

Signal design for pedestrians as if they were thinking adults

MALCOLM DAFF

Practice Leader

Traffic and Mobility

Sinclair Knight Merz

590 Orrong Road Armadale

Victoria Australia 3145

mdaff@skm.com.au

BRIDGET CRAMPHORN

Consultation Specialist

Sinclair Knight Merz

590 Orrong Road Armadale

Victoria Australia 3145

bcramporn@skm.com.au

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ABSTRACT

This paper outlines a new model of pedestrian behaviour in which pedestrians make choices between different objectives when they choose when and where to cross roads and railway lines. These objectives involve minimising walking distance, minimising delay and minimising the chance of being hit. Drawing on detailed video based studies of many thousands of pedestrians at rail and road crossings the authors explain why pedestrians behave in ways signal designers find mystifying or stupid. It asserts that the common practice of showing a red signal to pedestrians when most pedestrians find it safe to cross leads to disrespect for the signal. Several hundred interviews of pedestrians administered just after they crossed roads and rail lines provide insight into their perceptions. Many pedestrians find that they can minimise delay and minimise walking distance by ignoring signals. This signalling practice leads to greater danger, rather than less danger because pedestrians will ignore red signals when it is really unsafe to cross. It concludes by calling for new designs of crossings of roads and rail lines that recognise the wide range in pedestrians' abilities.



MALCOLM DAFF

Malcolm Daff has spent many years as a traffic engineer working in various Australian consulting firms. Over the past fifteen years he has specialised in the infrastructure needs of pedestrians and of cyclists. This includes many research oriented studies of pedestrian behaviour and practical projects including the management of traffic in town centres and the design of pedestrian level crossings of rail lines.

BRIDGET CRAMPHORN

Bridget Cramphorn has specialised in public consultation associated with transport infrastructure projects. This includes a large number of studies where the perceptions of roads users when facing in particular traffic were investigated.



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MALCOLM DAFF

*Practice Leader
Traffic and Mobility
Sinclair Knight Merz
mdaff@skm.com.au*

BRIDGET CRAMPHORN

*Consultation Specialist
Sinclair Knight Merz
bcramphorn@skm.com.au*

Introduction

This paper was born from the authors' personal and professional experiences over the past 20 years. Signal designers seem to have made implicit assumptions about the nature of pedestrian behaviour in the way they have designed pedestrian signals to control pedestrian access across roads and across railway tracks. Actual pedestrian behaviour seems to be quite different. There seems to have been a disconnection between the professional practices of signal designers and the way we all seem to behave as pedestrians.

It is our contention that many of the practices of signal designers have reflected a *parent to child* relationship between the designer and the pedestrian. The designer tells the pedestrian what is permissible and the pedestrian will then behave safely by obeying the signals. This is the model that was taught to us as children- 'Wait for the green light'.

When pedestrians don't follow the rules signal designers declare that pedestrians are unmanageable, stupid - or both. Pedestrians are then seen as 'problems' in a way that other road users are not seen. This model of 'parent and child' is not helpful to advancing the practice of signal design.

An Unfortunate View of Pedestrian Behaviour

The following statements were made recently by practicing engineers and elected politicians in Victoria. They characterise pedestrian behaviour as erratic and unpredictable. It is therefore not surprising that the design response to such behaviour is characterised by fencing, signals that tell the pedestrian what *not* to do and signalling that withholds information from people wanting to cross.

- "They are erratic, unpredictable and stupid."
- "Behave like cut snakes."
- "If you want to see stupidity just go to a level crossing."
- "If they go when they shouldn't it's their own fault."
- "They ignore signals there to protect them."
- "They need to be caged."
- "I regard those who go the wrong way through gates as suicides" (ie use the railway crossing bypass the wrong direction).
- "Interested in public safety? What we are interested in is not having the Coroner point his finger at us."



