INTERNATIONAL CYCLING INFRASTRUCTURE BEST PRACTICE STUDY

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Report for
Transport for London

INTERNATIONAL CYCLING INFRASTRUCTURE
BEST PRACTICE STUDY

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00 EXECUTIVE SUMMARY + KEY FINDINGS

STUDY PURPOSE + PROCESS

Achieving the Mayor's Vision for Cycling in London (March 2013) will, amongst other things, require London practitioners to apply tried-and-tested techniques from around the world to the London context, and to innovate as necessary. To this end, TfL commissioned a study of selected cities, to understand better what makes for success in relation to cycle infrastructure, safety and culture. The study was tasked to focus on design approaches in cities with high levels of cycling and/or recent significant growth in cycling numbers.

The study was based around visits during 2013 to 14 cities of different character, to learn from them by interviews with local practitioners, by observation and by riding. The cities were chosen to enable different types of lesson to be learned: from what works best in cities where mass cycling is established, to how cities lower down the curve have applied learning from those further up (as London now seeks to); and from physical techniques to systems of governance. For this reason, we visited cities as diverse as New York and Utrecht. The former is a mega-city of 8+ million inhabitants with low overall levels of cycling (like London), but with a recent successful policy of reallocating street space from general traffic to cycling. By contrast, Utrecht has around a third of a million inhabitants and is one of the world's great cycling cities, where around a third of all journeys are by bicycle.

The full list of cities visited for this study is:

- Berlin
- Brighton & Hove
- Cambridge
- Christchurch
- Dublin
- Malmo + Lund
- Minneapolis
- Munich
- Nantes
- New York
- Seville
- Stockholm
- Utrecht
- Washington DC

Additionally, arising from study visits undertaken by members of the consultancy team earlier in 2013, lessons from Amsterdam and Copenhagen have also been incorporated within this report.

City visits were mostly of two days' duration, with cycling itineraries typically being 40-50km per city. In addition to members of the consultancy team, around 15 officers from TfL took part in the city visits.

OBSERVATIONS + LESSONS

A wealth of cycling-related information for each city was obtained from the visits and related researches. To facilitate comparison between cities, this information has been summarised under common headings in a series of illustrated bulletins (see Appendix A). However, since the details we obtained varied from city to city, strict 'benchmarking' (comparison with a standard) has not been possible.

Although the study's focus was on cycling infrastructure, the matter of the applicability of different measures in the contemporary London/ UK context also required investigation of issues such as governance, policy, funding, legal and regulatory frameworks. In addition, and bearing in mind one of the main outcomes sought by the Mayor's Cycling Vision - "streets where cyclists feel they belong and are safe", the study needed to embrace more subjective considerations like perceptions of safety and street use culture.

It would be good, of course, if the precise conditions found in cities where large numbers of cyclists currently do feel they belong and are safe could simply be replicated on the streets of London. However, as the practitioners we met were keen to emphasise, the many and varied differences between cities, and indeed between individual streets in the same city, mean that the best design solution in any location will arise from the context-appropriate application of sound principles and good standards; not from the cut-and-pasting of rigid design templates. Section 02 of this report presents some thoughts on a range of contextual factors.

COMMON TECHNIQUES

When these conditions are found, a wide range of cycle-friendly approaches or techniques have commonly been adopted. Many of these are familiar in London and the UK, though several are less so, and some are currently absent. Section 04 of this report presents information concerning around 35 such topics (plus sub-variants).

In the case of some, we can be quite confident and specific about how and why they provide good cycling conditions. In the case of others, we present a range of the alternative approaches that we found, together with some commentary on the differences between them and the potential benefits of their application in different circumstances. In all cases, we consider the implications for practice in London and the UK generally. The topics and techniques are presented under the following five themes:

- Links
- Junctions + Crossings
- Network/Traffic Management
- Interaction with Other Users
- Miscellaneous

The report also gives an indication of the 'degree of difficulty' of applying each technique in the UK context. Three categories are used, as follows:

- Techniques on which there are no UK legal or regulatory constraints, and which are already used in best London/UK practice.
- Techniques that are relatively rare in London/UK and about which there are some concerns over the current UK legal or regulatory position and/or their operational and safety record.
- Techniques that currently cannot be widely adopted in London/UK due to legal, regulatory or other obstacles.

The report does not categorise techniques in terms of their possible traffic capacity and/or cost implications. This is because the approach of the most successful cycling cities is to meet these challenges squarely, not use them as a justification for inaction.

COMMON CONDITIONS

Drilling down from these high-level factors, we found a range of conditions to be common in most cities with mature cycling cultures, recent significant growth in cycling, or a commitment to growing cycling. Together, these conditions comprise what could be considered an ideal basis for growing cycling.

1. There is strong, clear political and technical pro-cycling leadership which is supported through all parts of the lead organisation.

2. Cycling is considered an entirely legitimate, desirable, everyday, 'grown up' mode of transport, worthy of investment, even if current cycling levels are comparatively low.

3. Increasing cycle mode share is part of an integrated approach to decreasing car mode share. There is no intended overall abstraction from walking and public transport; and improving cycle safety and convenience is not intended to diminish pedestrian safety and convenience.

4. Loss of traffic capacity or parking to create better cycling facilities, while often a considerable challenge, is not a veto on such action.

5. There is dedicated, fit-for-purpose space for cycling, generally free of intrusion by heavy and fast motor vehicle traffic. In cities where the aim is to grow cycling rapidly, simple, cheap and effective means of securing this space have been used as first steps, with more permanent solutions following in due course.

6. There is clarity about the overall cycling network (including planned future development), with connectedness, continuity, directness and legibility all being key attributes.

7. There is no differential cycle route branding, simply three principal types of cycle facility that make up well-planned and designed cycle networks:

a. Paths/tracks/lanes on busier streets which provide a degree of separation from motor vehicles that is appropriate to motor traffic flows/speeds and the demand for cycling.

b. Quiet streets/'bicycle streets' with 30kph/20mph or lower speed limits and often restrictions on motor vehicle access, particularly for through movements.

c. Cycleways/'greenways' away from the main highway (e.g. bicycle-only streets, paths in parks and along old railway lines and canals), but still well connected to the rest of the network at frequent intervals.

8. There is clear, widely-accepted and routinely-used guidance on the design of cycling infrastructure.

9. The frequency of occasions when cyclists need to give way or stop is minimised. This means that people cycling are able to make steady progress at a comfortable speed.

10. At least subjectively, where the cycle mode share is greater, the driving culture (and indeed city culture generally) is more respectful of the needs of cyclists. Local traffic laws often play a part in this.

11. Making better provision for cycling, even in the most well-cycled cities, is an ongoing challenge; with growth in cycling, and of city populations as a whole, requiring clear forward planning.

KEY FINDINGS

This study has yielded a great deal of valuable information, but no simple formula that will transform London or other UK cities into places as attractive to cycle in as, say, the capital cities of the Netherlands, Denmark and Germany. What is needed is concerted action, on several fronts, according to a clear plan, over the long term.

The report's authors trust that the following key study findings - distilled from Sections 02, 03 and 04 - will help guide such action.

Liveability

Good conditions for cycling, and resulting high levels of cycling, are only found where the city's political and technical leaders consider that increasing the mode share of this form of transport is beneficial for the city in economic, social and environmental terms; and part of an overall approach to enhancing city liveability.

Leadership

This leadership is critical because creating good conditions for cycling may mean taking highway space currently used for moving or parked motor vehicles; and this often draws local public opposition even in cities with very high levels of cycle ownership and use.

Governance

Systems of governance relating to transport vary between cities. Those with comparable systems to London (i.e. with a strong strategic authority able to lead by example on its own highways, and to appropriately influence the boroughs through that leadership) seem to have the best structure for improving conditions for cycling.

Long term commitment

Cities with the largest cycling levels and most cycling-friendly street use cultures have achieved that status as a result of policy and associated action over the long term, with an incremental approach to improving provision. Continuity of commitment to cycling as a desirable and benign mode, one worthy of major investment, is essential.

Incremental change
Some cities have shown that it is possible to grow cycling levels significantly over just a few years by employing pragmatic, relatively inexpensive, and sometimes intentionally 'interim' means of securing space for cycling. Upgrading this infrastructure to the standard found in mature cycling cities is not precluded (and sometimes consciously provided for) by the measures initially used.

Infrastructure principles
In terms of infrastructure, there are some very clear and sound principles underlying the design of measures in the best cycling cities. However, there is no single physical 'model' that is either clearly optimal or directly transferable to London. Each city has applied the principles in a way that has been the best fit (e.g. politically for the whole city, or technically for any given street) at the time of intervention.

Protection + Separation
The cities with the highest cycling levels, and those that have successfully grown cycling levels over relatively short periods, generally afford cycling good physical protection or effective spatial separation from motor traffic, unless traffic speeds and volumes are low.

Similarities + differences
While there is, therefore, generally quite a strong 'common language' of cycling infrastructure provision across successful cycling cities, there are differences in 'accent' that can be quite important. A good example of this is the way in which different cities make provision for opposed turns by cyclists at signalised junctions. (See Common Technique J3.)

Avoiding jargon
Care needs to be taken in the use of certain terms, as confusion or over-generalisation can arise. For example, different terms to describe forms of cycle segregation, like 'hybrid', 'light', 'semi' and 'soft', have begun to abound, although their meaning is by no means easily or commonly understood. This report seeks to describe techniques simply on the basis of their characteristics.

Avoiding compromised designs
Cities that are serious about growing cycling do not employ measures that are obvious compromises; such as cycle lanes that are too narrow to be fit for purpose, operate only part-time, and/or terminate abruptly or with a hazardous merge.

Legal + regulatory scope for change
In almost every study city, the legal framework, and associated signal control methods, generally provide for much greater flexibility in terms of designing for cycling than is currently the case in the UK. (For example, see Common Technique J6.) While the scope for positive change in providing for cycling in the UK is constrained to some extent by existing highway regulations, all the study cities visited provide good examples of how better cycling provision can still be made within a less conducive regulatory framework.

Streetscene impact
Cycling infrastructure can successfully be designed as an integrated part of the streetscape – although there are also unsuccessful examples of this. Though a mode of transport that it is highly desirable to encourage, cycling in cities is primarily a means to an end. Provision for cycling should do as much as it can to contribute positively to, and not to detract from, the wider experience of being in a city. While it is important that aesthetic concerns do not compromise the practical utility of cycle infrastructure, it is also important that purely functional considerations should not compromise the attractiveness of streets for all users.

Pedestrian-cyclist interaction
In intensely cycled cities, the interaction of cycle traffic with pedestrians can sometimes seem disorderly to UK eyes. However, no evidence was found of specific safety problems arising from such interaction; and people seem generally to have learned to negotiate harmoniously with one another at close quarters. Nevertheless, since the views of pedestrian user groups were not canvassed as part of this study, the known concerns of some UK user groups cannot adequately be addressed by simply arguing "it seems to work fine over there".

Driving cultures

In study cities with more mature cycling cultures, drivers were found to be notably more respectful of cycling and observant of the rules of the road than in London. To suggest this is simply because the Dutch, for example, are naturally more respectful people is barely credible. Much more credible is that better driver behaviour is a general product of more liveable cities, and specifically the result of a virtuous relationship involving good cycling infrastructure, a supportive legal framework, and growth in the number of people cycling.

Cycle parking

Making adequate provision for cycle parking is a high priority in all well-cycled cities. Even where cycle theft is not considered a major problem and fixed stands are not a requirement, simply finding the necessary space (on or off street) can be a significant challenge.

In closing

Within the study cities, relatively few techniques were found that cannot currently be used in the UK context; and indeed London has shown that it can apply some of the best techniques very well.

As a simple consequence of population size and development density, only New York (of the cities visited) faces a comparable challenge to that faced by London in terms of how physically to accommodate significant growth in the volume of cycling. Berlin - with a population of 3.5m, relatively high density, a cycle mode share of around 15%, and a comparable governance structure - may be an especially helpful city for London to learn more from.

None of the study cities that now have mature cycling cultures started with a cycling and general street use culture comparable with London's today. There is, therefore, no ready template for a transitional process that London, or indeed other UK cities, can follow.

None of the study cities is perfect for cycling; none is resting on its laurels; none is simply planning to do more of the same; and all have targets to grow cycling still further.

01 INTRODUCTION

BACKGROUND TO THIS STUDY

The Mayor of London has set a target to increase cycling by 400% from 2001 levels by 2026, and Transport for London (TfL) recognises that the delivery of world class cycling infrastructure in London will require practitioners to learn from others around the world, to apply tried-and-tested techniques the London context, and to innovate as necessary.

The Mayor's Vision for Cycling, launched in March 2013, describes how the profile of cycling in London will be transformed and sets out the investment to back up the vision. It emphasises how infrastructure will contribute to creating better, safer, more comfortable and more direct facilities for cyclists. The following quotes are extracts from the Vision.

"There will be more Dutch-style, fully-segregated lanes and junctions; more mandatory cycle lanes, semi-segregated from general traffic; and a network of direct back-street Quietways, with segregation and junction improvements over the hard parts."

"*Where it is not possible to segregate without substantially interfering with buses, we will install semi-segregation: shared bus and bike lanes, better separated from the rest of the traffic with means such as French-style ridges, cats' eyes, rumble strips or traffic wands in the road.*"

TfL wants to learn about how others have worked to make their cities more attractive for cycling, and considers that a study of international (and national) best practice should help inform the choices London needs to make about what infrastructure may be appropriate and how and where it might be used.

STUDY PURPOSE + AUDIENCE

This research study was commissioned to compare good practice from cities in the UK, Europe and worldwide to learn from success in relation to cycle infrastructure, cycle safety and cycling culture. It was tasked to focus on design approaches in cities that have successfully achieved significant growth in cycling numbers.

This study feeds into a wider programme of work being undertaken across TfL to identify, develop and share best practice in all elements of cycle provision.

STUDY PROCESS

The heart of the study has been visits to fourteen cities of different character, to learn from them by interviews with local practitioners and by riding. The cities were chosen by the TfL client group and consultancy team as enabling different types of lesson to be learned. In terms of current cycling mode share, the study cities range from New York to Utrecht; from a mega-city of 8+ million inhabitants that has recently begun to reallocate street space from general traffic to cycling to one of the world's foremost cycling cities where around a third of all journeys are by bicycle. The full list of cities visited for this study is:

- Berlin
- Brighton & Hove
- Cambridge
- Christchurch
- Dublin
- Malmo + Lund
- Minneapolis
- Munich
- Nantes
- New York
- Seville
- Stockholm
- Utrecht
- Washington DC

Arising from study visits undertaken by the lead members of the consultancy team earlier in 2013, lessons from Amsterdam and Copenhagen have also been incorporated within this report.

It was considered important not just to learn direct lessons from cities regarded as models of cycling provision, but also to understand how other cities have previously applied lessons from these Dutch and Danish exemplars.

City visits were typically of two days' duration. In addition to meeting with local practitioners, the study team covered as much ground by bicycle as possible, often in the company of their hosts. On average, cycling itineraries were of between 40km and 50km per city. Where possible, the consultancy team members were accompanied by TfL officers. In total, 15 TfL officers took part in the city visits.

REPORT STRUCTURE

Section 02 presents what we trust are helpful reflections on what we found, together with some of the main lessons we learned relating to the application of best practice from other cities to London and the rest of the UK.

Section 03 then drills down to establish what we have called 'Common Conditions' for cycling success.

Section 04 looks into the detail of a wide range of 'Common Techniques' used by study cities to encourage and enable cycling.

Appendix A contains summary reports for each city the team visited. To facilitate comparison between cities, these reports present information under common headings. However, since the details we obtained varied from city to city, strict 'benchmarking' (comparison with a standard) has not been possible.

REPORT STATUS + ACKNOWLEDGEMENTS

This document is the report of the study's two lead consultants - John Dales and Phil Jones - to Transport for London. In preparing the report, we have gratefully received assistance from our consultancy colleagues (see inside front cover) and from our TfL client group.

The scope of the study means that this report isn't able to present exhaustive research of all the many issues it covers. This is consistent with the study's intended outcomes. We have relied largely on existing datasets and documentation, on the contributions of specific individuals, and our understanding and interpretation of these sources. We are sure there will be differences of opinion about some of the information we present, not least because we have such differences between ourselves, and also because the practitioners we met have strong views of their own that differ from those of others.

The people we interviewed in each study city are identified within the City Summaries presented in Appendix A; and we want to take this opportunity to record our sincere gratitude to these individuals for putting their time and expertise at our disposal. Our thanks are also due to Kevin Mayne of the European Cyclists' Federation for putting us in touch with some of the people we met and learned from.


Kreisverwaltungsreferat


FAIR
BIKE

02 OBSERVATIONS + LESSONS

This section presents important observations and the main lessons we learned relating to the application of best practice from the study cities to London and the rest of the UK.

EVIDENCE + SUBJECTIVITY

Arising from the city visits and related researches, we consider it will be helpful to comment here on the nature of the conclusions that can be drawn from the information we obtained. We are conscious that, on the one hand, practitioners and others would welcome proof of the kind that states, "If you do this, you will achieve that"; but also that, on the other, it is widely recognised that what is needed to get more people cycling more often is that people should feel safe in doing so, and that this involves an obvious element of subjectivity.

Perhaps the first thing to be said is that we have uncovered no evidence that proves an unequivocal causal relationship between one type of intervention (e.g. a specific cycle path design, or a method dealing with opposed turns at signals) and its effect (e.g. a given increase in cycle volumes, or a given change in cyclist casualty statistics). This is partly because of the simple lack of data available to enable comparison of before-and-after indicators for optional measures across different countries; and it is also, of course, partly due to the inherent complexity of the environments in which people cycle. Numerous factors are at play, many of them only indirectly to do with cycling.

For these reasons, we consider it helpful to look first at the general, not the specific; by which we mean, for example, that since a third or more of all journeys in Utrecht are made by bicycle it is reasonable to adopt the premise that there is much to be learned from that city, and indeed the Netherlands as a whole, about how to create conditions that encourage mass cycling. Similarly, there are likely to be important lessons to be learned from Cambridge, a UK city where almost a third of journeys to work are made by bike.

CULTURE

This brings us to the matter of cycling and broader street use cultures, how they differ, and how they change. In conducting this study, only in New York and Minneapolis did we find a cycling culture comparable to that frequently derided in London as dominated by speeding MAMILs (middle-aged men in Lycra); a culture that is quite different from the much more relaxed, all-age, helmetless and low-viz cycling culture found in the Netherlands and elsewhere in Europe.

A high-speed, assertive cycling culture seems to be a corollary of the prevailing driving culture which, in London and these US cities, is often characterised by impatience and limited concern for other road users. Signs of positive change in this regard have been observable in recent years - at least in certain parts of the cities in question; and these may relate to the introduction of public bike hire schemes, to infrastructure improvements, and to less quantifiable social trends. Nevertheless, London faces a considerable challenge in moving from its current street-use culture - with often divisive modal identities - to one that compares favourably with what we found in mature cycling cities.

Bearing in mind the importance of subjective safety in determining whether people choose to cycle or not, we can report that we always felt that drivers in cities with mature cycling cultures were much more mindful of cyclists than in London, and indeed the UK generally. However, we cannot assert that the reason for this is that these drivers are necessarily more respectful of cycling, or that they think "that cyclist could easily be me or my child", or that they drive around ever-conscious of their 'presumed liability' if a collision with a cyclist were to occur.

