivers who become pedestrians when they have vehicle trouble. Space must be provided to permit and induce the driver/pedestrian to pull off far enough from the traveled portion of the roadway to be safe.

5.143 Freeway Repair Regulation and Warning Signs. This countermeasure is also directed at the pedestrian who leaves his car on the freeway. Effective alternative means for repairs to cars that become disabled on the freeways should be provided. In addition, personal repair work on freeways might be prohibited. Motorists would have to be informed of the specifics by signs and other means. Adequate communications to secure aid would have to be provided (e.g., call boxes, vehicle and helicopter patrols).

5.144 Driver Training—Freeway Repairs and Emergency Procedures. Driver training and safety education programs should include information on the seriousness of this problem and the need to stay away from the traveled portion of the roadway. In addition, special procedures for securing assistance and local regulations regarding repair practices should be included.

5.145 Freeway Design—Pedestrian Crossing. Both existing and planned freeways should be evaluated to ensure the provision of adequate separated pedestrian crossways. It does not appear sufficient to erect fences or other barriers to prevent local residents from taking "shortcuts".

5.146 Parking Lot Design Requirements. Requirements and standards should be set for off-street parking areas with respect to:

- Public access
- Illumination
- Nonvehicle obstructions to vision.

The objective would be to minimize the number of pedestrians in the area and assist detection by drivers.

ATYPICAL PEDESTRIAN ACTIVITY

5.147 This group includes three accident types in which the victim is engaged in an activity not usually thought of as being a pedestrian activity, or an activity which is unusual for urban pedestrians. These types are

(08)	Nonped activity—in roadway	(2.2%)
(21)	Ped walking in roadway	(1.1%)
(31)	Working on vehicle	(.3%).

Together these types account for almost 4% of the cases reviewed.

Nonpedestrian Activity in Roadway (08)

5.148 Basic Type Description. The victim is performing a specified activity in the roadway, such as repairing the street, painting the curb, etc. A person who goes into the street to retrieve an object or avoid a danger is not included.

5.149 Summary Data. The most frequent primary precipitating factor was pedestrian course—unusual place. Pedestrian distraction—play, and distraction NFS, were also noted along with driver search inattention, inadequate search, and search and detection NFS. Driver poor prediction of vehicle-pedestrian path interaction was also noted; in fact, 21% of the total sample cases in which this was a primary factor fell into the type 08 category although type 08 accounts for only 2.2% of the total cases in the sample. Of the cases involving pedestrian course—unusual place, 19% were in this type.

5.150 Pedestrian and driver alcohol were the predisposing factors most frequently identified. Pedestrian human factors NFS, parked cars, and limitations on search and detection due to vehicle projections were also noted.

5.151 Most pedestrians were not moving. In general they appeared to be looking behind or to one side, working (50%) or playing (25%), and not attending to traffic.[7] Almost 85% never recognized the need for evasive action. About half the drivers were proceeding at sustained speeds and half never recognized the need for evasive action. Accidents were spread over time of day and pedestrian age, although there were peaks for the lower ages and in the late afternoon hours. Two-thirds occurred during daylight hours. Forty percent were in commercial areas and most of the rest were in residential areas. Pre-involvement speed was over 30 mph in 15% of the cases.

Pedestrian Walking in Roadway (21)

5.152 Basic Type Description. The pedestrian is walking in the roadway, with or against traffic. This does not include typical jaywalking. This type was established because the activity is unusual in urban areas.

---

[7] It should be noted that pedestrians playing in the road were about three-fourths of 1% of the sample, compared to the larger proportions playing on the side and darting out into the roadway.

5.153 Summary Data. The two most frequent primary precipitating factors were pedestrian search—inattention and driver course—speed. Predisposing factors noted most often were pedestrian human factors—alcohol and heavy exposure—pedestrian-vehicle conflicts, Weather—visibility and slippery conditions—was also noted.

5.154 Most pedestrians were walking normally and looking ahead. Most were on the shoulder or on a highway structure like an overpass. The need for evasive action was not recognized by 77%. Forty-two percent of the victims were between 10 and 32 years old, and 46% were between 40 and 60 years old. Incidents occurred during all hours except early morning, but most were in the afternoon and at night; 86% were midblock, 36% were in commercial areas, and 32% were in one-family residential areas. Only 64% were in the daytime and 14% were in unlighted areas. Alcohol presence was reported negative for about 75% of both drivers and pedestrians.

