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PEDESTRIAN-BICYCLE COUNTERMEASURES

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Pedestrians

The American Automobile Association (AAA) has reported on the marked decrease in pedestrian fatalities which occurred from 1937 to 1962 (Manual on Pedestrian Safety, 1964). During that time, the general U.S. population grew by 46 percent, motor vehicle mileage increased by 183 percent, and traffic fatalities grew by 37 percent. It is interesting that, along with these increases, pedestrian deaths decreased by nearly 50 percent. This dramatic decrease in pedestrian fatalities has been attributed to pedestrian safety programs of various kinds, many of which were advocated and initiated by AAA. The change in the number and rate of pedestrians killed by motor vehicles since 1962, however, has been in the upward direction. This increase has been explained by slackened community efforts in the area of pedestrian safety. In only a limited number of cases can definitive associations between pedestrian fatalities and countermeasures designed to prevent these deaths be determined. Although fluctuations in pedestrian accident and death rates have indeed occurred in the past 40 years, properly conducted evaluative research has not always been brought to bear. Consequently, it is impossible to determine the effect of various countermeasures in terms of changes in the pedestrian accident situation. Haddon, Valien, McCarroll, and Bumberger (1961) were aware of this unfortunate situation:

> Despite this lack of scientifically gathered information, large sums are spent annually throughout the United States in 'pedestrian control' programs, public exhortations, and other measures which though often reasonable have not been the

> subject of adequately designed evaluations. To the contrary, much has been made of short-term fluctuations in incidence, both as evidence of the efficacy of such measures where the changes have been downward and where the reverse has been the case, as evidence for their need (p. 656).

It is imperative that research not only be conducted after the implementation of countermeasures, but also before. Well-conducted investigative research should be undertaken. R. B. Sleight (Forbes, 1972) spoke of this need when he commented upon the endorsement by the U.S. Congress of pedestrian safety programs:

> This endorsement of pedestrian safety programs has not been backed up by the magnitude of research and administrative strength that would seem warranted when we consider that about 10,000 on-foot Americans per year are dying as a consequence of collisions with motor vehicles (p. 251).

Countermeasures designed to effect a decrease in pedestrian and bicycle accident and injury rates have dealt with the human, the vehicle, and the environment. Evaluations of some of these programs and changes have been undertaken, while the effectiveness of others has been assumed and remains unchallenged. Both investigative and evaluative research are needed in order to deal with the pedestrian accident situation in a realistic and effective manner. Without the former, the problems and issues surrounding pedestrian accidents will not be fully understood. Without the latter, it is impossible to determine if the countermeasures implemented are indeed responsible for accident reduction.

Human-oriented countermeasures.

Human-oriented countermeasures designed to prevent pedestrian accidents have received much attention. The proponents of this approach assume that people make errors in judgment which lead to accidents. It is further assumed that these persons must be persuaded, through education and enforcement, to practice safe behaviors in order to save their lives.

Educational programs are being increasingly used. Advocates of these programs recognize that pedestrian accidents are more prevalent among the very young, the very old, and the intoxicated adult, most of whom are non-drivers. The need for education is greatest for these non-driving groups, especially for children below age 16. Not only are school programs necessary, but public education and safety campaigning through all of the media are required in order to reach those who are not in school. Parents should also be made aware of the dangers of certain behaviors, such as playing in or near the streets. In addition to pointing out potential dangerous behaviors to both drivers and pedestrians, education could be used to inform persons of basic driving rules of the road and changing traffic regulations.

The focus of enforcement has been on the driver, with arrests being made for failing to yield to pedestrians at crosswalks, for driving too fast, parking where view obstructions are created, passing stopped school buses, etc. Little attention has been paid to pedestrian violations, even though these violations frequently contribute to accidents. Many accidents occur as a result of a child's playing in the street, a person's crossing between intersections or against a traffic light, or a pedestrian's simply failing to look for cars. Although selective enforcement of pedestrian ordinances varies between cities and areas of the country, minimal attention is generally paid to pedestrian behavior until it results in an accident.

