Puffins at Junctions
Design & Modelling Implications

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Introduction

This paper looks at the consequences of using the 'puffin' style crossing at junctions either as an 'all red' stage or as a parallel pedestrian facility (walk with traffic) in relation to delays both to vehicles and pedestrians. Notwithstanding the fact that issues discussed here may be applicable to stand alone 'mid block' puffin crossings, this paper looks specifically at the problems associated with the design and modelling of the puffin crossing within a junction.

The concept of the puffin crossing and how it operates in comparison to conventional far sided signals is well documented elsewhere and is not discussed here. However, there are three main issues to be considered that form the main points discussed in this paper. The first relates to the variable intergreen between the termination of the green man and the start of the green to traffic. The second relates to the duration of the green man time when considering parallel pedestrian phases and the third relates to the modelling of these scenarios.

Puffin Operation

The 'Puffin' crossing is a relatively new form of signalled pedestrian crossing which can be used in a 'mid block' location as a stand alone facility or as part of a signal controlled junction. The main features of a 'puffin' crossing relate to the use of kerbside detectors, on-crossing detectors and near sided pedestrian signal indications. The kerbside detectors, which are not only associated with puffins, detect pedestrians waiting at the kerbside and as such enables a pedestrian demand to be cancelled if the pedestrian moves out of the detection zone. The use of near sided pedestrian indications, together with on-crossing detectors, means that the pedestrian has a short 'invitation to cross' and can complete the crossing maneuver whilst being protected by the on-crossing detectors.

Fig 1 shows a diagrammatic view of the various puffin timing periods based on advice from LTN 2/95. The periods of interest are Period 4 which is the invitation to cross and the combination of Periods 5, 6, 7, 8 and 9 which is in effect the total intergreen between the green man and the start of the traffic phase. Period 6 is the variable period which in some cases could be extended up to 22 seconds by the on-crossing detectors.

Puffin Benefits

Putting aside the opinions regarding whether or not the nearside indication is of benefit or not, the main benefits are associated with the detectors. The kerbside detector enables demands to be cancelled when pedestrians move out of the waiting area. The on-crossing detector enables the variable intergreen to be reduced when pedestrians clear the crossing quickly, effectively allowing more green time to be allocated to traffic. Similarly, in the case of elderly or disabled groups crossing the road, they will be able to extend the intergreen ensuring that they have safely crossed the road before the traffic movement starts.

Fig 1 Puffin Sequence

The benefits to pedestrians and traffic were researched by the TRL in 1991 when they assessed two experimental puffin junctions; one in Rustington, West Sussex and the other in Woolwich, East London. The findings were published in Research Report 364 which stated that :

- '*the time allocated to pedestrians is linked to the number of people using the crossing. Thus larger numbers of pedestrians are able to acquire greater precedence*'.
- *'Taking an average saving of time covered by the survey, and averaging between sites, a saving in delay of £6 per hour is obtained which can be scaled up to £12,500 per annum'.*

Puffin Disbenefit

The problem here is taking the theoretical savings as sacrosanct and applying the savings across the network. The other issue is in the disguise of the benefits associated with one feature of the crossing over the possible disbenefit of other features. For example, the benefits generated in the Report 364 were made up from the following components:-

- *Canceling demands due to kerbside detectors*
- *Shortening crossing time when pedestrian flows are relatively low*
- *Delay saved to pedestrians due to increased crossing time*

It would be fair to conclude that kerbside detectors (when working properly) will always be of benefit and they can be used at any type of crossing. The real question is what effect the on-crossing detectors have on vehicle and pedestrian delays. Hence, looking specifically at RR 364, the benefit associated with kerbside detectors can be discounted and the delay saved to pedestrians would seem to be a red herring and can also be discounted. If pedestrians are gaining more time on the crossing due to increased intergreen periods then this enhances safety, it does not reduce delay. In fact, it could be argued that unless pedestrians are being encouraging to cross on the red man, the delays will be greater because the green man time on a puffin will be shorter than for a conventional 'far sided' crossing.

