Abstract

‘Scramble crossings’ for pedestrians at signal junctions are widely used in Japan and have been reintroduced in Canada and the United States as a way of prioritising pedestrian movement by stopping all traffic movement and allowing pedestrians to cross in every direction at the same time. Some examples exist in the UK but their use is not widespread. One potential reason for this is there is limited guidance on when ‘scramble crossings’ should be considered as potential schemes for promoting pedestrian priority.

This paper focuses on the proposed scramble or diagonal crossing scheme at Oxford Circus in central London. This has been designed by Atkins on behalf of The Crown Estate, Transport for London (TfL), Westminster City Council (WCC) and the New West End Company (NWEC) and was implemented during 2009.

The purpose of the paper is to identify some of the existing examples in the UK and overseas and review the existing guidance on their application of scrambled crossings. The paper then describes the design process and key features of the Oxford Circus scheme and based on this experience concludes by suggesting potential future applications of scramble crossings in the UK.

Introduction to scramble crossings

For the purpose of this paper the term ‘diagonal crossing’ will be used as well as ‘scramble crossing’ to describe signalised crossings which have an ‘all red’ stage and where pedestrians are encouraged to cross in all directions. Scramble crossings for pedestrians involve stopping all traffic movements at signalised junctions and allowing pedestrians to cross in every direction at the same time. Their origins are unclear but they are also known as a ‘Barnes Dance’ after Henry Barnes, a traffic engineer in the United States, who popularised the concept after overseeing their introduction in Denver and New York.

The general consensus is that the first scramble crossings were introduced in Vancouver and Kansas City in the 1940’s and spread to other cities in North America including Los Angeles in the 1950’s which at one point had 25 examples. Over 300 scramble crossings now exist in Japan including the ‘Shibuya crossing’ situated close to Tokyo’s Shibuya railway station which is said to be used by over 250,000 pedestrians every day. This is probably the most widely known example of a scramble crossing in the world.

The author considers that the popularisation of the motor car in the post-war period resulted in the withdrawal of some of the scramble crossings particularly in North America. However, the acknowledgement of the need to promote more sustainable modes of travel together with increased urbanisation has lead to scramble crossings being considered once again as a way of dealing with the conflicts between pedestrians and vehicles in the centre of our cities.

New scramble crossings have recently been introduced in Oakland (2002 at 8th Street / Webster Street) and Calgary (2003 in Quartier International district) and Toronto (2008 at Yonge Street / Dundas Square).

Potential advantages and disadvantages of scramble crossings

A number of papers have been published on the theoretical and actual benefits and disbenefits of introducing scramble crossings including papers by; Ahuja et al 20081, Ishaque and Noland 20062 and Bechtel et al 20033.

Through review of these papers and the author’s experience of developing the proposed scheme for Oxford Circus the key advantages of introducing scramble crossings include the following:

- Promotion of pedestrian priority and the relief of pedestrian congestion on more traditional orthogonal crossings and footways particularly where pedestrian volumes are very high.
- Reduction of walk distances and times particularly where pedestrians would otherwise use two orthogonal crossings to reach their intended destination and can now complete their journey through the junction by making a single diagonal crossing movement.
- Potential improvements in safety by reducing conflicts between pedestrians and vehicles. Bechtel et al 2003 demonstrated in their analysis of the Oakland scramble crossing that safety benefits were realised by the introduction of a scrambled crossing. The North American examples of scramble crossings have particular
benefits of reducing the conflict between pedestrians crossing and vehicles turning left and right 'on red' which is legally permitted in the United States. But this is not permitted when a scramble crossing operates.

Ahuja et al. 2008 concluded that scramble crossings are beneficial only when both pedestrian and vehicular volumes are relatively high and the junction is characterised by significant delay for both modes of travel. In free flowing conditions for vehicles and pedestrians, they concluded a conventional crossing arrangement would be a better solution as scrambled crossings generally lead to an increase in delays at the junction. This may in turn lead to an increase in pedestrians not complying with the signals and therefore an increase in conflict between pedestrians and vehicles.

The potential drawbacks of introducing scramble crossings for pedestrians including the following:

- Increased delays to vehicles particularly where an 'all red' signal stage has to be introduced.
- The effectiveness of scramble crossings relies on pedestrian compliance with the signals and several examples are considered to suffer from pedestrians failing to 'clear' the junction at the end of the crossing periods leading to potential additional delays to vehicles.
- Increase in the perceived risk to pedestrians by the removal of barriers and guardrails to allow crossing in all directions. The key consideration is the potential risk of pedestrians waiting to cross on diagonal movements at the corners of junctions being struck by vehicles turning left around the corners.