While some persons claim that enforcement can effectively save pedestrian lives, others maintain that it is impossible to prevent errors in judgment which lead to encounters with motor vehicles. Singer (1969) reported on a field experiment which was designed to investigate the effect of increased enforcement on pedestrian violations. Although the data on nationwide enforcement and citations were very limited, they showed no significant relationship between citation activity (both for pedestrians and for motor vehicle violations against pedestrians) and the incidence of pedestrian casualties in urban areas. A study by Wiener (1968) demonstrated that illegal crossing of the elderly decreased during publicized enforcement, but returned to its former level four months after the campaign.

Researchers have looked at other social and psychological factors in the human-oriented approach (e.g., Lashley, 1960; Haddon et al., 1961; Backett and Johnston, 1959). Such variables as socioeconomic level, family stresses, conformity, risk-taking behavior, knowledge of locality, and emotional stability have been used in comparing accident-involved pedestrians with non-involved control groups. Although some interesting findings resulted, accident causes or preventive countermeasures based on the findings have not been suggested.

Vehicle-oriented countermeasures.

Vehicle-oriented countermeasures have been suggested and initiated. When dealing with the problem of pedestrian accidents, the pedestrian, the driver, and the motor vehicle must all be considered. If the pedestrian is viewed as a vehicle, physical characteristics (as opposed to human-oriented, internal factors) which might affect the likelihood of an accident or injury would be taken into account. One cannot, in any practical way, make the pedestrian more crashworthy; if he is hit, he is very likely to be injured. But attempts can be made to change his observable characteristics such that he is less likely to be struck by a car in the first place. For example, because many nighttime accidents might have been avoided if the victim had been seen, it has been suggested that pedestrians wear light-colored clothes and/or reflective material at night.

Suggestions have been made for improving the design of motor vehicles in order to save the lives of pedestrians. Several studies have shown that vehicle illumination has an influence on the frequency of pedestrian accidents; consequently, lighting improvements have been made. In the past two or three years, many computer-simulated investigations have been conducted to determine the effects of front-end design on pedestrian safety (e.g., Jones et al., 1974; Segal, 1969; Fisher and Hall, 1972; Robbins et al., 1970, 1971; Baird, 1974). Based on Wakeland's (1962) finding that certain design features had been responsible for causing fatal injuries, many persons have recommended using "soft" frontal structure, removing protuberances, rounding hoods, etc. While some persons advocate such changes, others argue that alterations in the vehicle are not feasible. McCarroll (1962) believes that changes in the exterior design of motor vehicles cannot be expected to have high payoff in reducing fatalities, because specific features of external automotive design cannot often be incriminated as the direct cause of injury.

Environment-oriented countermeasures.

The largest number of proposed countermeasures fall into the environmental, or engineering, category with emphasis on making the roadways safer for pedestrians. The most frequently mentioned measures are sidewalks, crosswalks, and traffic signals.

The effects of marked vs. unmarked crosswalks at intersections have been studied with somewhat surprising results. Utter (1949) showed that pedestrians were more likely to cross in the painted crosswalks and motor vehicles were more likely to yield at these marked areas than unmarked crosswalks. But researchers in San Diego (Herms, 1970), counting accidents in 400 intersections for five years and controlling for pedestrian and traffic flow, showed that twice as many pedestrian accidents occurred in the marked crosswalks as in the unmarked ones. Investigators concluded that marked crosswalks can be more dangerous because of the false sense of security given to pedestrians which leads them to take more risks.

The relative merits of different kinds of crosswalks have been investigated (controlled, uncontrolled, "zebra", "panda", etc.). The Road Research Laboratory in England has done the most extensive research in this area. Their studies have demonstrated that the greatest danger to pedestrians is near (within 50 yards), but not in, crosswalks and that the implementation of "zebra" (striped) crosswalks tended to increase visibility and usage and to reduce pedestrian accidents (Jacobs, 1965; Mackie and Older, 1965; Jacobs and Wilson, 1967).