Working on Vehicle (31)

5.155 Basic Type Description. The victim is struck while working on a car, or is struck by his own car in the course of working on it. Backup accidents as described above are not included. Accidents occurring off-street are included. Driverless vehicle accidents are included if the vehicle involved was being worked on.

5.156 Summary Data. Primary precipitating factors were pedestrian misperception of driver's intent, pedestrian's poor prediction of vehicle/pedestrian path interaction, driver course—speed, and driver—lost control. Predisposing factors identified were heavy exposure, working on auto, and driver human factors—alcohol. Very few cases were involved so that generalizations are tenuous. However those cases reported did involve slow speeds in midblock in commercial areas during the day.

Countermeasures—Atypical Pedestrian Activity

5.157 Roadway Worker Protection Requirements. Various warning devices and protective measures are available to limit the possibility of workers in the road being struck. These include the use of flashing lights on vehicles and barriers, warning flags raised above car top level, bright reflective vests, advance warning signs, and placement of work vehicles in the roadway as a warning and barrier. While some private organizations, like the telephone company, appear to have excellent programs, it is recommended that local jurisdictions establish specific standards that will require all who are permitted to work in the street to adhere to the same kinds of procedures.

5.158 Provision of Pedestrian Pathways. The suggestion that separate pathways be provided for pedestrians in urban areas is hardly new. The few areas where they do not exist in cities should be improved.

5.159 This group contains two special types that accounted for 2% of the sample.

(13) Rear-wheel truck or bus (.5%)

(19) Weird. (1.2%).

No countermeasure discussion is included because of the nature of the cases in this group.

Rear-Wheel Truck or Bus (13)

5.160 Basic Type Description. This type may be used when other types do not apply, but it is determined that the pedestrian somehow gets run over by the rear wheels of a truck or bus. "Rear" includes all other than front.

5.161 Summary Data. The main precipitating factors were related to the pedestrian course: short-time exposure, heavy exposure to vehicles, and unexpected place. Improperly supervised children, pedestrian human factors—old age, and pedestrian human factors—alcohol were predisposing factors, as were heavy exposure due to pedestrian/vehicle turns and safety zone design. Weather—slippery conditions was also noted.

5.162 All cases involved fatalities. The drivers were usually proceeding from a stop or turning a corner. Accidents happened in the afternoon and at night (60% in daylight, 30% at night with lighting). Half were in commercial areas; half were at or near intersections. Of the pedestrians involved, 65% were over 60,and alcohol presence was ruled out on the accident report for only half of them. It has been hypothesized that some of these may be suicides, and that some resulted from pedestrians slipping.

Weird (19)

5.163 Basic Type Description. These are cases that were not expected to turn up more than once in the study and for which it would be inappropriate to focus on countermeasures. Only very unusual cases are included (e.g., the pedestrian was standing near the open door of the motionless car instructing a friend learning to drive; something unintended occurred causing the car to move forward and the open door knocked down the pedestrian).

5.164 Summary Data. Although these cases, by their very nature, were not expected to show similarities, two points may be worth noting. The most frequent precipitating factor was pedestrian course—unusual place and the most frequent predisposing factors were pedestrian human factors—alcohol and pedestrian human factors—NFS. It would however be inappropriate to conclude that most weird cases result from those factors.

ATYPICAL CAUSES—NOT PEDESTRIAN COUNTERMEASURE CORRECTIVE

5.165 The following types are included in this group:

(03) Illegal or antisocial act to ped (1.1%)

(04) Illegal or antisocial act by ped (.9%)

(05) Hot pursuit (.1%)

(08) Result of auto-auto collision (2.6%)

(22) Driverless vehicle (.4%).

They account for 5% of the cases received. For the most part their solutions fall outside the usual province of pedestrian safety. Thus only the basic type descriptions will be presented, followed by a brief discussion of causes and countermeasures for the whole group.