In places like Amsterdam, Berlin, Copenhagen, Malmo, Munich and Utrecht, drivers seemed to take the lion's share of responsibility for looking out for cyclists while turning. Similarly, drivers in these cities readily fell in behind cyclists in quiet, residential 20mph streets, rather than impatiently (sometimes aggressively) tail-gating them.

There is no evidence that these benign street use cultures are the result of specific 'culture change' programmes. Rather, they are a characteristic of liveable cities in which there is a virtuous relationship involving various factors, including good cycling infrastructure, a supportive legal framework, and growth in the number of people cycling.

CHANGE

Almost every authority we visited outside the Netherlands or Denmark explicitly stated that they had looked to cities in these countries for guidance on how they might grow cycling. Yet there are numerous differences between the ways that these two countries, and different cities in them, provide for cycling. There is, in short, no single package of techniques that has been proven to be effective in all circumstances. "Listen and learn, but then find your own way" summarises a repeated theme from the practitioners we met.

Improving conditions for cycling in London will inevitably be the result of a complex process, covering policy-making, planning and engineering, over the long term. While several of the cities covered by this study show where London should be heading, and also to some extent how, London is moving on from a set of circumstances that is unique, and so the path of change will be its own.

To that end, our researches have identified certain conditions on which truly good provision for cycling depends. They have also enabled us to make recommendations on design techniques that we believe will, if adopted and pursued, achieve and sustain growth in cycling throughout London.

GOVERNANCE

Broadly speaking, we saw four models for transport governance within cities:

1. A single (or very powerful) transport authority for the whole city

2. A two-tier arrangement, with a city-level lead authority for the main transport systems and significant subsidiary authorities responsible for local provision

3. A two-tier arrangement with a single city authority but with one or more external authorities (e.g. State, County) responsible for all or some transport functions within the city

4. Multiple authorities across the city with no overall lead

The first of these models tended to be applied very effectively in the smaller cities such as Malmo, Nantes, Seville and Brighton & Hove, although New York is also an example of this type, where the Department of Transport controls every street across the five boroughs.

In terms of transport alone – and specifically cycling – this model can achieve the best outcome as it allows for consistent, well-planned and appropriately-funded interventions that can effect change very quickly. The downside is that a change of political regime can bring about an immediate end to that programme of investment – as was recently the case in Seville, for example.

In the larger cities, there tends to be a tension between the need for consistent and strong leadership and the requirement for decision making that reflects local concerns, and so the second model tends to be favoured in these places, including London, of course.

This structure allows for strong leadership from the centre; typically covering the principal highway network, a strategic cycling network plan, technical guidance and funding. It also allows for variations of emphasis on relatively minor streets, according to local decisions.

The third structure was seen in cities such as Cambridge, where the wider County Council has responsibility for transport, and in Minneapolis where some main highways are state- and county-controlled. The fourth model operates in Stockholm and to a lesser extent in Copenhagen.

These latter two types of structure make it more difficult to achieve good provision across a city. The third model may, for example, lead to decisions for the city being made by politicians or officers with limited experience or interest in urban conditions. The fourth model allows for cycling and wider transport policies to change at each borough boundary, and constrains strategic network planning.

Our conclusions from this are that model one is best suited for encouraging cycling in most UK cities, and model two is best suited for London.

POLICY + FUNDING

The best and most mature cycling cities such as Utrecht, Copenhagen and Malmo have enjoyed continuous cross-party support for cycling over many years. This has allowed pro-cycling policies to be developed and (crucially) put into effect through consistent, adequate and ring-fenced funding. This has also enabled skilled teams to be built and maintained who can develop cycling networks to a consistent and high standard.

Certainty of forward funding for the foreseeable future is a characteristic of cities with good provision for cycling and high cycling levels. It was notable that in most of the cities we visited, officers were easily able to name a figure for their cycling investment programme.

Even where a focus on improving cycling conditions has been more recent, we found that where investment is well focused on cost-effective measures – such as in Seville and New York – it is possible to make a significant difference over just one or two political terms.

LEGAL + REGULATORY FRAMEWORKS

Evidence from the study cities is that a supportive legal and regulatory framework is a very important ingredient on creating good conditions for cycling. Such support encourages (and helps enforce) better behaviour from all road users, particularly drivers. It also enables transport authorities to put good infrastructure into place.

National laws and regulations are especially valuable in ensuring consistency of user expectations and practice. Good examples from the countries visited include: the legal requirement for drivers, when turning, to give way to cyclists (and pedestrians) going ahead; and the presumed civil liability of drivers in the event of a collision with a cyclist.

In terms of highway regulations, some features used to enable cycling in countries like Denmark and the Netherlands are not currently allowed by the UK's Traffic Signs Regulations and General Directions. (See Section 03 for details. The features in question are 'Common Techniques' categorised in group C, as described on p.20.) Evidence from the study visits indicates that the potential benefits of these features on UK highways could justify appropriate regulatory change. The ongoing update of the TSRGD by the DfT presents an opportunity for this.

In some instances – for example in New York and Minneapolis – the cities themselves have been able to bring in helpful local laws. In New York, a city ordinance means that it is illegal to park a motor vehicle in any cycle lane. In Minneapolis, cyclists are allowed to cycle on any sidewalk (footway) except in the commercial district and where signed to the contrary.

Some UK city-specific laws do exist, such as the general footway parking ban contained in the Greater London (General Powers) Act 1974, but they are uncommon. More readily achievable are place-specific Traffic Regulation Orders (TROs), such as that for the London Safer Lorry Scheme, due later in 2014. Other UK cities could seek similar local provisions, should they so choose.

THE ONGOING CHALLENGE

One closing observation worth recording is that, even in the cities with most cycling, the work to encourage and grow cycling is not done - and never will be. Amsterdam, Copenhagen and Utrecht are great for cycling in, but they're not paragons. There are, and will remain, issues to address and challenges to rise to. From observation and from speaking with practitioners, some of the key challenges are:

- Maintaining and growing cycle mode share as cities grow, both in land area and density.
- Tackling pedestrian/cycle and cycle/cycle conflicts and related congestion, especially at certain locations, such as at the 'corners' of signalised junctions.
- Finding, or creating, space and infrastructure for cycle parking, the demand for which is almost always where the amount of space is at a premium.
- Enhancing bike-rail interchange in order to increase the length of journeys for which cycling can play a role in reducing the demand for car travel.
- Developing electric bicycle use - to enable longer journeys and cycling by more people on steeper gradients.

03 COMMON TECHNIQUES

This chapter covers a broad range of relevant topics and, in relation to each, the approaches or techniques that have commonly been adopted in the cities we visited.

In the case of some topics, we can be quite confident and specific about techniques that will provide good cycling conditions, if implemented. In the case of others, we present a range of techniques that we found, and some commentary on the differences between them and the potential benefits of their use in different circumstances. In all cases, we consider their application in the London and wider UK context.

The topics and techniques are presented under the following five themes:

- LINKS
- JUNCTIONS + CROSSINGS
- NETWORK/TRAFFIC MANAGEMENT
- INTERACTION WITH OTHER USERS
- MISCELLANEOUS

A list summarising all the topics/techniques covered is set out on the facing page. The rest of this section is a series of illustrated fact-sheets for each technique, grouped by theme.

We have given an indication of the 'degree of difficulty' relating to the application of each techniques in the UK context. This has largely to do with the legal and/or regulatory framework in place at the time of writing, but may relate to specific UK practitioner or public concerns about the operational, safety or other aspects of the technique in question. The 'degree of difficulty' categories are:

A. Techniques on which there are no UK legal or regulatory constraints, and which are already used in best London/UK practice.

B. Techniques that are relatively rare in London/UK and/or about which there are some concerns over factors like the current UK legal or regulatory position or their operational and safety record.

C. Techniques that currently cannot be widely adopted in London/UK due to legal, regulatory or other obstacles.

It is worth making clear that we have not categorised techniques relative to their possible traffic capacity and/or cost implications. The approach of the most successful cycling cities is to meet these challenges squarely, not use them as a justification for inaction.

Finally, we have also added a category of 'UNCOMMON TECHNIQUES' to highlight specific features that were almost completely absent in the non-UK/Irish study cities, but which have been common practice in the UK for many years. However well-intentioned, these features are usually signs of cycling not being taken sufficiently seriously as a valuable, everyday form of transport.

LINKS

L1 - Fit-for-purpose cycle lanes/paths/tracks

L2 - Separating cycles and motor traffic - options

L3 - Cycleways away from motor traffic

L4 - Bi-directional cycle lanes/tracks

L5 - Interaction of lanes/tracks with side streets

L6 - Addressing pinch-points

JUNCTIONS + CROSSINGS

J1 - Advanced stop-lines

J2 - Cycle-specific signals

J3 - Two-stage opposed turns

J4 - Measures to minimise 'left hook' conflicts

J5 - Cycle exemptions at red signals

J6 - Simultaneous greens for cycles, parallel pedestrians and turning traffic

J7 - Cycle-friendly roundabouts

J8 - Parallel pedestrian and cycle crossings

(Unsignalised side street junctions - see L5)

NETWORK/TRAFFIC MANAGEMENT

N1 - Use of low speed limits

N2 - Bicycle Streets

N3 - Use of very low speed limits

N4 - Filtered permeability

N5 - Cycle contra-flows

N6 - Wayfinding

N7 - Cycle lane/track construction and maintenance

N8 - Traffic lane widths tailored to available space

INTERACTION WITH OTHER USERS

I1 - Cycleways and footways: degrees of separation

I2 - Measures to address specific types of potential pedestrian-cyclist conflict

I3 - Bicycles at bus stops

I4 - Bicycles in bus lanes

I5 - Bicycles and trams

I6 - Use of bicycle paths by other modes

MISCELLANEOUS

M1 - Use of colour

M2 - Cycle parking

M3 - De-cluttering

M4 - Public cycle hire

M5 - Cycle-friendly 'accessories'

M6 - Promoting cycling

UNCOMMON TECHNIQUES

A brief checklist of cycle infrastructure features that are still relatively common in the UK but extremely uncommon in international best practice.

LINKS

L1 - Fit-for-purpose cycle lanes/paths/tracks
i.e. of an adequate standard to meet cyclists' needs and flows, that minimise conflicts with pedestrians, and which motor vehicles do not normally enter.

It shouldn't need saying, but UK experience suggests that it does: if a lane or track is meant for cycling, then, quite simply, it should be possible to cycle in it. This relates to issues such as width, freedom from obstruction or incursion, and availability at any time.

While there were considerable differences in the form of cycle lane/track provision in the cities we visited, the cycling facilities in the cities with the higher cycle mode shares almost always shared the following characteristics:

- Adequately wide for one cyclist to travel comfortably away from parked or moving vehicles on either side; and typically also with sufficient space for one cyclist comfortably to overtake another. Minimum acceptable width is considered to be 1.5m, with many cities also adding 0.5m 'dooring zone' clearance as standard.
- While cars and other motor vehicles may be able to cross the lane/track to park or load, parking or loading within the facility lane itself is prohibited at all times, and enforced.
- Lanes/tracks are typically operational 24/7 and 365 days a year.
- Cycling within bus lanes is enabled by means of a marked cycle lane with a distinct bus lane on the offside, or through an undifferentiated combined lane of adequate width for a bus comfortably to overtake a bicycle (e.g. 4.5m wide). See I4.

In other words, while the level of physical protection afforded to cyclists may vary, the focus is almost always on ensuring that there is sufficient space of sufficient quality to ensure that the passage of bicycles is maintained, and feels comfortable and safe.

Where cycle tracks are deployed, two particular details are sometimes used - especially in Dutch cities - to make the tracks as cycle-friendly as possible:

- well-designed, integrated ramp transitions from side streets and adjacent premises
- angled kerbs that ensure pedals with not strike the kerb and thereby encourage use of the full track width

Application in London + the UK

Sample cycle lane/track design guidance

In terms of why, how and where to deploy different forms of cycle lane/track provision, we consider that the guidance adopted by Utrecht is a good example of a clear template. An excerpt is reproduced on the following pages, and we think it is exemplary in terms of its simplicity and clarity.

UTRECHT Profiles

There are three basic profiles available, with a total of seven variants, for positioning the bicycle in the cross-section of a road. The choice of a basic profile can be approached from two directions. The most obvious is the approach from the basis of vehicle traffic: the basic profile is chosen based on the function of the road and the intensity and speed of vehicle traffic. However, a reverse approach is also possible and in many cases will appear to be usable: initially the preferred basic profile to be used will be determined and then the conditions must be created, with respect to vehicle traffic, in which this profile can be used. This is an especially usable approach if it is desired that safe and comfortable bicycle routes are realised, but when it is not desired or possible to lay separate bicycle paths. Within residential areas, traffic circulation measures will be used to realise corridors with limited traffic. The following three basic profiles are available for bicycle tracks, with in total seven variants.

Basic profile 1: Physical separation

Function: Guarantee cyclists their own space or provide protection from the pressure of motorised traffic. Offering short connections.

Use: By cyclists and possible moped riders. Used when car speeds and intensity are high (see graph). Furthermore, this profile is to be recommended when there is a high proportion of heavy traffic.

Design: Separation of the cyclists from other traffic using a verge, barrier and/or height difference. If required, a separate route. Separate bicycle routes can be used to supplement the network of bicycle routes.

Variants:
1. Separate one-way bicycle path alongside both sides of the road.
2. Separate two-way bicycle path along one or both sides of the road.
3. Solitary bicycle path.

Road category: Running alongside separate bus lanes. Running alongside main roads. For bicycle connections that have their own route.

Basic profile 2: Visual separation

Function: Indicate a separate space for bicyclists.

Use: Only for cyclists. Used when vehicle speeds are between 30 and 50 km/ hour within the built-up area and 60 km/hour outside of the built-up area and in the event of high traffic intensity (see graph). Can be used to improve subjective safety. Furthermore, this profile can also fulfil a function in indicating the cohesion of the bicycle network.

Design: Separation by a dashed or solid line. The lane must preferably be red and must always have the bicycle symbol. The bicycle lane has a legal status.

Variants:
4. Bicycle lanes in spacious profile, whereby cyclists are visually and legally separated from car traffic and can be overtaken.

Road category: Among other things by access roads to residential districts.

Basic profile 3: Mixed profile

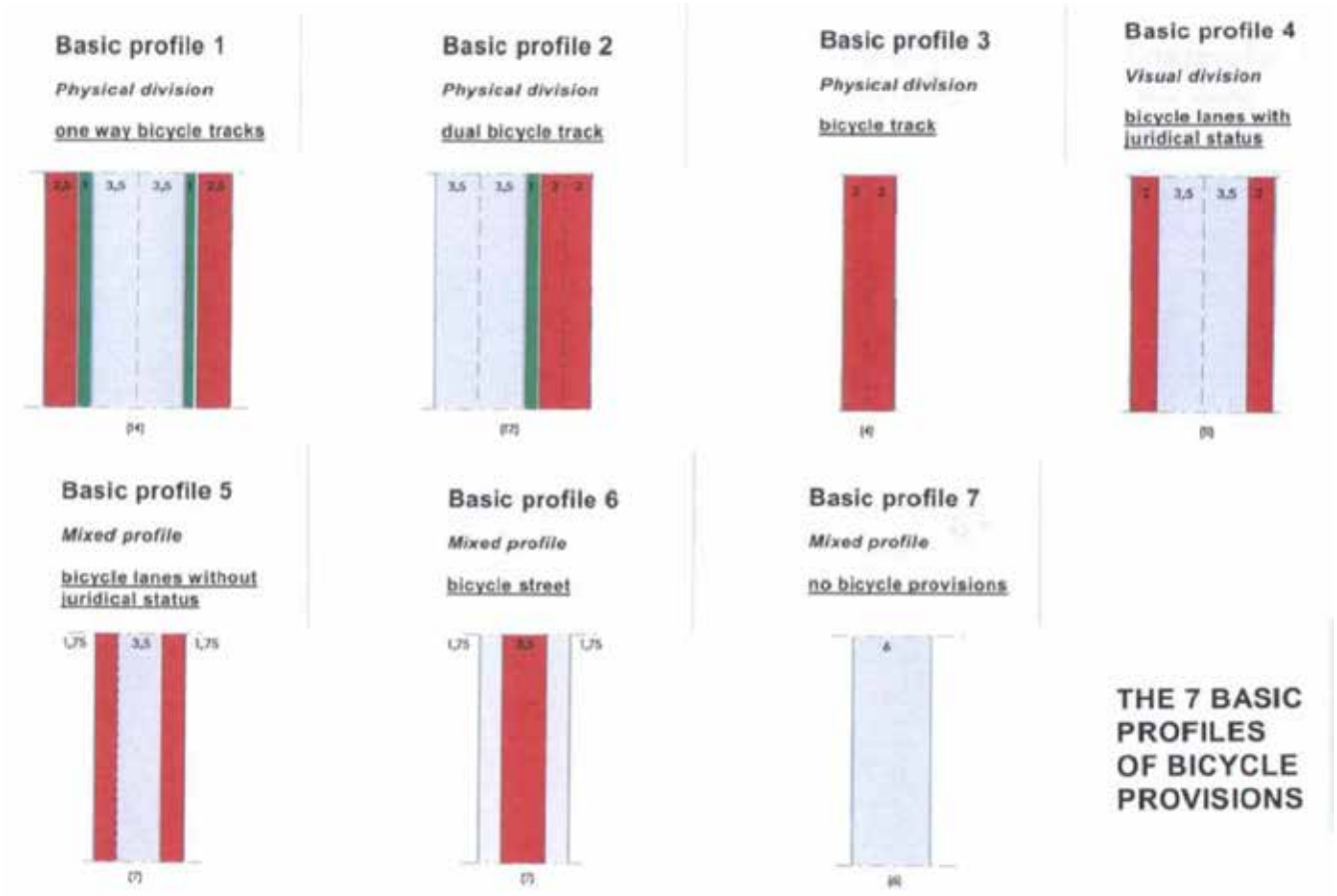
Function: To offer spacious, recognisable and comfortable bicycle routes on roads where multiple types of traffic are allowed. The handling of multiple types of traffic in the same space.

Use: All types of traffic are mixed. Used for low speed-intensity combinations (see graph). Suitable for use in 30 km/hour zones. Outside of the built-up area, maximum 60 km/hour.

Design: Bicycle traffic and vehicle traffic are not physically separated; on a wide profile with overtaking possibilities for vehicle traffic or on a narrow profile without the possibility for vehicle traffic to overtake. By using variations in paving material, marking or the use of colour, the function as bicycle connection can be emphasised. This is the bicycle street profile. One type of layout for a profile with mixed traffic can be a single lane with bicycle lane without a legal status.

Variants:
5. Bicycle lanes without a legal status in a narrow profile, whereby the bicyclists are only visually separated from the car traffic but cannot always be overtaken. The other traffic may also make use of these lanes.
6. Roads for mixed traffic whereby, by using variations in paving, marking or colour, the presence of the cyclist is emphasised (including the bicycle street profile).
7. Roads for mixed traffic where no provisions are made to emphasise the presence of cyclists.

Road category: In residential areas.



Berlin - an off-carriageway track of adequate width and good visual separation from the footway.

