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RESESEARCH PROBLEM STATEMENTS

mode
1 highway transportation

subject areas
51 transportation safety
52 human factors
54 operations and traffic control

OPERATION AND MAINTENANCE OF TRANSPORTATION FACILITIES

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INTRODUCTION

Committee A3B04, Pedestrians, has recognized the identification of research needs to be a major committee function. The committee has previously evaluated and published research problem statements, and the publication of this Circular is a continuation of that activity. The Circular is intended as a means for communicating problem statements to the transportation research community.

PRIORITY RANKING

While all problem statements contained in this Circular are considered important, a priority ranking system was employed to inform researchers which problems the committee considers the most urgent. The problem statements were solicited from committee members and ranked by them during 1979. The resulting ranking represents the committee's judgement as to the relative importance of each of the nine problem statements. Three categories of priority have been used to suggest the level of urgency and emphasis required.

Priority Category	Problem Statement Number	Title
High	1	Traffic Conflict Analysis as a Measure of Pedestrian Safety

Priority Category	Problem Statement Number	Title
High	2	Identification and Prioritization of Pedestrian Safety Problem Location
High	3	Development of a Pedestrian Exposure Data Collection Technique
Moderate	4	Pedestrian Comprehension of Traffic Control Devices
Moderate	5	Evaluation of Pedestrian Street Crossing Behavior at Signalized Intersections
Moderate	6	Pedestrian Visibility
Low	7	Evaluation of Specific Safety Messages for Child and Elderly Pedestrians
Low	8	Improvement of State and Local Accident Driver Record Systems
Low	9	Special Event System Planning and Design

PROBLEM NO. 1: TRAFFIC CONFLICTS ANALYSIS AS A MEASURE OF PEDESTRIAN SAFETY

One of the most difficult problems for safety engineers is to identify cost-effective highway improvements for pedestrians. This is because of the lack of good measures of pedestrian danger or risk. Pedestrian accidents are often random in nature and usually don't occur with much regularity at any specific highway location. Even when a specific location or section is identified as having an unsually high number of pedestrian accidents, chances are that pedestrian accidents will not reoccur at that site for several months regardless of any highway improvements. Thus, using only pedestrian accidents to warrant pedestrian-related improvements may often not result in a wise expenditure of funds.

Consideration of high pedestrian volumes to warrant pedestrian improvements may also result in unwise decisions. Studies have shown that when large numbers of pedestrians are present, the motorists are more alert to pedestrian movement. In one Kentucky study, the presence of several children was found to cause significantly lower vehicle speeds in school zones than when few or no children were present. In another study, pedestrian accident rates were found to be lower for school children walking in groups of two or more than for children walking alone. Large masses of pedestrians after concerts or sporting events often stop traffic on major arterials and take over the right-of-way. Considering only pedestrian volumes, therefore, is not a valid method for identifying pedestrian safety needs.

Other measures of pedestrian danger need to be identified and tested for use in identifying locations with the greatest likelihood of vehicle-pedestrian accidents. Possible methods include counts of conflicts between pedestrians and vehicles. Vehicle speeds, geometric conditions, and types of pedestrians (elderly, school children, college students, handicapped) involved in conflicts should also be considered in developing warrants for pedestrian improvements.

Research Proposed

The primary objective of this research is to develop a procedure for using traffic conflict counts to identify pedestrian problem areas. Conflict numbers, rates, and severities will be calculated for several locations where pedestrian safety is a problem. Conflict types may include the following:

1. Vehicles slowing or swerving to avoid pedestrians,
2. Pedestrians caught in roadway median waiting for gaps before crossing street,
3. Pedestrian violations (jaywalking, crossing against signal),
4. Pedestrians running across street, and
5. Near-miss accidents between vehicles and pedestrians.

Based on the conflict counts, general guidelines should be developed for identifying pedestrian problem areas. Such guidelines should show what combinations of highway geometrics, vehicle speeds, pedestrian and vehicle volumes, and traffic conflicts should warrant consideration of safety improvements. The conflict procedure should be used not only to identify problem locations, but also to help select appropriate improvements and to evaluate the effectiveness of such improvements (before and after study).