Illegal or Antisocial Act to Pedestrian (03)

5.166 Basic Type Description. This type includes crashes that were precipitated by an illegal or antisocial act to the pedestrian, or that were themselves antisocial acts. For purposes of this classification, traffic violations by the driver per se are not considered as antisocial or illegal acts. If the driver deliberately runs down the pedestrian, the case would be included. If the pedestrian is fleeing from an attack, the case is included, unless the pedestrian has just committed an illegal or antisocial act and leaving the scene (see illegal acts by pedestrians, paragraph 5.167).

Illegal or Antisocial Act by Pedestrian (04)

5.167 Basic Type Description. The crashes in this type are precipitated by illegal or antisocial acts by the pedestrian. Fleeing from the scene of a criminal act, attempting to rob a driver at a stop sign, and jumping on the rear of a car are all included. Probable suicide is also involved. (This requires evidence of intent.) Jaywalking, crossing against a red light, and other "routine" pedestrian violations are not included.

Hot Pursuit (05)

5.168 Basic Type Description. Cases in which pedestrians are struck by pursuing police, vehicles being pursued, or emergency vehicles, are classified in this type. Although this special type was identified early in the study as a type requiring unique preventive measures, there was only one incident (resulting in two fatalities) reviewed and thus, no data will be presented.

Result of Auto-Auto Crash (08)

5.169 Basic Type Description. Crashes classified in this type result directly from an auto-auto crash, an auto-fixed object crash, or the avoidance of such crashes. For example, if a car strikes another car that is then thrown against a pedestrian, the case would be included here. A case could be included in this type even if the pedestrian were in an off-street location.

Driverless Vehicle (22)

5.170 Basic Type Description. This type includes all incidents in which the pedestrian is struck by a vehicle without a driver, except if the pedestrian was working on his car.

Atypical Causes - Causes and Countermeasures Discussion

5.171 The most frequent type in this group was result of auto-auto crash (18). Its causes and countermeasures are clearly beyond the scope of this study, as are the causes and countermeasures for type (22), driverless vehicle cases. The hot pursuit type (05) was almost nonexistent, but the establishment or review of regulations governing the use of emergency vehicles and their manner of operation might prevent future incidents.

5.172 Illegal or antisocial acts by pedestrians will require attitude and behavior changes that would have a far-reaching influence on society. Thus the determination of basic cause(s) and the development of unique countermeasures for this type are obviously beyond the scope of this study. However, this type is often actually a unique kind of dart-out and should be reduced by countermeasures aimed at dart-outs and dashes.

CAUSES NOT STUDIED

5.173 A few cases received fell into types that precluded a detailed study of precipitating factors and countermeasures. Thus only the basic type description and frequency are presented.

Inadequate Information—Nonfatal (11)

5.174 Basic Type Description. This category is used for cases for which the information obtained was so limited, conflicting, or open to question that it is hazardous to draw any conclusions. The pedestrian survives the crash. This type accounted for 2.6% of the cases.

Inadequate Information—Fatal (12)

5.175 Basic Type Description. This is the same as the previous "inadequate information" type except that the pedestrian dies. (The distinction was made as aid to methodological analysis.) This type accounted for .8% of the total cases.

Pedestrian Operating Bike or Cart (17)

5.176 Basic Type Description. This type covers cases in which the pedestrian was actually operating a bike, cart, or some vehicle. Few such reports were received, and they represent a biased sample. Type (17) accounted for 2.2% of the cases received.

Probable Nonaccident (30)

5.177 Basic Type Description. Although a pedestrian and a vehicle are involved, cases in this category are probably not accidents. This covers cases where the crash has not been substantiated and it is probable that contact was not made. (A claim by the pedestrian often follows.) Of the total cases, .4% fell into this category.

Excluded For Other Reasons (32)

5.178 Basic Type Description. This classification was used for cases not otherwise described that did not fit the scope of the study. A major reason for exclusion is that the pedestrian was struck by something other than a licensed motor vehicle, e.g., a bicycle; .3% of the cases were of this type.

INFREQUENT OR UNIDENTIFIABLE CAUSAL PATTERN

Introduction

5.179 Cases in this type were not assigned to the other types described above. There were two possible reasons for this. First, they could be cases that had infrequent patterns but were not unusual enough to be classified as "weird." Secondly, they could be cases for which sufficient evidence was not available to support a judgment of cause.