Berlin - a 1.5m-wide cycle lane and 0.5m buffer zone, where incursion by vehicles is only in order to access parking bays

A generously-proportioned cycle track in central Utrecht

Houten: a 'forgiving' kerb at the edge of a cycle track - angled to avoid being clipped by pedals on the down-stroke

Seville - cycle track replaced car parking. Angled car parking (more spaces) now occupies what was a running lane

Munich - a well-proportioned cycle lane, plus buffer, where previously there was a second general traffic lane

Extra cycle capacity where it's needed - in this case, near Amsterdam Central Station

A fairly typical arrangement in Amsterdam, outside the historic centre: carriageway; parking; cycle track; footway

Typical cycle lane in Hammarby - a new suburb of Stockholm

A heavily-used and appropriately wide cycle track in central Copenhagen

Brighton & Hove - a gentle transition from on-carriageway cycle lane (in bus lane) to off-carriageway 'shared use' path

Plenty of room to cycle alongside/overtake on Brighton & Hove's Old Shoreham Road track

L2 - Separating cycles & motor traffic - options

a. Stepped cycle tracks
b. Vertical features that are difficult/ impossible for motor vehicles to overrun
c. Intermittent vertical features that motor vehicles can overrun relatively easily
d. Painted lines
e. Offside car parking, trees and street furniture

This section covers a range of techniques used to separate cycle lanes/tracks from the adjacent general carriageway. These vary greatly in respect of cost, engineering complexity and effectiveness in delivering both objective and subjective safety for cyclists.

a. Stepped cycle tracks

Cycle tracks that are separated by a kerb step from both footway to one side and main carriageway to the other (hence sometimes called 'half height' tracks) are used extensively in Copenhagen and other Danish cities, and are also becoming more commonplace elsewhere. They are typically uni- directional, with cyclists travelling in the same direction as motor traffic.

Sometimes also known as 'hybrid' tracks or lanes, because they're spatially in the same location as carriageway-level lanes but are raised above the level of the carriageway (say at +75mm) and thus offer a degree of segregation similar to a wholly separate track. The cycle track slopes back from the carriageway so that it is then possible to have a second kerb, typically around 25-50mm high, up to the footway.

The approach taken in Copenhagen over many years has been to initially provide space for cycling in the form of a painted lane, which is converted to a stepped track as funds become available.

The main advantages of stepped tracks are:

- They take no more space than a simple traffic lane
- Cyclists are in the same location as in a lane, which means that cyclists are in a consistent position in the cross-section and their presence can easily be anticipated by drivers and pedestrians.
- Because of their constant position, it is very easy for a lane to change to a track, and vice versa. This is often done on the approach to both major and minor junctions, so that cyclists can be placed in a more visible position from which they can assert their right of way
- Having a full kerb at the carriageway edge helps to prevent vehicles from parking on the track; in some cases designated parking spaces are situated along the track.
- They are better than 'lightly-segregated' tracks in visual terms, requiring very little in the way of signs and markings to form an effective space for cycling that is clearly separate from both pedestrian and motor traffic space.

Stepped tracks are much more costly to construct than 'lightly-segregated' tracks, however, normally requiring additional drainage infrastructure.

New York has implemented a number of stepped tracks and, like Copenhagen, has done this after initially taking the space using low cost 'light segregation'.

There are few stepped tracks in the UK presently, but probably the best example is in Brighton & Hove, on Old Shoreham Road. This was constructed in 2012 by narrowing the carriageway from 2 very wide lanes to a total of 6.1m over a length of around 1.5km. The one-way tracks on each side are 1.5-2.6m wide.

Cycling on Old Shoreham Road is given a strong sense of priority over side streets by simply continuing the cycle track treatment across the minor arm, giving no indication that cyclists should give way, and setting back the give way marking on the minor arm. Reducing the corner radii has also helped to prioritise cycle movements by slowing the speed of turning vehicles.

b. Vertical features that are difficult/impossible for motor vehicles to overrun

Several cities separate their carriageway-level cycle lanes from the adjacent main carriageway using more or less intermittent features that make it very difficult, if not impossible, for motor vehicles to encroach. We observed a number of different features on our city visits, and are aware that others have been employed in other cities. Such features include:

- Slender plastic bollards (which can be spring-mounted), sometimes referred to as 'wands'
- Relatively high-profile concrete blocks, such as the semi-circular 'Lacasitos' used in Seville
- Linear sections of concrete kerb with a significant upstand (e.g. 125mm), broken occasionally
- Continuous, high-profile barriers (e.g. railings or concrete panels)
- Planters (such as used in Vancouver)

These types of designs yield comparatively high degrees of subjective and actual safety to cyclists, but have a number of drawbacks compared to the 'lighter' techniques covered in section (c) below. These drawbacks include:

- Higher costs both in relation to basic construction (these vary according to type of feature) and to any future widening/ modifications
- Continuous systems interrupt road drainage so that additional gullies are needed, further adding to construction cost.
- The features are usually difficult to remove for general maintenance tasks
- It can be difficult, and sometimes impossible, for cyclists to enter or leave the track to access a local destination or to overtake slower moving cyclists
- Typically negative impact on visual amenity/ streetscape quality
- It is relatively difficult (at best) or impossible (at worst) for pedestrians to cross the street.

c. Intermittent vertical features that motor vehicles can overrun relatively easily

Often referred to as 'light segregation', in view of the relative simplicity of implementation and physical properties of the features used, this technique is commonly expressed in the form of the following:

- Raised thermoplastic road markings
- Specially-formed rubber/PVC devices (e.g. 'Armadillos')
- Short lengths of low-profile concrete kerb

Sometimes, car parking has been located on the offside of the separation features, between cyclists and moving motor traffic (see also L7). This appears to work well, although we were told that there was some initial confusion over this in Minneapolis, with drivers apparently being unclear as to where they should park (as not against a conventional kerb).

Based on our conversations with practitioners in the relevant study cities, there is a general consensus that this type of facility gives cyclists a much improved sense of subjective safety, and they are therefore very popular. Such schemes can be built quickly and cheaply since they do not interfere with buried services and drainage.

'Light segregation' allows cyclists to enter and leave the track easily (if no car parking is located alongside) and features can usually, if necessary, be easily removed for maintenance or modified as cycle flows increase.

Cambridge is planning to use 'light segregation' on a number of routes, and sees such provision on busy highways as critical to taking its cycle mode share (already the highest in the UK) to the next level.

d. Painted lines

Simple painted features, including solid and broken lines and wider hatched strips, are very widely used to define space for cycling. Such markings generally deliver limited subjective cyclist safety, relative to the features covered in (a) to (c) above. Nevertheless, practitioners in several study cities consider them effective on certain conditions: that the cycle lanes are themselves are adequately wide; that they're well enforced; and that the adjacent traffic lane is appropriately wide. In addition, it seems that marking the cycle lane on the offside of permitted kerbside parking, with a 'dooring zone' buffer, helps to discourage 'double parking' in the cycle lane itself. Officers in both Berlin and Munich also expressed the view that objective safety for cyclists in well-specified lanes is enhanced by drivers having an uninterrupted view of them.

e. Offside car parking, trees and street furniture

Several cities deploy typical street features on the offside of cycle lanes/tracks to provide additional protection for cyclists from general traffic. These include on-street parking, trees, verges, and street furniture like cycle racks, lamp columns and seating. The basic idea is simple: if these features are to be in the street anyway, then they may as well also be used for this additional purpose.

Placing kerbside parking on the offside of cycle tracks/lanes, rather than the nearside, has no impact on the amount of parking provided. Yet it gives cyclists protection from moving vehicles and means drivers do not have to cross the cycle lane to access the parking bays.

As regards concerns about possible 'dooring', where cars are parked facing the direction of travel on that side of the street, it is only the passenger doors that would open into a nearside cycle lane/track. Passenger doors usually open less often than the driver's door, because every car has a driver. Additionally, if a dooring does occur, cyclists would be thrown into the adjacent footway, not the carriageway.

Where loading across the cycle track takes place, this may cause an occasional obstruction of the cycle lane/track; but in most study cities this is considered preferable to the alternative of placing cycling between parked and moving vehicles.

Application in London + the UK

Although comparatively rare in London until recently, stepped tracks provide a good level of service and are likely to be appropriate in a range of circumstances. These situations include high quality streetscape schemes where carriageways are being narrowed but defined and protected space needs to be maintained for cycling.

When considering more permanent, 'heavier' segregation - i.e. types (a) or (b) - it will be important to provide a track width at the outset that is likely to accommodate significant future growth in cycling.

The impact on pedestrian crossing movements, in the local context, should also be an important factor in selecting the preferred form of separation. With simple stepped tracks, any pedestrians tripping on the upstand would typically fall into the cycle track itself or footway. With other forms of physical separation (e.g. kerbed strips, Seville-style 'Lacasitos', and thermoplastic humps), any pedestrians tripping might also fall into the main carriageway.

Based on our visits to New York and Seville, in particular, we consider 'light segregation' likely to be an effective means of quickly securing safer space for cycling. The option to move to a 'heavier' form of segregation, if later considered desirable or necessary, will always remain.

To date, 'light segregation' has not been widely used greatly in London, other than temporarily in relation to roadworks. PVC 'armadillos' (and also some planters) have been used as a form of on Royal College Street in Camden, and the experience with this scheme has indicated that there are unlikely to be significant regulatory obstacles to installing these kinds of measures elsewhere in London and the UK. (Their use is now currently also being trialled in Manchester.)

Flexible wands are already used on UK roads, although not commonly in combination with cycle lanes. There is little reason to expect that they cannot be adapted for use in cycling infrastructure, and indeed a small number are to be found protecting cycle lanes at Admiralty Arch in London and on the Lewes Road in Brighton & Hove. Flexible wands are likely to be suitable for use in locations where lower-profile separators are considered not to provide adequate separation, e.g. on the approaches to junctions, where there are concerns about turning motor vehicles encroaching (see also J4).

Experience from several study cities suggests strongly that, where painted markings are used, the following conditions should apply:

- the lanes themselves are fit for purpose in terms of width and hours of operation;
- enforcement or illegal parking/loading is effective;
- the width of the separator itself should help to increase subjectivity safety (i.e. hatched areas are preferable to narrow lines); and
- the width of the adjacent traffic lane should be sufficient to minimise the likelihood of encroachment.

The use of offside parking to protect cycle lanes/tracks is uncommon in London and the UK at present. The best example we saw in a UK study city is on Grand Avenue and The Drive in Hove. From observations in other study cities, the benefits of offside parking in terms of the subjective safety of cycling seem clear; the basic arrangement is space neutral; and the technique does not generally reduce the existing level of parking provision.


Stepped cycle track in Copenhagen


Stepped cycle track in Utrecht


Stepped cycle track in Stockholm

Utrecht - stepped separation provides good protection, but is not an uncrossable barrier to vehicles

The stepped Old Shoreham Road track between Brighton and Hove

Typical stepped cycle track profile in Munich

New York - stepped track as part of public realm scheme

Barrier-separated cycle track in Stockholm...

...and in Seville

New York - where simple painted lanes become...

...stepped tracks when funds allow.

Flexible wands, with extra-wide painted buffer strip: New York

Flexible wands, with painted buffer strip: Minneapolis

Seville - robust concrete 'Lacasitos'

Seville - non-flexible wand-like bollards

Of these three separation techniques recently trialled at the TRL, only wands were observed in study cities

Raised thermoplastic markings: Nantes

Wide buffer strip with offside parking: Nantes

Extra-wide buffer markings on rural dual carriageway: Nantes

Painted lanes are used in most study cities. In Amsterdam, such lanes are operational 24/7 and usually found only in...

...streets with low traffic flows/speeds. The broken line indicates that vehicles can cross to park on the nearside.

Berlin: this cycle track is separated from the main carriage-way by parking, a kerb and a tree-planted strip

Berlin: transition from an on-carriageway lane to a stepped track on the approach to a signalised junction

Seville - the offside parking here is also step-separated from the cycle track

Copenhagen - the offside parking here separated from the cycle lane by a painted line

Amsterdam - this track is both step-separated and protected by parking, street furniture and trees

In Houten, near Utrecht, this cycle track is separated from the carriageway by a generous verge and trees

L3 - Cycleways away from motor traffic
e.g. through parklands; along waterfronts, canals or old rail corridors; or simply forming a road where only cycling is allowed.

In most of the cities visited there were a number of important routes in the cycling network that were entirely free from motor traffic. The terms used for the routes included Greenways and bicycle roads, but regardless of the term used and the environment through which the route passed, the experience for cyclists was generally the same.

The best examples of these share a number of characteristics.

In general they are:

- On key desire lines and therefore heavily used for utility cycling (as well as recreational cycling in some cases). In several of cities visited they are amongst the busiest cycle routes in the network.
- Of generous width – typically at least 3m but sometimes over 5m, and with a centreline to separate cyclists by direction.
- Fully segregated (between pedestrians and cyclists). There is usually a kerb or verge separating the footway from the cycle track, and pedestrians treat it as a narrow carriageway to be crossed.
- Well integrated with the rest of the cycle network with regular connections to streets and/or other routes, and linking key origins and destinations
- Free of frequent junctions or other places where cyclists need to stop.

In many cases the routes were alongside live or redundant transport corridors – major highways, railways, canals and busways - and so benefited from their directness and gentle gradients. Other routes were through parks and greenspaces and in one case (Malmo) along city streets where motor traffic had been removed entirely.

These cycle routes are popular because they enable cyclists to travel at a reasonable and continuous speed, without needing to stop very often and with no risk from motor vehicles. They are constructed and maintained as significant infrastructure in their own right, with good quality lighting and smooth surfaces.

Application in London + the UK

This study has shown that high quality routes through parks, etc. can form an important element of a city's cycle network, and not just recreational facilities.

A particular challenge that London faces relates to the fact that parks and canal towpaths are typically not under the jurisdiction of the highway authority and are, in addition, often subject to a number of non-highway-type bylaws. Engagement with local authority parks departments, the Royal Parks, and the Canal and River Trust should be based on reference to existing best UK and non-UK practice, with the aim of establishing new standard approaches to cycling provision away from motor traffic that can be readily applied in almost all circumstances.

Another challenge is that of lighting the cycleways sufficiently for the purposes of navigation and personal security - so that they are not merely part-time facilities. Introducing new lighting is likely to require consultation with relevant authorities and local people. The impact on certain wildlife species can be an especially tricky issue to resolve.

Midtown Greenway: Minneapolis

Connection to Midtown Greenway: Minneapolis

Martin Olav Sabo Bridge, Midtown Greenway: Minneapolis

Malmo: Bi-directional cycle path along motor traffic-free street (except frontage access)

Malmo: Bicycle roundabout - where several motor traffic-free routes meet

Separate, parallel cycle and pedestrian paths beneath a major traffic junction: Lund

A common sight in Houten

Cycling through the Tiergarten in Berlin

Stockholm - a ride in the park near Huvudsta, Stockholm

A waterside cycle track in Stockholm

Seville - where a wooden 'boardcycle' helps smooth the ride over cobbles along the waterfront

Another cycle track alongside the Guadalquivir navigation in Seville

L4 - Bi-directional cycle lanes/tracks

These are rarely the norm when alongside motor traffic, but are used in certain circumstances (e.g. for cost/speed/simplicity of construction; where street frontage is one-sided; or where the main carriageway is very busy/difficult to cross).

In most study cities, cycle tracks and lanes were one-directional, with cyclists travelling in the same direction as motor traffic. However, in some locations bi-directional tracks are used, generally for one or more of the following reasons:

- Where the street frontage is one sided (e.g. along waterfronts)
- Where the main carriageway is busy and difficult to cross, bi-driectional tracks on both sides mean cyclists can travel in either direction without having to get to the other side
- On routes that are entirely separate from highways (see L3), thus forming a highway that is exclusively for cycles (but usually with a footway alongside)
- To cope with large and complex junctions where it is easier to thread a two-way cycle route through than provide a route on all sides.

Only Seville and Malmo use bi-directional tracks as the default solution. In Seville, where the overriding aim was to construct a comprehensive network quickly and cheaply, it was judged that the best solution was to provide a bi-directional track along one side of each main street, around 2.5m in width and physically segregated.

In Malmo, a decision to provide only two-way tracks was taken in the 1970s when investment in a segregated cycle network began. The reasons for this decision could not be established but it has led to a network which generally feels very welcoming and calm, and with very little interaction with motor traffic.

Bi-directional tracks on one side of a two-way street set up counter-intuitive movement patterns that may cause driver (and pedestrian) confusion when crossing. Therefore, this arrangement works best where there is legal protection for cyclists over turning movements (see also L5).

Application in London + the UK

At the moment, two-way tracks are the exception in London rather than the norm and we see no reason to change that. There will be situations when two way tracks will be appropriate, and when they are used the issues to be considered should include:

- A careful assessment of likely future demand so that adequate width is provided at the start.
- Notwithstanding the above, how the route could be widened in future if necessary
- Frequency of junctions and crossings
- The likelihood of cyclists wanting to enter and exit the track mid-link, especially from/to the opposite side of the street
- How bi-directional routes connect with other cycle routes

Summary of advantages + disadvantages of bi-directional cycle lanes/tracks

Advantages	Disadvantages
Provide a high profile and direct route attracting high cycle flows.	Cycle-on-cycle congestion can be a problem, particularly at junctions where turning complexity is greater than with one-way routes
Cheaper and simpler to construct than two one-way routes on both sides of a highway. This may be particularly important on bridges.	Complex arrangements are often required where bi-directional routes start and end.
Enable cyclists to travel in their desired direction more easily	May be less safe than one way routes, as drivers may not expect cyclists in both directions. Head on cycle-cycle collisions can be a problem.
Reduce the number of turns that cyclists need to make at some junctions	Access problems to one-sided bi-directional tracks on highways with frequent side streets

In Malmo, almost all tracks built date are bi-directional; but this policy is changing

Bi-directional tracks around and across a large roundabout: Malmo

As in Malmo, bi-directional tracks are the norm in Seville...

...always on one side of the street only, and protected in a variety of ways

Central, segregated, bi-directional track: New York

A bi-directional track in Brooklyn, lightly-segregated by a wide painted buffer strip

A bi-directional track runs through the one-of-a-kind urban realm of Superkilen in Copenhagen

Bi-directional tracks are commoner where there there is one-sided frontage (Stockholm waterfront to right)

One of several bridges in Stockholm where a former traffic lane has been re-used as a bi-directional track

Where roads are difficult to cross - as here in Stockholm - bi-directional tracks on each side respond to natural demand

A central, raised bi-directional track between bus lanes on Cours des 50 Otages in Nantes

Bi-directional track alongside a busy road in Nantes

L5 - Interaction of lanes/tracks with side streets

Cycle lane/track priority over traffic leaving and entering unsignalised side streets.

Where cycle lanes or tracks cross the mouth of side-streets, clear priority for cycling (and walking on the parallel footway) is generally established over vehicles turning either into or out of the side street. In most cities we visited, this is usually a regulation enforced by law, and often relates to a more general traffic law, such as right-turners always give way to those crossing their path (whether in a motor vehicle, on a bicycle, or on foot).

