THE ECONOMIC IMPACT OF TRAFFIC SIGNALS AND THE EFFECT OF REMOVING TRAFFIC CONTROL REGULATIONS AT ROAD JUNCTIONS IN THE UK

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SUMMARY

There is both quantitative and anecdotal evidence to indicate that at certain locations road safety and congestion might be improved, with attendant economic and environmental benefits, by removing conventional junction control and introducing principles of shared space for particular periods of the day, or indeed as a permanent solution.

Under the Traffic Management Act 2004, traffic managers should be able to 'consider any possible action' to improve the efficiency of their road network. Current Department for Transport advice on traffic management and street design reminds us that there is no statutory requirement for junction controls. Yet the absence of research into alternative methods of junction control means that options are restricted.

A study by Colin Buchanan for the Greater London Authority in 2009 concluded that there are clearly, in general, time savings and hence an economic benefit to the use of traffic signal control but that there are periods of the day when greater benefit would be achieved by switching off traffic signals, and indeed there are likely to be numerous sites where signal control is not required at all.

Hence there is a case for establishing trials to test the benefits of conventional controls against the potential benefits of uncontrolled, natural traffic flow, to provide evidence that could help improve the safety and efficiency of our urban and possibly rural road networks, and the wider public realm, and to achieve a more sustainable approach to traffic management.

Across a number of junctions with, and then without, conventional traffic signal or priority control, these before-and-after trials enable us to monitor any changes to traffic demand and migration, congestion, vehicle and pedestrian journey time, and impact on buses, vulnerable road-user amenity, driver conduct, and the environment.

The first such ground-breaking trial commenced in September 2009 at a complex and busy signal controlled junction in Portishead, near Bristol. This is already showing considerable benefits and raises some interesting questions regarding the way we design our road infrastructure, and has led neighbouring Bristol City Council and Devon Councils to undertake trials at a variety of sites.

1. BACKGROUND

Over recent years, there has been a rapid increase in the number of sites where traffic signal control is considered to be the only solution to pedestrian and cyclist amenity, road safety, traffic management and capacity issues.

Yet at junctions where traffic lights are out of action and normal priority rules do not apply, road-users can, in a lot of circumstances, experience less congestion and delay. Pedestrian amenity can improve and courtesy can flourish, with a readiness among drivers to give way.

Many anecdotal reports and eye-witness accounts echo the ideas of observers who argue that freedom to filter at junctions, without automated systems and regulations, can deal adequately with traffic and pedestrian conflict and reduce congestion. They argue that uncertainty about junction priority stimulates slower approach speeds, driver vigilance, and co-operation among all road-users. It is suggested that this approach may also offer particular benefits to users of sustainable modes such as walking and cycling.

At a growing number of locations in mainland Europe and now in the UK, conventional traffic control principles are being challenged with the introduction of *shared space*, where sites previously regulated using automatic traffic control have had traffic lights removed and the junctions have been redesigned to create attractive public spaces that are destinations in their own right, with well publicised success. Yet, to date, the technical aspects of shared space have never been tested in a robust manner. To a lesser degree, the use of flashing amber signals (with scope to maintain pedestrian actuated crossing stages) is widely used to provide a part-time solution.

With the prospect of inexpensive solutions to some of our road safety, congestion and sustainability problems, it is becoming a matter of urgency to determine whether or not removing traffic control regulations (in the form of conventional signals and priority rules), or disabling traffic signals for certain periods of the day, can bring economic, environmental, road safety, traffic management and sustainability benefits.

The Department for Transport (DfT), Transport for London (TfL) and the Greater London Authority (GLA) have been considering these issues for some time. In 2006, TfL commissioned Transport Research Laboratory (TRL) to undertake a study into *simplified streetscape design* and its appropriateness to London streets. The results were inconclusive, as there was very little understanding of how, why and where shared spaces work and how safe they might be. In 2007, GLA commissioned Colin Buchanan (CB) to undertake a simple economic assessment of traffic signals across London and the benefits that might result from removal. The results demonstrated that there could indeed be benefits to removal, and this led to a more detailed study of the economic impact of traffic signals in November 2009. At the same time, the Stage 1 report from the ongoing DfT study into shared space was released, concluding that shared spaces are certainly no worse than conventional forms of control in terms of safety, and may even offer benefits.