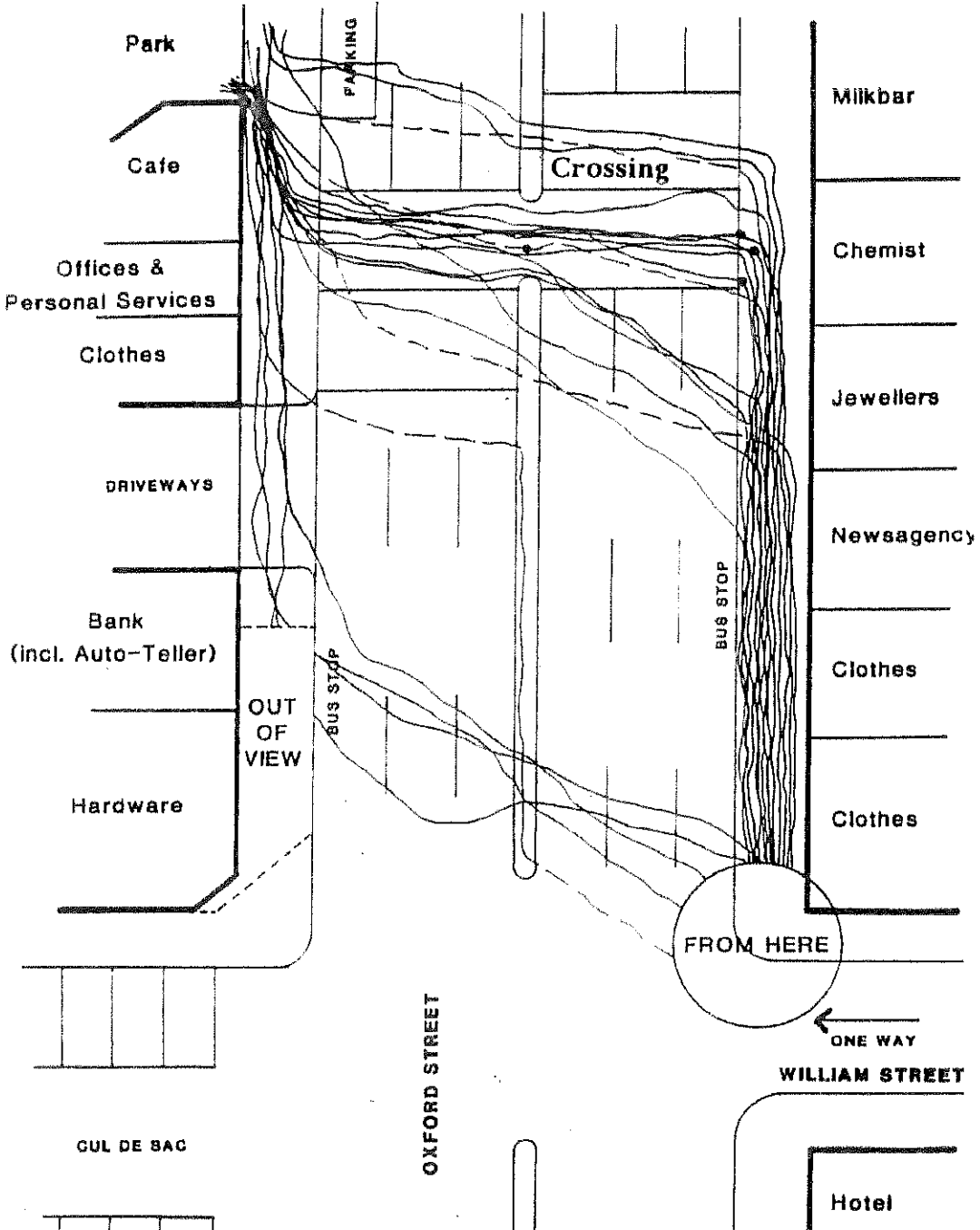
Observations of Pedestrian Behaviour

The following conclusions draw on the authors' studies of pedestrian behaviour and perceptions when crossing arterial roads - typically carrying between 1000 and 4000 vehicles/hour. We concentrated on the behaviour of pedestrians crossing at mid-block push button pedestrian crossings although some studies have included intersection signals. These studies are summarised in Table 1. They have previously been reported in Daff et al (1992) and Daff (1994). These results are compatible with the findings of others.

Table 1 – Authors previous video based studies of pedestrian behaviour crossing arterial roads near traffic signals

LOCATION	PEDESTRIANS OBSERVED	PEDESTRIANS INTERVIEWED
Enmore Road Sydney	175	2 discussion groups
Marrickville Road Marrickville (1)	248	2 discussion groups/100 interviews
Parramatta Road Leichhardt	272	
Marrickville Road Marrickville (2)	5,409	98 interviews
Oxford Street Paddington	3,076	2 discussion groups/199 interviews
TOTAL		