Very often, this priority is reinforced by design. Sometimes, this design takes the form of the footway and cycle track materials simply continuing, unbroken across the mouth of the junction, without even a nod to a potential pause-point: pedestrians and cyclists have priority and do not need to wait to cross – that is the responsibility of those crossing the foot and cycle ways. Sometimes, the basic track design/materials are discontinued, and there is a stronger sense that pedestrians and cyclists are crossing (not just continuing); but the path will still be very clearly marked, perhaps in different materials, or just with paint. Where the cycle provision is in the form of a lane, this is typically marked across the mouth of the junction using dashed lines, 'elephants' feet' markings and/or coloured surfacing.

Whatever the design, the point is to emphasise that people cycling (and walking) along the main street have priority and do/should not need to give way to motor traffic. In our view, the most successful arrangement of this type that we saw in the UK was on the Old Shoreham Road cycle track between Brighton and Hove.

Application in London + the UK

In most study cities, priority for cycling (and walking) over turning traffic at side streets is established in law. While the UK has no equivalent legal protection, the Highway Code does establish relevant rules of engagement, as follows.

- Rule 170 says drivers should take extra care at junctions and should, inter alia: generally watch out for cyclists and pedestrians; watch out for pedestrians crossing a road into which the driver is turning. If they have started to cross they have priority, so drivers should give way.
- Rule 183 states that, when turning, drivers should give way to any vehicles using a bus lane, cycle lane or tramway from either direction.
- Rule 206 adds that drivers should go carefully and slowly when, inter alia, needing to cross a pavement or cycle track; for example, to reach or leave a driveway. In these circumstances, drivers should give way to pedestrians and cyclists on the pavement.

Side street entry treatments are increasingly common in the UK, and typically consist of raised pedestrian paths at the same level and on the same alignment as the footway to either side. These can work very effectively in enforcing 'Rule 170' pedestrian priority over motor traffic, although some drivers do sometimes 'bully' their way across. Applying the same rule to crossing cycle tracks and paths should be a relatively small step. Design can obviously help in this regard (as on the Old Shoreham Road, for example).

TfL and the London Boroughs should liaise with the DfT to explore, firstly, strengthening of the relevant Highway Code provisions. These discussions should also encompass making the necessary legal and/or regulatory changes such that drivers would also have to give way to cycle lanes and tracks as they cross the mouths of minor arms at junctions.

Continuous footways over side streets are currently (early 2014) being installed by Lambeth Council as part of public realm improvements in the Clapham Old Town area. In each circumstance, pedestrian flows greatly exceed traffic volumes. This scheme gives an opportunity to explore the potential pros and cons of such a layout, for cycling, in the London context.

Copenhagen - no break, markings or other differentiation as this cycle track crosses a minor side street

Copenhagen - car driver on side arm waits patiently as a cyclist and pedestrian go by

Munich - simple markings and materials help emphasise cycle priority as the track crosses a side street

Stockholm - continuous, wide foot/cycle-path across a side street junction

Utrecht - cycle track priority over the side street is emphasised by use of coloured asphalt

Brighton & Hove - typical treatment on the Old Shoreham Road as the cycle track crosses a minor side street

L6 - Addressing pinch-points

Continuity of fit-for-purpose cycle lanes/tracks across bridges and other pinch-points; also pedestrian/cycle-only bridges used to enhance priority over motor traffic (see also N4).

Bridges – most often over railway corridors and rivers – are often pinch-points on the highway network; and typically much more costly to widen than highways at ground level. Nevertheless, on the principle that a chain is only as strong as its weakest link, it is important to maintain adequate space for cycling across such features – and this is what the well-cycled cities we visited have done.

Stockholm is perhaps an extreme example, though nevertheless a good one. The fact that the city embraces a number of inlets means that each of the relatively small number of often long bridge spans is an extremely important link. Failure to provide effectively for the passage of bicycles would in some cases mean isolating large parts of the city in relation to that mode. It was therefore notable that several bridges have clearly had a previous traffic lane re-assigned to a bi-directional cycle track, and there is generally good cycle provision on all bridges we encountered.

Elsewhere, we observed a range of provision, from wide bridges with conventional cycle lanes/tracks to pedestrian- and cycle-only bridges, as well as some occasions where a lightweight pedestrian/cycle bridge had been constructed immediately adjacent (and sometimes physically attached) to the older main highway bridge.

As some of the accompanying pictures show, parapet heights on some bridges we saw were lower than the 1.4m standard in the UK (TD 19/06).

Application in London + the UK

Bridges a key locations for cycling in London. The challenges vary from providing for very high cycle flows over generally wide Thames bridges in the central area, to enabling safe cycling for relatively small volumes of cyclists over the city's large number of relatively old and narrow bridges over railway/tube tracks.

A similar variety of challenges has been faced by the study cities, with responses including reallocation of carriageway to cycle tracks, comprehensive bridge widening; and a new, lightweight foot and/or cycle bridge 'bolted on' to the existing structure.

Whatever the response, however, we did not observe cycle lanes or tracks simply ending or petering out at pinch-points. Neither did we find pedestrians and cyclists being expected to share the same path in such locations, when they were separated on each side of the pinch-point.

Concerning bridge parapet heights, allowing heights below the UK standard 1.4m would generally reduce construction costs of new bridges, and so should be investigated. The Sustrans Technical Information Note No.30 on Parapet Heights on Cycle Routes is a very helpful guide on this topic. It may also be helpful to explore the implementation of below-standard parapet heights with the DfT; with the prospect of the standard being lowered in due course.

As on several Stockholm bridges, the Vasabron cycle track has been achieved by re-assigning a former traffic lane

Brighton & Hove: where the Old Shoreham Road narrows, separate cycle & foot paths merge into a wide shared path

Seville - the Puente de la Cartuja, though narrow, had part of the carriageway reassigned to cycles in the mid-late 2000s

Seville - Puente del Alamillo, with a central pedestrian-cycle path integral to the design

Low-parapet cycle, pedestrian and local access-only bridge over the A27 motorway between Utrecht and Houten

The same bridge over the A27 has a custom-designed metal lattice screen on one side to act as a wind break

Utrecht - classic example of a pedestrian-cycle bridge that is a form of filtered permeability (see N4)

Utrecht - this narrow cycle-pedestrian bridge is part of a highway bridge (to left) over a railway corridor (to right).

Amsterdam - where it would be unthinkable to build a new bridge without dedicated provision for walking and cycling

Munich - this bridge over the very wide rail corridor has generous, adjacent cycle- and foot-paths on either side

Copenhagen - a purpose-built pedestrian-cycle bridge over a major highway.

Copenhagen - the Brygge Broen gives walking and cycling a major advantage over motor traffic for crossing Sydhavnen

JUNCTIONS + CROSSINGS

J1 - Advanced stop-lines
(a) Full-width box in front of all traffic lanes at signalised junctions.
(b) Simple forward extension of nearside cycle lane/track ahead of the vehicle stop line.

Advanced Stop Lines (ASLs) are only widely used in a small number of the overseas cities we studied – most notably New York and Dublin. ASLs are used only occasionally in cities with more mature cycling cultures and high mode shares - such as Utrecht, Malmo/Lund, Stockholm and Copenhagen - and here usually only in specific contexts.

ASLs may be simple forward protrusions of a nearside lane/track that places cyclists more visibly in the line-of-sight of drivers. This is the predominant arrangement in most study cities, since cyclists are only very rarely intended to make opposed turns from the outside lane.

ASLs may also be boxes that straddle each of the general traffic lanes behind - a technique used to assist cyclists in making turns from the offside. These were rare in continental European study cities.

In locations where ASLs are a simple protrusion of a nearside lane/track the benefit is principally that of enhancing the visibility of cyclists to drivers. Full width ASLs have the additional benefit, when the signal is at red, of enabling cyclists safely to establish a position ahead of motor vehicles prior to making an opposed turn. There is no such benefit, however, for cyclists arriving just as the red light is turning to green, or during the green phase.

The use of 'early start' signals (see J2) - as in Dublin, Cambridge and Brighton & Hove - presents the opportunity to increase the value of ASLs to cyclists, as it gives a safe period for cyclists already in the ASL to complete their manoeuvre before motor traffic starts, and also extends the period when cyclists can enter the ASL with no conflict. However, it does not deal with the situation when cyclists approach an ASL during the green phase.

Application in London + the UK

The use of ASLs as simple forward protrusions of nearside lanes/tracks, rather than as full-width boxes, is appropriate where there is no right turn or where cyclists are encouraged to make right turns in two stages (see J3).

Where used, cycle access to ASLs should ideally be via lanes/tracks of appropriate width (see L1).

New signalling techniques, such as those currently deployed at the A11/A12 Bow roundabout, offer the opportunity for ASLs to be used more effectively than previously to give priority and enhanced safety to cyclists.

The visual prominence of cyclists to motor vehicle drivers, especially in relation to the potential for 'nearside hook' manoeuvres, is what we understand to be the main reason for the use of nearside lane protrusion ASLs in continental Europe. These countries generally also have legal and regulatory protection for cyclists in such circumstances (see J4). In London (and the rest of the UK), where such protection is limited (some Highway Code rules apply), the design of ASLs, including their depth, should take into account a full understanding of the field of view of drivers in all types of vehicle.

Copenhagen - nearside lane-only ASL

Nearside lane-only ASL in Utrecht

A very short nearside lane ASL in Berlin - does the minimum of putting the cyclist plainly in a car driver's line of sight

Berlin - stepped cycle track extended in advance of general stop-line

A rare full-width ASZ in Utrecht - on a narrow, relatively quiet street (Burgemeester Reigerstraat)

Another full-width ASZ, in Stockholm. These are uncommon because two-stage left turns are the norm.

J2 - Cycle-specific signals

Small, low level signal aspects that enable provision of separate cycle stages or a early start for cycles.

Introduction

All of the cities visited use traffic signals with phases specifically for cycle traffic. In most cases (the exceptions being in the US and UK), small red/amber/green aspects are used, all with bicycle symbols. These are sometimes mounted at high level on the same column as the main signals, but are also often placed at low level, where they can be more easily seen by cyclists. In some cases arrows are added to the aspects to indicate that cyclists are only allowed to make specific turns.

In cities in continental Europe it is commonplace for cycle phases to run concurrently with parallel motor traffic and pedestrian phases (see J6 for details).

Cycle-only stages

In some cases, cyclists are given exclusive stages so that they can pass through the junction with no potential conflict with other users. This arrangement is particularly beneficial in subjective safety terms where heavy right (UK left) turning motor traffic flows cross the cycle stream. However, this will typically increase delays for all users.

New York explored this arrangement in some locations, but found that some cyclists ignored the cycle-only red and came into serious conflict with turning traffic. While such problems may have arisen because the arrangement was novel and/or unfamiliar, NYC engineers now prefer to run cyclists and motor traffic together on a single phase, with give way markings to indicate that drivers should give way to cyclists on entering the 'mixing zone' (see J4).

Early-start at ASLs

Cycle signals are used to give an early start at advanced stop lines in Dublin, Brighton & Hove and Cambridge. This is a simple method of separating cyclists from motor traffic in time, with the cycle signal turning to green several seconds before the main motor traffic green starts.

A key issue with this arrangement is the need to provide a cycle signal that is easily visible to cyclists and unlikely to confuse drivers.

Dublin has used low level cycle signals for several years, and these work very well in giving cyclists an early start at ASLs. The signals are directly in the line-of-sight for cyclists.

On the Old Shoreham Road, Brighton & Hove has installed a separate cycle green aspect which is angled towards cyclists waiting at the ASL. Observations suggest that the lack of an amber aspect means some cyclists react late to the signal, and so can lose the intended advantage.

The early start arrangement at the Catholic Church junction in Cambridge provides a 7 second early start green for cyclists, with the green cycle aspect at the same height angle as the main primary and secondary signals. This means that the primary can be awkward to see for cyclists waiting at the ASL; while the secondary signal, being several metres away across the junction, is quite easy to miss.

Application in London + the UK

Appropriately-designed cycle-specific signals can have clear benefits for cycling, especially when used systematically. The principal benefits include: providing clear, unambiguous instructions to all users; and allowing cycle-friendly signalling arrangements such as cycle-only stages and early starts.

While high level cycle signal aspects have been used at junctions in London and other cities for a many years, low level cycle-specific signals would deliver the above benefits more effectively. TfL has recently been authorised by the DfT to trial low-level signals (with full cycle aspects), and this welcome development could bring UK practice into line with international best practice.

Where junction capacity is a constraint on implementing cycle-only stages, early start signalling can still deliver advantages for cycling. They allow cyclists to get away more comfortably from a standing start (although they do not provide an advantage to cyclists arriving at the stop line during the all-traffic green); and they also give cyclists arriving on red advanced warning of when general traffic will start to move.

Dublin - early start

Brighton & Hove - Old Shoreham Road early start

Copenhagen - high level cycle-specific signal aspect

Cambridge - cyclist early start green from an ASL

Amsterdam - low level cycle signal with ‘count up’ (to next green)

Berlin - distinct sets of low-level cycle signals controlling different manoeuvres

Amsterdam - early start, from very rare painted ASL

Amsterdam

J3 - Two-stage opposed turns

Provision for simple two-stage left turns for cycles (right in UK) at traffic signals.

At signalised junctions, making opposed turns (to the left in continental Europe and the USA; to the right in the UK) is a manoeuvre fraught with potential danger for cyclists, especially where cycling takes places mostly or exclusively in nearside lanes/tracks. In order to make the opposed turn in the conventional manner, cyclists would need to signal and move into or across one or more lanes of moving motor traffic. Especially where there is more than one traffic lane, and where traffic volumes and speeds are relatively high, and where cyclists have to wait in an exposed location in the middle of the junction to complete the turn, this creates exactly the kind of hostile conditions that greatly diminish the subjective safety of cycling.

Many of the cities we visited therefore address this issue by adopting a simple technique: enabling cyclists to make the opposed turn in two stages. Take the standard case of a north-south/east-west crossroads in Copenhagen, and consider cyclists who have approached from the south and wish to turn left to head west. In the first stage, they stay in the nearside lane and travel ahead on the green signal, not making the turn at once. However, they do not exit the junction, but instead drop over to the right, so that they are now in front of the stop-line for traffic making the east-west ahead movement. The cyclists turn their bikes through 90° and wait. In stage two, they simply cycle off ahead to the west when they (and the traffic behind them, including others cyclists) gets the necessary green signal.

This arrangement requires a certain amount of space for waiting, and a green signal aspect that the cyclists can see for stage two. Often, this is simply the high level general signal on the far side of the junction. Sometimes there is also a low-level cycle signal immediately alongside the waiting 'pocket'. Markings to support/encourage the manoeuvre vary, including from junction to junction within the same city; and there may or may not be a separate stop line. Two-stage turns are generally optional, but in Copenhagen they are legally compulsory and therefore so commonplace that we observed no special signals or markings: cyclists just do it.

In terms of cycling convenience, rather than safety, concerns are often expressed about the loss of time cyclists experience in have to make the turn in two signal stages, rather than one. However, at junctions where the oncoming opposing flow of traffic precludes cyclists from completing the turn until the very end of the first stage, delaying the turn to the beginning of the following stage means time losses can be marginal.

Application in London + the UK

In the UK, cyclists are occasionally observed informally to make two-stage turns where they deem this safer. In addition, there have been some attempts at creating comparable 'jug-handled' turn arrangements, which typically require rather complex signal arrangements. The best facilities we observed during this study were both formal and very simply articulated.

For the foreseeable future, two-stage turns by cyclists at signals will be optional, as there is no law enforcing – and this may not prove necessary or desirable in any case. Southampton has recently changed a roundabout into a signalised junction with informal provision for two-stage turns; and this may be a scheme that other cities can learn from.

In the UK generally, the critical ingredient is awareness of the manoeuvre by cyclists and other highway users alike. This will involve learning new behaviours, and therefore any pilots should be accompanied by appropriate information, publicity, and possibly even organised 'ride-throughs' to demonstrate use. The potential benefits are definitely worth exploring.

Copenhagen - cyclists waiting between the two stages. Here, there are no markings, whereas....

...in Amsterdam, the waiting 'pocket' is typically much more formally-articulated.

Berlin - ahead and left-turn options on entering the junction. At this particular location...

...this is where cyclists wait if they want to turn left

Stockholm - a waiting pocket just off the main carriageway

Munich - a waiting pocket within the carriageway (used where there are cycle lanes, not tracks)

J4 - Measures to minimise 'left hook' conflicts

Dealing with safety concerns arising from nearside turns at signals.

A particular problem at signalised junctions is the conflict between motor traffic making nearside turns (left in UK/Ireland, right elsewhere) and cyclists going ahead.

In many study cities, this problem is mitigated by the fact that, by law, the turning traffic has to (and does) give way to cyclists going ahead at the same time on a defined route. This provides a good level of actual and subjective safety. The arrangement can cause delays to turning motor traffic, but if this is a problem the green time given to cyclists can be cut short, so as to give the turning traffic some green time of its own.

The preferred arrangement in New York is to provide 'mixing zones' shared by cycles and motor traffic on the approach to the stop line. Triangular markings on the entrance to the mixing zone indicate that drivers must give way to cyclists entering the zone. We observed a similar arrangement at some junctions in Copenhagen.

A different arrangement is common in Munich, and increasingly Berlin. Here, cyclists wanting to travel ahead are given a painted lane in which to do so, with right-turning cycles and general traffic sharing a nearside lane. Turning traffic has to cross the painted cycle lane to access the mixed turning lane. Engineers in these cities consider it to be objectively safer for the cycle/motor traffic interaction to take place some way back from the stop line.

Washington DC uses this arrangement, but provides additional protection for cycling by using 'wands' to limit the length of the crossing zone for motor traffic.

Application in London + the UK

Separate cycle-only phases offer the greatest level of subjective safety, but will have the largest impact on overall capacity. (Parallel traffic, cycle and pedestrian greens could offer a good balance between subjective/objective safety and overall junction capacity, but are not permitted in the UK. See discussion in J6.)

New York-style 'mixing zones' could offer a good level of protection for cyclists, but would require signs/markings to show that motor traffic must give way to cycles on entry. Such an arrangement is unfamiliar in the UK and the regulatory position would need to be clarified prior to any trials.

The arrangement with an ahead cycle lane and a mixed nearside turning lane is sometimes used in the UK. An example is to be found on Hills Road in Cambridge. Where this arrangement is used, it is important that the ahead cycle lane is both wide and conspicuous, and that the section over which motor traffic can cross to the nearside is as short as possible. As in Washington DC, light segregation could be used to limit the length of the crossing zone.

New York - 'Mixing zone' where green lane colouring is cut short to show that cyclists do not have absolute priority

Copenhagen - a similar arrangement to the New York 'mixing zone'

Berlin - ahead lane for cycles with mixed nearside turning lane.

Washington DC - a similar arrangement to the Berlin example, but with 'wands' used to limit the crossing section

Utrecht - ahead cycle traffic from the nearside track has to cross right-turning general traffic approaching the stop-line

Cambridge: left turning & ahead cycles split approaching the zone where left-turning general traffic crosses

J5 - Cycle exemptions at red signals

Permitting cycle traffic to go through red signals, with requirement to give way to pedestrians.

In many cities in the US (but not New York), all traffic is permitted to turn right (UK left) on red, although it must give way to traffic on the main route. Cyclists are considered part of the traffic mix and are also able to take advantage of the rule, reducing delay.