2. WHERE'S THE EVIDENCE?

It is often reported that there is anecdotal evidence of traffic conditions being improved at junctions where traffic signals have failed. It is, however, just as often not reported where congestion and possibly safety actually gets worse because these are not reported. Local newspapers often contain letters and reports from the public of their experiences in sailing through a junction with minimal delay as a consequence of signal failure, asking why on earth were they ever there in the first place. But there will never (or very rarely) be any letters from those who have experienced greater delay as a consequence of signal failure, and who then go on to applaud the traffic engineers who designed the controlled traffic management system that is switched back on – normally within a few hours.

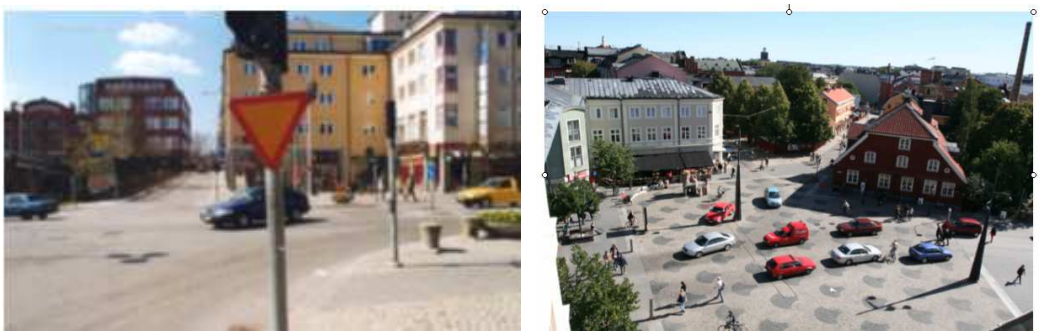
There are also very good reasons why vehicular traffic might experience improved conditions following a signal failure, which might be:

- ***Low or reduced traffic demand,*** either naturally or as a consequence of the traffic signal failure which causes drivers to avoid the area;
- ***Net benefit from use of 'lost time',*** where the effective removal of the lost time normally associated with the phase intergreen periods reduces delays;
- ***Loss of pedestrian/ cyclist/ equestrian crossing stage,*** which is probably the single greatest reason for any capacity improvements during failures;
- ***Loss of bus, tram and emergency vehicle priority protocols,*** which might normally lead to green signal extensions or terminations causing delay to general traffic;
- ***Imbalance of traffic demand and 'natural' priority,*** where busy movements dominate during uncontrolled conditions and experience improvements;
- ***Revert to off-side priority rule,*** similarly, and particularly at roundabouts, traffic may adopt a known and trusted protocol that benefits particular traffic streams;
- ***Loss of UTC strategy,*** it is possible that strategies deploy a traffic management/ gating function that cannot be maintained during signal failure;
- ***Inappropriate or inefficient traffic signal installation,*** as it is conceivable that at some locations the traffic signal installation is not appropriate or is not operating efficiently under normal operations. This could be due to a whole number of reasons, but generally:
    - at fixed-time installations, insufficient maintenance of the facility or review of traffic signal timing plans and monitoring of traffic demand;
    - historic installation that is no longer relevant to present day traffic conditions, introduction of VA or adaptive systems such as MOVA, SCATS or SCOOT more appropriate;
    - political, local resident or lobby group influence in the form of control, particularly with regard to pedestrian/ cyclist facilities;
    - poor design.

There is no evidence of whether, overall, conditions improve or become worse as a consequence of signal failure. Not only is the variety of form and complexity of junctions so great that what seems beneficial at one site may not necessarily be as good at another, but for every anecdote from the general public of congestion relief there is a corresponding anecdote from traffic managers of worsening congestion. It is therefore clear that anecdotal evidence could not be relied upon to form any meaningful view on the issue of removing junction controls.

The amount of before-and-after data for sites where shared space has been introduced, and where traffic control regulations have been relaxed or removed is extremely limited. To our knowledge, there are only two instances where this data is available, The Laweiplein, Drachten, Netherlands and Gossip Square, Skvallertorget, Sweden.

The Laweiplein, Drachten, before and after.



Gossip Square, Skvallertorget, before and after.

For The Laweiplein, very simple before-and-after data was presented in *Evaluation of the reconstruction into a square with roundabout*, a report produced in 2006 by the local university. It considers a 2-hour evening peak period on a single day before and then after the introduction of the scheme. It shows that traffic volume rose from 1,400vph to 1,850vph, and that bus delays were considerably reduced, which seems to provide evidence that shared space has traffic management benefits over conventional designs. Yet, a simple modelling exercise demonstrates that a traffic signal arrangement was never the optimum solution in traffic engineering terms in the first place, and that a roundabout with Zebra crossings would have been perfectly adequate. The lack of formal priority is not really an issue.