Analysing the data listed in RR 364, it is possible to identify the disbenefit to vehicles associated with the on-crossing detectors. Using a 'value of time' of £14.20 per vehicle hour, the total delay to vehicles at the Rustington site is in the region of £5,800 per annum based only on the four surveyed hours. At Woolwich, the delay costs were higher in the region of £15,300 per annum based on the three surveyed hours. Bearing in mind that these sites would probably be classified as low to medium pedestrian usage, the additional delay computed is likely to be applicable to most sites and indeed will be exacerbated at sites with heavy pedestrian flows.

As puffins have become more common, anecdotal evidence would suggest that pedestrians have begun to realise how they can profit by abusing the variable intergreen. A feature which is becoming more prevalent at some puffin crossings is the fact that pedestrians arriving on the red man will still cross the road if there are pedestrians already on the crossing and the signals to traffic are still showing red. This is a situation where the 'non vulnerable' category of pedestrians (who can cross the road quickly) are extending the intergreens causing excessive delay to traffic. The variability of the Intergreen also means that coordinated systems such as SCOOT may have difficulty in setting a sensible minimum cycle time. Hence the cycle time for pedestrians may become higher resulting in increased pedestrian delays and frustration.

Application to junctions with Parallel Pedestrian facilities

For many years engineers have optimised the Interstage period by adding phase delays to compensate for the long intergreens associated with pedestrians (Figs 2 to 5). This method enables the junction to operate with maximum capacity whilst at the same time maximising the available 'green man' to pedestrians. However, this method is only valid if the length of the intergreen is known. In the case of a parallel puffin, the intergreen is an unknown quantity and therefore cannot be compensated.

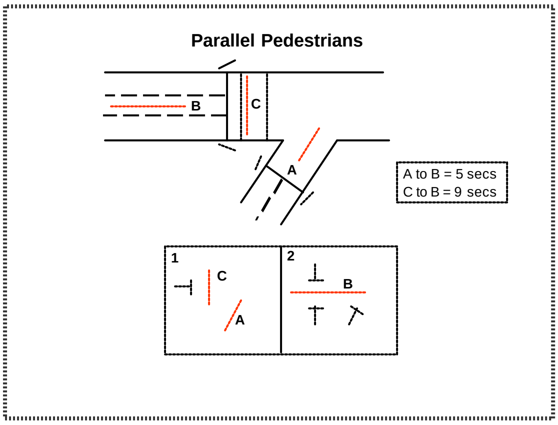


Fig 2

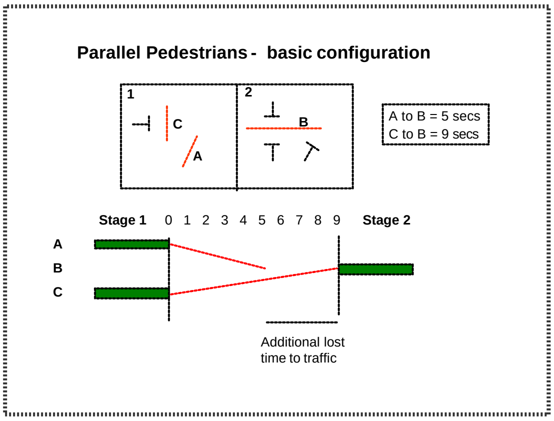
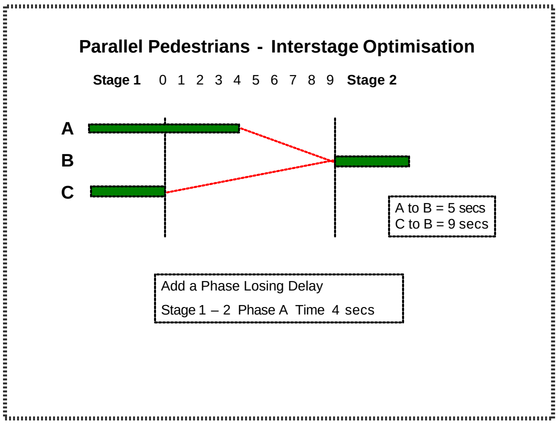


