8 Junctions

Introduction

Junctions are the most difficult and important places to create good infrastructure for cycling. They are the most hazardous locations where cyclists are potentially in conflict with motor vehicles, and they are also a source of delay and inconvenience. It is important to consider both of these issues when trying to make junctions work better for cyclists.

Around 68% of reported injury accidents to cyclists occur at or near road junctions, with a further 6% at private drives and entrances. The 3 most common accident types at junctions are (in order):

- Cyclist going straight ahead struck by left turning vehicle at side road.
- Cyclist going ahead struck by vehicle exiting a side road.
- Cyclist going ahead struck by vehicle turning right into a side road.

Design Objectives

At junctions the key objectives for cycling are:

- Minimise stopping and starting on key radial routes to smooth the flow of cyclists along the route.
- Remove or reduce conflict by separating cyclists from opposing vehicle movements using dedicated space within the highway and/or dedicated time at signals (including sufficient intergreen time to clear large junctions or junctions on steep gradients before the opposing flow is released).
- Provide clear and unambiguous information about priority to all users to avoid errors.
- On roads where there is a high proportion of HGVs, separate cyclists from vehicles with restricted visibility
- Separate cyclists from vehicles at large high capacity junctions due to high speed differential.
- Minimise disruption to pedestrians.

Design Principles

- Greater separation is required with greater speed and volume of motor traffic and on gradients where cycle speeds can be unusually fast or slow.
- Greater separation is required where there is a high proportion of HGV traffic.
- Greater separation is required where there is a high proportion of child/elderly cyclists and pedestrians.
- Greater separation is required at complex junctions with more than 4 arms and at locations designed to speed the flow of motorised traffic such as large unsignalised roundabouts.
- Junctions with acute angles such as slip roads or where the flare of the junction mouth enables vehicles to turn in and out quickly are most hazardous for cyclists. An approach angle perpendicular to the main junction with ‘square’ kerblines offers better visibility splays and potentially lower speeds.

Types of Facility at Junctions

The optimum facility will depend on site specific factors. The options available include:

- Grade separated cycle subways and bridges at major road junctions
- Roundabout with separate cycle track and signalled crossings such as toucans or cycle-only crossings
- Dutch style roundabout with separate cycle tracks and cycle/pedestrian crossing priority on each arm
- Two-stage right turn at a signalised junction
- Advanced stop lines
- Early start signals
- Loop detectors / push button to trigger a separate cycle track phase at signalled junctions
- Priority crossings at side roads

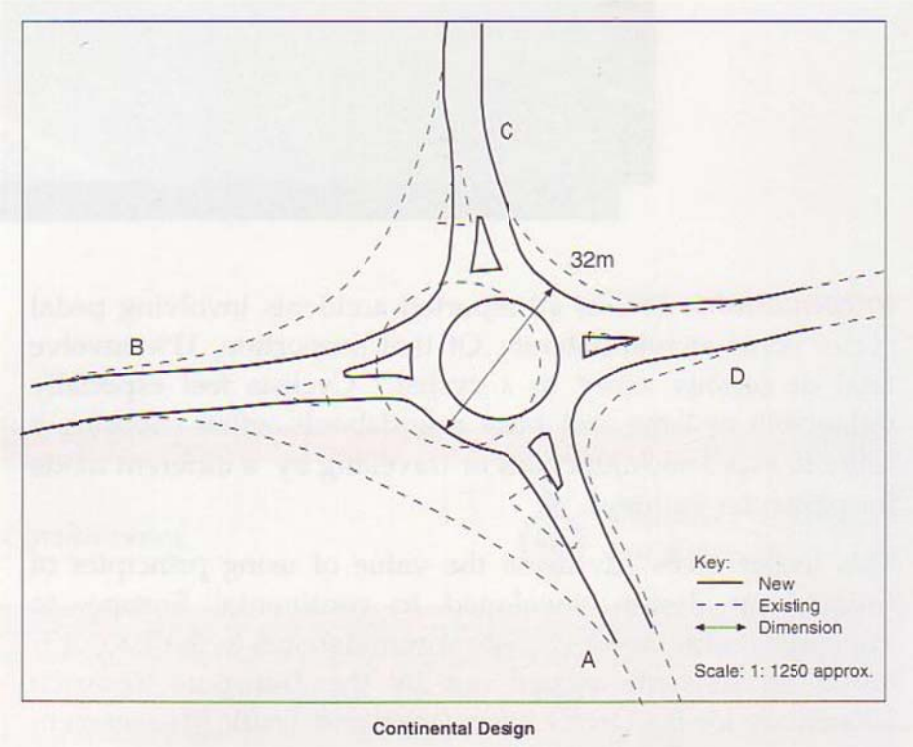
Roundabouts

Large multi-lane and multi-arm roundabouts are particularly hazardous locations for cyclists although they often have comparatively good safety records for motorised traffic. Cyclists are at risk on the approach (usually shunt/merge type collisions from other traffic entering and not looking at cyclists on their nearside), on the circulating carriageway (from traffic entering and leaving across the path of the cyclist) and when leaving (usually from traffic continuing around the roundabout in the outer lane).