PROBLEM NO. 2: IDENTIFICATION AND PRIORITIZATION OF PEDESTRIAN SAFETY PROBLEM LOCATIONS

There is currently a need to develop an effective but inexpensive means of identifying and prioritizing pedestrian safety problem locations. The use of pedestrian accident data is often very misleading because of the infrequence and randomness of these events. The use of pedestrian behavior data, while possibly effective, is too costly to be considered for widespread use. Other methods must therefore be investigated to fill this need.

One possible means of identifying problem locations would be to use location characteristics (street width, pedestrian and vehicle volumes, sight distance, etc.). These characteristics are normally available or can be easily obtained or estimated by the engineer. Locational characteristics are currently informally used to determine where investment should be made in countermeasures (e.g. proximity to schools), but no systematic means exists to deal with pedestrian safety problem locations on a broad scale. Such an approach, if proved effective, would be of significant benefit to the engineer.

Research Proposed

1. Develop a method to identify and prioritize pedestrian safety problem locations using readily available locational characteristics.
2. Test and revise the methodology based on comparison with other reliable safety descriptors (long term accident statistics, behavioral data, etc.)
3. Develop a user's manual which describes the methodology and which (using previous research) suggests appropriate countermeasures.

PROBLEM NO. 3: DEVELOPMENT OF PEDESTRIAN EXPOSURE DATA COLLECTION TECHNIQUES

Although there are many studies of pedestrian accident data in the U.S., we have no pedestrian exposure data. We cannot therefore determine whether any pedestrian descriptors represent overinvolvement or underinvolvement or merely proportional representation (for example, accidents at crosswalks, or intersections or signalized intersections). Even though the accident frequency may be high, if the rate cannot be determined (accident for variable of interest divided by exposure for variable of interest) we cannot be certain that a specific condition (device, type of nighttime illumination, marking, etc.) is not functioning extremely well in terms of the potential accidents that could have occurred. A device experiencing its "fair share" of the accidents, based on the number of vehicular and pedestrian opportunities for accidents, might be an order of magnitude beyond what a community will deem acceptable because only the accident data are available. On a cost-effectiveness basis it is not wise to install devices to prevent a low-probability accident because the funds could be used elsewhere to prevent a larger number of accidents. Yet this is being done by many jurisdictions for political expediency, particularly where the very young are involved.

There is an urgent need for exposure data to guide optimal allocation of funds for pedestrian safety devices. The development of pedestrian exposure data over prolonged periods of time will permit the traffic engineer to determine what changes are required in facilities in order to attain a high likelihood of accident free operation. This is not possible at the present time.

There are very few techniques for gathering pedestrian exposure data in the U.S. other than rather unsophisticated, short-term counts of people. These are not carried on over long periods of time, nor both day and night, nor in bad weather, nor in inconvenient locations. The situations in which the accident potential might be expected to increase are typically not covered. There is also a real question of intra-observer reliability for these counts since criteria for the necessary categories (direction, age, sex, handicapped, running vs. walking, and the bike) are difficult to determine, and since people cannot pay constant attention over long periods.

The two mechanized, unobtrusive techniques used to date have serious short comings:

1. The mechanical counter hidden in a carpet (Cameron) indicates only time and number of people. It is a very important first step but cannot even indicate direction.
2. The use of time lapse photography (Berger, Kent) provides a number of advantages over the automated mechanical counter but in general cannot be used under other than ideal conditions (daylight-good weather) and for limited time durations several hours), with technicians present, to change film frequently. Videotaping systems might extend the low light capabilities of an optical system but the costs become very high for any extended period of time if a permanent record is desired. One promising development is permanent T.V. cameras relying information to technicians in remote locations who code only the data of interest but make a permanent record in special cases.

Research Proposed

Develop techniques for gathering low-cost, reliable data on pedestrian exposure that can be used readily by city traffic engineering departments.