Fig 3



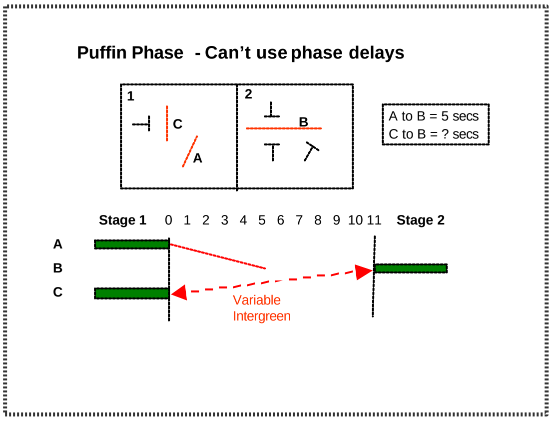


Fig 4

Fig 5

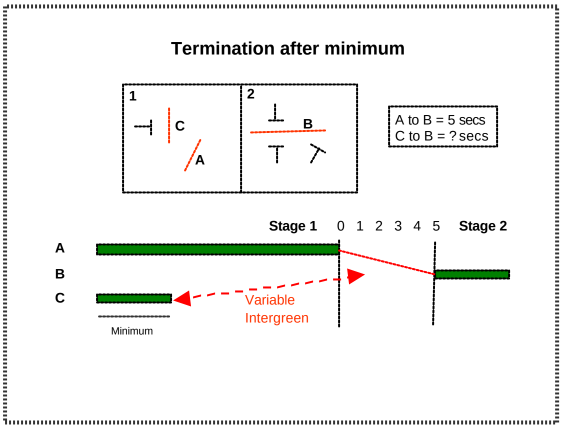


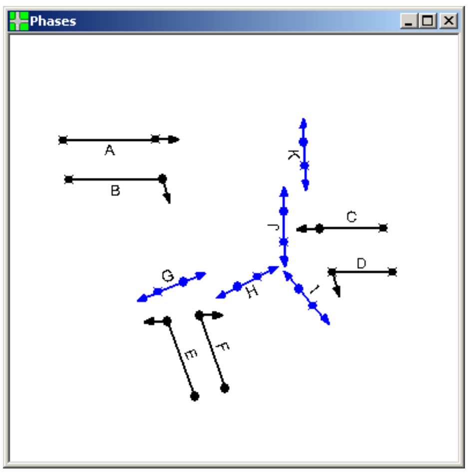
Fig 6

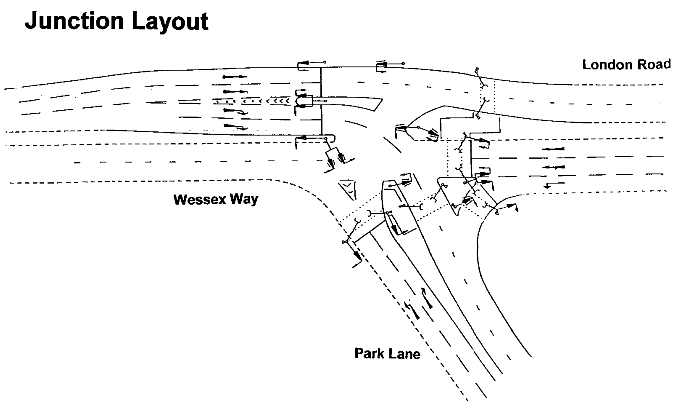
One solution to this problem is to configure the pedestrian puffin phase as having a Type 3 termination. This means that the pedestrian phase will run at the beginning of the stage for its minimum period and then terminate, allowing the intergreen to time off before the conflicting traffic movement starts. This, however, has the disadvantage to pedestrians that the green man (invitation to cross) is only on for a short period of time, thereby increasing the average delay to pedestrians (Fig 6). The other problem is that pedestrians arriving after the green man has terminated, will perceive no traffic conflict for the duration of the stage and may result in pedestrians violating the red man indication.

