YOUNG AND OLD -- A STUDY IN PEDESTRIAN SAFETY

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ABSTRACT

The pedestrian has been somewhat neglected in the traffic engineering sphere as an important and legitimate road user. Many of the pedestrians are young or senior citizens.

The young pedestrian is described in terms of underdeveloped areas such as vision, hearing, concentration, estimation of speeds and his thinking process.

The elderly pedestrian is also viewed in terms of eyesight, equilibrium and reaction time. Practical solutions to assist them with the task of successfully negotiating a street system are then discussed.

This paper also compares the relative performance of various techniques and devices used in the pedestrian sphere including painted median treatments, pedestrian nibs, pedestrian islands and zebra marked crossings. The performances of various forms of devices are compared with the study clearly portraying that the zebra crossing is far from the safe facility perceived by the general public. The use of pedestrian medians together with adequate gaps and pedestrian handrails are commended.

This paper concludes that there is great opportunity to install at low cost simple but proven facilities and that there is an urgent need to do so as good housekeeping on our existing road system.

INTRODUCTION

In 1986 a total of 2 888 road fatalities were reported in Australia with 29 179 people being recorded as injured during the same period. Pedestrians accounted for 537 of the fatalities and 3 421 of the injuries reports. Almost 40% of those killed were aged 60 or more. These are the tragic statistics of a group of very vulnerable road users - the pedestrians. (Road Crash Statistics Australia March 1989)

Two groups of people, because of physical and other limitations, are far more at risk when coping with traffic than the general population. They are the young and the elderly.

CHILDREN

DEVELOPMENT OF CHILDREN

Psychological

Child development can be divided into four main stages.

In the first stage, the child is not yet fit to cope with traffic in any form.

In the second, (from age 2 to about 7) thinking is at first very concrete, that is, bound to the immediate present, strongly centred around one point at a time and thus rather rigid and egocentric.

The third so called operational stage (from age 7 to 10), is mainly characterized by the use of a far more abstract kind of representation. This abstractness enables the child to reason about events not actually present and relate them to other events that have already taken place, or to anticipate what will happen in the future.

At about the age of ten, the child finally reaches the fourth stage, the stage of formal operations, in which it achieves an adult grasp on the principles of logical thought. The child is now able to participate in traffic as a pedestrian at an adult level, at least as far as intellectual development is concerned.

Eyesight

The region that can be seen whilst looking straight ahead is called the visual field. The adult eye is particularly sensitive to movement in the peripheral field. However, this ability is not well developed in children and hampers their performance in traffic.

It has been found that in 6 year old children the peripheral vision is not yet fully developed. Furthermore, 5 year old test subjects were found to have an immature near/far eye accommodation. This accommodation did not show marked increase in speed until age 8. The development of vision therefore is an extremely complicated process which is completed only at the age of 16

Hearing

The child's ability to locate the source of a sound similarly showed developmental trends. Thus the child is, to some extent, handicapped in the use of hearing to locate the sounds of approaching traffic.

The lowest sensitivity to sounds was found among 5 year olds. The sensitivity then increased with age, and reached its peak at 12 years of age, after which it decreased again at 13 and 14 years of age.

It has been found that the perception of sound is less effective in the child than in the adult. Children select different sounds from adults, sounds that provide them with new information or momentarily attract their attention. These sounds however may have no relevance to the task in hand of coping with traffic.

One can never be certain whether or not a small child with normal hearing perceives correctly where sounds are coming from, whether they be the sounds of engines or horns. The child may imagine that a sound comes from a totally wrong direction and act accordingly. Children may appear to look about them quite correctly and watch out for traffic situations, but in fact, they are looking at entirely different objects, and in a corresponding way, they may also be listening to sounds other than the relevant traffic sounds.

Physical Size

Small children are further disadvantaged because of their height. The children's lower eye level leads them to experience traffic differently. For example small children can not look over the tops of cars to determine if traffic is approaching.