For Gossip Square, there is no data for the 'before' conditions, but reasonably detailed analysis of 'after' conditions, showing that 14,000 vehicles pass through the unregulated junction during a weekday (broadly 1,400vph), with over 800 pedestrians per hour throughout the day.

In order to understand the issues in greater detail, TfL commissioned TRL to assess the traffic management and safety implications of simplified streetscapes. PPR292 *A Review of Simplified Streetscape Schemes* was published, with very little fanfare, in 2006 and set out their findings. Some of the conclusions were:

> *'One surprising finding was that while a sizeable number of people expressed a keen interest in such radical design ideas (and claimed to be personally involved in relevant schemes) very few were able, or willing, to provide any information that would have been useful to this review.'*
>
> *'There is no readily available body of published research literature on the impact of such simplification schemes, nor is there a clear understanding of why such schemes, which go against historical urban design principles, might or might not work.'*

Simplified streetscape principles are gradually being accepted by local highway authorities in the UK as a possible solution to particular issues at sites where traffic volumes are low and there is no likelihood of significant traffic impact. Yet these are generally indistinguishable from conventional shared surface treatments, and/or they tend to be along links rather than at places. This is certainly true of the Kensington High Street, London and New Road, Brighton schemes, which have not challenged the principles of conventional traffic management control to any degree. The very latest scheme at Ashford, Kent is by far the greatest step taken into the world of shared space and unregulated junction control in the UK, however this really only involves two junctions where formal control is challenged. One of these is dubbed The Notaroundabout, yet traffic behaves as if it were a roundabout generally because it looks and feels like a roundabout. The other is, at present, a location where vehicular traffic passes through what will be a junction once redevelopment is completed in the future, but is at present a lightly-used pedestrian route. As this is a new scheme, it cannot provide comparative data and so cannot be used as a case study for demonstrating any relative benefits over conventional formal traffic management, yet its success to date is a good indicator of what might be possible at other sites.

A degree of appraisal has been achieved by CB by applying micro-simulation modelling techniques. A simple crossroads junction with single lane approaches might be managed in several ways:

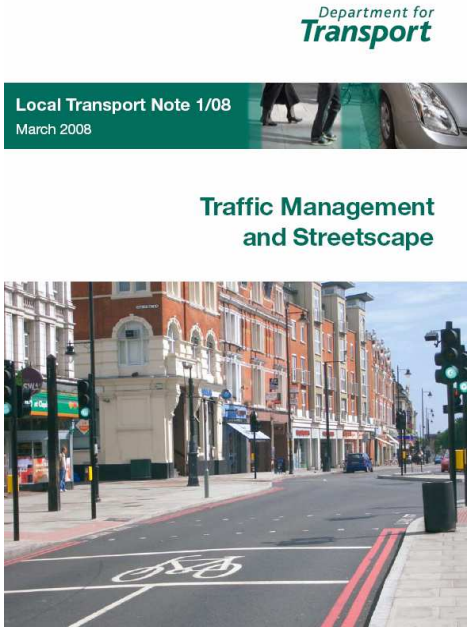
- Traffic signal control, a 3-stage arrangement with two traffic stages for major, then minor, road traffic and a pedestrian crossing stage allowing pedestrians to cross under a green man invitation (assumed to operate every cycle);
- Conventional major/minor priority control with a main through-road and two opposing side roads, with Zebra crossings over each arm (with refuges);

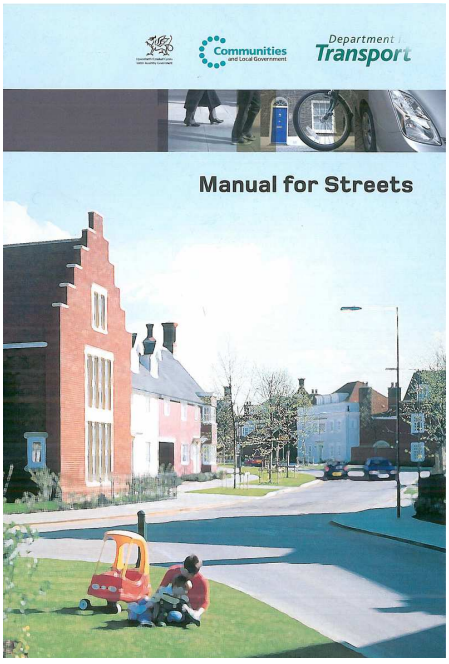
- Conventional mini-roundabout with offside priority rules and Zebra crossings provided over each arm (with refuges);
- Unregulated, shared space assuming 'filter-in-turn' behaviour from drivers, with courtesy pedestrian crossings where vehicles and pedestrians make intelligent decisions about how to move through the space safely.

