Priority for cycling in an urban traffic control system

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Summary

Traffic signals and other control infrastructure are a common occurrence in many urban areas and many city and regional authorities are beginning to explore ways in which they can use this infrastructure to achieve policy targets. Within the United Kingdom, two developments have come together to facilitate urban cycling. The first is the setting of targets for cycle use in the National Cycling Strategy and the second is the development of a new generation of Urban Traffic Management and Control (UTMC) systems. This paper briefly outlines existing provision for cycling in UTMC type systems and suggest how these techniques for encouraging cycle use can be deployed in a true UTMC system. This evidence is drawn from installations around the world, in areas of high and low cycle use. The negative impacts on cycling of UTMC systems are also highlighted. The paper concludes by providing speculation on how additional priority measures, so far untested, could be used to facilitate and encourage cycle journeys in the urban environment.

"*If the objective is to promote bicycle-use, a lot of benefits can be gained in the area of traffic-light regulation*" CROW (1993).

1. Policy background

In many continental European countries and a few United Kingdom cities cycling has maintained its position as an effective means of transportation. In many cases, however, cycling had diminished in volume and, until recently, in importance. In the UK cycling has declined from a nearly 11% share (23 bn pass. Kms) in 1952 to a less than 1% share (4 bn pass. Kms) in 1998 (DETR, 1999). From an attitude in the 1980's that cycling was just too dangerous and should be discouraged, the UK Government has recognised that increased cycle use can provide real benefits both for individuals' health and the environment - particularly if new cycle trips substitute for existing or new motorised trips. Given this new found importance, it is essential that the recent Government funded programme into the next generation of Urban Traffic Management and Control systems should take account of cycling as a mode in a more proactive manner than hitherto. This paper is a summary of that account, the full text of which can be found at www.utmc.org.uk or from the authors.

2. Cycling in the urban environment

Each cyclist is an individual who undertakes an individual journey, but most journeys can be placed into one of three categories : commuting, utility or leisure. A commuting journey is usually regular in terms of its departure time, route and duration. The aim is usually to get to the destination as quickly as possibly. The utility journey is made to accomplish some “domestic” task such as shopping or visiting friends. These journeys are much more varied and are less time constrained, with safety and comfort an increased priority. The leisure journey is primarily concerned with leaving the built-up environment and travelling in a more rural environment. People undertaking leisure trips may adopt a different mode of travel for the first and last legs of their journey such as the car or the train.

Within the urban environment most cyclists journeys within the peak hours will be for commuting purposes, whilst for the off-peak hours, utility cycling may be more important. This could mean that any optimisation for cyclists may need to be two phased, optimised for efficiency in the peak hours and optimised for safety during the off-peak hours.

There is evidence to suggest that the peak hour for cyclists is much more pronounced than for motorised traffic (Sharples, 1997 and Sharples, 1999) and that commuting cyclists prefer controlled environments such as traffic controlled junctions (Aultman-Hall, Hall, and Baetz, B, 1998). These two pieces of evidence would suggest that whilst the general level of cycle traffic may be low when spread throughout the day and across the urban area, there will be significant hotspots at sites and along routes which are highly instrumented. This more focused attention may provide justification for cycle friendly interventions at such sites.

3. Interventions for cyclists

There is large scope for providing for physical priority measures for cyclists. These measures include advanced stop lines, with (and counter) flow cycle lanes and turn ban exemptions. Such measures are to be commended since they raise the profile of cycling and provide real journey time and safety improvements for cyclists at little or no cost to other modes. There are, however, more subtle ways to facilitate the journey of a cyclists.

Much of the urban traffic infrastructure relies on the detection of vehicles in order to optimise a signal installation or a selective priority measure. Traditionally the detection of cyclists, and specifically the selective detection of cyclists, has proved to be poor. This is to some extent due to the physical characteristics of a cycle but adjustments to installations can be made to overcome this drawback. Experiments have been conducted to establish an efficient configuration (Leschinski, 1994), placing (Wood, Bretherton and Duan-Li-Ren, 1988) and operation (Guizhu, Zongfa and Xu, 1995) for detector loops so that cyclists are reliably detected. No studies could be found which attempted to distinguish a cyclists amongst a general stream of traffic using common loop technology. The advent of new technologies, particularly above ground detection devices, does have the potential to distinguish cyclists.

The danger is that without the functions within UTMC systems which are able to use this facility then there will be little incentive for equipment manufacturers to build in such functions. Of course without the necessary detection technology, it is unlikely that the functionality will be built into UTMC systems. A chicken and egg situation develops. The least which can be expected is that the detection infrastructure recognises cyclists so that they are not, for example, ignored on the minor arm of a signalised junction because it has failed to recognise their presence. The next step up is to enable selective detection, either by distinguishing a cyclist or placing a transponder on cycles, and use the existing techniques deployed for public transport vehicles to help the cyclist. The scope for this priority will be limited so paradoxically it might not be appropriate for situations of high cycle flow.

Another aspect to signal control is the offset between junctions. This offset is normally calculated to give a green wave for general traffic. In some situations a green-wave engineered for motorised traffic may result in a red wave for cyclists. This is unfortunate since a stop has more than just a delay or psychological impact on a cyclist, it also results in a loss of momentum and extra effort to set-off. A solution is to calculate the offset for exclusive cycle progression but this can have undesirable pollution and safety impacts. A technique for calculating offsets which allow for multiple progression bands through arterials has been developed by Taylor and Mahmassani (2000). The third aspect to traffic signal control is the signal cycle time at the junction. The literature suggests that most benefit is given to cyclists if this value is kept as low as is practicable. Another important aspect is the inter-greens which are provided between stage greens in order to allow traffic to clear the junction. Cyclists often adopt the longest route through a junction and can take longer to accelerate to a reasonable speed. This suggests that the inter-greens should be calculated on assumptions of greater clearance distances and lower speeds. Failure to do so may result in the potential for serious traffic conflicts and incidents.