Status and examples

**in the UK**

The basic prerequisite for introducing scramble crossings exists at a large number of signal junctions in the UK through the provision of an 'all red' traffic stage during which all traffic movements are stopped and pedestrians use all marked crossings at the same time. However, in the UK controlled pedestrian crossings at signal junctions are usually of the orthogonal / straight across or staggered type: these provide crossings of the traffic approaches to the junction.

In the UK the Department for Transport (DfT) sets out the design standards and guidelines for pedestrian facilities at signal controlled junctions. Design Manual for Roads and Bridges (DMRB) TD50/04* states that at traffic signal junctions ‘where a pedestrian need is established then appropriate signal controlled facilities should be provided’. Traffic Advisory Leaflet 5/05* describes the main options for providing pedestrian facilities at traffic signal junctions. This states that: “the designer has to consider the pedestrian flow patterns, degree of saturation and the topographical layout to decide on which option is best suited to a particular site”. The options identified include underpasses and overbridges; no pedestrian phase or stage; full pedestrian stage; parallel pedestrian facility; staggered pedestrian facility or displaced pedestrian facility. With respect to providing a full pedestrian stage, the advice from the DfT in terms of diagonal crossings is as follows: “Diagonal crossings (crossing the centre of the junction, say, from north east to southwest) are largely untied but a small number do exist. There are important design aspects to be incorporated. Diagonal crossings are not considered appropriate for many disabled users, particularly those who are visually impaired. Also road safety education generally teaches children not to cross diagonally at junctions. Conventionally orthogonal crossing places should therefore always be provided with flush dropped kerbs, tactile paving and audible / tactile signals. Flush dropped kerbs, tactile paving and audible and tactile signals should NOT be provided on the diagonal crossing part. If a lowered kerb is provided there should be a minimum upstand (after possible resurfacing) of at least 25mm. Careful thought also needs to be given to the use of markings or coloured surfacing at the junctions so that partially sighted pedestrians are not misled”. Although the advice is therefore prescriptive in terms of the design, little guidance is given to allow the designer to determine whether a diagonal crossing layout should be used as opposed to a more traditional arrangement with orthogonal crossings. This along with the perceived risk of not following guidance may be a key factor as to why diagonal crossings are still the exception to the norm in the UK.

Current UK examples of scramble or diagonal crossing layouts at signal junctions include:

- **Aberdeen** – Scrambled crossings at several locations across the town centre.
- **Balham High Road / Balham Station Road junction**, Balham, South London – urban signal junction located directly outside Balham London Underground Station with two diagonal crossings as shown in Figure 1. This is the first example of a diagonal crossing arrangement introduced in London.
- **A240 / A2022 Drift Bridge, Epsom Downs, Surrey** – suburban signal junction providing access to a local centre with single diagonal crossing from north-east to south-west corner only.
- **Balliol Road / Pembroke Road, Bootle, Merseyside** – urban signal junction with single diagonal crossing connecting two separate sites of Hugh Baird Higher Education College (introduced 2004-2005).
- **Oxford Road / Dover Street, Manchester** – urban signalised staggered crossroads in University area.

The original justification for providing diagonal and scramble crossings at these locations is not known. However, justification appears to be either a result of the existing layout (such as a staggered crossroads) which lends itself to a diagonal crossing and/or because they are in local and town centres, where pedestrian connectivity is important and pedestrian flows are relatively high. There are also a number of existing junctions where traditional orthogonal crossings are provided at signalised crossroads and where the absence of barriers to movement such as guardrail permit ‘informal’ diagonal crossing. This includes the A24
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Highway

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Figure 1 – Diagonal crossing in Balham, South London

Figure 2 - Informal diagonal crossing in Epsom town centre

High Street / Waterloo Road / Ashley Road junction in Epsom town centre close to Atkins’ offices and shown in Figure 2. This is situated in an outer London suburban town centre but also on the A24 London to Worthing Trunk Road. Such examples represent potential sites where formal diagonal or scramble crossings could be introduced.