5.180 Based on a review of the data tabulations for these cases and a second review of a large sample of the individual case records, several infrequent patterns have been identified. (That is, the complete causal pattern may not be clear, but enough situational or behavioral information does exist to be of some value in considering countermeasures.) An overview of the cases in this group is followed by the descriptions of the infrequent patterns.

Data Summary

5.181 Precipitating Factors. Five system failures accounted for over 40% of the primary precipitating factor identifications:

(06) Ped course—crossing against signal

(5U) Driver search and detection—NFS

(54) Driver search—inadequate search

(10) Ped search and detection—NFS

(13) Ped search—inattention

(14) Ped search—inadequate search.

5.182 Of special interest is the fact that although this type represented 17% of the total sample, 27% and 32% of the cases in which the first two factors were identified fell into this type. A number of other primary precipitating factors were overrepresented in this type. These factors and the percent of the total cases with these factors that fell into this type are:

(45) Driver course—wrong side of road	(76%)
(43) Driver course—run stop sign	(64%)
(02) Ped course—slow speed	(63%)
(42) Driver course—attempt to beat signal	(40%)

(71) Driver evaluation—misperception of ped intent (40%)

(5B) Driver detection—poor lighting (37%)

(5A) Driver detection—vision—sun (35%)

(52) Driver search—distraction (34%)

(21) Ped evaluation—misperception of driver intent (31%)

(41) Driver course—speed (29%).

These factors did not play too great a role in the previous types.

5.183 Predisposing Factors. All of the frequently identified predisposing factors, except heavy exposure to pedestrian vehicle turns, were overrepresented in this type. Notable predisposing factors and the percentage of all cases with those factors that fell in this type (listed in decreasing order of identifications) are:

(42) Ped human factors—old age (49%)

(43) Ped human factors—alcohol (38%)

(32) Heavy exposure—ped/vehicle turns (20%)

(61) Environment—weather—visibility (36%)

(21) Inducement to risk taking—signal timing (38%)

(53) Driver human factors—alcohol (38%)

(11) Limitations on search—vehicle projections (38%)

(52) Driver human factors—old age (46%).

5.184 Major Behavioral Items. There appeared to be a larger proportion of drivers attending to turning a corner than in the total sample (32% versus 20%). More striking, however, is the fact that more than half of the pedestrians identified as walking slowly fell into this type.

5.185 Basic Descriptive Items. Compared with the total sample, there was a greater proportion of older pedestrians (29% versus 14% over 60 years). There was less of a peak in the afternoon and a higher proportion in the early morning than in the total sample (8.7% versus 2.7% between midnight and 4:00 a.m.). Proportionately fewer accidents took place in one-family and multifamily residential areas; however, more took place in commercial areas (53% commercial versus 39% for the total sample). Intersection accidents were also represented proportionately higher (75% versus 50%). Speeds were somewhat higher (16% over 30 mph versus 9% for the total sample). Reported alcohol presence was higher for pedestrians (8.4% versus 4.4%) and for drivers (5.6% versus 2.6%).

Infrequent Patterns

5.186 A third of the cases in this type were subjected to a further case-by-case review. About 40% of them were identified as belonging to infrequent patterns which are briefly described here. (The estimated percent of the total sample that would fall into that pattern is also indicated.)

5.187 Unanticipated and Unusual Driver Behavior—Pedestrian Detection Failure or Delay (.9%). The driver runs a red light or a stop sign, attempts to beat the light or is going quite fast. The pedestrian either fails to detect him or does not detect him soon enough to take action.

5.188 Unanticipated and Unusual Driver Behavior—Pedestrian Evaluation Failure (.3%). The driver behavior is the same as above. The pedestrian detects the vehicle but does not correctly evaluate its future course (e.g., he expects it to stop for the red light).

5.189 Unanticipated and Unusual Driver Behavior—Pedestrian Failure—NFS (.1%). The same types of driver behaviors apply, but the pedestrian's reaction cannot be determined.

5.190 Pedestrian Assessment (.3%). The pedestrian assumes that the driver will detect and avoid.

5.191 Unanticipated and Unusual Pedestrian Behavior—Driver Detects (.7%). The driver detects the pedestrian, but then the pedestrian performs an unanticipated and unusual act.