Because studies in different cities have had contradictory results, the value of installing traffic signals has not been determined. Once signals are placed, however, some modes of operation are definitely more beneficial than others. The timing of traffic signals has been shown to be an important consideration. Depending on traffic flow, intervals can be altered to allow the person on foot the shortest possible wait in order to discourage risky behavior but, at the same time, enough time to cross the street with no danger. Lights should also be timed such that the traffic is completely cleared before pedestrians are allowed to cross.

Perhaps the most effective urban countermeasure has been the one-way street. Although inconvenient to motorists, one-way streets not only increase the capacity and efficiency of busy roads but also greatly reduce vehicle-pedestrian conflicts.

Sidewalks have been constructed in order to completely separate pedestrians and motor vehicles. Suggestions have been made for putting sidewalks alongside rural roads as well as in business areas. Recreational areas for children reduce the potential of playing in the streets and have been demonstrated to be effective in reducing pedestrian accident rate (Bartholomew, 1967).

Over and underpasses allow pedestrians to cross streets safely, but they are unfortunately not used by pedestrians unless they are conveniently located (Moore and Older, 1965). It has been shown that people use underpasses and bridges if crossing time is the same or less than crossing the road, but not if time is lost. Of course, there is the possibility of using barriers to force people onto these provisions or keep them off the roadways, but this adds to the expense of the countermeasure and does not insure utilization.

Other environmental safety devices include pedestrian islands which serve as a refuge for people crossing wide or busy streets, signs warning motorists of pedestrians or advising pedestrians of appropriate behavior, the removal of view obstructions, and others. Improved lighting of roadways is an important measure for preventing nighttime accidents, as studies in several cities have shown. For example, Harris and Christie (1954) reported a 43 percent reduction in nighttime pedestrian casualties after improving road illumination. City planning should always include means of minimizing the exposure of pedestrians to accidents, with channelization of traffic, pedestrian malls, careful planning of subdivisions, schools, industrial sites, etc.

One of the few studies identifying causes of pedestrian accidents as the basis of countermeasure recommendations was conducted in 1971 under NHTSA sponsorship (Snyder et al.). Researchers investigated a sample of 2157 pedestrian accidents in large urban areas by means of police records, interviews, and on-scene observations, attempting to identify precipitating events, predisposing factors, and target groups for the most frequently occurring accident types. The most appropriate countermeasures for the various causal classes were then recommended. It was found that the "dart-out" was the most frequent causal type, with parked cars and unattended children frequently being associated with it. Some of the countermeasures suggested were barriers to prevent running between parked cars, diagonal instead of parallel parking on only one side of the street, reduction of drivers' attention conflicts by various means, and public education. Recommendations were made to determine the frequency of accident types and target areas, estimate the cost effectiveness of countermeasures, apply them and measure their impact, and continually monitor pedestrian accidents.

Bicycles

While similar in nature to the pedestrian accident countermeasures discussed, the proposed measures to counteract the rising number of bicycle accidents are less numerous. Only recently have researchers begun to study this accident type and to recommend possible deterrents to its relative increase.

Human-oriented countermeasures.

Since bicyclists are expected to comply with all motor vehicle laws, there are many rules which they must understand. Some (e.g., British Columbia Safety Council, 1971) have suggested testing, and even licensing, of bicycle riders. The focus of education is even more on children than in the case of pedestrian accident countermeasures. Proponents of educational measures believe that rules of the road should be learned and followed, especially by children in the high-risk pre-school age group. Also since playing games, attempting tricks, or showing off frequently lead to injury, safe maneuvers should be taught. Naturally, children do not know or understand the rules or dangers of the road as well as the driving population. Education for this group is believed to be of great importance since using bicycles more as toys than as vehicles often leads to accidents.