The young child lives in a land of giants, which in crowded areas with a large proportion of adults, means that their concepts of the world are distorted and are probably menacing at many times.

ESTIMATION OF TRAFFIC SPEED AND GAPS

This is best portrayed by an experiment undertaken by Dr E Hoffman at the University of Melbourne in 1978 in which eighty subjects in four age groups (5-6, 7-8, 9-10 and adult) viewed a series of film clips of a vehicle approaching them along a roadway. Subjects estimated the time at which the vehicle would have passed them. With mean data, all age groups underestimated the time of arrival with the underestimation decreasing with increasing age. It was found that the ability of participants to accurately judge time was strongly age dependent. The data suggested that children would reach adult performance at about 12 years of age.

CONCENTRATION AND PERCEPTION

The way in which something is perceived and processed, is different in children compared with adults. In scanning a visual field young children tend to concentrate on more irrelevant items in the field of vision than older children. There is no planned search in connection with what the child is looking for. Rather, the search process is almost totally governed by conspicuous parts of the visual field such as something new, surprising, or an object with which the child is emotionally involved. In the case of traffic situations shown in a drawing form to children between 4 and 9 years old it was found that the children concentrated especially on those aspects which were irrelevant to the traffic task such as animals, playing children, or an ice cream van.

CONCENTRATION AND EVALUATION

Until the age of 5, concentration is almost non existent. From 5 years of age onwards this ability grows but it is as yet, not effective in ignoring irrelevant information. At about the age of 6 or 7 children learn to differentiate between occasions for playful exercise of curiosity and situations in which a more planned, systematic search is required. However, a child's ability to really focus on relevant information only becomes fully developed at about 11 years old.

BEHAVIOUR

It is quite possible that young children are totally unaware of many of the judgements that need to be made in the crossing of a road. In a study of accident-repeating children, the case of a 6 year old boy with a history of repeated accidents was described. On one occasion, the boy had been hospitalised after being knocked down by a car. It was discovered that the child had believed that by crossing his fingers before he crossed a busy road he would be protected from all danger. The child had been observed to follow the standard procedure of viewing traffic prior to entering the carriageway. However on further questioning it became apparent that this was a ritual for him which was performed without any relevance to traffic safety. (Sandels: Children in Traffic)

SCHOOL BUS ACCIDENTS IN WESTERN AUSTRALIA

To demonstrate the inability of young children to adequately cope with traffic an examination was made by the Main Roads Department of fatal accidents involving school buses in Western Australia.

In Western Australia some 24 000 children are transported to and from school with the buses travelling in excess of 130 000 km each day

ACCIDENT DATA

From accident data supplied by the Ministry of Education of Western Australia it was found that over the last 20 years, excluding the Merridin tragedy which involved a bus leaving the road whilst travelling home from a football match, there have been 15 fatal accidents in which 16 people have died. Of these fatal accidents 13 have occurred outside the Perth Metropolitan Area.

Of these 15 fatal accidents only two have involved another vehicle striking the school bus. One resulted in the only dual fatality, both students being of high school age.

SUMMARY OF DATA

Number of Fatal Accidents	15
Number of Fatalities	16

Of the 16 fatalities 11 involved students crossing roads to embark or having left the school bus.

Age of Person Fatally Injured

5 to 9 years	9
10 to 15 years	4
Adult	1
Unknown	2

As the numbers of students aged 10 years and above exceed those 9 years old or younger it is demonstrated that children under the age of 10 years are over represented in accidents involving school buses. Further examination of the correlation of age and the accident occurring crossing the road to or from the bus showed a very high proportion involved children 9 years old or younger.

CONCLUSION

The child of primary school age or younger is not a small adult in the traffic area. Traffic devices designed for use by adults are generally inadequate for young school children, due to their relatively underdeveloped stature, sight, hearing and mental abilities as well as their psychological immaturity. Accordingly primary school children in particular should have adult supervision to superimpose on them the adult's ability to cross busy roads if optimum safety is to be obtained.