Assessment of Options

In order to put the comments above into some form of perspective, a simple generic 'T' junction with parallel pedestrian facilities was used to compare the various alternatives. LINSIG was used for the assessment because it was considered the most appropriate tool for this task. The key views of the LINSIG model are shown in Fig 7 and the results of six scenarios are given in Table 1, showing PRC, vehicular delay and the total green man time for all the pedestrian phases per cycle. The base model assuming conventional far sided signals with a fixed intergreen gives a Practical Reserve Capacity (PRC) of 3.0% on an 80 second cycle time; the cycle time was kept constant at 80 seconds for all scenarios. It should be noted that the 'green man' time was calculated to be 154 seconds (average 31 seconds per phase) giving pedestrians a relatively good window of opportunity to cross the road. The introduction of phase delays (Interstage optimisation) to maximise traffic green time, increases the PRC to 18.5%, reduces junction delay by about 20% and reduces 'green man' time to 141 seconds (28 seconds per phase).

If the pedestrian phases are changed to the 'puffin' type then the effect is very difficult to predict because of the uncertainty in knowing how long the on-crossing detectors will extend for. However, this is not an excuse to bail out now. It is relatively straightforward to model the range of scenarios ie best case - intergreen running to minimum and worst case – intergreen running to maximum. One can see that in the former case, the PRC is reasonable at 12.5% but in the later case the PRC drops to -74.4%. Again, this may be considered unrealistic but in view of the way pedestrians are stepping onto the crossing during the red man, then at some locations delays of this nature may become the norm.





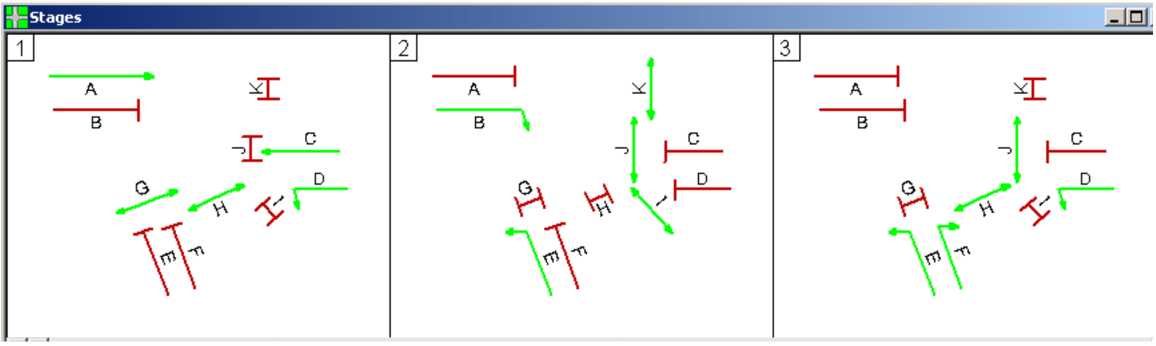


Fig 7 – LINSIG Views for 'T' junction

Option	PRC %	Delay pcu hrs	Green Man secs
Conventional Far Sided Signals – Fixed Intergreen	3.0	32.9	154
Far sided Signals with Interstage Optimisation	18.5	26.1	141
Puffin – assuming intergreens run to minimum	12.5	27.4	154
Puffin – assuming intergreens run to maximum	- 74.4	309.6	154
Puffin – assuming average extension (2.0) RR 364	- 9.0	49.2	154
Puffin – assuming termination on minimum	18.5	26.1	35

Table 1 – PRC and Delay for 'T' junction under different configurations

Based in RR 364, the survey data collected for the two sites indicated that the average additional time for pedestrians was in the region of 2 seconds. Whilst it could be argued that this figure may well be on the low side, it enables a mean value to be computed. Generally, it would be fair to say that a study is required into methods of determining average intergreens for assessment purposes. If the intergreens are extended by 2 seconds, the PRC drops to -9.0% and delays increase by over 50% from the base scenario.

The main point to note here is that if you are faced with a puffin conversion at a junction which has already been designed with phase delays, then you could easily be doubling the delays to traffic.

The last option on Table 1 assumes termination of the pedestrian phase on minimum, which generally (provided the stages are long enough) will allow the intergreen to time off prior to the start of the conflicting traffic phase. Because the intergreen is effectively timing off during the Stage, it has no effect on capacity, and gives results which are in keeping with the optimised interstage. However, the down side is that the pedestrian phases only run to minimum, reducing the total 'green man' time down from 154 seconds to 35 seconds (7 seconds per phase) which unless crossing on the red man is considered acceptable, will significantly increase pedestrian delay.

