STAGED PEDESTRIAN CROSSINGS

Megan Fowler (presenter)
BE (Hons), MET, GIPENZ
Traffic Engineer, ViaStrada
http://viastrada.co.nz/

Axel Wilke
BE (Hons), ME, GIPENZ
Director, ViaStrada
http://viastrada.co.nz/

ABSTRACT

The safety of pedestrians crossing multi-lane road intersections is often threatened by filtering turning vehicles. The introduction of staged pedestrian crossings, where the crossing of departure and approach lanes are treated as two separate tasks, can provide more protection to pedestrians by allowing greater control of the traffic. Related changes to the phasing arrangement such as direction-dependant pedestrian crossing timings can also result in the staged pedestrian crossing increasing the intersection efficiency.

This technical note discusses the design and modelling of staged pedestrian crossings, as well as addressing common concerns about their implementation.

1 INTRODUCTION

The majority of pedestrian crossings at signalised intersections in New Zealand involve pedestrians crossing parallel to through vehicles, with filtering turning vehicles. The potential for conflict between filtering vehicles and pedestrians puts the pedestrians at risk, especially when the filtering vehicles are right turners which have travelled a greater distance and are therefore more likely to be travelling at a faster speed and may be distracted by the task of finding a suitable gap in oncoming through traffic. An analysis of New Zealand CAS data shows that filter right turns account for approximately 25% of all pedestrian related crashes and filter left turns for about 10%. Turner, Roozenburg and Francis (2006) developed an accident prediction model for right turning vehicles colliding with pedestrians on the road and found that "fewer accidents occur when fewer pedestrians cross on the 'green man' and possibly indicates that there are safety issues where pedestrians are crossing legally and motorists filter turn right."

While the practice of allowing filter turns through parallel crosswalk phases is in many cases unsafe for pedestrians, it remains common practice because of the perceived inefficiency of any other form of operation. Feasible alternatives do however exist. For example, filter turning through pedestrians is not permitted in Britain. While it may not be realistic or necessary to completely eradicate filter turning from signalised intersection in New Zealand, it is the opinion of the authors that it should be greatly reduced. One way of achieving this, while still maintaining a reasonable level of efficiency for all road users, involves staged pedestrian crossings.

Staged pedestrian crossings enable pedestrians to cross the two halves of the road (i.e. approach and departure) in two, separate phases. Thus, as the two halves of the crossing task can be controlled individually, vehicular traffic on half of the road can operate at the same time as one half of the crossing. This provides more opportunity to protect crossing pedestrians by assigning late starts to turning vehicles but, as the crossing time is shorter than for the full width of the road, the turning vehicles are not held back for as long. Chen *et al.* (2007) showed that, with the overlapping and combining of vehicle and pedestrian movements, the introduction of staged pedestrian crossings to an intersection may have no effect on vehicle throughput.

The operation of a staged pedestrian crossing is assisted by a staggered pedestrian refuge which physically separates the two crossing points and provides storage space for waiting pedestrians.

2 SUGGESTED CONCEPTS

2.1 Refuge Design

Design of the staggered pedestrian refuge island is an essential component for a staged crossing. British guidance on midblock crossings suggests (DFT, 1995) that pedestrian refuges should not be used other than for staggered crossings as they can be confusing for road users and often do not provide sufficient space; this follows through to crossings at intersections also. This point illustrates the importance of staggered crossings in Britain.

DFT (1995) states that the island should be long enough to allow a minimum distance of 3 m between the two crossings and wide enough to allow a 2 m wide path. A minimum island size of 10 m by 3 m is also recommended by DFT (2005).

The direction of the stagger is important. Generally a left-hand stagger is preferred as it ensures pedestrians must walk towards the direction of oncoming traffic and are therefore made aware that they must follow the pedestrian signals and only cross when given right of way. This is consistent with the design of midblock crossings. However, at an intersection, the left-hand stagger moves the stop line of the approach lanes further from the intersection centre and thus increases the intersection clearance time and decreases efficiency. For this reason, DFT (2005) allows right-hand staggers to be considered at intersections.