The Oxford Circus case study

London’s West End has been one of the UK’s dominant retail and entertainment centres since the early 19th century. It continues to be a vibrant place with a distinctive retail offer and range of attractions and is renowned on an international level. However, its popularity presents unique problems for its infrastructure and public realm including congested streets, vehicular and pedestrian conflicts and a tired looking street environment.

Existing junction layout (2008)

Oxford Circus is at the heart of the West End and one of the most renowned junctions in the world, marking the convergence of London’s two most famous retail streets, Oxford Street and Regent Street. The junction is a signalised crossroads with traditional orthogonal crossings for pedestrians on all four arms, each of which include central islands as shown in Figures 3 and 4. The crossings are ‘straight across’ with pedestrians crossing either Regent Street or Oxford Street in one continuous movement – this is facilitated by the provision of an ‘all red’ traffic stage during which every pedestrian crossing operates. Each of the four crossings are set back between 7 and 15 metres from the junction which means they do not serve the key pedestrian desire lines along the footways on either side of the two streets. Stairways to Oxford Circus London Underground station are located at each of the four corners of the Circus and stone balustrades mark the kerbs around each of the corners preventing crossing by pedestrians anywhere other than at the formal crossings. The layout of the London Underground stairways and the balustrades means that pedestrians cannot walk between them creating areas of ‘dead space’.

Guardrails are used in the vicinity of the orthogonal crossings on the central islands and further down each approach to the junction.

Both Regent Street approaches have two lanes of traffic, as does the approach from Oxford Street west which has one lane dedicated to right turning buses. There is a single lane on the Oxford Street east approach. A number of turning movements are banned including the right turns from both Regent Street approaches and Oxford Street east as well as the left turn from Regent Street north. The Oxford Street approaches are generally perceived to be for the use of buses and taxis only during 0700-1900 hours but in actual fact service vehicles are permitted to make certain turns to and from Oxford Street. Separate traffic stages are provided for Regent Street and Oxford Street with an extended phase for the right turning buses from Oxford Street west.

Current use and operating conditions

Oxford Circus is dominated by pedestrians and is extremely busy at most times of day, particularly at weekends. Typically, pedestrians account for 64 percent of all people passing through the junction. Bus passengers account for the next highest proportion, at 32 percent, with around 1 percent of people passing though in private cars, taxis, on motorcycles and by cycle.
Figure 3 – Plan of existing Oxford Circus layout (before scheme)
The four pedestrian crossings are also extremely busy and do not always clear of pedestrians at the end of the crossing stage. Many of the existing pedestrians use two crossings as part of their journey through the junctions and would therefore be well served by a diagonal crossing.

A number of vehicle turning movements are banned which results in 64 percent of pedestrians crossing during the ‘red man’ phase when either Regent Street or Oxford Street traffic movements are on ‘green’. Conflicts between pedestrians are also an issue, for example between those accessing the London Underground and others passing through the junction using the footways and crossings. Faced with these conditions a small number of pedestrians opt to walk in the road on the ‘traffic side’ of the balustrades and guardrail as shown in Figure 7.

Both streets are major traffic thoroughfares - typically, hourly traffic flows peak at approximately 2,000 vehicles per hour during the week with around 500 to 700 vehicles per hour on Regent Street in each direction and 200 to 400 vehicles per hour on Oxford Street in each direction. The junction is generally considered to be operating at or close to capacity for a large part of the day with queues evident on all approaches but particularly Oxford Street west. The junction is a key ‘node’ in the network of traffic signals in this part of the West End.

Buses account for a significant proportion of the existing traffic at Oxford Circus: a total of 24 bus routes pass through the Circus with over 400 buses per hour on a typical weekday. Several of the routes terminate in the area and pass through the junction more than once in accessing and egressing from their stands. Oxford Circus is highly accessible by bus and is also a key interchange between the various bus services and between buses and London Underground. Bus stops are located within 200 metres of the junction on all four approaches.

**Scheme development**
Westminster City Council, The Crown Estate, Transport for London and the New West End Company, together with other key stakeholders, developed and adopted the ‘Oxford,
Regent and Bond Street (ORB) Action Plan, a vision for the future development of the West End to safeguard its position as one of Europe’s finest shopping districts. The action plan puts forward a number of proposals to improve the quality of the public realm and to enhance the visitor experience.