Of more relevance to this study, a relatively recent change in the law in France has enabled traffic authorities to exempt only cyclists from stopping at red when turning right (nearside turn), or going ahead at T-junctions. The traffic rule is that cyclists must give way to pedestrians crossing when proceeding on red – essentially cyclists must treat the crossings as zebras.

This has been widely adopted in Nantes, following extensive consultation with pedestrian groups, including the visually-impaired, and evaluation studies have found that the system is working well.

Application in London + the UK

As with the possible introduction of simultaneous 'parallel' green/give-way-on-turning arrangements (see J6), allowing cyclists to pass through red signals or to be permitted to take part in a pedestrian/cycle scramble stage would be a significant change to traffic law, which would require considerable investigation and trials, followed by public education. The level and severity of the potential conflict (being pedestrian/cycle only) would be less than with change to a parallel green system, however, and may be more acceptable politically.

There are many junctions where cyclists are held for long periods on red, including while pedestrians are crossing and, subject to local context, it could be reasonable for them to be allowed to proceed with caution. Where this has been tried in study cities, the indications are that it works well, reducing delays and improving safety for cyclists. (It should also be noted that pedestrians and cyclists are considered capable of sharing space in many other circumstances - on shared use paths and in pedestrianised streets - just not at traffic signals.)

Nantes - cyclist turns right under exemption from red signal

A close-up of the sign indicating the turn exemption

J6 - Simultaneous greens for cycles, parallel pedestrians and turning traffic

Permitting general traffic to turn across parallel cycle and pedestrian crossings on green, with general traffic required to give way to both; including use of flashing amber signals.

At signals in most non-UK study cities, crossing cyclists and pedestrians get a green signal at the same time as parallel ahead and associated turning general traffic; the latter being obliged by law to give way to the former. Crossings are often zebra-striped to reinforce this behaviour.

The advantages of this arrangement are:

- Most crossroads or T-junctions can operate on a simple two stage arrangement, reducing overall cycle times and the length of time waiting at red. This can bring an increase in capacity and a reduction in delays for all users.
- Pedestrians generally receive long green times and make a full crossing in one signal stage. Two stage crossings are less commonplace, and there is no need for an awkward stagger. This also saves overall space, as median islands become unnecessary.
- Cyclists travelling in parallel with pedestrian crossings likewise benefit from the requirement for motor vehicles to give way when turning. This is the case whether the cycle route is immediately adjacent to the motor traffic lane or separated/set back behind a small island.
- The reduced signal cycle times and simple staging makes two stage opposed turns (see J3) more attractive, as the second stage always immediately follows the first.
- Drivers tend to be cautious when turning. (This may encourage drivers to adopt similar behaviour at unsignalised junctions, See L5.)

In Dublin, there is no standard requirement for motorists to give way to pedestrians when turning at traffic signals, but is sometimes indicated by the use of a flashing amber aspect. Similarly, a flashing amber cycle aspect is sometimes used to indicate that cyclists must give way to pedestrians when turning.

Flashing amber signals were also observed at some junctions in Munich and Seville to reinforce to drivers the need to give way to pedestrians and cyclists while turning.

'Scramble' stages

A development of this flexible signalling arrangement is the use of a cycle 'scramble' stage, where cyclists on all arms get a green signal at the same time. This has not yet been used in any study city, but there are examples in at least Groningen (NL).

The Irish National Cycle Manual allows for a combined cycle and pedestrian 'scramble' stage, subject to Departmental approval. It is described as a 'junction toucan' on the basis that, it being accepted that pedestrians and cyclists can mix at standalone crossings, a combined 'scramble' stage is simply extending the concept to all arms of a junction.

Application in London + the UK

Clearly, making such a fundamental change in the way that traffic signals operate in the UK would require extensive consultation, research and trials, not to mention a concerted programme of public education if the change were to be implemented. However, this is not a reason in itself for dismissing the possibility outright. Our view is that the potential benefits for all users justify serious exploration of these signal concepts in the UK context.

Seville - a flashing amber aspect reminds drivers to give way to crossing pedestrians and cyclists when making the turn

Copenhagen - Pedestrians & cyclists go on green with motor traffic required to give way on turns, so that...

...although cycle tracks typically break at junctions, drivers will look and wait for cyclists before turning.

Munich - the rule is that right-turning drivers must give way to cyclists (and parallel pedestrians) when turning right

Munich - here, the flashing amber indicates that drivers must give way to cyclists and pedestrians when making a left turn

Amsterdam - right-turning car drivers giving way to cyclists going ahead while both have a green signal

Utrecht - informatory signal aspect cautioning right-turning drivers to watch for crossing cyclists and pedestrians

J7 - Cycle-friendly roundabouts

From compact roundabouts where cycles can share the carriageway comfortably to the provision of external cycle tracks around the general carriageway.

Roundabouts can present major problems for cyclists, particularly large diameter multi-lane roundabouts with fast, weaving traffic. Roundabouts of this type have a poor safety record for cycling.

However, when done well, roundabouts can have advantages over traffic signal controlled junctions. Cyclists are to keep moving through the junction with no stopping and waiting for red signals, losing momentum in the process. Well-designed roundabouts will reduce traffic speeds and thus the severity of any collisions.

Although roundabouts are very common in the UK, they were less well represented in the cities studied. Nevertheless we were able to identify the following ways of providing for cycling:

1. Small roundabouts with 'continental' geometry (tight entries and exits, single circulatory lane), cyclists mixed with general traffic with no markings

2. Small roundabouts with markings in the centre of the circulatory carriageway, designed to encourage cyclists to take the primary position

3. Roundabouts with a cycle lane around the outside of the circulatory carriageway

4. Roundabouts with external tracks where cyclists had to give way when crossing the entries and exits.

5. Roundabouts with external tracks and signalised crossings of the entries and exits

6. Roundabouts with external tracks that had priority over junction entries and exits

Dealing with each of these in turn:

1. 'Continental' geometry roundabouts, no cycle markings

Roundabouts elsewhere in Europe often have tighter geometry than is normal in the UK. Such designs reduce motor vehicle speeds significantly and prevent weaving and overtaking on the circulatory carriageway and therefore make it much easier for cyclists to negotiate the junction safely in the 'primary' position.

A good example of was seen in Lund where the one-way cycle tracks on either side did not continue through the junction itself. Although this type of design is unlikely to appeal to less confident cyclists, it did work well at this location. The high level of courtesy shown by drivers in Lund was clearly a positive factor, however.

There are many roundabouts in Nantes and most of them do not have cycle facilities at the junction itself. Unlike the Lund example though, the cycle lanes usually continue up to the give way line, which makes it more difficult to turn left (UK right) and increases the potential for right- (UK left-) hooking collisions if cyclists remain at the edge of the carriageway.

Along the central two-way track on Cours des 50 Otages in Nantes there are several mini roundabouts with no markings. Cyclists arrive at these junctions in a central position, which places them in a very visible position. The arrangement works surprisingly well in terms of subjective safety, which is probably due to the balance between motor traffic (5000 vpd) and cyclists (4000 per day)

2. Small roundabouts with cycle markings in the centre of the circulatory carriageway

This arrangement was only seen in Nantes at two junctions. Although it is understood to be performing well in actual safety terms, subjective safety was not as good as layouts where cyclists are separated from motor vehicles.

Type 1 - Lund: 'Continental' geometry roundabout with no cycle facilities

Type 1 - Lund: Cycle tracks become lanes, which then end several metres before the roundabout junction

Type 1 - Nantes: Cycle lane continuing up to junction

Type 2 - Nantes

Type 3 - Utrecht

Type 3 - Copenhagen (Fureso): small roundabout with annular cycle lane

3. Roundabouts with an annular cycle lane

A cycle lane around the outside of the circulatory carriageway is easy to enter and leave, but it creates a potential conflict between exiting motor vehicles and cyclists continuing around the junction, potentially leading to a (UK) left-hook problem, especially in countries with no legal protection for cyclists in such circumstances. In Dublin (Dun Laoghaire), this arrangement was tried at one junction, but left-hooking concerns led to the design being changed to Type 4 – external track with cyclists giving way.

4. Roundabouts with external tracks where cyclists give way when crossing entries/exits

This solution was often used in Nantes, usually with two-way tracks, and with the crossing points parallel to pedestrian zebras. It is understood that there is a nervousness in Nantes over giving priority to cyclists across roundabout arms as drivers may not give way to cyclists crossing. This can of course lead to significant delays to cyclists if motor traffic flows are high, but in most cases the arrangement worked fairly well, as flows were not particularly heavy. In several locations drivers did stop out of courtesy to allow cyclists to cross.

5. Roundabouts with external tracks and signalised crossings of the entries and exits

This arrangement provides a high degree of subjective safety for cyclists, but at the expense of increased delays, particularly if there is a need to cross a number of arms. Making the cycle track two-way will reduce this problem, however.

6. Roundabouts with external tracks with priority over junction entries and exits

This is the best solution for cyclists in terms of convenience and subjective safety, as long as driver compliance with the crossing is good. It was seen to work very well in Malmo, with two way tracks, and in Amsterdam and Utrecht with one way tracks. The crossings are usually parallel to marked zebras so that both cyclists and pedestrians have priority over motor traffic.

Application in London + the UK

While Type 1 continental geometry has been promoted by both the DfT and TfL for some time, there are very few examples of this type of junction. Engineers still tend to follow conventional UK practice, with generous flares on entry, 'easy exits' for motor vehciles and wide circulatory carriageways.

It may be that Type 2 markings in the circulatory carriageway could be useful additions to some roundabouts, but this is only likely to improve subjective safety where traffic flows are low.

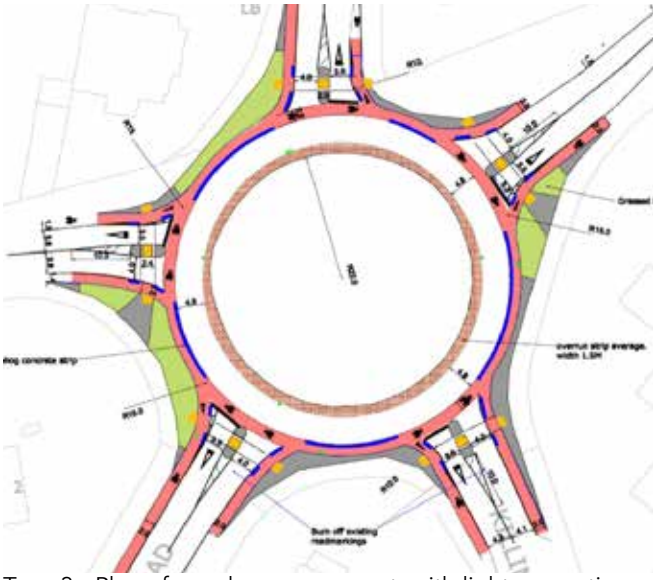
Low traffic flows are also preferable for Type 3 annular lane designs, and the geometry should be very tight so that the risk of hooking accidents is limited. Any further trials of this type of layout in Ireland, where driving culture is similar to the UK, will be worth monitoring.

Type 4 tracks without priority could be used now without difficulty, but this will not give adequate priority to cyclists in most situations.

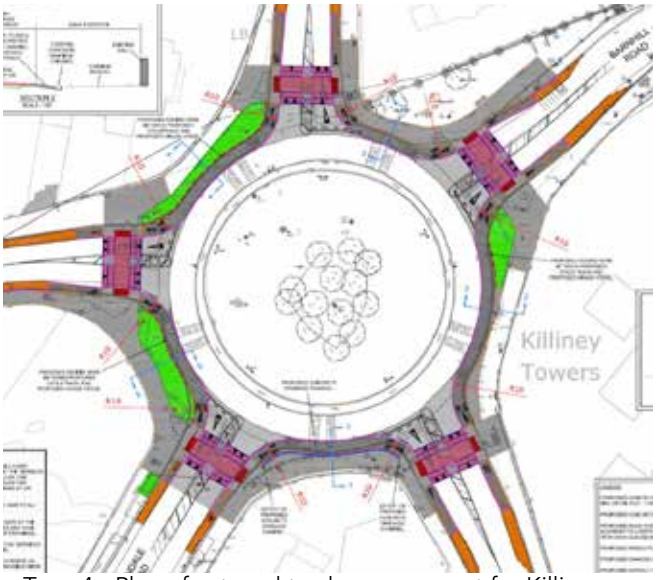
Type 5 signalised crossings are also possible as things stand. If used, then the cycle track should be two-way so that cyclists can negotiate the junction with the minimum number of crossings.

Type 6 provides the greatest subjective safety for cyclists, and perhaps all users. A UK pilot, using the outcomes from trials recently undertaken at the Transport Research Laboratory, would be helpful in understanding more about the potential benefits.

Implementation of Type 6 designs in the UK will require regulatory change to allow a new type of crossing using elephants' feet markings for cycles immediately adjacent to a pedestrian zebra, with the requirement for traffic to give way to both pedestrians and cyclists crossing (see also J8.)



Type 3 - Plan of annular arrangement, with light separation: Killiney Towers (Dublin). This now to be replaced with...



...Type 4 - Plan of external track arrangement for Killiney Towers roundabout, with cyclists now giving way

Type 4 - Nantes

Type 5 - Berlin

Type 6 - Amsterdam

Utrecht - one arm of a very large 'Type 6' roundabout

Aerial view from Google of the 'Type 6' roundabout in Amsterdam (see also bottom left picture on page 62). Tram tracks run north-south through the junction.

Aerial view from Google of the large 'Type 6' roundabout in Utrecht (see also bottom right picture on page 62).

J8 - Parallel pedestrian & cycle crossings
(a) Unsignalised pedestrian and cycle crossings immediately adjacent to one another and clearly separated by markings.
(b) As above, but at signalised crossings.

Continental European cities routinely place cycle crossings parallel to and alongside pedestrian crossings in a very wide range of circumstances, including both signalised and unsignalised junctions. The cycle route is usually marked with 'elephants' feet' on one or both sides.

The elephants' feet markings, however, do not themselves give priority to cyclists over motor traffic. Where definite priority of cycles over motor traffic is considered necessary, small 'sharks' teeth' triangles (denoting 'give way') are usually placed alongside. However, in many cases cyclists are able to exert priority even in the absence of sharks' teeth. For instance, in several countries there is a strong culture that drivers give way to pedestrians and cyclists crossing a side road (see also L5); in others, this practice is the law.

Application in London + the UK

It is established UK practice that cyclists and pedestrians may share the same crossing. This is the case at Toucan facilities and at uncontrolled crossings. (The precise UK legal position on cyclists sharing zebra crossings is unclear.)

As regards cycle and pedestrian crossings parallel and adjacent to each other, this is only currently allowed at signalised junctions, subject to special DfT authorisation. This technique cannot currently be used in unsignalised locations.

However, the draft 2015 TSRGD proposes a parallel cycle and pedestrian crossing arrangement at unsignalised locations, comparable to the facilities seen in many of the study cities. If confirmed, this will give UK practitioners a new cycle infrastructure tool, enabling them to increase cycling priority generally and maintain better cycle route continuity.


Unsignalised crossing of a side street in Malmo, with cycle track immediately alongside pedestrian path


Signalised, mid-link, parallel pedestrian and cycle crossing in Stockholm

Joint pedestrian-cycle signal at a parallel crossing in Munich

Amsterdam - a simple priority crossroads with parallel cycle and pedestrian crossings (with 'sharks' teeth') on all arms

Unsignalised crossing at a roundabout in Stockholm - pedestrians have priority over motor traffic; bicycles do not

Parallel crossings on one arm of a signalised junction in Seville

NETWORK + TRAFFIC MANAGEMENT

N1 - Use of low speed limits
30km/h (20mph) speed limits in residential areas, high streets and town centres. (See also N2+N3)

30 kph (18.6 mph) speed limits are commonplace in all the European cities we visited, often being the norm for all but the most heavily-trafficked streets. In Brighton & Hove, a city centre 20 mph zone was created in 2013, and a second phase extension was passed early in 2014. Cambridge is actively pursuing 20 mph limits on most residential and shopping streets in the city.

The prevailing justification is that the severity of injuries to pedestrians and cyclists in collisions involving motor vehicles is much less at 30 kph or lower than at 50 kph (31 mph); and that lowering link speeds has a marginal impact on motor traffic journey times in cities, compared with delays at junctions.

As far as we could find, enforcement levels and means varied from city to city, but we understood that compliance was generally much better than is reported (often anecdotally) in relation to UK 20 mph limits. This perhaps relates to the general point made in Chapter 02 concerning driver behaviour in well-cycled cities: consideration by drivers for other, vulnerable road users seems to be greater where levels of walking and cycling are higher. In some cities, the rule is that streets with 30kph limits may not also have dedicated cycle infrastructure installed.

Application in London + the UK

Many London Boroughs have, or are actively pursuing, widespread 20 mph limits, especially on residential streets, where people seem to accept the benefits more readily.

Streets should be designed to self-enforce 20 mph speeds wherever possible, and TfL and the Boroughs should work with the DfT to ensure that establishing new 20 mph limits, either on single streets or as zones, is as straightforward as possible. They should also work with the Police to agree design principles and establish clear and effective protocols for enforcement.

Utrecht - lower speed limit on a high street where space restrictions preclude physically separated tracks

Stockholm - typical transition from distributor to central area access street

N2 - Bicycle Streets

Designated 'Bicycle Streets' where cycling has clear priority over (low flows of) motor traffic.

In the Netherlands, and increasingly in Germany, some streets are designated as 'Bicycle Streets'.

Dutch 'Fietsstraten' have no legal status, they are simply streets where bicycles are accorded priority over motor vehicles, and many are clearly signed accordingly. Their success essentially depends on compliance by drivers - the vast majority of whom will be local residents.

German 'Fahrradstrassen' have a clearer status in law (being designated by traffic regulation orders), but are essentially similar in character.

Key to the success of a bicycle street is for traffic speeds and volumes to be relatively low, and cycle volumes to be relatively high. The maximum speed limit must be 30kph (under 20mph). The advised maximum daily traffic flow for a bicycle street is 2,000 in the Netherlands and 3,000 in Germany. Cycle volumes should be no lower than those for general traffic, and ideally higher. Measures associated with bicycle streets typically include filtering permeability and allowing two-way cycling on otherwise one-way streets. (See N1, N4 and N5).

At the heart of the concept is that all drivers on bicycle streets are only on the first or last few hundred metres of a trip to/from a local destination. There is no through motor traffic, drivers are not usually in a hurry, and these are 'their' streets.

There is generally very little in the way of formal cycle infrastructure in these streets – because none is needed. As some signs in the Netherlands say, 'Cars are Guests' – they are expected to move on the terms of cyclists, and this also creates a great walking environment.

We found cycling along a Fietsstraat or a Fahrradstrasse to be generally a very comfortable experience; each having the air of the best-designed UK 'Home Zones'.

Application in London + the UK

While formally designating a street as a Bicycle Street has no UK precedent known to us, the DfT is now proposing to take forward the opportunity to trial the 'Cycle Streets' concept within the revised TSRGD (due 2015). Possible supporting measures include a ban on overtaking on lightly-trafficked streets where cycle flows are high, and an advisory speed limit of 15 mph. This is a natural and positive progression from the now widely-accepted practice of having 20 mph speed limits (and actual speeds) on most residential streets.

While there is (as in the Netherlands) no requirement for a legal instrument for their implementation in the UK, active DfT support, and the new measures that may be allowed, would be very helpful in both encouraging and enabling UK practitioners to pursue such schemes.