THE ELDERLY

INTRODUCTION

The status of the aged in any society is determined by the interaction between social, psychological and biological factors. This section briefly describes some of the biological or physical factors which can combine with social factors to downgrade the status of the elderly in the fast, complex and noisy environments of Western technological society. To plan the urban environment without taking into account the physical changes of ageing can contribute to the exclusion of healthy, well-motivated elderly people from a wide range of activities younger members of the community take for granted. This is particularly true for elderly pedestrians.

With the focus on this group the following age associated changes need to be recognised:-

THE VISUAL SYSTEM

Pathological changes in the ageing visual system such as glaucoma and cataracts are not considered here. In normal ageing, where disease is not a factor, there occurs from age 20 to 60 a gradual decline in the amount of light which reaches the retina. As a consequence an elderly person will require a larger amount of light compared to a young or middle aged person, in order to see adequately. Poorly lit roads, pavements and signs can then present a hazard. In addition dark-adaptation is less efficient with advancing years, which means that for the elderly moving from a lit situation such as a hotel, club or house into a dark or less well illuminated situation is again hazardous as the eyes take longer to adjust to the change. It may also have some relevance to the design of signs and the colour of vehicles that age brings a yellowing of the lens of the eye so that shorter wave lengths of light such as the blues and violets of the spectrum become more difficult to distinguish (Gilbert, 1957)

EQUILIBRIUM OR BALANCE

In general, after the early struggles of infancy, we are able to maintain or gain the upright position despite disturbances in the environment which cause us to stumble or falter. This state of balance or equilibrium is monitored by complex sensory organs in the inner ear and by vision. In the elderly these monitors do not function as efficiently or as fast as they do in younger people. Therefore the elderly are, and very often, know they are more at risk of a fall, not only when they are moving, but also at times when they are standing still. The feeling of insecurity is increased when the visual system is trying to cope with fast moving traffic and cannot scan the surface for irregularities. The tendency, in order to protect balance, is to move slowly and cautiously, and when standing to look for some form of support. So with a very real fear of a stumble and its consequences, elderly pedestrians may well hesitate, and prolong a decision as to when to cross a road.

REACTION TIME

This includes the time taken to select and initiate a response to some situation, and takes longer in the elderly - this extra time sometimes being critical in avoiding an accident. Elderly males are said to have slightly longer reaction times than elderly females. However, slowing of response selection and initiation is fairly general in men and women with ageing, and the more complex the situation the more marked the effect that would be expected. In traffic where it is not possible to anticipate what drivers will do, given the consequences of a wrong decision, the slowness and apparent hesitancy of some elderly pedestrians might seem to be a very sensible precaution, and recognition of the limits of their own capabilities.

PEDESTRIAN FACILITIES

GUARD CONTROLLED CROSSINGS

One of the best safety facilities for children operating in Western Australia has been the guard controlled crossing which was introduced in the late 1960's. At such crossings a trained adult controls traffic to allow the safe passage of children, normally only of primary school age, across the road thereby superimposing an adult view of the traffic on young students.

Willett and Grindvalds (1977) found that the advent of such crossings the percentage of pedestrian accidents involving children aged 5 to 16 declined. Another of their findings was that the accident risk for pedestrians was some 7 times higher at marked zebra crossings than at guard controlled crossings. With respect to drivers the vehicular accident rate was some 20 times greater. Both results were statistically significant.

ZEBRA MARKED PEDESTRIAN CROSSINGS/CONCRETE PEDESTRIAN ISLAND

Many zebra crossings in Western Australia had been in place for a number of years when it became obvious from examination of reported accidents in the early 1970's that some of these devices were not safe for pedestrian use.