- **Few pedestrians diverted to use the crossings.** Most pedestrians were walking on routes that fell diagonally across the crossings i.e. if they turned right from the footpath to step onto the crossing then they turned left to walk along the far-side footpath (and vice versa). Only 27% of those using the crossings in the sample diverted to use them. The crossings were on the direct route for the other 73% of pedestrians.
- **Females and older pedestrians are more likely to follow 'proper' conforming behaviour than males.** Females and older pedestrians were more likely to divert to use a crossing and were more likely to wait until the green signal when at the crossing.
- **A large proportion of pedestrians who crossed at the push button signals violated proper conforming behaviour.** They commenced to cross against the DON'T WALK display (39%) or against the flashing DON'T WALK display (6%). Only 54% commenced to cross on green.
- **Detailed studies of the actual paths taken by pedestrians show most pedestrians do not conform to proper conforming behaviour.** The two plots shown as Figure 1 and Figure 2 are typical of pedestrian behaviour when crossing arterial roads. Pedestrians make dynamic decisions on the crossing location and the time of crossing dependent on the flow of traffic. Generally they would only use the crossing if it was convenient and would only wait for the green signal if there were no prior opportunities. A careful inspection of Figure 1 shows the pedestrians who were most likely to be delayed were those who crossed at the push button signals and who waited for the green signal. Only one of the 20 pedestrians observed in Figure 2 diverted to the signals and waited for the green signal.