Even as things stand, a range of existing tools (see N1, N4 and N5), if designed wisely in context, can be used to create most of the effect of Bicycle Streets. Such streets are likely to become an extremely valuable measure in improving conditions for cycling in large parts of many UK cities where the demand for on-street parking will, in practice, and particularly in residential streets, preclude the creation of designated space (lanes/tracks) for cycling.

A carriageway marking for a Fahrradstrasse in Munich...


...and a pole mounted sign for a Berlin Bicycle Street


The start of a 'home-zone' type street in Utrecht...

A more recent sight in Utrecht - cars admitted as cyclists' guests!


...and the sign looking the other way to just an 'ordinary', yet still very cycle-friendly, residential street (see N1)

A higher-speed, but still very lightly-trafficked 'Fietsweg' linking Utrecht with Houten

N3 - Use of very low speed limits

Speed limits of below 20mph in highly sensitive areas.

Speed limits of below 30kph (20 mph) are found in a number of streets in several of the cities we visited. We found a limit as low as 5kph, and all circumstances were on the public highway.

The rationale for such low speed limits varied, but all locations were places where the movement of vehicles was clearly subservient to that of people on foot or on bikes, and where the need for vehicle access was highly local. Locations included residential streets where children play, outside schools, more-or-less pedestrianised areas with high volumes of people (including tourists) on foot, and some Fahrradstrassen in Berlin.

We believe that, as in the UK, the speed limit can only be legally enforced against motorists, as bicycles are not fitted with speedometers.

Application in London + the UK

While below-20 speed limits are used on certain streets in the UK, these are on private land, not the public highway. No limit lower than 20mph can currently be legally enforced on the public highway.

The DfT has indicated that advisory 15mph limits may be permitted by the 2015 TSRGD (see under N2). This presents the opportunity for exploring the implementation of below-20mph limits in certain streets/areas in due course.

15km/h limit near a primary school in Utrecht


Berlin - 10km/h limit in the congested area around the Brandenberg Gate, which is very popular with tourists

Munich - just 5km/h in the very centre of the city

N4 - Filtered permeability

The highway network is configured to allow more direct access on bicycles than by motor vehicles.

Huge benefits for cycling and walking can be achieved through judicious traffic management – specifically, the closure of certain streets to the through movement of motor traffic. In places like Houten, just south of Utrecht, this form of traffic management has in fact been built into the design and layout of the town's street network, with streets that are open to all users being connected by sections only usable on foot and by bike. Simple signs and small bollards are used to ensure general traffic is excluded.

Filtered permeability has been used to great effect in Cambridge, where the highway authority believes that it is one of the main reasons why cycle mode share is so high, even by international standards.

The features used to filter permeability for different modes on highways that were originally available for passage by all vary from lines of bollards to historic monuments. Sometimes, what were once junctions are simply closed off by extending the footway across the minor arm and blocking the way for motor vehicles with street furniture and/or soft landscaping.

Whatever form of filtering is used, the purpose is to create quiet streets that are safer for walking and cycling, and to give those latter modes a competitive advantage over motor vehicles in terms of journey directness and time.

Application in London + the UK

Filtering the permeability of streets is a tool already used in certain locations in London and the UK generally. In Hackney, it has been used as the technique of choice to make streets more walkable and cyclable. Filtering permeability is the simplest and cheapest way of reducing traffic volumes and speeds.

Closing streets to through general traffic can draw adverse criticism from people, including local residents, who do not want the convenience of travel by car to be reduced. Nevertheless, when the benefits are effectively articulated, and when the location and design of closure feature(s) are subject to engagement with local people, this technique can be of huge value in achieving better walking at cycling at very low cost.

Berlin - the Brandenburg Gate as traffic filter!

Berlin - a simple row of bollards prevents the passage of motor vehicles

Stockholm - a sign indicating clearly that this is a no through street - but not for cyclists

Stockholm - what was a side street junction with a large roundabout has simply been closed off; but not to bikes

Houten - again, bicycles (and mopeds) are allowed to pass where motor vehicles are not (see also 5.3.3)

Cambridge - a filtered permeability treatment, featuring street trees

N5 - Cycle contra-flows

Contra-flow cycling is permitted on otherwise one-way streets using simple signs/lines.

Allowing cyclists to travel both ways on streets that have one-way operation for general traffic is commonplace in most of the cities we visited. Often this has been achieved simply by placing a plate exempting cyclists below the no entry sign; and this arrangement may also be emphasised with a short, notional section of cycle lane marking at the access point. These simple arrangements are used especially on lightly-trafficked streets where there is little space to mark a meaningful lane for the whole length of the street. In certain locations, the signs and markings have been used to legitimise activity that, while understandable and relatively safe, what was previously technically illegal and may have led to conflicts with both drivers and pedestrians.

In France, it is now a legal requirement that all routes in 30km/h zones are two way for cycling.

In some places, where the width is available, a full, designated cycle lane is provided in the 'contra-flow' direction. In some cities, where one-way streets, though lightly-trafficked, are so narrow that it would be impossible for a car to pass a bicycle, contra-flow cycling is not authorised by signs, but is permitted or simply not enforced against.

Application in London + the UK

Simple yet formal cycle contra-flow arrangements, conforming with international best practice, are increasingly common in London and elsewhere in the UK. This cycle-friendly measure should continue to be rolled out wherever cycle route permeability, street width and other local conditions permit.

Munich - bicycles exempted from the no entry restriction


Munich - simple road marking on entry to 'no entry' street


Utrecht - contra-flow on the grand scale: a one-way street with one-way cycle track in the other direction alongside

N6 - Wayfinding
Cycle networks are highly legible with key destinations well signed.

Destination signing for cycle routes is commonplace in the cities we visited, though systems varied considerably. Commonly, there are two broad types of signage: for local and regional destinations. Most signs showed named destinations with direction and distance. Map-type network information was more evident in the Netherlands than other countries.

Colour-coding on signs was sometimes used to distinguish local and regional routes/ destinations. In Lund, colour-coding was used to highlight the principal cross city routes.

We generally did not find coloured surfacing or any other road markings used as a cycling legibility feature in the cities we visited. The principal exception is on the Copenhagen cycle superhighways outside the city core, where a simple 50mm wide orange line indicates the route.

In the Netherlands, we observed wide use of a number-based node ("knooppunt") system of signing, which is especially valuable for regional networks that have key orientation points at the junction of routes in locations that are not easily described by a regular place-name.

Signage systems are especially valuable to irregular users of any given route, and in the best examples are a demonstration of the fact that cycling is treated with the same respect as motoring (see 'Common Condition' 2 in section 04). As with general traffic signage, cycle direction signs are deployed only at major junctions, not every possible decision-point.

Cambridge has developed a set of principal and secondary destinations which are signed in blue and black lettering (as with conventional highway signing). These destinations are also shown separately on the city's cycle map, so that users receive a consistent message.

Application in London + the UK

Simple, clear signage systems will make a positive contribution to cycle network legibility in the UK. A limited number of destinations should be used, and distance information is valuable.

While directional signs are the basis of successful systems, map-type signs can play a useful supporting role. Coloured surface markings may assist in route legibility, but there is little relevant evidence from the study cities.

Consistency of signage materials, destination names, branding, etc. is important, not least in reducing visual clutter and potential confusion.

Stockholm - regional cycle network

Stockholm - local destinations

Utrecht - fingerpost signs pointing towards destinations and, below, signs to numbered 'nodes' ...

...such as this one, on the cycle path between Utrecht and Houten

Amsterdam - another map-type regional network sign with node ('knooppunt') number

Simple cycle route fingerpost signs in Berlin - of a standard style also used widely in Munich

N7 - Cycle lane/track construction + maintenance
Smooth, well-constructed surfaces and prioritisation of strategic cycle routes for general and winter maintenance.

General Maintenance

As with capital investment, the best cycling cities placed great emphasis on the maintenance of the riding quality of the cycle tracks and lanes, including during the winter. Ride quality in most of the cities we visited was high, with routes generally constructed of smooth bituminous materials, giving a good level of comfort.

Winter Maintenance

Malmo and Lund experience cold winters and there is often snow. The city authorities give a high priority to clearing the main cycle routes well before the morning peak, and because of this winter cycling is maintained at around 80% of summer levels in the two cities. In Lund, we were told that the five principal radial cycle routes are considered equal in winter maintenance terms to the motorway passing around the town.

The cycle networks in both cities are almost wholly separate from motor traffic, and so snow clearance is carried out by specially-designed small machines.

Application in London + the UK

Cycle lanes/tracks should be constructed and maintained to at least as high a standard as the adjacent carriageway, bearing in mind that defects have a disproportionate impact on cycles relative to motor vehicles.

One particular area to watch out for is the type and quality of surface dressing often used for cycle lanes. If this dressing starts to fail, cyclists will find it more comfortable to use the adjacent general carriageway, and this could set up dangerous conflicts with motor traffic.

Similarly it is important that highway authorities equip themselves to maintain cycle lanes/tracks through the winter; giving as high a priority to strategic cycle routes as to strategic streets and roads.


Malmo: signs indicating cycle maintenance regimes

N8 - Traffic lane widths tailored to available space

Balanced, flexible application of lane width standards to ensure adequate space for cycling and help moderate traffic speeds.

In many situations, there can be conflicts between creating adequate space for cycling and maintaining general highway capacity. In order to help reconcile this conflict, several study cities use general lanes of around 3m or less on busy urban streets. This had enabled cycle lanes/tracks to be accommodated, while minimising any reduction in highway capacity. The carriageway of Old Shoreham Road in Brighton & Hove is typically 6.1m wide between the cycle tracks. In New York, narrower lanes are considered also to encourage slower driving which brings additional safety benefits.

On some quieter streets in several cities, the space left for motor vehicles is narrowed to the point that, in order to pass one another, large vehicles have to encroach onto painted (and necessarily advisory) cycle lanes provided on both sides of the street. This is established practice in the Netherlands and is beginning to be used in France (where the technique is termed 'Chaucidou' - which roughly translates as 'a road for gentle traffic'). In Cambridge, we were told that a similar technique has been used, with the central space between cycle lanes being as little as 5.5m wide, even on a bus route.

Application in London + the UK

There is already guidance advising the use of narrower lanes when necessary, including as part of cycling schemes. Manual for Streets 2 notes that lane widths of 2-2.5m may be appropriate in some circumstances. The busy single carriageway on Brighton & Hove's Old Shoreham Road is 6.1m wide between the new cycle tracks.

Conventional highway design practice is often uncomfortable with specifying lane widths much below the general DMRB standard of 3.65m. This tends to be based on concerns about network resilience and safety. Fears about what might happen to general traffic on rare occasions should not obstruct the implementation of infrastructure that will deliver good cycling conditions 24/7/365. Default positions on lane widths are generally unhelpful.

Old Shoreham Road in Brighton & Hove: a 6.1m carriageway with no centre-line between stepped cycle tracks

Burgemeester Reigerstraat in Utrecht: the central space is no more than 4.5m wide

An experimental 'Chaucidou' arrangement in Nantes (photo via Ouest France)

INTERACTION WITH OTHER USERS

I1 - Cycleways + footways: degrees of separation

From clear segregation, to subtler differentiation, to 'shared use' paths.

In the Dutch cities, and others based on the Dutch model, much of the cycling network is in the form of tracks alongside, but separate from, the main carriageway. While these tracks may be at or close to the same level as the footway, the default design is for a clear separation between the space for cyclists and the space for pedestrians. 'Shared use' paths were generally rare in the study cities, and indeed the Netherlands does not even have an equivalent of the 'Diagram 956' sign commonly used in the UK.

Separation of adjacent cycle tracks and footpaths is achieved in various ways, with different materials being used for the pedestrian and cycle space in most cities. Commonly, the cycle track is constructed from smooth asphalt, while the footway is normally paved in blocks or slabs. This provides colour, tonal and textural contrast. Material choices tend to be highly consistent across a city, so that users who are familiar with the 'language' readily understand how any space is to be used.

Level differences are also used as a form of separation between cycle tracks and footways in some cities. In Copenhagen, for example, cycle tracks are usually intermediate in height between the carriageway to one side and the footway to the other (see L2, stepped separation).

By contrast, in Malmo, a cobbled strip is used as a detectable separator; and while some sections of pedestrian/cycle route are unsegregated 'shared use' paths, these are normally reserved for places where the space is inadequate for distinct paths of adequate width.

Where it exists on links, separation between pedestrians and cyclists is usually maintained at junctions, although this can lead to complex paving patterns and can leave pedestrians having to wait on small islands of footway.

As for adjacent pedestrian and cycle routes away from highways, in most cases these are separated into distinct tracks for each group.

While simple 'shared use' paths were the exception in the study cities, we did encounter several locations where the separation of adjacent cycle and footpaths was marked very subtly, with common materials being used for each. These were typically encountered in locations where a non-standard, less visually intrusive, form of construction had been considered appropriate in view of the particular qualities or sensitivities of the built environment; or where the desire to create a harmonious, integrated space had been a key design driver.

In such locations, strict observance of the distinction between cycleway and footway seemed to be less than where separation was clearer. However, the busier the place, the more that cyclists seemed to respond in moderating their speeds and taking special care to avoid people on foot.

Application in London + the UK

The clear separation of adjacent pedestrian and cycle paths generally works well for both groups, and is especially important on principal cycle routes where design cycling speeds and volumes are relatively high. Where pursued, it is important that a consistent visual language and other details are used to make the distinction obvious, and that the two paths are of adequate width. If these conditions are not met, pedestrians and cyclists may stray into each other's space, leading to more conflict, rather than less.

Using similar materials for adjacent paths can be an appropriate design response in spaces and streets where the quality of the visual environment is a legitimate influence on design.

'Shared use' paths can be an appropriate design response where pedestrian and cycle flows are relatively low, where space is at a premium and when other options have been fully explored. However, they should not be considered a default response to concerns about loss of traffic capacity or on-street parking.

Malmo: bi-directional cycle tracks with distinct footway to right of picture (woman pushing buggy is in the cycle track!)

Strong material contrast between cycle track and footway: Lund

Footway alongside 'bicycle road': Malmo

Amsterdam: distinct materials, as well as a step, used to separate adjacent cycle track and footway

Minneapolis: These are the rules!

Copenhagen: the track is step-separated from the adjacent footway, and is also usually in visually different materials

Berlin: different colours, materials and patterns used to distinguish cycle path from adjacent footpath

Amsterdam: the cycle lane materials in Dam Square are in keeping with the rest of the streetscape in this famous place

Copenhagen: same materials used for cycle and foot paths on Vester Voldgade; small step and metal studs separate

Stockholm's historic waterfront: the foot and cycle paths are differentiated, but so subtly they're essentially 'shared use'

Copenhagen: a bi-directional cycle track runs through the unique Superkilen public realm treatment

New public space at Am Harras, Munich: parking bays, cycle path & footway in same materials with small step separation

I2 - Measures to address specific types of potential pedestrian-cyclist conflict

(a) Where pedestrian and cycle paths cross
(b) In motor-traffic-free ('pedestrianised') streets.

Where there are high levels of cycling, the potential for conflicts between cyclists and pedestrians arises. This has been a particular concern in some cities during periods of comparatively rapid growth in cycling, when reallocation of street space from motor traffic to cycling is in transition. It is also usually more of a challenge where cycling takes place on tracks immediately adjacent to footways than on lanes in the general carriageway.

Where cycle and pedestrian paths cross

All the cities we visited had some locations where poorly resolved interactions between cycling and walking occur. While this is an almost inevitable consequence of the sheer density of movement activity in the busiest and often most space-constrained parts of cities, different techniques can be used to mitigate adverse impacts.

In cities with off-carriageway cycle tracks, the corners of signalised junctions were the most common focus of potential conflict. This is due mainly to the sheer numbers of people waiting to cross where others are also trying to pass. The best solution to such challenges is to ensure the footways and cycle tracks are adequately wide and waiting areas sufficiently large. Physical constraints mean this is sometimes not possible; in other circumstances it involves (further) reallocation of space away from motor traffic.

We saw good examples of grade-separated cycle facilities in Houten (south of Utrecht), but did not observe any grade-separation of cycling and walking facilities at busy central area junctions.

Cycle/pedestrian conflicts can also occur on links where simple growth in pedestrian and/or cyclist volumes means previous path widths become inadequate. Responses we observed include path/track widening, and the replacement of old footway-level tracks by new lanes in the carriageway - combined with the reuse of the old cycle tracks as new footway space. This latter approach is increasingly common in Munich and Berlin, where the space for the new lanes is taken from former traffic or parking lanes.

Where walking routes and cycle paths cross, design for relative priorities generally responded to the local context, including comparative flows of pedestrians and cyclists. For this reason, we found no common approach in such locations, even within the same city.

In many cases, pedestrians are expected to treat the cycle track as a minor road to be crossed. In others, zebra and/or give way markings are used to indicate priority to pedestrians crossing. While we observed very little strict observance of such markings by cyclists, neither did we see any unpleasant incidents or aggression from either cyclists or pedestrians; cyclists generally slowed in anticipation or cycled around pedestrians, albeit at close quarters. These types of interaction are looked at further in connection with cycle bypasses at bus stops (see I3).

We found no evidence of tactile paving being used to demarcate thresholds where cycle paths meet areas where pedestrians will be. Neither did we find cycle path narrowing used as a measure to slow cyclists in similar circumstances.

At locations where there were stand-alone signalised ('Pelican'-type) pedestrian crossings, we found two basic arrangements; sometimes both in the same city. When pedestrians have a green signal to cross, cyclists on tracks were sometimes signalled to stop, in the same way as motor traffic, and sometimes there no signals.

Where on-carriageway cycle lanes approach mid-block pedestrian crossings (signalised or zebra), we found the lanes were marked right up to the crossing point (which UK zig-zag marking regulations do not currently allow).

Cycling in 'pedestrianised' areas

We found little consistency of approach to cycling in motor-traffic-free streets. One or both of two simple techniques were reasonably common: the use of signs at entry points to explain that the priority is for walking, and that cycling is permitted on those terms; the use of cycling symbols – on signs and/or on the ground – to remind all users that cycling is not banned.

Where signs and/or markings were used to define a 'cycle path' through a pedestrian priority area, we found that strict adherence to the 'cyclist' and 'pedestrian' areas – by both user groups – was generally low. The important point, however, was that cycling was tolerated and incidences of actual pedestrian-cyclist conflict seemed (and are reported to be) minimal.

In the German cities, the idea of 'Rambo cyclists' bullying pedestrians has gained some media traction. While such popular caricatures tend to be based on small segments of the population in question (e.g. 'cyclists'), some practitioners we spoke to were concerned that bad publicity might hamper the installation of cycle-friendly measures.

Application in London + the UK

A key lesson is to be cautious in implementing cycle-friendly measures that "work fine over there" but may lead to unhelpful conflicts if thoughtlessly cut-and-paste to the contemporary UK street use culture. While such measures may not engender conflict in well-cycled cities, the question for the UK is how to get there from a base condition where mass cycling is not an everyday experience and in which improving provision for cycling can easily be misconstrued as impinging on conditions for walking.

As noted above, we often found circumstances where signs and markings were used to urge, and sometimes require, cyclists to give way to pedestrians. Such signs and markings are easy to install and simple to remove, and they could be useful as a short-term measure while all users get used to new techniques. It is essential not to jeopardise the broad acceptance of new measures by possible early adverse publicity.