Various assumptions regarding turning proportions might be made, but with fairly typical values the results demonstrated that the unregulated strategy accommodates up to around 1700pcu per hour, which is similar to a conventional major/minor priority controlled junction, but will have more evenly balanced delays with far less priority to the major road. However, both traffic signal control and mini-roundabout control accommodate up to 2000pcu per hour, with lower values of queues and delays. Although this was an interesting exercise, it cannot be considered as evidence of what might happen at unregulated junctions, because despite our best efforts to represent driver behaviour at unregulated sites, the micro-simulation models cannot yet be fully validated against actual behaviour.

3. CURRENT GUIDANCE AND LEGISLATION

Current design guidance seems to lead the designer towards the consideration of avoiding unnecessary traffic regulation controls. Although Manual for Streets is aimed at residential environments, it contains similar advice to LTN 1/08 Traffic Management and Streetscape, where we are reminded that 'there is no statutory requirement for junction priority to be specified' and that 'there is no fundamental need to provide traffic signs or markings'.





Neither of these documents, nor indeed any current DfT or DMRB design guidance, provides advice on how to determine when and where it might or might not be appropriate to consider a lack of formal control. Mention is made of the London Borough Pedestrian Priority Areas (PPAs) study undertaken by TRL in 2002 for the Transport for London Bus Priority Team, which concluded that 'there is a self-limiting factor on pedestrians sharing space with motorists, of around 100vph'. This study looked at a high street environment rather than a junction, yet clearly does not match the results reported from the Netherlands and Sweden.

The Traffic Management Act 2004, gives local highway authorities, now local traffic authorities (LTAs), new opportunities for considering all road-users equally. It places a duty on LTAs to:

> 'manage their road network with a view to. . .
>
> (a) securing the expeditious movement of traffic on the authority's road network

Traffic implies a mix of vehicles, cyclists and pedestrians. There is no stipulation about priorities, which are at the discretion of the LTA and consequently set the focus for streetscape design and traffic management.

The action which the authority may take in performing that duty includes. . .

> (a) the more efficient use of their road network; or
>
> (b) the avoidance, elimination or reduction of road congestion or other disruption on [the] road network…

And that:

> A local traffic authority shall make such arrangements as they consider appropriate for planning and carrying out the action to be taken in performing the network management duty [and]
>
> (a) identify things…which are causing…road congestion or other disruption to the movement of traffic on their road network; and
>
> (b) consider any possible action that could be taken in response to…anything so identified;

This clearly places a responsibility on LTAs to consider all possible solutions, yet it is evident that in the UK not all possible solutions are necessarily available to them. Trials to evaluate the unregulated approach therefore seems timely. If successful, appropriate elements may be incorporated into traffic management systems as a means of expediting movement, reducing congestion, improving road safety and offering sustainability benefits in terms of reduced environmental impact.

The DfT is currently mid-way into a detailed study of shared space and, in December 2009, published Stage 1 report. Although generally a desktop exercise at present, the report reaches some important conclusions regarding the safety aspect of shared space schemes, namely:

- …there is no evidence that Shared Space schemes result in more casualties than traditional layouts at the types of flow at which they have been implemented in the UK;

- some evidence from the Netherlands that at locations with motorised traffic flow of greater than c.14, 000 vehicles per day Shared Space layouts may have more casualties, relative to traditional layouts and that risk to cyclists may be increased in these settings
- …at the few UK schemes where exposure data are available there does appear to be a positive effect in reducing the number of casualties and the level of risk to pedestrians and cyclists.

The study, however, does not address the specific issues of traffic management function and provides no new insight into where this form of scheme might, or might not, be appropriate.