When choosing between a left-hand and right-hand stagger it is important to consider consistency with crossings on other legs of the intersection and nearby intersections. It is also important to consider the direction of pedestrian desire lines, especially in New Zealand where the staggered crossing is not as common and people may be less willing to slightly increase their travel time in favour of significantly increasing their safety.

2.2 Assisting Infrastructure

It is important that all infrastructure at a staged crossing conveys to pedestrians and motorists that the crossing is in fact two independent crossings and, in some cases, pedestrians may be expected to wait in the central refuge before completing their crossing. Thus, the visibility of signal aspects is very important, especially for the crossing directions beginning from the central refuge. Supporting signage may be used to ensure pedestrians take note of the signals and understand the independent nature of the two crossings.

It is common practice in Britain to provide guardrails along the path in the staggered refuge to ensure pedestrians follow the stagger rather than attempt to cross the road in a straight line. From an urban design point of view this is undesirable as it can be very unattractive and implies that pedestrians need to be controlled. More subtle approaches, such as using low cover landscaping are therefore recommended.

2.3 Phasing

Phasing for a staged pedestrian crossing should be tailored to suit the traffic volumes of the intersection and the coordination scheme for the network. It is therefore difficult (and somewhat unwise) to present a generic solution but several general principles are noted.

The most important concept for the phasing of staged pedestrian crossings is that the two halves of a crossing can be operated independently. Thus, when the approach leg of the crossing is in operation the approach traffic will be stopped but traffic entering the departure leg may be allowed and vice-versa, as shown in Figure 1. This is particularly useful where turning volumes are high. Whereas with a standard crossing arrangement the pedestrian movement cannot be operated at the same time as exclusive turning movements, with a staged crossing half of the crossing can operate.

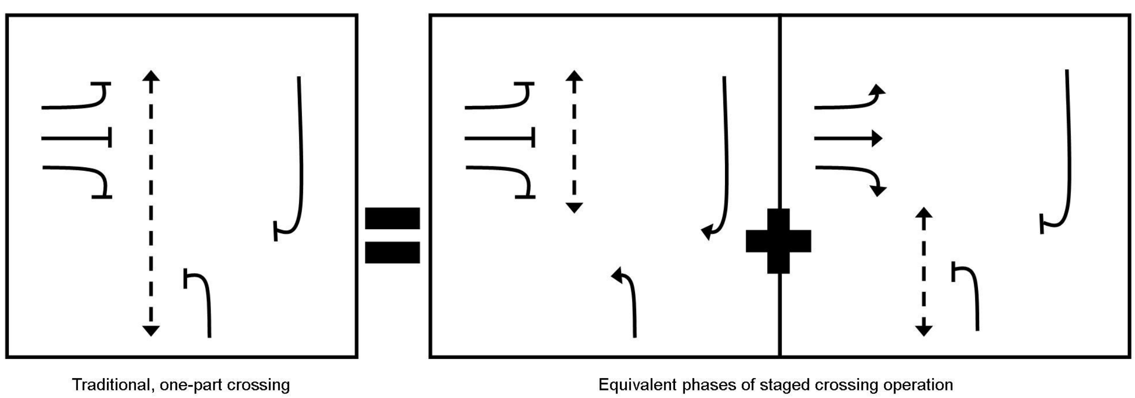

Figure 1: Phase components of traditional and staged crossings

By using separate hardware for the four pedestrian call buttons used in a staged crossing (as shown in Figure 2), the phasing can be coordinated according to the direction of crossing demand – thus pedestrians do not have to spend long waiting at the centre of the intersection and efficient phasing is still maintained for vehicle flow. This is particularly useful in peak periods at locations where most pedestrians cross in the same direction (for example, the edge of a CBD).