As to allowing cycle lane markings to run right up to formal mid-block pedestrian crossings, this is very rarely done in the UK at present, because of restrictions related to zig-zag markings. However, the ongoing review of the TSRGD indicates that this will no longer be a constraint from 2015.

The Avenida de la Constitucion in Seville - a subtly-signed cycle path exists (alongside the tram track), but the over-riding pedestrian priority is made clear. In practice, people walk and cycle almost wherever they please, but pedestrian/cyclist conflicts are minimal.


Irish National Cycle Manual: cycle lane markings through zebra zig-zags. Such arrangements should be readily permissible in the UK from 2015.

Berlin - a pedestrian street that cyclists can use

Berlin - a close-up of the 'rules of engagement'

Stockholm - markings indicating the cyclists should give way to pedestrians

Stockholm - cycle over-crowding can block pedestrian paths

Munich - sign warning cyclists of the presence of pedestrians in a mix-zone at a crossing

Seville - typical warning to cyclists on approach to a pedestrian crossing

I3 - Bicycles at bus stops

Minimising pedestrian-cycle conflicts at bus stops (including bus stop bypasses).

Following on from I2, locations where cycle tracks pass bus stops are obviously a potential focus of pedestrian-cycle conflicts. The big question is, where do the cyclists go?

A common design response in many continental European cities is to run the cycle track to the nearside of the bus stop, meaning that the stop itself (including the shelter) is on an 'island' between the cycle track and main carriageway, and bus passengers cross the cycle track to get to and from the stop. This bypass arrangement is sometimes termed a 'floating bus stop'.

The success of bypass layouts in practice depend on detail and context. They work best where there is sufficient space to deploy the optimal design details. These comprise a reasonably straight/direct cycle path, good inter-visibility for all users, and pedestrian crossing arrangements that are appropriate to the balance of pedestrian and cycle flows at peak times.

We found examples that seemed to work very well for all concerned; but also some where the bus stop islands were little more than perches; and others where the sheer numbers of bus passengers, other pedestrians and cyclists at peaks made interactions somewhat chaotic.

In the UK, Brighton & Hove has used a bus stop bypass layout on the Lewes Road that, based on experience in the first year of operation, seems to be reasonably successful. The context is one where pedestrian and bus passenger flows are relatively light, especially outside the peaks, and space is not a major constraint. As the bottom right photo on page 85 shows, the cycle by-pass is treated as a carriageway, where through movement by cyclists is prioritised.

Bus shelters in the Lewes Road scheme are located on islands that appear to be large enough for the number of passengers needing to wait there; and inter-visibility between pedestrians/passengers and cyclists is good.

We observed very few upright signs used to indicate that cyclists should give way to pedestrians at and around bus stops, but did see some surface markings, including zebra-style crossings and warning signs to cyclists. In most instances, there were no signs or markings at all, with the negotiation of pedestrian-cyclist interactions resting on circumspection and common sense on the part of both user groups.

As was the case in Copenhagen (see top two photos on page 85), some cities deployed cycle bypasses at some bus stops and different arrangements at others. The most common alternative layout is to run the cycle track to the offside of the shelter/waiting area (which is contiguous with the main footway). With such an arrangement, boarding and alighting is directly from or into the cycle track, and we generally (but not always) observed cyclists giving way or slowing in these circumstances. Markings urging cyclists to give way were more common with this arrangement.

The following, less common, means of managing the interaction of cycling facilities and bus stops were seen in some cities.

- Bus laybys (or half-width bays) with continuous on-carriageway cycle lanes passing to the offside of the bus stopping area. Here, buses and cyclists need to cross paths on approach to and exit from the stop.
- Placing cycle lanes on the offside in one-way streets.
- Bi-directional cycle tracks in the centre of the carriageway.

None of the above options involve any conflict between cyclists and pedestrians at bus stops; but each has other, different practical challenges as well as different levels of subjective safety for cycling.

Application in London + the UK

There is no one-size-fits-all arrangement guaranteed to work best in any given location.

The arrangement that makes cycling feel most comfortable is the bypass. However, in order to deliver the full potential of this layout, sufficient space is needed to provide the following: adequately wide and straight cycle tracks; similarly adequate footway widths and bus stop/shelter islands; good inter-visibility for all; and pedestrian crossing arrangements that encourage and enable priorities that are appropriate for the context. It will often be difficult to implement such a template on streets where space is at a premium; and sub-standard designs may deliver a poor level of service for more than one user group. There is no merit in implementing any layout that is unlikely to be used in practice by most cyclists (due, for example to awkward deviations from the straight and/or conflicts with pedestrians encroaching on the nominal cycle track).

Where the decision is taken to use other layouts, critical considerations include how best to manage pedestrian-cyclist interactions and how to make arrangements for cyclists both be and seem as comfortable as possible.

Concerning pedestrian-cycle interaction, we consider it likely to be advisable - in the early days - to use signs and lines, and possibly also vertical deflection, to ensure that cyclists give way to pedestrians where they should. While such supporting features may not always be necessary as such layouts becomes for familiar and better understood, they may be helpful in minimising the likelihood of conflicts, and attendant negative publicity, from arising.

(We think it important to note here that none of the study cities has as many frequent bus services as London; and that therefore none has faced the challenge London now does in terms of implementing comfortable bus stop/cycle interfaces in so many heavily-bused and often space-constrained streets.)

Dublin - where cyclists are presented with options as to how to pass a bus stop

Berlin - an off-carriageway cycle track passing in front of a bus stop

Munich - the bus shelter is in the space used elsewhere for parking. Here, inter-visibility is somewhat compromised.

Bus stop bypasses are commonplace in Copenhagen but...

...by no means ubiquitous. Space constraints often lead to sub-optimal arrangements that rely on considerate cycling

A well-specified arrangement in Stockholm, though the railings are perhaps a little unnecessary

A very narrow 'floating' bus stop in Utrecht, though passenger demand in this location is low.

A typical bus stop bypass in Seville

This is the standard bypass layout along most of the Lewes Road cycle track in Brighton & Hove

I4 - Bicycles in bus lanes

Provision of adequate width for buses to pass cycles in designated bus lanes.

Most cities we visited have a general policy of clearly separating cycle lanes/paths and bus lanes. This is in recognition of the fact that these two types of traffic do not always mix harmoniously, especially where there are large flows of either.

Where cycling within bus lanes is found, this is typically provided for by means of a marked cycle lane on the nearside immediately adjacent to a distinct bus lane on the offside. Brighton & Hove City Council recently reassigned general carriageway and central reservation space to implement such an arrangement on the Lewes Road.

Occasionally, provision comprises a single, undifferentiated combined lane of adequate width for a bus comfortably to overtake a bicycle (e.g. at least 4.5m wide).

Of the cities visited, only Nantes and Dublin consider standard bus lanes as part of the designated cycle network. These felt reasonable to cycle in, but were not as subjectively safe as other parts of the network.

Application in London + the UK

Bus lanes are very common in London, many being installed in the 1980s and 1990s to provide bus priority through congested traffic.

Although they are better for cycling than mixing with general traffic, bus lanes without separate cycle facilities are not considered to represent the best of international practice, which provides effective separation between cycles and buses. Where space is available, this could be achieved by widening bus lanes and providing a cycle lane or track within the increased width.

There may be situations where effective bus priority can be provided through signalling, rather than lanes; and it may also be that general traffic reductions over time eliminate the need for static bus priority measures on some streets. If and when these conditions apply, space released could be reallocated to dedicated cycle lanes/tracks.

Nantes - the buff-coloured surfacing denotes a bus lane which, as in the UK, cyclists are permitted also to use

Cycle lane inside fully-specified bus lane - Brighton & Hove

Cycle lane inside fully-specified bus lane - Stockholm

I5 - Bicycles and trams

Measures to minimise risk of colliding with trams and of cycle wheels being caught in tram tracks.

Most cities we visited have tram services, ranging from Seville's single, four-stop line in the centre of the city to Amsterdam's comprehensive network. The interaction of bicycles with trams, and especially with tram tracks, is frequently cited as a cause for concern.

Undeniably, getting your cycle wheel caught in a tram track can be a disconcerting and possibly dangerous event. Despite this, and despite the fact that relatively simple, spring-loaded mechanisms could, in principle, be used to 'fill in' the track gaps (with these being pushed down by tram wheels as they pass), we did not encounter any special cycle-friendly design techniques used in connection with trams.

Practitioners were conscious of the potential problem, and generally seek to ensure that the interaction of cycle paths and trams tracks is as near to the perpendicular as possible. However, beyond that, it seems to be that cyclists are expected to, and do, 'work it out'.

In this regard, it is important to note that, where cyclists are generally provided with a nearside lane/track, and where they make opposed turns at signalised junctions in two stages, or are able to use 'Dutch-style' roundabouts (Type 6 in J8), the incidence of cyclists needing to weave sideways across parallel tram tracks is greatly diminished.

Application in London + the UK

At present, London only has a single, relatively simple tram system - the Croydon Tramlink; and we know that Croydon Council officers are exploring the use of spring-loaded track fillers to ease the movement of bicycles across tracks. The problem of cycle-tram interactions can generally be resolved through the design of the cycle network as a whole: i.e. the use of nearside lanes/tracks and the design for cycle movements at junctions. These basic techniques do most to ensure cyclists rarely need to weave across tram tracks at a shallow angle.

In Amsterdam, cycling in some streets is segregated from adjacent tram tracks (as here); in others, it is not

In the study cities, cyclists and trams seem to get along fine. Here in Berlin, cycle symbols are placed between the tracks.

In Seville, even though a cycle path is marked to one side of the tram, some choose to cycle between the tracks

I6 - Use of bicycle paths by other modes

Permissions for other designated user groups to use cycle tracks.

Different non-cyclist user groups are permitted to travel in cycle tracks in different cities and countries. These include wheelchairs, mobility scooters/cars, and mopeds. It seems that segways – usually only encountered in the form of tourists groups on tours – are also able to use bike tracks (they were observed doing this in Berlin, Munich and Amsterdam).

The key issues related to cycle track use by others are twofold: the specification of the track, notably its width, such that overtaking is relatively comfortable and safe; and the possible adverse impact of one user group on another.

In this second regard, the main concern relates to relatively fast (and noisy) mopeds passing relatively slow bicycles. In the Netherlands, mopeds (speeds limited to 30kph) are generally allowed to use cycle tracks (unless signs specify otherwise), and the fact that tracks are often busy with pedal cycles means the faster vehicles (which may sometimes have had their speed limiter removed) often create uncomfortable, and at least subjectively unsafe, conditions for cycling.

Application in London + the UK

The available evidence from the study cities suggests that London, and the UK generally, should not adopt a policy where mopeds are allowed to use cycle tracks by default.

The use of cycle tracks by users of wheelchairs and mobility scooters should be considered carefully. The chief issue to address is speed relative to that of cyclists and pedestrians.

Clearly, cycle track design standards (widths) should take this into account. It is also worth saying here that cycle track design should also consider the implications of use by people with hand-cycles and tricycles.

Amsterdam - motor scooters are generally allowed...

...but not when signs clearly state they should use the main carriageway

Amsterdam - a small mobility car legally using a cycle track

Utrecht - wheelchair users are welcome on cycle tracks

Stockholm - a moped user waits to (legally) use a cycle crossing

Seville - a reminder that wheelchair users are welcome

MISCELLANEOUS

M1 - Use of colour
Application of coloured materials to denote cycle lanes/tracks and cycle routes across junctions.

Coloured surfacing is used in all of the cities studied – in some cases quite widely and in others in a more limited way. Practitioners generally consider that this provides a stronger indication to all road users that cyclists are to be expected at that location. It is also recognised, however, that coloured surfacing adds costs (particularly where it is frequently overrun by motor traffic) and can have some negative visual impacts.

Amsterdam, Utrecht and Copenhagen use colour consistently, but do so quite differently. In the Netherlands, the colour is usually that of the asphalt itself, is virtually ubiquitous, and is generally a dark red. In Copenhagen, colour is reserved for places where there is high conflict between cyclists and motor traffic - e.g. at junctions - and is a bright blue surface treatment.

Some cities in the US (eg Washington) also use colour in the Copenhagen way. New York alone takes the contrary view that colour should not be used where traffic and cyclists are mixing as it may cause confusion as to relative priorities. But New York does use green surfacing widely for cycle lanes themselves.

In Seville, almost every metre of cycle track has a green surface coating. In other cities – eg Nantes, Malmo/Lund and Dublin – the use of coloured surfacing was being reduced, but this appears to be largely on cost grounds.

The use of coloured surfacing unbounded by white lines (broken or solid) is very rare in study cities. Only in Copenhagen is this technique widely used, to indicate cycle paths through junctions.

Application in London + the UK

A key lesson from study cities is the importance of consistency in the use of colour to denote cycle facilities. Unlike in London, we did not observe the use of more than one colour in any given city.

In the study cities, colour is used for one or more of three reasons: (a) generally emphasising the presence of cycles; (b) highlighting potential conflict points; and (c) wayfinding/route continuity. While we found no objective evidence to indicate the value of colour in each of these regards, (a) was observed to be more common than (b), which in turn was more common than (c).

Similarly, we found no objective evidence concerning the relative safety benefits of different colours. There is a balance to be struck between the positive impact of colour in raising user awareness, and the negative impact on streetscape quality.

If colour is considered worth using, it is important that it is well maintained

Copenhagen - unbounded cycle lane markings through a busy junction

Berlin - coloured surfacing used to emphasise the cycle lane as it crosses a side street

Stockholm - coloured surfacing used to highlight a cycle lane, as it crosses the exit arm of a major junction

Stockholm - bounded colour used to denoted the cycle lanes through a bust crossroads

Utrecht - dark red coloured asphalt is the default materials for cycle tracks

Seville - all cycle lanes, tracks and crossings are painted green

M2 - Cycle parking

Provision of adequate levels of secure cycle parking, incl. at public transport interchanges.

General

Other than public cycle hire schemes, cycling is a private mode of transport which generates a demand for parking at the start and end of every journey. In cities with high levels of cycling the demand for parking at destinations can become a major problem, which requires significant level of investment if cluttered streets are to be avoided.

In countries where cycles often have self-locking systems (e.g. Netherlands, Denmark), the simplest cycle parking only requires space to be provided. This type of parking is still fairly insecure, however, and some form of fixed stand is usually regarded as desirable.

Front wheel stands ('wheel benders') are widely used in Denmark and the Netherlands, and are regarded as acceptable. In other places, however, Sheffield-type stands are the most common form of cycle parking. Other, more creative types of stand are sometimes used but these are relatively rare, which reflects their additional cost and relative complexity of use.

In many places stands are located in the carriageway, often displacing car parking next to the kerb, although stands on the footway are also common.

For Public Transport

Although some cities such as Copenhagen and Minneapolis make it easy to take cycles onto public transport (and Nantes offers a folding bike for long term rent for this reason), most cities take the approach of providing good quality and secure cycle parking at stations and other major transport stops.

This sometimes involves the reallocation of car parking spaces in existing multi-storey car parks, while elsewhere entirely new high quality facilities are provided. At Utrecht, the world's largest cycle parking facility (for 12,500 bikes) is under construction, with phase one due to open in 2016 and completion due in 2018.

The rail service from Malmo to Copenhagen has recently been improved and many people now commute between the two daily. Malmo has invested in high quality cycle parking facilities at two stations on the line, an element of which is secure paid-for parking. There are also bike shops/servicing at both stations.

Nantes has long had a strategy of improving public transport – both light rail and bus rapid transit - and there is a network of park and ride site across the city, both large and small. The municipality is providing secure cycle parking at these sites to give increased access to public transport for people living in the suburbs.

Application in London + the UK

The Sheffield stand, widely used in the UK, is the simplest and most practical form of public cycle parking that we found, and we see no reason to move away from it.

However, most cycle parking in the UK is currently on the footway, and this can have an adverse effect on pedestrian desire lines and adds to clutter. As more cycle parking needs to be provided, greater emphasis should be given to placing stands in carriageway space, displacing car parking where necessary.

Although there is some cycle parking at most UK and London rail/tube stations, current aspirations - such as those embodied in the London Mayor's Vision for Cycling - mean that we will need to look at ways of substantially increasing the quantity and quality of cycle parking at interchanges. Facilities such as those we saw in Malmo, Munich and Utrecht (the latter under construction) provide a model that UK cities could seek to follow in order to achieve better synergy between cycling and the public transport network.

Cycle parking for public transport does not always have to be on the grand scale and Nantes, for example, shows how a distributed network of smaller facilities - at important bus stops, not just railway stations - can also play a worthwhile role.

Secure, paid-for cycle parking at Triangeln Station: Malmo

Malmo: Hyllie Station - cycle parking replacing car parking

Part of the huge bicycle park at Pasing station in western Munich

Nantes: Secure cycle parking spaces at suburban bus stop

Free public bike parking in central Utrecht

Houten Central Station

M3 - De-cluttering

Planning & management of street furniture, lighting infrastructure, trees etc. to assist cycling.

In all of the overseas cities we visited, cycle routes away from carriageways were mostly free of isolated obstacles such as sign posts, which are a major source of cycle-only collisions.

The main exception to this was where bollards are placed in the centre of tracks where they meet highways, to prevent access by motor vehicles. Even in that case, we were told that Utrecht is aiming to remove many or most of these bollards, on the basis that the cure is worse than the problem.

Trees are often placed carefully at the outer edges of cycle routes, forming a sympathetic means of separating the space for cycling from footways and carriageways. In Seville, trees are considered extremely valuable, and cycle track design works around their presence, rather than the other way around.

As for street lighting, several study cities (e.g. Copenhagen, Stockholm, Utrecht) use catenary wires or wall-mounted lamps, which reduce the number of poles in the street.

Application in London + the UK

Driven by the de-cluttering agenda, there has been a greater emphasis on reducing the number of vertical objects of all kinds in the public realm, and placing those that must remain in a less intrusive location. This advice is set out in TfL's Streetscape Guidance.

The large number of street trees in London are a major asset and should not be considered merely as obstacles to better cycling provision.

By contrast with trees, lighting columns are more easy to move or remove, and so should not be considered a major constraint on finding clear space for cycling. While there are restrictions on suspending or wall-mounting street lighting in London, these should increasingly be addressed, rather than routinely filed under 'too difficult'.

Seville - a policy of losing no trees (valued especially for shade) leads to sub-optimal design in some locations...

...but elsewhere the continued presence of trees is less of a problem for cycling and a considerable boon for the street

Copenhagen - suspended street lights minimise the numbers of poles at surface level...

...as is also general practice in Stockholm...

...and common in Utrecht.

Munich - a cycle track is a cycle track, not a repository for poles and other street furniture

M4 - Public cycle hire

Provision of a public bike hire/share system.

Public cycle hire schemes are sometimes spoken of as something of a gimmick, yet it is noticeable that such schemes were present in almost every city we visited. Many German cities have the English-named 'Call-a-Bike' system, run by Deutsche Bahn; Stockholm has its City Bike; Seville its Sevici; New York has CitiBike; Nantes has Bicloo; Minneapolis has the limited Nice Ride system; and Dublin has Dublin Bikes.