5.192 Pedestrian Driver Interaction (.5%). In this pattern, the driver and pedestrian fail to match their evasive action and/or misinterpret each other's intent.

5.193 Vehicle Turn/Merge Situation (.7%). These cases appear to be the same as type (24), except that there was not sufficient evidence in the case record to show that the driver was attending to the conflicting demand for his attention from the traffic.

5.194 Legal Pedestrian Vehicle Conflicts (.9%). Situations where both the pedestrian and the vehicle have the green or can otherwise legally proceed across the same path. Some unique or unidentifiable set of circumstances occurs and the collision results.

5.195 Unexplained Unsignalized Intersection Crossing (.5%). The pedestrian is crossing an intersection and is struck. There is no apparent reason for the accident.

5.196 Caught by Signal Change (.7%). The pedestrian is crossing with the signal. Before he completes the crossing the signal changes and he is struck by a vehicle proceeding with the signal.

5.197 Pedestrian Escaping Danger (.3%). The pedestrian is escaping from some danger other than illegal or antisocial acts (e.g., material falling from a building under construction). In avoiding the initial danger he enters into a collision course.

5.198 Conclusion. The preceding analysis of infrequent patterns has shown:

- An additional 2.2% of the cases involving dangerous, unexpected, illegal driver behavior
- An additional 1.5% of the cases involving problems of misperception and evaluation
- An additional 1.6% of the cases involving dangerous situations that have entered into other causal types
- An additional .7% of the cases identifying signal change as a problem.

Countermeasure Discussion—Infrequent of Unidentifiable Patterns

5.199 Certain countermeasures already identified would apply to some of the patterns discussed in this group. Signal retiming or modification would apply to the signal change pattern. Conflict reduction, right turn attention conflict reduction, left turn attention conflict reduction, as well as pedestrian and driver education relative to legal intersection conflicts would apply to the dangerous situation patterns.

5.200 Driver-Pedestrian Communication/Evaluation Procedures and Education. This countermeasure is directed primarily to the patterns which involve dangerous unexpected, illegal driver behavior and also those which involve problems of misperception and evaluation. (Together they account for an estimated 3.7% of the sample.) In addition they apply to a large part of the 10% in the unidentifiable pattern group.

5.201 Two steps are involved. One is the establishment of a small set of standard signals that may be used for pedestrian-driver communication and a set of standard evasive maneuvers for pedestrians and drivers in particular circumstances. (For example, a hand signal for pedestrians about to enter the roadway in a legal conflict situation.) The second step would involve education in the use of these procedures and in principles of evaluating collision threats and driver-pedestrian intentions. It would in effect deal with particular aspects of "how to cross the street."

OTHER COUNTERMEASURE CONSIDERATIONS

5.202 The preceding discussion has identified causal patterns and relevant countermeasures. Omission of a countermeasure does not necessarily imply that it is of no value. Countermeasures for accidents involving children going to and from school were not discussed because this type of accident was not frequent, probably due to the effectiveness of the current countermeasures being applied. Although relatively few urban accidents occurred in unlighted areas at night, reflectorized markings or clothing are certainly desirable and would probably prevent some injuries. In addition there are some different ideas regarding pedestrian protection which deserve further consideration although they have not been included in specific countermeasure recommendations.

5.203 Pedestrian Signal Information Content. The use of pedestrian signals is growing and standardization will probably exist soon. However, the information provided by the common "walk-don't walk" signal is minimal. The fact that "don't walk" does not mean that at all is probably not serious because people can be expected to learn that it means "don't leave the curb." The signals give advice rather than information and many people do not accept advice.

5.204 The red signal to a driver gives him advice and information. It not only tells him that he is legally advised not to go, it also tells him that someone else is being told to proceed across his path. For the pedestrian, however, "walk" is only advice. Vehicles may or may not be told to cross his path at the same time. Only in Denver was it noted that the removal of "don't walk" (followed by no pedestrian signal) meant it was permissible to cross, but one was subject to some legal vehicle threat. In Denver, "walk" means that no vehicles are permitted to cross the pedestrian path.

5.205 The pedestrian should be informed of the three basic conditions:

- Heavy, fast-moving, or direct traffic flow across his path
- Turning and presumably lighter traffic
- No legally permitted traffic.