Signalisation of large roundabouts is helpful to faster and more confident cyclists, and advanced stop lines at the traffic signals can help. However, roundabouts are designed to maximise the traffic flow and the wide carriageway and high speed differential makes them a hostile environment for slower cyclists. The preferred arrangements at large roundabouts (more than 3 arms and/or over 10,000 vpd) are therefore:

- Alternative routes that avoid the junction altogether (providing these are not lengthy diversions from any nearby destinations);
- Grade separation using subways or bridges (in new build situations the aim should be to keep pedestrians and cyclists at ground level and raise or lower the carriageway);
- Cycle tracks with signalled at-grade crossings of each arm;
- Signalised roundabout with advanced stop lines.

Smaller roundabouts on single lane, single carriageway roads can more easily be modified to make them more cycle friendly. Roundabouts with ‘tight’ geometry, using relatively large centre islands, single lane circulatory carriageway, single entry and exit lanes with minimal flare and maximum deflection are safer for cyclists. Textured over-run material can be used to accommodate any additional space required by HGVs. The diagram below is taken from Traffic Advisory Leaflet 9/97 which covers ‘continental design geometry’. The dashed line shows an existing UK roundabout while the solid line shows the typical continental design which has a better safety record for cyclists.



Extract fom TAL 9/97 showing comparative UK and continental geometry

The Transport Research Laboratory is currently trialling a number of configurations of a 'Dutch style' roundabout that combines the 'continental' geometry shown above, with the addition of priority cycle track and pedestrian crossings on each arm. This work will help to determine how to mark out the crossings in such a way that priority is clear to all users.

Dutch style roundabout trial at Transport Research Laboratory

Grade Separation

Grade separation can be the preferred option at busy, complex and high speed junctions where it is difficult to provide at grade facilities that are both safe *and convenient* to use. The cumulative delay at signalised at-grade crossings of multi-arm junctions can be unacceptably long for convenient cycling. Cyclists and pedestrians sometimes object to subways and bridges because of personal security or because they take them on a long diversion away from the shortest route. Problems with subways and bridges can sometimes be designed out, and this may be preferable to replacement with an at-grade crossing, particularly for cyclists for whom stopping and starting requires additional effort.

Where a subway or bridge is near to a junction but not actually on it, the cycle route should lead to the crossing point via the shortest route, often from some way in advance of the junction, so that the grade separated feature forms a 'natural' part of the route rather than a last minute diversion away from a straight desire line along a main road.

This subway at Bristol St on the left offers relatively good visibility and enables cyclists to avoid a large, busy junction on the ring road. By contrast the Salford Circus subways beneath Spaghetti Junction have a poor crime record and are remote and threatening.

Subways should ideally offer a straight approach, gentle gradients of 5% and good visibility through to the other side. Dutch guidance suggests that if a steeper ramp gradient is required, the bottom section of the ramp is steepest (where the cyclist still has momentum) and then gets shallower towards the top.

Queensway and the ring road have a number of large grade-separated junctions, so subways are likely to remain an ingredient of provision for cyclists in Birmingham for at least the next decade. With improved links to the adjacent roads, the subways in many cases would offer the safest and most convenient routes through a major junction. Further enhancements such as lighting, CCTV and widening may be needed to improve personal security.

New roads with grade separation can be constructed similar to the designs in Stevenage and the Netherlands, where the carriageway is raised up by a few metres so that there isn't such a large height difference for pedestrians and cyclists and the approaches are therefore shorter and can more easily be in line with the tunnel section for better visibility.

Signal Controlled Junctions

Advanced Stop Lines. Advanced stop lines enable cyclists to wait and move off ahead of queuing traffic when the lights change. Where there are high levels of cycling they can be helpful to the overall departure flow at the lights by enabling cyclists to move off quickly to reduce delay to other traffic. The reservoir area also enables cyclists waiting to turn right to take up an appropriate position towards the centre of the road. A TRL study concluded that the depth of the ASL reservoir is only the equivalent to a single pcu and therefore ASLs have little impact on capacity unless a queuing lane is removed, and may actually improve capacity in some cases because the lead in lanes and ASL box have a similar effect (on actual vehicle turning paths) to increasing the radius of the junction. Some adjustment to inter-green time may be required, and the traffic light sensor loops may need to be relocated. Where coloured surfacing is proposed it may make economic sense to plane off the surface, relocate the loops and install the advanced stop line using coloured asphalt for a longer life.