There may be a tendency to consider that the more mature cycling cities do not have or need such systems. However, the Netherlands has OV Fiets, which is run by Dutch Railways and is well used for local travel by people visiting cities by train. Additionally, while Copenhagen's City Bike system (opened in 1995) closed in 2012, a new generation Go Bike system is on its way – one that Malmo plans to adopt as well.

Though the Netherlands and Denmark show you can build a high cycling mode share without such systems, almost all the study cities show that public bicycle hire is a valuable component of any strategy designed to make cycling an easy and convenient transport choice for as many journeys as possible by as many people as possible.

Application in London + the UK

Experience in London has confirmed what is reported and evidenced in many of our study cities: that public cycle hire systems can make a positive contribution to increasing the number and type of people who cycle (visitors as well as local people), and the number of cyclists on the streets.

We observed that typical users of public cycle hire bikes (in the study cities and also in London) tend to look quite different from the hi-viz-clad UK commuter stereotype. This has the indirect benefit of communicating a more inclusive message about urban cycling (see also M6).

For these reasons, we consider that public cycle hire schemes should generally be explored by any UK city seeking to implement a broad package of measures to grow cycling.

Stockholm City Bikes

Berlin, Munich and other German cities have the Call-a-Bike system. operated by Deutsche Bahn

Minneapolis - 'Nice Ride'

Seville's Sevici hire bikes

In the Netherlands, OV-Fiets bike hire tends to be focused on railway stations

M5 - Cycle-friendly 'accessories'

Public facilities to assist with maintenance, increase convenience, and promote cycling.

Several cities we visited have installed various 'accessories' to promote and encourage cycling. These features are of the 'nice-to-have' variety, rather than essentials, and include public cycle counters, foot pumps, foot/arm rests and angled rubbish bins. The most complete collection we saw was in Copenhagen. Such features may be considered gimmicks, and may have short- rather than long-term value, but they exist in many cities (including Utrecht), are relatively inexpensive, and are not merely cosmetic.

Cycle pumps are of obvious value, especially to people who pass them most days and their regular routes and know where to find them when needed. Cycle-friendly rubbish bins treat cyclists a little like pedestrians – people who can engage with their physical surroundings while travelling, not just observe them. Foot and arm rests for cyclists at signalised junctions are fun, and are a little like cycle-friendly pieces of public art; but their impact in terms of cluttering the street at what are often congested locations needs to be considered.

On the whole, these accessories are perhaps best simply at promoting a cycling culture; and this is certainly the case with cycle counters – which are present in at least Copenhagen and Stockholm. In providing information about cycling flows, to passing cyclists, pedestrians and drivers alike, they can help show the contribution that cycling makes to getting people moving around those cities.

Other features we encountered may be of more direct value to every cyclist, such as standard ramp riser units formed with a sinusoidal profile to make cycling over humps or speed tables more comfortable. In Copenhagen, we also saw a series of ground-mounted green lights, controlled in such a way as to provide a 'green wave' to cyclists in a cycle track on the approach to a signalised junction. The idea is to give advance warning of when a green cycle signal ahead will turn to red, with the row of green ground lights been switched off one by one at around the average speed of cycling. It is not clear how well the system works (in technical terms) or how helpful it is to cyclists.

Application in London + the UK

Hackney Council installed a public cycle counter in Goldsmith's Row in August 2013. This is a heavily-cycled route that motorists cannot use (see N4) and so the information it provides seems mostly for the encouragement of cyclists, although the data can also be used in more general pro-cycling publicity. There is now also a similar counter on Royal College Street in Camden.

If public cycle counters are also clearly visible to motorists - as on Dronning Louises Bro in Copenhagen - this gives an indication to drivers as to how much more congested their journeys might be if that many people were not going by bike. This could be of greater value in promoting the acceptance of cycle-friendly infrastructure.

As for other cycle-friendly accessories (like the public cycle pumps and cycle repair tool hubs that are becoming increasingly common on London streets), our observations from the study cities indicate that these are helpful for both practical and promotional purposes. They can therefore be considered a useful, though by no means essential, element of any authority's package of cycle-friendly measures.

Copenhagen - bike bin

Stockholm - bike counter and pump

Copenhagen - foot and arm rest at signals

Stockholm - that pump in use

Copenhagen - inset 'green wave' lights counting down on the approach to a signalised junction.


Copenhagen - counter on the Dronning Louises Bro, part of the trunk Norrebrogade cycle route


Utrecht - simple wayside bike pump


Amsterdam - sinusoidal ramp profiles make for a very smooth ride

M6 - Promoting cycling

Well-resourced programmes to market cycling, and the provision of information/maps, etc.

Marketing cycling can seem incongruous in the context of it being ordinary, everyday activity; and indeed we saw little active promotion of cycling in the Netherlands (where that might be construed as similar to marketing breathing). But we did find different methods used to encourage people to cycle that seemed appropriate and effective in the local circumstances.

In New York, which has relatively low cycling levels, Bike Ambassadors from Transportation Alternatives work with business and community partners - including the NYPD, schools and elected officials - providing information about cycling and promoting a safe-cycling message.

Malmo, which has mass cycling, runs regular, high-profile campaigns to continue to promote sustainable transport in general and cycling in particular. One of these is the "No Ridiculous Car Journeys" month, which has been repeated several times and features a competition to find "the most ridiculous car driver". The winner gets a bicycle or (if they already have one) a bus pass!

Munich - the self-styled 'Radlhauptstadt' (bicycle capital) - has major events programme to keep cycling positively in the public eye. These include the very popular Radlnacht (night-time bike festival), cycle-chic fashion shows, and other initiatives that help make a cycling culture both fun and normative.

Perhaps the most valuable promotional cycling 'freebie' that we found - in many cities - were excellent cycle route maps. These aren't just good for tourists, they make sense for anyone making an unfamiliar journey.

Application in London + the UK

The current London and UK focus is rightly on delivering a better cycling 'product' - through the kind of measures discussed elsewhere in this chapter. But as cities improve the cycling stories they have to tell, they should tell them as effectively as possible. Because so many are so unfamiliar with cycling, promotional activity will be a legitimate and necessary part of growing cycling levels.

Malmo Council pool bikes in the colours of the local football club. Sign reads: 'In Malmo, everything is ridiculously close'.

One of Transalt's Bike Amassadors taking time off to smile for the camera

In Munich, Bavaria herself is the figurehead for a successful programme of varied events that keep cycling to the fore.

SUMMARY OF COMMON TECHNIQUES

LINKS

L1 - Fit-for-purpose cycle lanes/paths/tracks
i.e. of an adequate standard to meet cyclists' needs and flows, that minimise conflicts with pedestrians, and which motor vehicles do not normally enter.

L2 - Separating cycles & motor traffic - options
a. Stepped cycle tracks
b. Vertical features that are difficult/ impossible for motor vehicles to overrun
c. Intermittent vertical features that motor vehicles can overrun relatively easily
d. Painted lines
e. Offside car parking, trees and street furniture

L3 - Cycleways away from motor traffic
e.g. through parklands; along waterfronts, canals or old rail corridors; or simply forming a road where only cycling is allowed.

L4 - Bi-directional cycle lanes/tracks
These are rarely the norm when alongside motor traffic, but are used in certain circumstances (e.g. for cost/speed/simplicity of construction; where street frontage is one-sided; or where the main carriageway is very busy/difficult to cross).

L5 - Interaction of lanes/tracks with side streets
Cycle lane/track priority over traffic leaving and entering unsignalised side streets.

L6 - Addressing pinch-points
Continuity of fit-for-purpose cycle lanes/tracks across bridges and other pinch-points; also pedestrian/cycle-only bridges used to enhance priority over motor traffic (see also N4).

JUNCTIONS + CROSSINGS

J1 - Advanced stop-lines
(a) Full-width box in front of all traffic lanes at signalised junctions.
(b) Simple forward extension of nearside cycle lane/track ahead of the vehicle stop line.

J2 - Cycle-specific signals
Small, low level signal aspects that enable provision of separate cycle stages or a early start for cycles.

J3 - Two-stage opposed turns
Provision for simple two-stage left turns for cycles (right in UK) at traffic signals.

J4 - Measures to minimise 'left hook' conflicts
Dealing with safety concerns arising from nearside turns at signals.

J5 - Cycle exemptions at red signals
Permitting cycle traffic to go through red signals, with requirement to give way to pedestrians.

J6 - Simultaneous greens for cycles, parallel pedestrians and turning traffic
Permitting general traffic to turn across parallel cycle and pedestrian crossings on green, with general traffic required to give way to both; including use of flashing amber signals.

J7 - Cycle-friendly roundabouts
From compact roundabouts where cycles can share the carriageway comfortably to the provision of external cycle tracks around the general carriageway

J8 - Parallel pedestrian & cycle crossings
(a) Unsignalised pedestrian and cycle crossings immediately adjacent to one another and clearly separated by markings.
(b) As above, but at signalised crossings.

Unsignalised side street junctions - see L5

NETWORK/TRAFFIC MANAGEMENT

N1 - Use of low speed limits
30km/h (20mph) speed limits in residential areas, high streets and town centres. (See also N2+N3)

N2 - Bicycle Streets
Designated 'Bicycle Streets' where cycling has clear priority over (low flows of) motor traffic.

N3 - Use of very low speed limits
Speed limits of below 20mph in highly sensitive areas.

N4 - Filtered permeability
The highway network is configured to allow more direct access on bicycles than by motor vehicles.

N5 - Cycle contra-flows
Contra-flow cycling is permitted on otherwise one-way streets using simple signs/lines.

N6 - Wayfinding
Cycle networks are highly legible with key destinations well signed.

N7 - Cycle lane/track construction + maintenance
Smooth, well-constructed surfaces and prioritisation of strategic cycle routes for general and winter maintenance.

N8 - Traffic lane widths tailored to available space
Balanced, flexible application of lane width standards to ensure adequate space for cycling and help moderate traffic speeds.

INTERACTION WITH OTHER USERS

I1 - Cycleways + footways: degrees of separation
From clear segregation, to subtler differentiation, to 'shared use' paths.

I2 - Measures to address specific types of potential pedestrian-cyclist conflict
(a) Where pedestrian and cycle paths interact
(b) In motor-traffic-free ('pedestrianised') streets.

I3 - Bicycles at bus stops
Minimising pedestrian-cycle conflicts at bus stops (including bus stop bypasses).

I4 - Bicycles in bus lanes
Provision of adequate width for buses to pass cycles in designated bus lanes.

I5 - Bicycles and trams
Measures to minimise risk of colliding with trams and of cycle wheels being caught in tram tracks.

I6 - Use of bicycle paths by other modes
Permissions for other designated user groups to use cycle tracks.

MISCELLANEOUS

M1 - Use of colour
Application of coloured materials to denote cycle lanes/tracks and cycle routes across junctions.

M2 - Cycle parking
Provision of adequate levels of secure cycle parking, incl. at public transport interchanges.

M3 - De-cluttering
Planning & management of street furniture, lighting infrastructure, trees etc. to assist cycling.

M4 - Public cycle hire
Provision of a public bike hire/share system.

M5 - Cycle-friendly 'accessories'
Public facilities to assist with maintenance, increase convenience, and promote cycling.

M6 - Promoting cycling
Well-resourced programmes to market cycling, and the provision of information/maps, etc.

UNCOMMON TECHNIQUES

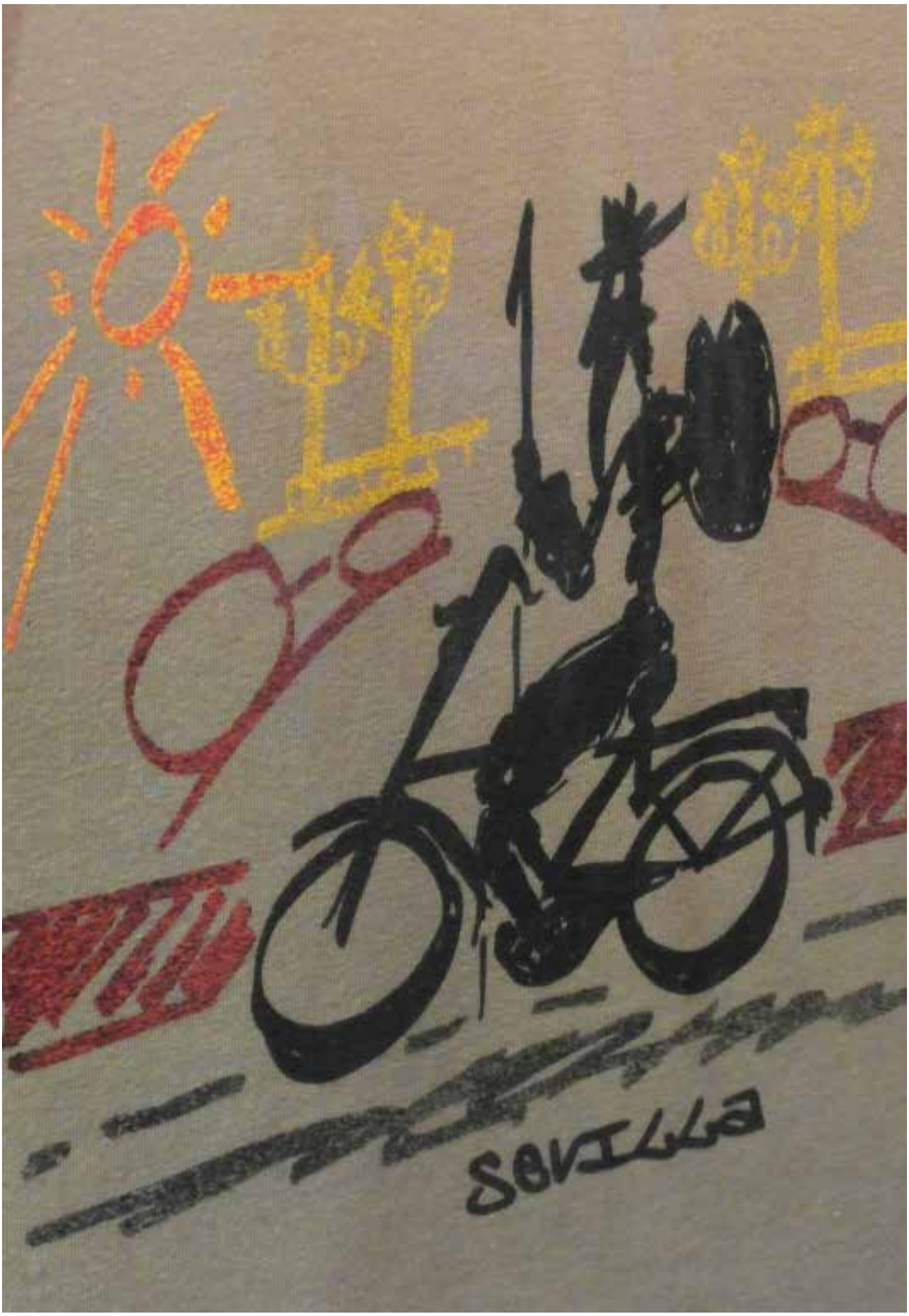
The common techniques we have listed were, by our definition, those that are present in many, if not most, of the study cities. In addition to what we saw, however, we were struck by what we did not see. Indeed, in most of the cities we visited, there was an almost complete absence of several 'cycling infrastructure' features that have been common practice in the UK for many years.

However well-intentioned, these features are usually signs that cycling has not been taken sufficiently seriously as a valuable, everyday form of transport. Most are evidence of a failure to meet a fundamental best practice benchmark: cycle lanes/tracks that are of sufficient width, available 24/7 and don't break, even 'when the going gets tough'.

The UK can and should aspire to such a standard of provision; and we consider the following checklist likely to be helpful in reminding UK practitioners of a range of all too familiar features that must become increasingly uncommon on our streets, if we are serious about growing cycling levels. All statements apply to our observations of the non-UK/Irish study cities.

- Part-time cycle lanes (that can legally be used by moving/parked vehicles at some times of day) are very rare and usually non-existent.
- We found no 'Cyclists Dismount' signs, other than exceptionally at temporary roadworks.
- While some lanes/tracks were insufficiently wide relative to demand, we did not find designated cycle lanes/tracks that are too narrow for one cyclist (i.e. essentially tokenistic).
- We did not observe tactile paving used to mark transitions from separate foot & cycle paths to 'shared use'; nor highly regulated approaches to pedestrian/cycle 'mixing zones'
- We did not find cyclists required to give way to motor traffic at side street crossings (including car park accesses, etc.). In such circumstances, cycle tracks (and footways) have formal priority over at least turning motor traffic, and these priorities are well observed by all.
- We did not see any arbitrary or abrupt ends to cycle lanes/tracks.
- We did not observe cycle lanes/tracks ending with hazardous merges into busy general carriageways.
- We have no record of any 'End' or 'End of Cycle Route' signs; and certainly saw none where the cycle lane/path is simply crossing a side street.

A collage of features that are all too common in the UK, but virtually absent in non-UK/Irish cities with high cycling levels (centre photo credit: Ben Weber)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04 COMMON CONDITIONS

Improving conditions for cycling could seem to be a matter simply of getting the techniques right. However, in comparing notes, it became clear that there are several higher order (pre-) conditions that are common or very common in the cities we visited. These conditions seem to be found alike in cities with mature cycling cultures, those that have experienced recent significant growth in cycling's mode share, and those committed to growing cycling (albeit from a low base). Those we have identified are:

1. There is strong, clear political and technical pro-cycling leadership which is supported through all parts of the lead organisation.

2. Cycling is considered an entirely legitimate, desirable, everyday, 'grown up' mode of transport, worthy of substantial, planned, long-term investment, even if current cycling levels are comparatively low.

3. Increasing cycle mode share is part of an integrated approach to decreasing car mode share. There is no intended overall abstraction from walking and public transport; and improving cycle safety and convenience is not intended to diminish pedestrian safety and convenience.

4. Loss of traffic capacity or parking to create better cycling facilities, while often a considerable challenge, is not a veto.

5. There is dedicated, fit-for-purpose space for cycling, typically of one of these three types:

    a. Paths/tracks/lanes on busier streets which provide a degree of separation from motor vehicles that is appropriate for the motor traffic flows/ speeds and the demand for cycling.

    b. Quiet streets or 'Cycle Streets' (e.g. Fietsstraten, Fahrradstrassen, Zones de Rencontres) with 30kph/20mph or lower speed limits and often restrictions on motor vehicle access, particularly for through movements.

    c. Motor traffic-free cycleways or 'greenways' away from the main highway (e.g. bicycle-only streets, paths in parks and along old railway lines, country paths) but still well connected to the rest of the network at frequent intervals.

6. Where the aim is to grow cycling rapidly, simple, cheap and effective means of securing this space have been used as first steps. More fully integrated solutions have sometimes followed or are being considered, as necessary.

7. There is clarity about the overall cycling network (including planned future development), with connectedness, continuity, directness and legibility all being key attributes.

8. There is clear, widely-accepted and routinely-used guidance on the design of cycling infrastructure.

9. The frequency of occasions when cyclists need to give way or stop is minimised. This means that people cycling are able to make steady progress at a comfortable speed.

10. Where the cycling mode share is greater, the driving culture (and indeed city culture generally) is respectful of cycling. Local traffic laws often play a part in this.

11. Even in the most well-cycled cities, making better provision for cycling is an ongoing challenge; with growth in cycling, and of city populations as a whole, requiring clear forward planning.