These conditions are somewhat comparable to red, amber and green (RGA). Why should not the pedestrian have a distinct RGA, obviously different enough not to be confused with the vehicle signal (e.g., a sign that flashes "pedestrian" in the appropriate color)?

5.206 The influence of pedestrian signals is not as great as that of vehicle signals. Unless acceptance of walk-don't walk or RGA signals for pedestrians is developed through means of attitude change or behavior modification, consideration should be given to providing additional information in the signal as a means to gaining acceptance. The actual effect can only be determined through experimentation, but "countdown" signals may reduce the number of pedestrians in the crosswalk just before or just after a pedestrian green. Such digital signals would show the number of seconds remaining before the signal changes. This information may induce people to wait for a pedestrian green or amber signal; it might also prevent some from starting too late. While implementation cannot be recommended, study and demonstration appears warranted.

5.207 Crossing Simplification. Many of the countermeasures discussed already have the effect of simplifying the crossing situation. It would be expected that the fewer directions from which threatening traffic can arrive, the more likely the pedestrian will be able to handle the situation. The positive effect of one-way streets in simplifying pedestrian crossings, reducing pedestrian accidents, and improving traffic flow is documented elsewhere[8/] and is apparently not disputed. The existence of many two-way streets, however, makes it desirable to call attention to this measure once again.

5.208 Another approach to crossing simplification is mentioned here for further analysis and consideration. That is the use of non-intersection pedestrian crossings. This would reduce the threat from turning vehicles. Midblock signals and corner pedestrian barriers might be required. Difficulties with traffic flow might make midblock signalization difficult but it may be feasible in some locations. A crossing some feet in from the intersection would mean that a pedestrian only has traffic coming from his side rather than from behind on his side and in front on his side. Again, this approach is suggested for further analysis and testing rather than immediate implementation.

8/ Automotive Safety Foundation, Traffic Control and Roadway Elements, Washington, D. C., 1963, p. 72.

VI. PROGRAMMATIC RECOMMENDATIONS

INTRODUCTION

6.1 This section deals with the application of the findings and recommendations. This study has identified various countermeasures relevant to over two-thirds of urban pedestrian accidents. A significant reduction in pedestrian accidents is possible, even with partially effective countermeasures. Recommendations for a program to reduce pedestrian accidents fall into three areas that are treated below:

- Federal countermeasure application
- Local countermeasure implementation
- Future research and development.

FEDERAL COUNTERMEASURE APPLICATION

6.2 Two of the accident types identified are amenable to reductions by means of vehicle design action. Back-up accidents involving pedestrians should be very largely reduced by means of the warning devices recommended. The vehicle exit warning devices suggested should produce noticeable reduction in accidents involving pedestrians exiting from vehicles. Both steps appear well within the state-of-the-art and would be very inexpensive design changes.

6.3 Therefore, it is suggested that NHSB include these measures in its program for the development of vehicle safety standards.

LOCAL COUNTERMEASURE IMPLEMENTATION

Introduction

6.4 Although the Federal Government may provide support, the application of pedestrian countermeasures is primarily within the realm of local government agencies. This study has identified problems and possible solutions. Priority areas will also be identified later. However, one program that will best serve the needs for all localities cannot be developed. Both the nature of the problem and the feasibility of selected countermeasures will vary from locality-to-locality. Thus the following identify the major recommended steps for a local program to reduce pedestrian accidents, and indicates general guidelines with respect to priority areas.

Local Pedestrian Program Steps

6.5 A few major types of pedestrian accidents account for most of the deaths and injuries. However, the relative frequency of each will vary from city to city. In addition, the specific targets (e.g., geographic locations) towards which countermeasures can be most effectively directed must be determined locally. Therefore, it is recommended that the results of this project may be applied to a local program as follows:

a. Determine the specific frequency of identifiable accident types in the city and the target areas in which they occur.

b. Estimate the cost effectiveness of various countermeasure combinations within local action constraints.

c. Systematically apply these countermeasures and measure their impact in terms of the reduction in the accident types towards which they were directed and the resulting savings in lives and injuries.

d. Establish a procedure for continual monitoring of pedestrian accidents to identify areas needing attention in the future.