As a result over the last fifteen years the Main Roads Department has actively pursued a controversial policy of removing zebra marked crossings from four-laned roads in the Perth metropolitan area and replacing them with concrete median islands The result has been that over this period, the number of zebra crossings in Perth has fallen from 170 to fewer than 60. This action was based on the premise that pedestrians assume right of way on marked crossings, while taking additional care when a median island is involved.

To verify the action taken, 25 sites were examined on a year before and after basis. It was noted that the most prevalent accident types at such crossings were pedestrian and rear end vehicular accidents.

The change in these categories for the 25 sites is tabulated below.

TYPE OF ACCIDENT	BEFORE	AFTER	REDUCTION
PEDESTRIAN	26	5	21
VEHICULAR	79	13	66

The dramatic reduction in accident rates after the replacement of zebra crossings by concrete islands shows that:

- Pedestrian accidents reduced to one fifth of their original level.

- Rear end accidents reduced to one sixth of their original level.

At a number of treated locations the number of pedestrians crossing the road were counted before and after the replacement of the zebra crossings with concrete islands. It was found that in the "after period" the pedestrian volumes were over 90% of the counts recorded before the zebra crossings were removed indicating that reduction of pedestrian usage of the crossing points was not a major cause of accident reduction.

COST ANALYSIS

The respective average costs in 1986 dollars for pedestrian and rear end accidents are $12 800 and $2 000 each.

The cost to the community of accidents on a before and after basis is therefore:

BEFORE	
26 pedestrian accidents @ $12 800	$ 332 800
79 rear end accidents @ $2 000	$ 158 000
TOTAL	$ 490 800
AFTER	
5 pedestrian accidents @ $12 800	$ 64 000
13 rear end accidents @ $2 000	$ 26 000
TOTAL	$ 90 000
Cost saving	$400 800

COST EFFECTIVENESS

Average cost to replace a zebra marked crossing with a concrete island - $20 000. Cost of replacing 25 crossings - $500 000. It is therefore seen that the cost would be recouped in 15 months due to accident savings.

CONCRETE/PAINTED MEDIANS VERSUS ZEBRA MARKED PEDESTRIAN CROSSINGS

It has become common practice in Perth to install 1.2 - 1.8 metre wide islands at 150-200 m centres, connecting them with painted median island for continuity purposes.

One such treatment in a country town combined with two zebra crossings gave the opportunity to compare the performance of the two pedestrian devices.

The section of road was 600m in length. The environment was the centre of a major rural town with commercial development on either side of the road over its entire length.

The zebra crossings were at third points, ie at 200 m and 400 m from the start of the road. Pedestrian volumes were taken for several hours and accident patterns over a 4.5 year period were analysed.

The results were that of the 14 reported pedestrian accidents over the 4.5 year period, seven had occurred on the marked crossings while seven had occurred at locations away from the crossings.

Pedestrians using the zebra marked pedestrian crossings	403
Pedestrians not using the zebra marked pedestrian crossings	1 282

The number of pedestrians not using the crossing was three times higher than those using the crossings whilst accident numbers were the same for both device types. This indicated that using the zebra crossings at this location was three times as hazardous as using the painted/concrete median.

CONCRETE/PAINTED MEDIANS VERSUS UNDIVIDED ROADS

A study was undertaken on a three year before and after basis on a section of Main Road through a metropolitan commercial area where a 1.2 m concrete/painted island had been installed. (It should be noted that 1.5-1.8 metre islands are the preferred width. This allows people with prams, and cyclists, to stand at right angles to the traffic flow without intrusion or exposure into a traffic lane.)

. Pedestrian accidents before	7
. Pedestrian accidents after	3
. Traffic volume before (mean)	14 000 vpd
. Traffic volume after (mean)	21 000 vpd

This study showed the halving of pedestrian accident rate even though the traffic volume increased by 50 percent during the period. The installation of such a device would also obviously reduce opposite direction accidents At locations in Metropolitan Perth these islands have been found to reduce operating speed on narrower roads especially when used in combination with pedestrian nibs.