As part of the ORB Action Plan, Atkins (working for The Crown Estate) proposed a comprehensive redesign of Oxford Circus to provide more space for pedestrians through reduced street clutter, selective footway widening and diagonal (scramble) crossings. The overarching objective was to transform Oxford Circus into a rejuvenated space befitting its status as gateway to the West End and address its problems in terms of discouraging visitors, shoppers and tourists.

A plan and image of the proposed scheme are presented in Figures 8 and 9 - the key elements are as follows:

- Two new diagonal crossings for pedestrians.
- Straight across crossings realigned to better serve the pedestrian desire lines with narrowed central islands.
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Figure 8 – Plan of Oxford Circus scheme
Footway widening on Regent Street both north and south of the junction which together with the removal of street clutter to create 63 percent more usable space for pedestrians.

Removal of balustrades and guardrail to facilitate diagonal and scramble crossing.

Introduction of or improvement to bus lanes on the Regent Street approaches.

Closure of Princes Street and Little Argyll Street, two side streets south of the Oxford Circus junction.

The new diagonal crossings are the centrepiece of the scheme and were identified as potential solutions to the existing pedestrian congestion on footways and crossings, particularly in the light of the fact that pedestrians outnumber those travelling in vehicles twenty to one and that a large number of the existing pedestrians use more than one crossing to complete their journey through the junction. The perception also was that as an ‘all red’ traffic stage already existed, that diagonal crossings could be implemented without a significant impact on traffic conditions since the broad order distribution of signal ‘green’ time between vehicles and pedestrians and the overall cycle time could be maintained. Minimising the traffic impact and the effect on buses in particular was also a key objective of the scheme.

The new diagonal crossings are approximately 4 metres wide and between 25 and 27 metres in length. This compares with the realigned straight across crossings which are 4 to 6 metres wide and between 11 and 15 metres in length. In common with the realigned straight across crossings, the diagonal crossings have dedicated signal heads and studs marking the width of the crossing. It should be noted, however, that as with other ‘scramble’ crossings already in existence there is an expectation that pedestrians will also cross outside of the stud markings making full use of the space in the centre of the junction between opposing stop lines and their parallel stud marks. Extensive public and stakeholder consultation was carried out on the design philosophy to be applied to the diagonal crossings. The public consultation gave feedback which was very positive with 95 percent of respondents expressing their support. Consultation with accessibility groups such as Guide Dogs for the Blind helped to influence the design and as a result of this consultation it was decided that different coloured skid resistant surfacing would be used to mark out the diagonal and straight across crossings. It was also decided that whilst tactile paving and dropped kerbs would be used for the straight across crossings, none would be used for the diagonal crossings which would feature a 50mm upstand at the kerb. A compromise was therefore sought between providing access to all crossings for all users and the desire to not encourage use of the diagonals by the partially sighted who could become confused by the arrangement which is not yet standard practise in the UK.

A pedestrian ‘countdown’ system was also considered for implementation in parallel with the scheme that would visibly and audibly count down the time in seconds until the end of the pedestrian crossing stage. As this technology is also untried in the UK and requires approval from the DfT it was decided to omit countdown from the scheme for the time being although it will be considered for implementation at a later date.

Guidance and approval was sought from Transport for London’s Directorate of Traffic Operations (DTO) who manage the signal junctions within the Greater London Authority area on the appropriate intergreen and pedestrian crossing timings. These have been derived with reference and in accordance with the appropriate guidance (TA 16/817 and TTS56).

It was decided to reduce the pedestrian invitation from the standard 9 seconds to 8 seconds. This decision was taken in order to minimise the impact of the scheme on traffic conditions and therefore bus journey times. A comparison of the existing and proposed signal settings including traffic stage lengths, inter greens and pedestrian stage is presented in Table 1 (for the two signal cycle times currently used in the weekday Inter Peak Hour (1300-1400 hours) and the cycle time used in the weekday PM Peak Hour (1700-1800 hours). The table indicates that the overall length of the pedestrian crossing stage (inclusive of subsequent intergreen) has been increased from 26 to 32 seconds. This increase is associated with the increased length of the longest single crossing to approximately 26 metres (the diagonal from south east to north west) with the scheme in place compared to the existing longest crossing (Regent Street South) which is approximately 17 metres in length. The new diagonal crossing therefore requires a pedestrian crossing stage which is 6 seconds longer than the existing stage inclusive of the subsequent intergreen period.