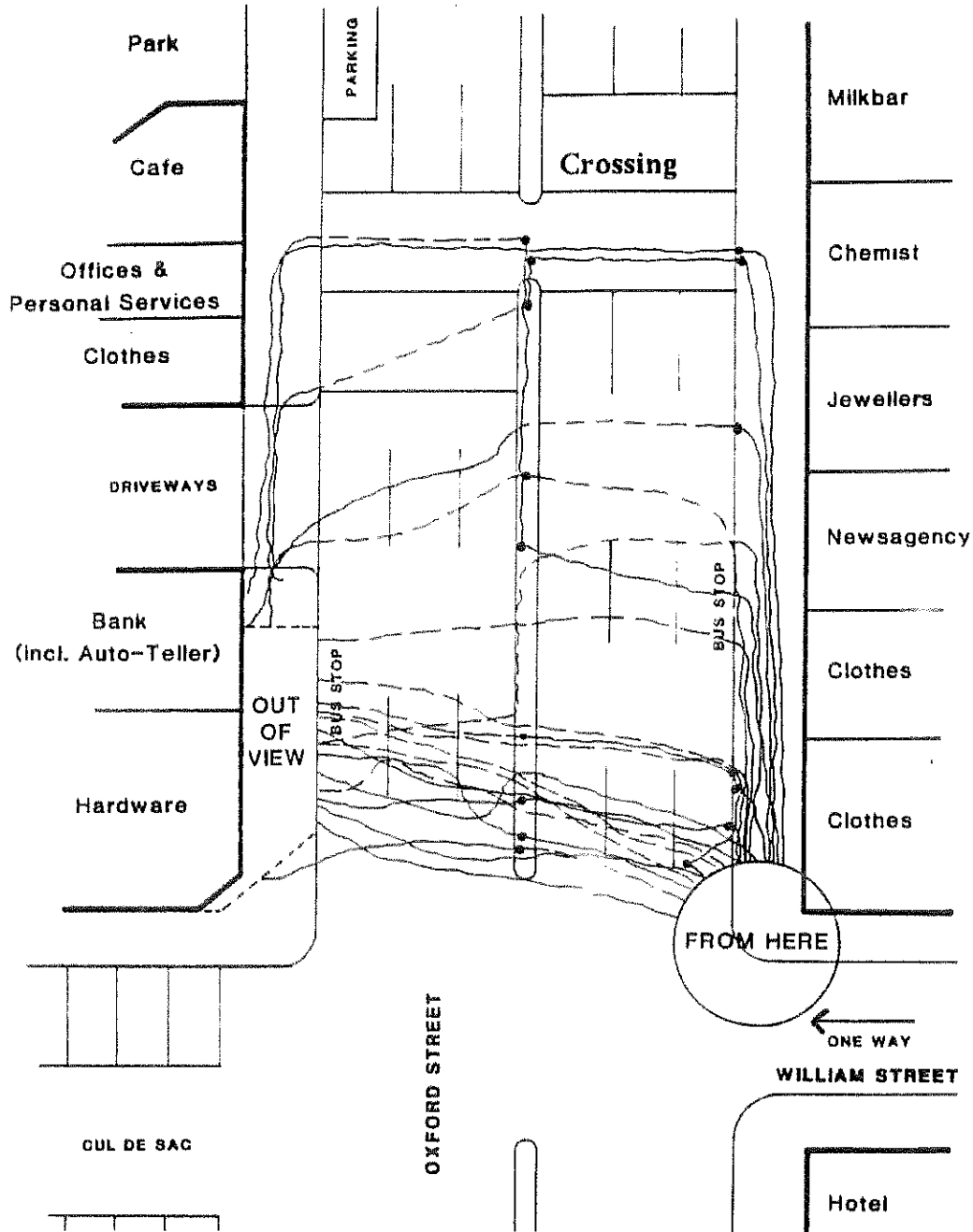


- _____ Solid line indicates the traffic was stationary when the pedestrian crossed
- - - - - Broken line indicates that traffic was moving when the pedestrian crossed
- dot shows where the pedestrian waited

Figure 1 – Actual paths of 20 pedestrians crossing Oxford Street from the bottom right to the top left of the page

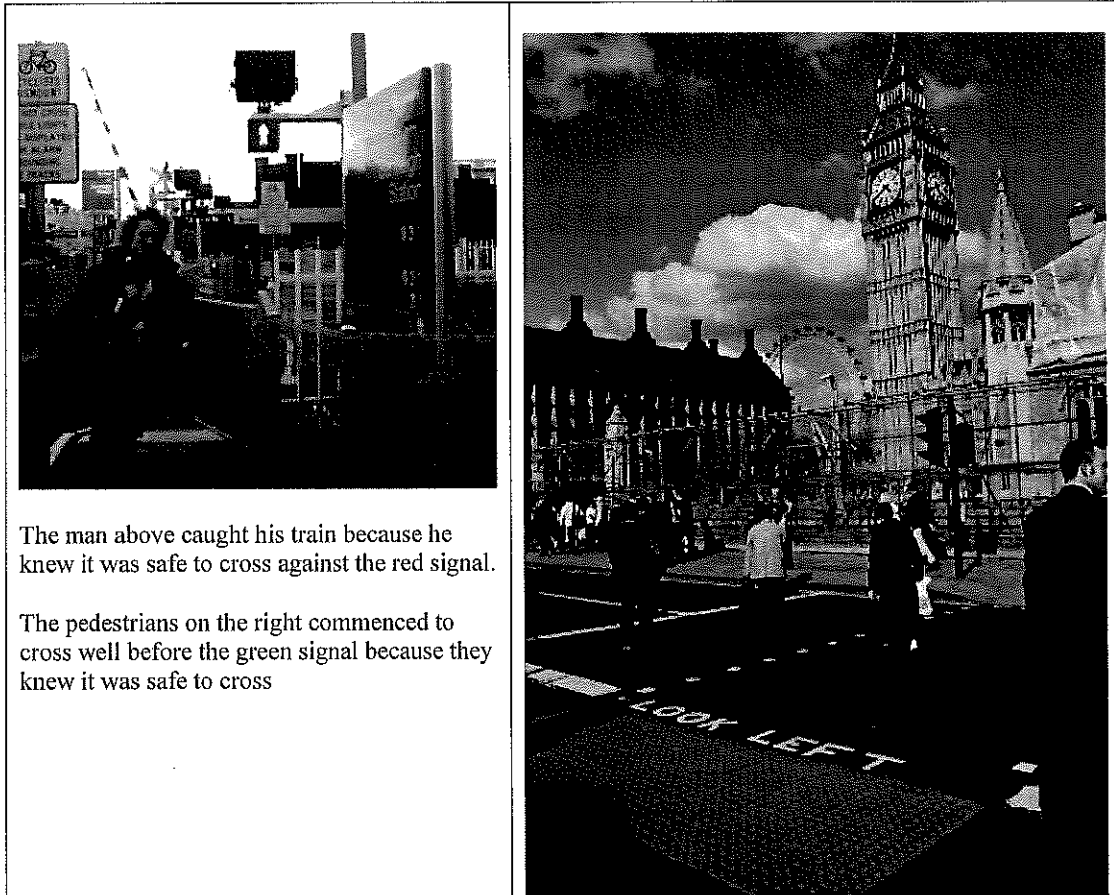


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- _____ Solid line indicates the traffic was stationary when the pedestrian crossed
- Broken line indicates that traffic was moving when the pedestrian crossed
- dot shows where the pedestrian waited

Figure 2 – Actual paths of 20 pedestrians crossing Oxford Street from the bottom right to the bottom left of the page- to the bank and the hardware shop



The man above caught his train because he knew it was safe to cross against the red signal.