The example illustrates the fact that a variable intergreen will increase delays to traffic. To some degree, this may be acceptable in a 'pedestrian friendly' environment. However, if the pedestrian abuse of the red man continues to be a problem then the delays to traffic start to reach unacceptable levels. If the 'variability' is removed by terminating the pedestrian early, then although traffic delays can be minimised, pedestrian delays will be substantially increased.

Modelling Options on LINSIG and TranEd

The scenarios listed in table 1 have all been successfully modelled in LINSIG and there is no reason why the same techniques cannot be used in TranEd. The use of phase delays have been a feature of LINSIG and the Interstage View for a number of years. The modelling of different intergreen variations however has to be undertaken by entering different intergreens for each scenario. It is anticipated that multiple intergreen matrices will be available in future versions of LINSIG and TranEd which will enable the user to quickly choose which intergreen value to use for a model ie a minimum, maximum or operational value.

Modeling phases which have a 'type 3' appearance in LINSIG may seem more problematic. However, this can be modeled in LINSIG, for the above example, by adding three new 'dummy' Stages; one for each early termination. Since there are three stages, each containing a parallel puffin phase, then a 'dummy' Stage needs to be added to each existing Stage in order to terminate the pedestrians early (Fig 8). The new Stages could be added so that the numbers are sequential ie the original three stages would become 1, 3 and 5; the dummy Stages would be 2, 4 and 6.

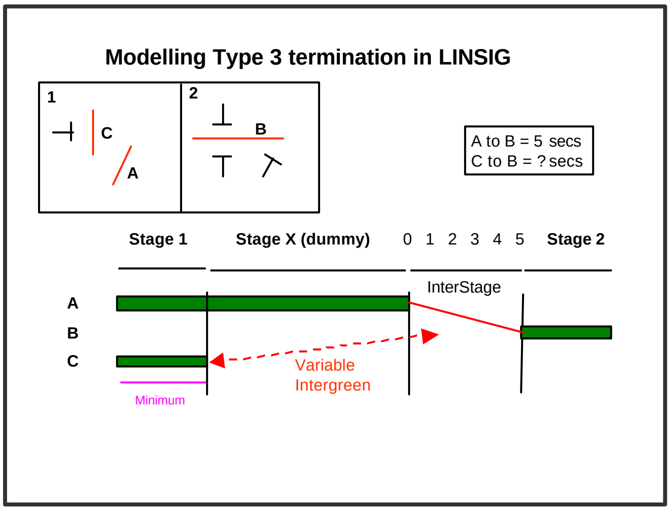


Fig 8 – Modeling Type 3 appearances in LINSIG

However, I have a preference to see the dummy stages added at the end because they will not be part of the final configuration. Hence the real stages remain as 1, 2 and 3 with the dummy stage for each termination being 4, 5 and 6 respectively. This means that the Stage sequence in LINSIG will be 1, 4, 2, 5, 3, 6. This has the advantage that when you look at the Phase Stage Diagram, you can easily ignore the dummy stage change points by mentally blanking or drawing over the stage change points (Fig 9).