In order to assist the aged when crossing, inverted U shaped handrails have also been installed at locations used by a significant number of senior citizens.

PEDESTRIAN NIBS

The effect of pedestrian nibs on accident occurrence has also been reviewed. Examining two locations in Berkshire UK, the preliminary results are as follows.

LOCATION	TOTAL ACCIDENTS per annum		PEDESTRIAN ACCIDENT per annum	
	BEFORE	AFTER	BEFORE	AFTER
Wordsworth Ave	10.4	7.0	4.4	1 5
Soultey Green	10.0	8.5	5.2	2 5

These results indicate the usefulness of pedestrian nibs.

OVERPASSES/UNDERPASSES (GRADE SEPARATION)

Grade separation of pedestrian and motor vehicles is highly desirable from a safety viewpoint.

Experience both in Australia and overseas, however, has shown that such devices suffer from a number of disadvantages These include: -

. The inability of the elderly, disabled or infirm to access such devices due to the change in elevation required.

- The expense of such structures.

- The lack of ability to provide continuity of fencing at most locations to prevent pedestrians crossing at grade near the structure

- The fear of personal attack in underpasses especially at night.

However, where grade separation is required it should be noted that an underpass only requires a change of elevation of 3.5 metres compared to the overpass requirement of 6.5 metres.

SIGNALISED CROSSINGS

The other area of pedestrian safety, which is not treated in depth in this paper, is the allocation of right of way by means of traffic signals.

The following data, much of which was obtained in a study tour undertaken by the author to Europe and North America in 1988 indicates that signalised crossings are not without their problems.

- Studies in the United Kingdom reveal that signalised pedestrian crossing (Pelicans) are not necessarily safer than zebra crossings (County Surveyors Society report May 1987).

- Obedience to the 'walk/dont walk' signals by pedestrians ranged from good in West Germany to mediocre in most of the European countries. In Holland, an amber flashing light is being tested instead of a red prohibitive signal to accommodate poor pedestrian obedience to the 'dont walk' signal.

- In the United Kingdom, increased skid resistant surfaces are being applied on the approaches to pedestrian signals.

- Also in the United Kingdom the possibility of detection of pedestrians by infra red means are being examined.

- Audible warning devices ranged from clicking to bird calls to assist those with impaired vision. In Denmark, a variable noise output was seen maintaining the level of clicking marginally above the ambient traffic noise.

- In Denmark, the use of angled gaps in islands was noted as an aid to optimise pedestrian orientation for crossing the road.

- In Western Australia, hand rails have been well accepted as a means of enhancing the stability of elderly pedestrians.

OTHER FACILITIES

In order to optimise the level of pedestrian safety other facilities need to be considered. These include:-

(a) Co-ordination of bus stop positions with pedestrian facilities.
(b) Provision of well constructed and maintained footpaths.
(c) Street lighting provision.
(d) Provision of pedestrian ramps.
(e) Driver education.

CONCLUSION

The implementing of simple treatments can greatly enhance safety for pedestrians crossing a road.

Devices which assist, rather than give legal right of way, are preferable, as legal sanction tends to reduce the level of caution and consideration given to the task of crossing the road.

Such devices are both effective and economic as they can often be installed without the need for road widening.

Observation of various classes of pedestrians and knowledge of their limitations will allow for the provision of facilities tailored to suit those who are among our most vulnerable road users, the pedestrian.

Pedestrian islands are a cheap and effective way of improving pedestrian safety

Zebra crossings on major roads in Western Australia have not been found to be a safe device.

Signalised crossings are not necessarily safer than zebra crossings.

Grade separation for pedestrians is generally ineffective except in the case of freeways, railways or rivers.

Angled gaps and hand rails could assist with pedestrian orientation for crossing the road

It is therefore concluded that by careful observation and planning, much of our existing road system could and should be upgraded as a part of good housekeeping to improve the general level of safety for these road users.

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