Guidance and approval was sought from Transport for London’s Directorate of Traffic Operations (DTO) who manage the signal

Figure 9 – image of Oxford Circus scheme – view towards north east corner (Nike Town)
A significant investment was made in undertaking detailed appraisals of the proposed scheme for a number of reasons:

- The innovative nature of the scheme particularly the diagonal crossing and scramble zone.
- The high profile nature of Oxford Circus and its role as the key junction in the West End and the surrounding network of traffic signals.
- The large number of stakeholders involved in any such scheme in central London.

Although the development of the scheme was predominantly funded by The Crown Estate, the costs of its implementation will be shared between The Crown Estate, Transport for London and Westminster City Council. For this reason a standard TfL Business Case was required to evaluate the financial benefits of the scheme. This, in itself, required detailed appraisals of the effects of the scheme on the various users that currently pass through the Circus, particularly, pedestrians, buses and other vehicles.

Atkins Intelligent Space undertook a detailed manual analysis of pedestrian movements including Fruin Level of Service (LoS) as well as developing Legion pedestrian micro-simulation models of the Circus. Atkins Transport Planning developed a parallel VISSIM vehicle micro-simulation model to evaluate the impacts on overall junction operating conditions and the impact on particular vehicle classes.

This encompassed the prediction of before and after journey times for buses and other vehicles, predicted queues and predicted Degrees of Saturation for traffic. The VISSIM model included the full length of Oxford Street from Marble Arch in the west to St Giles Circus in the east and Regent Street from Langham Place in the north to Great Marlborough Street / Maddox Street in the south. Both models were audited and approved by the relevant departments within TfL.

Detailed analysis of the pedestrian movement issues predicts that the scheme will have the following effects:

- Average walk times through the junction will be reduced by 52 seconds by virtue of reduced pedestrian congestion and the provision of the diagonal crossings which will allow many pedestrians to undertake a single crossing movement rather than use two of the existing straight across crossings in succession.
- Fruin LoS on the footways in the immediate vicinity of Oxford Circus are predicted to improve from Level of Service between D and F to Levels of Service between A and C as shown in Figure 10. This represents a significant improvement from the existing congested environment to busy but generally free flowing conditions for pedestrians.

Typically the new diagonal crossings will attract use by up to 6,500 pedestrians per hour who will be abstracted from the four straight across crossings improving conditions there.

- The configuration of the space on the footways and around the London Underground stairways will provide separate ‘wait’ zones for pedestrians congregate to use all of the crossings and ‘through’ zones for walking pedestrians. Movement either side of the London Underground stairways will also be possible. This is illustrated by the images from the Legion pedestrian model presented in Figure 11.

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<th>Stage 2 Green (West)</th>
<th>Stage 3 Green (Central)</th>
<th>Stage 4 Green (Pedestrian)</th>
<th>Stage 5 Green (West)</th>
<th>Stage 6 Green (Central)</th>
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<td>104 second cycle</td>
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In this context and based on the signal settings presented in Table 1, the VISSIM model has predicted the following impacts on traffic and buses of the scheme:

With the exception of the Princes Street side road traffic which will be removed from Oxford Circus, all other traffic currently passing through the junction will still be able to do so on a typical day. Widening is considered to have the greatest impact as it reduces the Regent Street southbound movement from two lanes of traffic to one.

The reduction in traffic-traffic and traffic-pedestrian inter green times and the removal of the Princes Street side road traffic has also helped to mitigate this potential effect. New or improved bus lanes have been provided on both sides of Regent Street to provide buses with priority on these approaches to the Circus.

Case studies of other schemes have indicated that the introduction of diagonal crossings can have a significant impact on traffic. This is not predicted to be the case at Oxford Circus. Although the signal setting standards have been relaxed by reducing the ‘invitation to cross’ to 8 seconds this has in effect been one of the measures used to minimise the impact of the overall scheme. The proposed footway

Whilst the diagonal crossings are only one element of the scheme, they are key to its success: without them the realigned crossings are predicted to be overcapacity and function in much the same way as the existing straight across crossings. It is notable that the Legion model can only simulate the current conditions if pedestrians are permitted to cross during the red man phase (as actually happens) whilst the scheme can operate effectively assuming 100 percent compliance by pedestrians.

A VISSIM micro-simulation model, an image from which is shown in Figure 12, has been used to demonstrate that the scheme could deliver the significant benefits for pedestrians and the public realm without a significant impact on junction capacity and knock-on effects on journey times for traffic and buses.