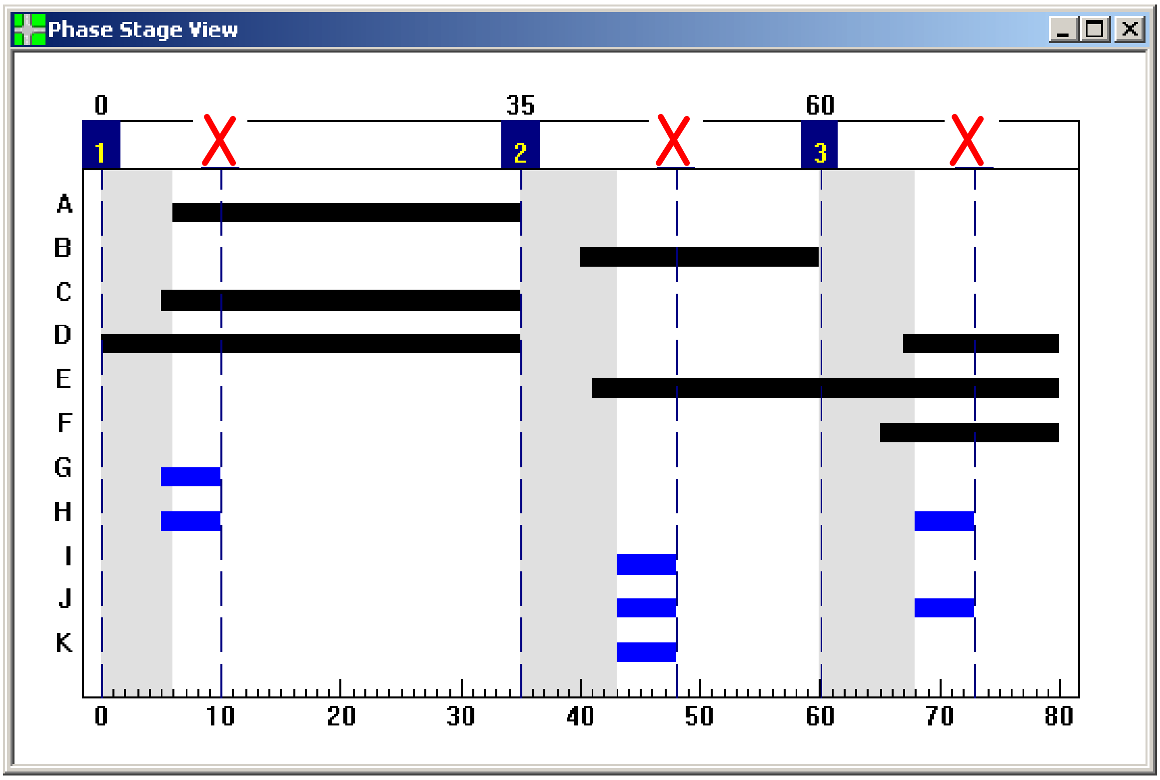


Fig 9 – Phase / Stage Diagram in LINSIG showing Type 3 terminations

Summary

A puffin crossing has the benefit of kerbside and on-crossing detectors, which according to the TRL Research Report 364 offers benefits to traffic and pedestrians in the region of £12,500 per site per annum. In reality, a substantial part of the benefit is associated with the kerbside detector which can be used at almost any site. The use of the on-crossing detectors should in theory enable the intergreens to be reduced because the majority of people will be able to cross the road quickly. In reality, at times of the day when pedestrian flows are relatively low, this is likely to be true. However, at busier times and as a result of pedestrians violating the 'red man' indication' this would not seem to be the case.

The survey data collected by TRL in RR 364 shows that the on-crossing detectors have a significant disbenefit to traffic of £5,800 and £15,300 per annum for the Rustington and Woolwich sites respectively (using current values of £14.20 per vehicle hour). Although pedestrians get more time to cross the road, it can be argued that the average delay to the pedestrian is increased because of the shorter 'green man' period.

Junctions which have parallel pedestrian facilities usually benefit from having long periods of 'green man' and optimised interstages. Unfortunately, the variability of intergreens on a puffin negates the use of phase delays and the increasing practice of pedestrians crossing on the red man can also extend the intergreen beyond expectations causing significant delays to traffic. Traffic delays can be minimised by terminating pedestrian phases on minimum, but this may be considered to be a disadvantage to the pedestrian.

It is unclear whether the 'on crossing' detectors are giving the expected benefits. There is no doubt that the variable intergreen is making the clearance period safer for pedestrians. However, the increase in 'red man' violation is worrying and could negate the benefits offered by the variable intergreen.

Whatever method is used to configure puffins within a junction, the effect on vehicular capacity and delay as well as pedestrian delays should be considered carefully. To do this, some ingenuity may be needed in the use of assessment models. It is envisaged that later versions of LINSIG and TranEd will assist in the modelling.