Table 7: Recommended lane widths at advanced stop lines

Carriageway (m)	Cycle Lane (m)	Lane 1 (m)	Lane 2 (m)	Opposing Lane (m)
7.3	1.3	2.75	--	3.25
7.5	1.5	2.75	--	3.25
8.0	1.5	2.75		3.75
8.5	1.5	3.0		4.0
9.0	1.5	3.0		4.5 (3.0 + 1.5)
10.0 (1 lane)	1.5	3.5		5.0 (3.5 + 1.5)
10.0 (2 lane)	1.25	2.75	2.75	3.25
10.5	1.5	2.75	2.75	3.5
11.0	1.5	2.75	2.75	4.0
11.5	1.5	2.75	2.75	4.5 (3.0 + 1.5)
12.0	1.5	3.0	3.0	4.5 (3.0 + 1.5)
15.0	1.5	3.0	3.0	3.0 + 3.0 +1.5

Notes: All treatments on a site by site basis. Lanes of less than 3.0m unsuitable for regular HGV traffic and ASL lead in lanes should be advisory. Lanes below 3.0m (2.75m if few buses or HGVs) require agreement with the Traffic Manager

While some authorities choose to have a policy of fitting ASLs at every signalised junction, it is not always the optimum arrangement. Traffic Advisory Leaflets 8/93 and 5/96 note that right turning cyclists find it difficult to use nearside approach lanes where traffic flows per lane exceed 200-300 vehicles per hour, and that the reservoir is of limited value when the proportion of red time at signals is small.

There are some concerns around safety, as nearside feeder lanes and the area at the rear of the reservoir are in the blind spot for HGV drivers. The fitment of convex mirrors (known as Trixi Mirrors after a cyclist who was fatally injured at a junction) onto the traffic signal pole was approved by DfT for all local authorities in October 2011.

Advance stop line with Trixi mirror fitted to signal head

The standard depth of the reservoir (i.e. distance between the cycle stop line and other vehicle stop line) is 5.0m. Trials are currently taking place of 7.5m and 10.0m reservoirs to assist cyclists with a greater head start at busier junctions, and to provide additional separation from HGVs, buses and vans where the volume of cycle traffic is likely to lead to cyclists queuing in the nearside lane blindspot. The Department for Transport will currently authorise 7.5m ASLs on request (February, 2014).

Half width ASLs may be suitable on narrower roads where the path of larger vehicles turning into a junction occasionally crosses the centre line. Their use currently requires special authorisation.

Nearside feeder lanes intended for cyclists going straight ahead should never be placed alongside a left-turn traffic lane. If a central feeder lane is installed to the offside of a left-turning lane, it should generally be 2.0m wide to give adequate separation from the traffic. It is permissible to install ASLs with no lead-in lane where this is considered the best option. Occasionally an offside feeder lane may be required (usually where cyclists can turn right but other vehicles must go ahead only). The offside feeder lane requires special authorisation.

Separate phase. Cyclists may need to make movements that are not available to other traffic. The arrangement of stop lines is similar to a conventional junction, with a green cycle aspect on the signals. 'Elephants footprint' markings can be used to indicate the route through the junction if necessary. The 'elephants footprint' markings are not included in TSRGD and therefore require special authorisation.

This separate signal phase enables cyclists on Hill St to cross over to a contraflow track in Hurst Street on the opposite side of Smallbrook Queensway.

Where cyclists have a separate route marked through a signalled junction, elephants footprint markings will be authorised by DfT. (DfT)

Early start for cyclists. It is possible to include a separate signal head at traffic lights to release cyclists typically 2 to 5 seconds ahead of other traffic (using a green 'cycle' signal in a similar arrangement to a 'filter' light). This enables cyclists to clear the junction prior to turning traffic, reducing the likelihood of a conflict, and helps prevent vehicles being delayed by cyclists when the lights change. At present a full size signal aspect mounted at the same height as other traffic lights must be used as only the full size lights have legal approval for use. There are many existing examples of such lights including sites in Bradford, Cambridge, London and York. Trials are underway (2014) for separate low-level signals for cyclists with the intention that the equipment will get type approval and may therefore be approved by DfT for use in England (with special authorisation) from 2016 onwards.

Example of low level signal aspect on trial at Transport Research Laboratory

Two-stage Right Turns

At large signalised cross-roads and T junctions (such as where Edgbaston Road crosses Priory Road and Bristol Road), it can be difficult to provide adequate inter-green time for right-turning cyclists. Cyclists also find it hazardous to safely move into a central position on the multi-lane approaches. One idea adopted in Denmark and Ireland is to offer a two-stage right turn to enable cyclists to remain on the nearside and make the turn in two stages. *The arrangement shown in the photograph of an Irish cross roads is currently illegal within England but may become possible with special authorisation in future following trials. An experimental scheme is currently being trialled in Southampton.* It is legally possible to replicate this sort of arrangement at T junctions however by using cycle tracks and signs /signals shown within TSRGD.

Two-stage right turn with right turn pocket, Ireland (Phil Jones Associates)