Figure 10 – Fruin level of service analysis for Oxford Circus scheme

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In this context and based on the signal settings presented in Table 1, the VISSIM model has predicted the following impacts on traffic and buses of the scheme:

- With the exception of the Princes Street side road traffic which will be removed from Oxford Circus, all other traffic currently passing through the junction will still be able to do so on a typical day.
• Very little change in bus journey times is likely to occur – average journey time improvements of 7 to 15 seconds are predicted for buses during the weekday Inter Peak Hour and weekday PM Peak Hour. Journey time improvements are predicted on at least five of the eight possible bus turning movements during these periods.
• Very little change in the journey times for other vehicles is likely to occur – journey times are predicted to change by between +3 and -8 seconds during the two peak hours. Journey time improvements are predicted for around half the turning movements during these periods.
• The length of traffic queues is predicted to be similar to existing. Although small increases in queue lengths are predicted for some approaches this will be offset by the relocation of the stop lines at Oxford Circus which will provide greater ‘stacking space’ between the Circus and adjacent junctions. The probability of ‘blocking back’ of queues occurring is therefore similar to the existing. Notwithstanding that the impact on traffic and buses is essentially ‘neutral’, increasing the cycle time from the current 112 seconds to 116 or 120 seconds is now being considered by TfL to provide the highway network with greater resilience to un-planned events or accidents at Oxford Circus or nearby.

The overall financial benefits and disbenefits generated by the scheme as estimated by the Legion and VISSIM models and subsequently included in the TfL Business Case results in £6m of benefits per annum which can be disaggregated as follows:
- £5.1m - benefits for pedestrians per annum
- £800,000 - benefits for bus users per annum
- £10,000 - disbenefits for car users per annum
- £10,000 - benefits for taxi users per annum

The overall result is a Benefit – Cost Ratio (BCR) for the scheme of 12.9:1. This is a very healthy BCR as typically TfL is aiming to achieve a BCR of at least 1.5:1 for schemes that it is funding. The pedestrian benefits significantly outweigh the benefits and disbenefits for other modes given the huge number of pedestrians passing through the junction. Despite this the business case results do suggest that diagonal crossing solutions could represent viable schemes elsewhere even recognising that most locations in the UK will have significantly fewer numbers of pedestrians.

Overall conclusions & future applications of scramble crossings

The scheme at Oxford Circus includes an innovative scramble crossing arrangement which is untried as a solution in such a high profile location in the UK where a constrained environment is coupled with very high pedestrian and vehicular demand. Limited guidance exists in the UK on scramble crossing solutions and this tends to focus on the design aspects of scramble crossings instead of identifying the circumstances in which they should be considered as a way of promoting pedestrian priority. Based on the experience of developing the scheme for Oxford Circus and reviewing previous case studies, suitable locations in the UK for scramble crossings could potentially include:
- Town or local centres where there are crowded footways or crossings; where pedestrian flows are significant and pedestrian connectivity needs to be improved but where an existing junction for vehicles also needs to be maintained.
- Locations where a diagonal pedestrian desire line exists but is not served by the existing crossings, for example between two trip generators or attractors located on diagonally opposite corners of a signalised cross roads. In these circumstances, the scramble crossing as the potential to reduce walk times and distances as well as reduce the pressure on existing footways and crossings.
- Other locations where a signalised crossroads exists with an ‘all red’ traffic stage where further improvements for pedestrians would be welcome perhaps in relation to a new development. In this situation, benefits can be provided for pedestrians whilst potentially avoiding significant impacts on vehicle flows and delays. It is accepted, however, that this is likely to be highly site specific.

The Oxford Circus scheme was implemented at the end of 2009. It is anticipated a monitoring exercise will be undertaken in accordance with the approvals for the scheme obtained from Transport for London. This exercise will examine and record the actual impact of the scheme on junction operating conditions, particularly impacts on buses and other vehicles as well as the changes in pedestrian behaviour. The results of the monitoring exercise will help to further clarify the potential of introducing scramble crossings elsewhere.
References


5. Traffic Advisory Leaflet (TAL) 5/05, Pedestrian Facilities at Signal Controlled Crossings, Department for Transport (DfT) (March 2005)


‘Scrambled’ pedestrian crossings at signal controlled junctions – a case study