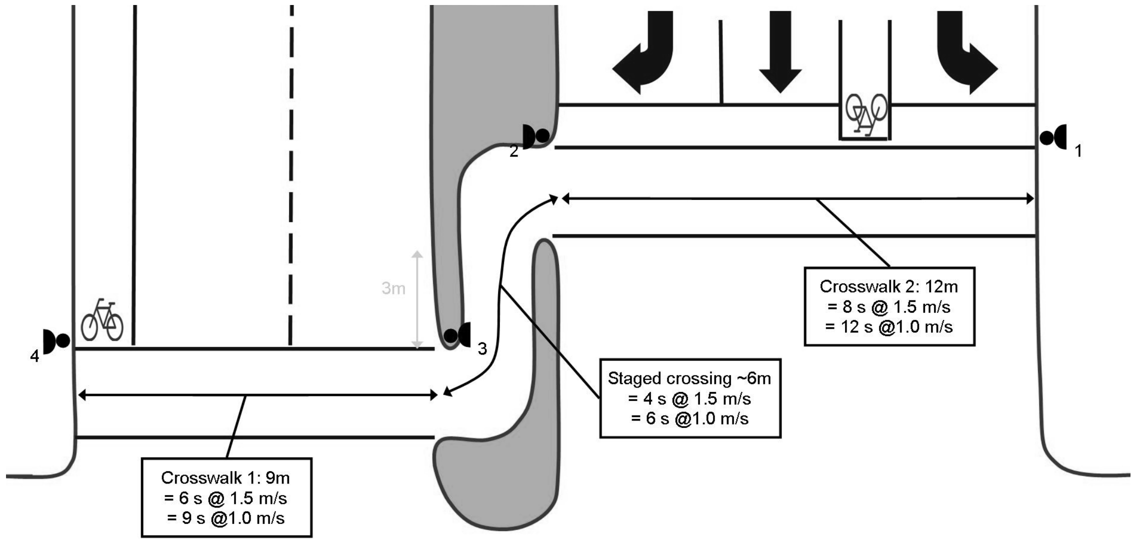

Figure 2: Staged pedestrian crossing scheme plan

Figure 2 shows a situation where knowing the direction of pedestrian travel can minimise the time required for late starts to turning movements. If demand is received from pedestrian call button 4, crosswalk 1 is operated with a 5 s walk and 8 s clearance (determined according to 15th percentile crossing speed of 1.2 m/s), and crosswalk 2 is operated with 12 s walk and 10 s clearance. This allows pedestrians who walk at an average speed (1.5 m/s) to cross the entire road in one go, and slower pedestrians to cross crosswalk 1 and wait at the centre for the next phase. At the same time, the red arrows for left and right turns into the street (i.e. across crosswalk 1) would be operated for 13 s and then extinguished to allow filtering, resulting in full pedestrian protection.

However, if demand was received from pedestrian call button 1, crosswalk 2 could be operated with 5 s walk and 10 s clearance, crosswalk 2 would be operated with 13 s walk and 8 s clearance and the red arrows would be displayed for 21 s. This difference in the length of the red arrow displays is due to the difference in the time it takes for the pedestrian to pass through the potential conflict zone given the different starting positions.

In cases such as this, a hierarchy of call buttons is required for situations where multiple demands are received for a phase.

2.4 Modelling

While SIDRA is a very useful tool for modelling most intersections it has been found to not work very well for modelling pedestrian effects by explicitly stating the volume of pedestrians as it assumes the pedestrian phases will be demanded every cycle. Therefore, an indirect approach of modelling pedestrian effects based on the late starts to turning movements is recommended. This requires an understanding of the time it takes a pedestrian to cross (and therefore the length of time an opposing turning movement will be stopped or is delayed) and the frequency of demand for the crosswalk. For example, if the time required for a slow pedestrian to cross a particular crosswalk is 6 s and the crosswalk phase is called approximately every three cycles, then an average start up delay of 2 s should be assigned to the turning movements in conflict with the crossing.

Microsimulation programmes (e.g. Paramics) would provide more accurate models of staged pedestrian crossings. It is recommended that such models are developed to give a better indication of the time costs or savings associated with staged pedestrian crossings.

Determining the frequency of pedestrian demand for a particular crosswalk can be difficult as data are not always readily available. One useful method is to collect data using SCATS intersection diagnostic monitors (IDMs) which give information for the phases run in every cycle of the observation period. By determining the total number of cycles and the number of crosswalk occurrences a demand frequency can be established.