A system should be developed which satisfies the following criteria:

1. Operates unattended through a 24-hour period
2. Operates coverly
3. Measures pedestrian flow both day and night by direction
4. Identifies characteristics of the pedestrian population (age group, sex, handicap), if at all possible
5. Permits consistent comparison of various sites
6. Permits cost-effective analysis of data

Uniform standards for data collection should be established to permit comparison of records for cities of varying size, climate, demographic and geographic characteristics. This should include equipment, procedures, data forms and procedures, criteria for selecting locations, sampling system, sample size, training of personnel.

PROBLEM NO. 4: PEDESTRIANS' COMPREHENSION OF TRAFFIC CONTROL DEVICES

Children and the elderly are at a greater risk than other age groups as pedestrians. Many accidents occur at intersections and it is possible that mid-block crossings may be promoted by anxiety and confusion at intersections, especially at controlled intersections. There is evidence that even young adult pedestrians do not understand traffic control devices as intended, and the elderly show uncertainty by "follow the leader" behavior. There is evidence that young children understand traffic devices very poorly. It is important to find out what the difficulties are that are experienced by each group, as well as the reasons for their difficulties, both for the development of optimal control and communication devices and for the developement of educational programs that will decrease rather than increase the risks. It is now necessary to know the average age (and variability) at which children can cope with traffic signs and signals, with and without special training, because of recent efforts to introduce traffic safety education into the full range of public school education, kindergarten through grade 12. This program will encourage more interaction with traffic and is potentially counterproductive. Since the elderly are typically obeying the law when struck, it is also essential to discover what their misunderstandings are before attempting countermeasure development. Males of all ages are at greater risk than females, hence attention should be paid to differences in behavior between males and females.

Research Proposed

The principal objective of this research is to evaluate the full range of understanding of traffic and traffic control devices by children, by young adults, and by the elderly, in order to lay a proper foundation for standards for control devices and educational programs directed toward the specific perceptual and cognitive problems encountered by these groups.

1. Develop an interview procedure to reveal pedestrians' perceptions and expectations at several different types of intersection control, including special procedures for very young children.
2. Interview a sample of people from each age group: every annual cohort from 4 through 12, adults 18 through 20, adults 30 through 40, and adults over 70, with approximately equal numbers of each sex. Analyze these data by age and sex. Identify differences between young adults and both the young and the elderly. Identify deficiencies in young adults.
3. Study the feasibility of developing control devices that would correct the deficient pedestrian behaviors.
4. Conduct a laboratory study of these behaviorally-oriented control devices, if any are feasible.
5. Devise a set of age standards for children for safe interaction with the several types of intersections.
6. Develop a set of behavioral objectives for training programs for each age group and sex.

PROBLEM NO. 5: EVALUATION OF PEDESTRIAN STREET CROSSING BEHAVIOR AT SIGNALIZED INTERSECTIONS

Pedestrian accidents have annually represented a significant portion of the severe injuries resulting from motor vehicle accidents. Although many programs have been introduced over the years, pedestrian fatalities have represented between 20% and 18% of all motor vehicle fatalities from the late 1950's through the present. State and local traffic engineering authorities have tried a variety of non-coordinated programs but have been unable to change the statistics. This seems to indicate that pedestrian fatalities are a function of vehicle exposure, a conclusion which is strengthened by the close relation between pedestrian and motor vehicle fatalities before, during, and after the energy crisis. About 3/4 of the pedestrian fatalities and almost 9 out of 10 non-fatal injuries occur in the

urban areas. The primary pedestrian action accident descriptor, not surprisingly, has been crossing or entering the roadway (over 60% of all accidents). Any research program hoping to alter the accident statistics should therefore be primarily urban in nature and should be oriented towards pedestrian street crossing behavior. Although there is little information in the U.S. as to distribution of pedestrian crossing exposure (e.g., at signalized intersections, unsignalized intersections, marked crosswalks, unmarked crosswalks, midblock crossings, etc.) the logical place to start would be to attempt to gain as much information as possible about those locations where we attempt to maximize control over vehicles and pedestrians, i.e., signalized intersections. If our current techniques at these locations are ineffective then we are expending vast funds in a cost ineffective manner. We should therefore evaluate pedestrian behavior at these locations to determine whether our control is effective or not.