All of these steps are currently within the state-of-the-art. Problems in establishing such a program will be more political and organizational than technical. (More will be said later in this section about public support.)

Priority Areas

6.6 Although relative frequencies will vary from city-to-city, it is expected that five accident types will account for over 50% of the pedestrian accidents in any city similar to those studied. Countermeasures directed at these types have the best opportunity for achieving substantial reductions. Therefore, it is suggested that local action be directed at the following accident types:

(01) Dart-out first half

(02) Dart-out second half

(07) Multiple threat

(24) Vehicle turn/merge attention conflict

(27) Intersection dash.

6.7 In most cities, the dart-out first half will be most frequent and should be given top priority. However, there is no substitute for local data in determining the relative efforts to be directed at these five types.

6.8 Another three accident types accounting for about 4% of the accidents are recommended for immediate action because their countermeasures are relatively simple, inexpensive and direct. These types are: (06) vendor, (23) bus stop related, and (25) off-street parking.

Countermeasure Priorities

6.9 A summary list of the countermeasures described earlier and the accident types to which they apply is presented in Table 6.1. Considering the accident types identified above and the likely cost and impact of the countermeasures, a list of those deserving the highest priority are given below. They have been chosen on the basis of judgments of effectiveness, assuming an interest in minimizing costs. With respect to traffic engineering, these countermeasures are:

- Street parking redeployment
- Meter post barriers
- Stop line modification
- Bus stop relocation
- Right and left turn attention conflict reduction
- Signal retiming
- Parking lot design requirements.

6.10 Those countermeasures primarily involving regulation are:

- Parking lot design and operating requirements
- Vendor regulation and warning devices
- Overtaking procedure ordinance.

6.11 With regard to driver training, pedestrian and public education, it is recommended that existing mechanisms be modified and expanded to include the specific content noted in the various education and training countermeasures.

6.12 Once again it must be stressed that local conditions must be considered so that programs are designed to meet particular circumstances and resources. However, these program suggestions are designed to point in the general direction of a program with moderate costs achieving short-term payoff.

FUTURE RESEARCH AND DEVELOPMENT

6.13 Although this report is oriented towards countermeasure application, it is important to note the areas in which continued research and application appears likely to lead to mid-term and long-run improvements. These areas include:

- Testing and evaluation of potential countermeasures noted earlier, which did not have sufficient evidence for immediate application (see Section V).
- Research and development in crossing behavior and the effect of various pedestrian signals on that behavior.
- Refinement of pedestrian accident investigation instruments to more precisely describe the unidentifiable and infrequent patterns.
- Development of additions to local reporting mechanisms to include pedestrian data needed for evaluation and monitoring.
- Development of packages of educational and informational materials containing specific information aimed at the reduction of particular accident types.

CONCLUSION

6.14 The seriousness of the pedestrian accident problem is not well known to the public. Compared to its relative contribution to vehicle deaths and injuries, it is given relatively little attention by safety professionals and local public officials. It is believed that this study has contributed to a much clearer understanding of the nature of pedestrian accidents and provides a basis for the belief that pedestrian accidents can be prevented. Action by local government is most important, but government action is usually stimulated by an informed public. Thus the final suggestion is that the public be informed of the seriousness of the pedestrian problem and the fact that something can be done about it.

TABLE 6.1

SUMMARY OF COUNTERMEASURES AND APPLICABLE ACCIDENT TYPES

Countermeasure Name	Applicable to Type
Street parking redeployment	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash (10) Pedestrian strikes vehicle
Prohibition of on-street parking	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash
Off-street parking/play areas	(01) Dart-out first half crossing (02) Dart-out second half crossing
Sidewalk parks	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash
Meter post barrier	(01) Dart-out first half crossing (02) Dart-out second half crossing
Signal retiming or modification	(27) Intersection dash (33) Infrequent, unidentifiable patterns
Conflict reduction	(27) Intersection dash (33) Infrequent, unidentifiable patterns
Specific driver training	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash
Specific adult education	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash
Specific preschool and primary grade education	(01) Dart-out first half crossing (02) Dart-out second half crossing (27) Intersection dash
Stop line modification	(07) Multiple threat situation
Driver procedures and traffic ordinance (overtaking)	(07) Multiple threat situation