3 CASE STUDY – BEALEY AVENUE

The authors have applied the suggested concepts to produce several scheme plans for staged pedestrian crossings. One study involved intersections along Bealey Avenue, a six lane, median divided major arterial on the edge of the CBD in Christchurch. The results of this study are shown in Table 1. It can be seen that the introduction of staged crossings reduced the delay and improved the spare capacity for each of the models except for the Manchester model where the spare capacity remained the same.

Table 1: Staged pedestrian crossing (SPC) effects on case study models

	Spare capacity		Average delay (s/person)		LOS	
Side road	**Base**	**SPC**	**Base**	**SPC**	**Base**	**SPC**
Manchester	-14%	-10%	39.0	34.9	D	C
Colombo	-19%	-18%	49.1	45.7	D	D
Durham am	-10%	-10%	51.4	50.4	D	D
Durham pm	8%	10%	35.7	33.4	D	C

4 POSSIBLE POINTS OF CONTENTION

As with most new ideas, the introduction of staged pedestrian crossings at signalised intersections throughout New Zealand may be opposed for several reasons. A major point of opposition is that pedestrians may have to wait at the centre of the road between streams of moving traffic, which could be considered unsafe. In general, the phasing of staged crossings should be designed so that pedestrians can cross the road without waiting; in some cases it may be that vehicular traffic must experience a slight increase in delay to enable this. In the cases where pedestrians are required to wait in the central refuge it is considered that the design of this refuge should provide them with adequate safety. The design and operation of many existing crossings at multi-lane intersections in New Zealand currently results in many pedestrians having to wait at the centre of the intersection for the next crossing phase. This occurs either because filtering turning vehicles do not give way, or because pedestrians do not understand the clearance phase (where the "red man" flashes meaning that no one should begin to cross the road, not that those currently crossing the road will not have enough time to complete their crossing). In this case, it seems that the introduction of staged crossings with consistent design and operating principles will actually improve safety and usability of crossings.

Another contentious issue is concerned with the use of split pedestrian approach operation; it is feared that pedestrians may assume their crosswalk is in operation because they can see that pedestrians at the other crosswalk are allowed to cross. Phasing, including which pedestrian lanterns are activated in any situation, should be designed very carefully to avoid confusion. The layout of the staged crossing should emphasise the independent nature of the two crosswalks so that pedestrians do not make false assumptions about the operation.

Some traffic engineers take the view that changes resulting in a decrease in efficiency should never be made to an intersection. While staged pedestrian crossings may in many cases serve to improve efficiency it is acknowledged that, in some cases, they will increase delays to motorists. The recently updated New Zealand Transport Strategy (MOT, 2008) states five transport objectives: ensuring environmental sustainability; assisting economic development; assisting safety and personal security; improving access and mobility; and protecting and promoting public health. It is stated that these objectives are of equal importance. While staged crossings may decrease efficiency for motorists (and, it is argued, therefore have a negative impact on economic development) they still contribute to the objectives of assisting safety and personal security and improving access and mobility. Economic development can also be improved by improving conditions for pedestrians, as can public health. Thus, it appears that the benefits of staged crossings outweigh their disbenefits when seen in the context of the New Zealand Transport Strategy.

Finally, it has been suggested that users will be unfamiliar with staged pedestrian crossings and this will lead to safety problems. The lack of consistency amongst current crossings at intersections in terms of island design, push button provision and phasing operation means that users are constantly faced with unfamiliar situations. Initially, staged crossings may seem new and confusing but with proper design and maybe education to those users considered most at risk, the introduction of a consistent treatment throughout the country may well make the crossings more understandable and therefore safer.

5 CONCLUSIONS

There is still some work to be done in terms of modelling, safety predictions / analysis and promotion of staged pedestrian crossings. However, the concepts presented here suggest that the introduction of staged pedestrian crossings throughout New Zealand could benefit safety and efficiency at signalised intersections. The British experience is that this concept can work well; it's time that New Zealand gave it a try.

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