Research Proposed

The primary objective of the research is to follow a sequential methodology that concludes with the determination of the effectiveness of pedestrian safety improvements at intersection locations. These improvements would be oriented towards: pedestrian crossing behavior, facility and traffic control devices. The identification and subsequent observation of the frequency and effectiveness of pedestrian crossing behaviors as well as a number of related variables represents the first step in the methodology suggested. This would result in a problem definition step (1) which would be followed by: (2) identification of alternative problem solutions, (3) determination of the ramifications of various combinations of solutions in alternative programs, (4) selection of an optimum program, (5) pilot test of the program, (6) implementation of the program after necessary modifications, and (7) evaluation of the program.

The first task in the research would be the definition of all of the variables of interest where data can realistically be gathered within approximately a one year and $50,000 to $100,000 limit. The next task and the heart of the research program would be the detailed collection of pedestrian street crossing behavior at signalized (and perhaps unsignalized) urban intersections. The techniques utilized would have to be unobtrusive, reliable, and relatively inexpensive.

It is suggested that the overall pedestrian population be broken down into several groups on the basis of age, e.g., the very young (under 5 years), the young (5-9), older children (10-14), late teens (15-19), young adults (25-30), (36-59), (over 60 years). Additional variables might include location data, traffic conditions, traffic control devices, environmental factors, additional pedestrian descriptors, significant vehicle descriptors, and finally one or more surregate measures of accident potential or crossing criticality.

Potential subclassifications under these categories might be, as follows:

1. General location data: roadway type, number of lanes, lane width, type of crosswalk, width of crosswalk, sidewalk features, including width, unusual geometrics, obstructions to pedestrian or driver sight distances, etc;
2. General traffic conditions: volume and mix, peak hourly traffic, speed, gap crossing lengths and proximity to crosswalk, violations of stop lines, crosswalk intrusions;
3. Traffic control devices: (a) vehicular traffic-type of control, if signal-timing sequence, other control and warning devices, sings and markings, actuation technique; and (b) pedestrian traffic-type of control, if signal and "ped head" messages, sequence, timing, height and general proximity information, actuation technique;
4. Environmental factors: weather, lighting, roadway and sidewalk condition-general temporary roadway and sidewalk features, obstructions to vision;
5. Pedestrian descriptors: age, groupings, sex, size of crossing "group" and makeup of "group", unusual pedestrian condition (handicapped, fatigued, not in control of facilities, etc.) possibly origin-destination of information, etc.; and
6. Other important vehicle descriptors: running controls (lights, stop lines, etc.) overt hostility to pedestrians-a' la' New York City (making pedestrian run or stop to prevent injury), other.

It is suggested that the young and very young, as well as perhaps the old and very old populations might be worthy of special attention because of their respective over representations in the accident data.

As to the young (9 and under), one of the most powerful factors that distinguishes the accident-involved youngster from the non-accident (observed) youngster is whether the child is accompanied or not.

Some research is in order to determine whether the accident reduction is due to drivers noticing the group, parental supervision, or modification of youngsters' behavior.

PROBLEM NO. 6: PEDESTRIAN VISIBILITY

Each year a great many pedestrians are killed or injured in accidents with motor vehicles. In 1975, 8700 were killed and over 300,000 were injured. Over 54% of the fatalities occurred at night dispite the fact that the probability of vehicle/pedestrian conflict is much lower at night than during the day. Almost 40% of the fatalities occurred in urban areas at night. Recent studies show that added street lighting is effective in reducing urban night pedestrian accidents indicating that night visibility of the pedestrian is a problem and can be improved. An earlier study brought out that 80% of the drivers who struck pedestrians reported that they did not see the pedestrian. Wearing of light colored clothing improves pedestrian visibility but is not adequate for many commonly encountered situations and cannot be relied on for the majority of pedestrians. One study showed the 15th percentile pedestrian's clothing to have a reflectance of only 13%. Retroreflective materials now exist in many forms that are effective in varying amounts and brightness and are an obvious countermeasure to the night visibility problem.