The pedestrians on the right commenced to cross well before the green signal because they knew it was safe to cross

Figure 3 – These pedestrians safely ignored the red signal and saved time

Pedestrians Perceptions

The studies reported above indicated that the behaviour of pedestrians at crossings is mirrored closely by their perceptions of the situation at the time. Perceptions were also related to the age and gender of the pedestrian with older pedestrians and to some extent females being more conservative.

- Those who always used the crossing believed that this was the only safe thing to do because the road was dangerous.
- However, for many, there was a belief that although everyone 'should use pedestrian crossings', they are really not for them but are aimed at the elderly, disabled or people with children – even though young people were well aware of their parents' teaching to 'cross at the lights'.
- Overall the behaviour of many people was governed by their assessment of the prevailing traffic situation and their own ability to deal with it. Thus they only saw the need to use the crossing if they assessed the road as carrying lots of traffic.
- People claimed to 'believe in their own ability to pick a gap'. Their decision making appears to be dynamic and opportunistic based on an assessment of their own abilities- they will cross 'when they feel it is safe'
- They wish to cross where it is logical, to maximise convenience and minimise delays – 'if the



crossing is en route and the light is green I'll use it'

- The main conclusion that can be drawn is that many pedestrians know what they ought to do at crossings but for a range of sensible and pragmatic reasons they choose to ignore them. This is probably because in many circumstances the signals are perceived as being inappropriate to both their needs at the time and the prevailing traffic situation.

An Opportunistic Model of Pedestrian Behaviour

It is clear that pedestrians do not behave in the 'proper' way that they were taught as children and the way in which they teach their own children. While monitoring traffic conditions they make simultaneous decisions on the crossing location, the time of crossing, and whether they should run based on objectives other than maximising safety. Other objectives can include such factors as;

- being in a hurry
- avoiding getting wet
- minimising walking distance, and
- minimising delay.

This understanding of pedestrian behaviour has been known by researchers for many years but does not seem to be acknowledged by many professionals responsible for signal designs targeting pedestrian traffic.

Ideal signal operation

Ideally signals would show green when it is safe to cross and show red when it is unsafe to cross. Signals would then be a reliable indicator of safety. This is illustrated in Table 2 where the four combinations of signal display and safety are shown. The two problem cells occur when there is a conflict between the signal display and the actual safety. It is rare that the signal designer will show a green signal when it is unsafe to cross because of the necessity for a conservative approach. We are therefore left with the problem cell where the signal shows red and it is really quite safe to cross.

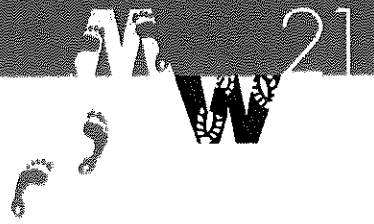


Table 2 – A matrix to guide decision making

		PEDESTRIAN SIGNAL DISPLAY	
		Green	Red
ACTUAL SITUATION	SAFE	OK	The Problem Situation – 'cry wolf'
	UNSAFE	Normally Doesn't Exist	OK

Credibility of the Pedestrian Warnings

This pertains to the problem cell in Table 2- the cry-wolf situation.

A central problem with the present operation of many pedestrian signals is the loss of credibility of the statutory signals in the minds of pedestrians. Because of 'conservative' signal practices pedestrians are often not permitted onto the crossing when it is quite safe to cross. These conservative practices can be the assumption that the pedestrian waiting to cross will be slow moving and hence would require a long gap, or the vehicle approaching the crossing (eg a train) could be travelling at the maximum speed and arrive at the crossing earlier than expected. It would seem that signal designers often show red to pedestrians 'just to be on the safe side'.

This conservative practice (of red signal- but safe to cross) has lead to pedestrians not trusting the signals as a sure indicator of danger- especially for nimble pedestrians. High violation rates at both rail crossings and arterial road crossings indicate many pedestrians consider the situation sufficiently safe - irrespective of the pedestrian display. This is particularly important when the pedestrian is running to catch a train or bus. Passengers can avoid unnecessary waiting for the next train - perhaps saving ten minutes by simply crossing against the signals.