Advocates of enforcement believe that enforcement of laws and regulations should play a large part in attempts to increase compliance and decrease accidents. It is presently the case that, while violations on the part of cyclists frequently lead to crashes, citations to bike riders are rare. It has been reported that the cyclist is at fault in over half of the crashes with motor vehicles (British Columbia Safety Council, 1971; Ontario Department of Transportation, 1970). Williams (1974) observed that the bicyclist and/or bicycle was probably responsible for over three-fourths of the 888 collisions which he investigated. Perhaps stricter enforcement along with increased education could help to ameliorate this situation.

Vehicle-oriented countermeasures.

Vehicle-oriented proposals involve measures to improve the safety of the bicycle. Although contribution of bicycle defects to accidents is unknown, between 13 and 25 percent of the bicycles involved in accidents of any kind are mechanically defective (Pascarella et al., 1971). Still, it is apparent that bicycles should be sold and maintained in good mechanical condition. In this effort, the U.S. Consumer Product Safety Commission is developing mandatory safety standards for bicycles and has the authority to ban new bicycles that do not meet the standards.

Because bicycle accidents occurring on dark, unlighted roads are much more likely to result in a fatality than those occurring under other light conditions (Waller and Reinfurt, 1969), all bicycles should be sold equipped with standard lights and reflectors. Bicycles should also be manufactured with the minimum amount of protuberances and with maximum visibility. Other safety devices which have been suggested by the Consumer Product Safety Commission include designing pedals to prevent slippage and eliminating front wheel brakes on bikes with rear coaster brakes. Another important factor in bicycle safety is the matching of rider and bicycle sizes. Disaccommodation of rider and bicycle presents a major safety hazard (Brezina and Kramer, 1970). The practice of buying a bicycle for a child which he "will grow into" is a prevalent but unsafe one. It may also be good safety practice to have a bell or horn as a warning device, a touring flag for added visibility, and carrying devices to prevent riders from carrying objects in their hands.

It is quite important that a bicycle be maintained. Inspection could be required or offered periodically, and could be mandatory when a bike is registered. Using such a method, bicycle registration would serve not only to retrieve stolen bikes but also to inspect all bicycles for safety.

Environment-related countermeasures.

The most popular suggestions made for preventing bicycle accidents involve the separation of motor vehicle and bicycle traffic. At the present time, a great deal of time and money are being invested in the development of bikeways. Recognition by the U.S. Congress of the increased attractiveness and importance of cycling resulted in the passage of the Federal-Aid Highway Act of 1973. Under the provisions of that Act, the Federal Highway Administration can authorize states to use their regularly apportioned federal highway funds for the construction of bikeways (and pedestrian walkways outside the normal federal-aid highway rights-of-way).

Bikeways can be divided into three classes. The first is the bicycle route, or Class III Bikeway, which involves the designation and signing of certain "safe" roadways as bike routes. These bikeways proved to be of no observable benefit in Palo Alto, California, where over 65 percent of survey respondents reported that they seldom or never used the signed routes (Smith, 1974). Another indication of the lack of effectiveness of the bike routes was a 24 percent increase in bike-motor vehicle incidents in the year after implementation.

The bike lane (Class II) divides the motor vehicle and pedal cycle by means of a line or barrier on the roadway which creates a restricted right-of-way for bicycles. This does leave problems in dealing with turning vehicles at intersections, but several methods of dealing with that conflict are being developed. The use of bike lanes is quite new in this country and has not been thoroughly evaluated. A Santa Barbara study (Popish and Lytel, 1973) showed that only 13 percent of the bicycle accidents would probably have been prevented had bike lanes or bikeways been provided. A Copenhagen study (Jorgensen and Rabani, 1967) showed that such lanes, which are divided from the other traffic lanes by a curb, do lead to a decrease in overall bicycle vehicle crashes when comparing roads with and without "tracks." However, the lanes produce an increase in intersectional crashes.

Designed exclusively for bicyclists and pedestrians, the bike path (Class III) is completely separate from the roadway and is intuitively the safest measure.

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