Research Proposed

1. Study the effectiveness of available retroreflective materials for pedestrian under various conditions of brightness, pattern, shape, area, color, and motion.
2. Develop a "visibility index" for comparing various retroreflective treatments with each other and with other materials commonly used for apparel.
3. Test retroreflective systems under field conditions to determine motorist response.
4. Recommend a procedure for providing a visual protection program for occupational pedestrians, identifiable pedestrian groups (such as the stranded freeway motorist) and for the general public.

PROBLEM NO. 7: EVALUATION OF SPECIFIC SAFETY MESSAGES FOR CHILD AND ELDERLY PEDESTRIANS

Children and the elderly are more frequently accident victims as pedestrians than are other age groups. Some of their problems arise from the fact that they are not knowledgeable about traffic, especially what to expect of drivers and how to handle ambiguous and conflict situations safely. Previous work has shown that successful safety messages must be very specific: directed toward a specific target group and specific behaviors, as well as being delivered at the appropriate time and place. Although some work has been done on pedestrian messages for special accident types, it is believed that a more thorough exploration of the effect on the behavior of young children and the elderly of messages directed toward how to handle conflict situations would be of great value. It is important to exhaust the possibilities in this area, since the alternatives are very costly.

Research Proposed

The primary objective of this research is to evaluate the effectiveness of specific safety messages for young children and elderly pedestrians.

1. Determine, from existing accident data and surveys of pedestrian behavior, what behavior of the two target groups are critical in putting the pedestrian at risk, and the environment in which each is found.
2. Determine what behaviors could be substituted for the risk-enhancing behaviors.
3. Determine what media, time, and place are suitable for accessing each of the target groups.
4. Develop messages to provide alternative behaviors for managing conflict situations for each group.
5. Test the effectiveness of the messages in terms of before-and-after behaviors, with control groups, for each target group.

PROBLEM NO. 8: IMPROVEMENT OF STATE AND LOCAL ACCIDENT AND DRIVING RECORD SYSTEMS

Pedestrian and pedalcyclists have long been considered as minor classifications of highway users. As such, in many locations, computerized accident and driving record systems have been designed to provide data on accidents from the viewpoints of motor vehicles and their operators. Information pertaining to accidents which involve pedestrians and pedalcyclists is often incomplete and inaccurate. Highway Safety program administrators and developmental researchers are becoming increasingly aware of the importance of planning for accident prevention measures which will reduce the frequency and severity of crashes which involve pedestrians, bicyclists, adult tricyclists, and moped operators. Effective planning, implementation, and evaluation of programmatic measures cannot take place in the absence of an acceptable data base.

Research Proposed

Develop a model for making pedestrian, bicycle, adult tricycle, and moped accidents integral and identifiable components of state and local accident and driving record systems. Successful completion will require a thorough review of (1) accident report forms and (2) state and local accident and driving record files so that the developed model can be adapted, readily, for improvement of existing systems.

PROBLEM NO. 9: SPECIAL EVENT SYSTEM PLANNING AND DESIGN

Transportation systems designed for normal pedestrian flows are frequently overloaded at times of special activities (e.g. stadium events, entertainment events, etc.). At these peak periods, great numbers of pedestrians arrive in the vicinity of a major generator and must be accommodated. It is not always cost-effective to design facilities to accommodate peak flows, yet peak loadings must be considered in the design and operation of pedestrian facilities. A methodology is needed to demonstrate how considerations of peak pedestrian travel should be incorporated into facility design and operation.

Research Proposed

Analyze the before and after results of major stadium and large civic center development with regard to pedestrian flow and level of service characteristics. Likely information sources include the cities of Cincinnati, Oakland, Seattle, New Orleans, Washington D.C., and Kansas City (Missouri). Based upon this information, develop a methodology for dealing with peak pedestrian loadings.