The repeated benefit the pedestrian obtains (such as reduced delays) from ignoring the red pedestrian display reinforces the violating behaviour. The pedestrian will then ignore the pedestrian display when it is really unsafe to cross. Many train collisions with pedestrians involve the pedestrian being hit by a *second* train that he/she is unaware of. Typically the pedestrian assumes that the warnings are continuing to operate 'just to be on the safe side' rather than validly warning of a second train¹.

¹ This is the issue that prompted this paper. In Melbourne a large percentage of pedestrian accidents at level crossings involve a second train.



The challenge to signal designers

Perhaps the most critical parameter that leads to conservative signal design is the wide range of walking speeds among different pedestrians. This range is far wider than the range in car speeds yet few of our signal concepts take this variation into account. Figure 4 highlights the difficulty for the designer of a conventional crossing. Measured average speeds of pedestrians crossing streets typically fall between 1.25 m/s and 1.5 m/s. However there are significant numbers of frail elderly who walk at speeds around 0.4 m/s. Traditionally the clearance time problem has been phrased in terms of 'what clearance speed represents the best compromise between providing adequate time to clear for slow moving pedestrians and the inefficiencies in doing so?'.

A more productive approach will be to design signal systems that respond to the large variations in walking speed. Achievements in this area already have included the concepts of the pelican crossing (the pedestrian clearance period has a flashing yellow signal for car drivers) and the puffin crossing (clearance time is extended via active detection of pedestrians on the crossing).

We know of no such concepts in the crossing of railway tracks. Creative thinking needs to be undertaken in this area.

Another approach that should be developed is the real time detection of vehicles so that the pedestrian display can change if there is no conflicting vehicular traffic. Often signal designers require pedestrians to wait after they have pushed the button even though there are no vehicles nearby. Better vehicle detection techniques promise to reduce the need for displaying red to pedestrians when it is safe to cross.

There will always be the need to educate pedestrians on how signals work and the teaching of conforming behaviour. However this does not replace the requirement of more creative thinking on new signals to assist pedestrians.

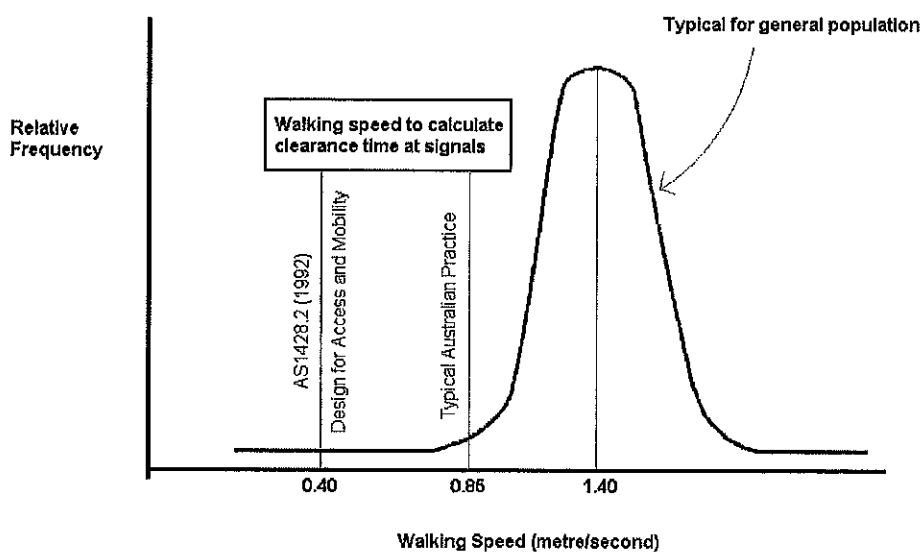
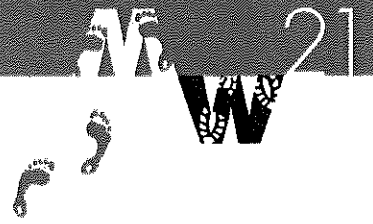


Figure 4 – Assumed Clearance Speeds and Typical Walking Speeds



Conclusions

The actual behaviour of adult pedestrians is quite different from the conforming behaviour taught to children. The actual behaviour is not taken into account in signal design. In particular the 'conservative' practice of displaying red to pedestrians when most pedestrians find it quite safe to cross leads to disrespect of the signal – people cannot distinguish when the situation is really dangerous for them and when it is not. New concepts in crossings are required that take into account the large range in walking speeds and physical abilities.

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