4. Examples of good practice

Three examples from three continents of good practice with regard to the provision for cyclists in urban traffic management and control systems are presented here. The first example is from Beijing in China (Wood, Bretherton and Liu, 1988 and Peck and Gorton, 1990).

During the mid 1980’s the level of traffic volume and a high growth rate lead the Beijing city authorities to consider the implementation of an urban traffic and control system in a section of the city. The system chosen was the SCOOT traffic control system (Bretherton, Wood, and Bowen,1998).

The system is designed to take specific consideration of cycles travelling along a link physically separated from motorised traffic. Within the link, a 45° parallelogram shaped loop shape was found to be more effective at detecting a cycle than the traditional rectangular shape. The optimum horizontal width for this loop was found to be 1.1m, which is the same as the average wheel base length of a cycle.

The position of the loop within the link was found to be a significant factor in the utility of the data provided. After a consideration of two options, one to place the detector at the entrance to the link and another to place it at the exit from the link, a third option was identified which was to place the loop a short distance from the stopline. This provided for a compromise between the effective operation of the offset and split optimisers within SCOOT. A set-back distance which made the journey time of a cycle correspond with that for cars travelling from the entry detector on the motorised link to its stopline was found to be ideal. This typically resulted in a cycle detector 50m to 100m before the stopline.

The team established a composite measure of cycle flow and occupancy called a Bicycle Link Profile Unit (BLPU) which was capable of aggregation with the normal SCOOT Link Profile Unit (LPU). This enabled the cycle link to be incorporated into the standard SCOOT model in the same manner as other links. Weighting functions are then available to advantage or disadvantage the cycle traffic stream relative to the motorised traffic stream.

Preliminary results following implementation suggest that the delay to motor vehicles has been reduced by 24%, whilst the reduction for cycle traffic is some 15%.

A European example is the historic city of York in the UK. Within York the level of commuting by cycles is high at 19% of trips and the level of congestion on the roads has resulted in the deployment of much urban traffic control infrastructure. The local authority has a package of techniques and expertise which it can use in the appropriate circumstances. One techniques is “tail-end biasing” where the offsets at the ends of greens are co-ordinated to provide for slower modes such as buses and cyclists. Another technique is the use of SCOOT detectors in cycle loops and “dummy” SCOOT loops which shadow existing SCOOT links. Increasingly use is made of microwave detectors mounted on signal heads which are able to accurately detect cyclists if they are travelling at 10km/h (6.25 mph) or more.

The third example is from the United States and shows how increased provision can be made for cycling as part of a comprehensive upgrade of traffic signal equipment. The upgrade was initiated by the Montana Department of Transportation and special regard was made to the effectiveness of new loop designs in detecting bicycles (Maki and Marshall, 1997). The final design adopted resembles the well known California University loop design. The interesting feature of this redesign was that the roadway was marked with a line and a symbol that indicated the path over the loop which was most sensitive to cycles.

5. Impact of non-signal UTC infrastructure

Increasingly urban traffic management and control systems are extending beyond traditional traffic signal installations. Table 1 lists a range of UTC functions and estimates the impact that they may have on cycling. The impact may be first order in that it has a direct impact on cycling as a mode. Alternatively, the impact may be second order, in that, it impacts adversely on a mode which itself impacts adversely on cyclists. As can be seen there is real potential for most UTC functions to aid cycling but there has to be the will by both the local authorities and the equipment manufacturers in order to realise these benefits. Potential minus points identified are: the use of just-in time stock control which may generate extra trips by light and heavy goods vehicles; the use of route guidance technologies which may increase the volume of traffic on the roads through induced traffic growth; and weather and emissions monitoring facilities which may actively dissuade people from cycling on “bad” days.

Function	**Cyclists**		**Examples**
	First	Second	
Traffic signal control	✔ ✔ ✔		Priority cycling measures
Mandatory sign control	✔ ✔		Turn ban exemptions
Physical network control	✔ ✔		Cut-throughs / Contraflow cycleways
Direct vehicle control		✔ ✔	Protection of advanced stop lines
Enforcement		✔ ✔	Lower vehicular speeds
Public transport management		✔	Reduce traffic volume
Emergency services management		✔	Faster response to accidents
HOV management	✔		A shared use facility
Freight management		✕	Increase in HGV trips, intimidating
Parking management		✔	Reduce "space seeking" vehicles
Weather and emissions monitoring		✕✕	Discourage cycling on "bad" days
Route guidance		✕✕	Increase traffic volume
Road pricing		✔ ✔	Reduce traffic volume
Network monitoring			Neutral
Performance evaluation		✔	If cycling part of evaluation criteria
Information management		✔	Encourage mode switch
Strategy selection		✔	Identify better cycling days
Event management			Neutral
Static database	✔		Accumulate data on cycling
System modelling	✔ ✔		Consideration of cycling trips
UTMC system operation			Neutral

Table 1: Impact of transport functions on cyclists

Key : A first order impact is a function primarily targeted at cyclists;
A second order impact is one which is primarily targeted at another mode but may have an effect on cyclists;
The number of ✔ 's indicates the extent of the positive impact;
The number of ✕'s indicates the extent of the negative impact;

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