5. ECONOMIC IMPACT OF TRAFFIC SIGNALS

In Greater London, the number of traffic signal installations has steadily increased with around a 1,000 new sets being introduced since the year 2000 so that the total is now over 5,000. At the beginning of 2009 there were 2,532 signalised road junctions. This increase in traffic signals has led to a perception that there are now too many and at the margins their benefits may be outweighed by increased congestion, or at least unnecessary delays outside peak hours. The Mayor for London is committed to tackling congestion by ensuring smoother traffic flow and Transport for London (TfL) continues to review all London traffic signals to ensure that they operate in the most efficient way. Proposals 30 and 83 in the current Draft Transport Strategy commit to :

Implementing a targeted programme of road network improvements, potentially including junction upgrades, to improve traffic flow on the most congested sections and to improve conditions for all road users

. . . introduce accessible for all, 'better streets' initiatives. Consideration will be given to trialling the removal of traffic signals where safe and appropriate.

To inform the debate on the cost and benefits of traffic signals GLA Economics commissioned CB, in 2007, to undertake an initial exploratory study which used a model of a theoretical junction to investigate whether or not it is beneficial, in economic terms, to remove traffic signal control and revert in that instance to a major / minor road priority rule. The initial study concluded that the economic benefits and disbenefits of traffic signals are heavily dependent not only on the volumes of traffic but also traffic composition, vehicle occupancy, pedestrian volumes and time of day. The study also highlighted that any assessment of traffic signals should take into account a wider spectrum of influencing factors including safety and network management issues. Whilst a theoretical study using a simplified approach, the initial work demonstrated that there was indeed merit in considering the issue in greater detail, and so GLA Economics commissioned CB to undertake further assessment in 2009.

In assessing the impact of traffic signals, a representative sample of the 2,500 road junctions was needed. In choosing which junctions were modelled account was taken of:

- The availability of an existing and DTO approved traffic model
- The availability of all-day traffic flow data
- The location and type of junction
- Whether the junction was a stand alone junction or part of a network of junctions
- Safety (in principle there was no overriding safety reason why consideration should not be given to switching off the traffic signal)
- Junction geometry (principally linked to safety issues)

Following discussions with TfL, five junctions were chosen, namely:

- A section of the Edgware Road covering seven separate junctions (all 4-arm junctions, inner-London)
- A312/B455 Target Roundabout (4-arm roundabout, outer London)
- A13/River Road junction (3-arm junction, outer London)
- East Barnet Road/Margaret Road (4 arm junction, outer London)
- A215 Norwood Road/Palace Road (3-arm junction, inner London)

These five junctions are broadly representative of two thirds of signalised junctions in London in terms of type and location, however it needs to be stressed that each junction is unique in terms of traffic volumes, composition and turning movements.

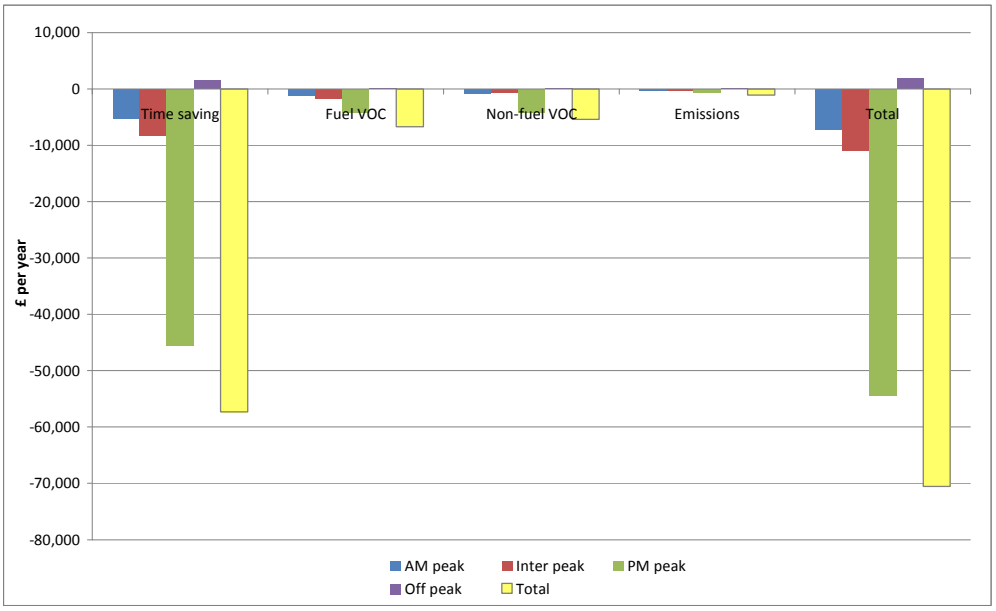
In modelling the junctions two scenarios were compared:

- 'Do Minimum', that is, the traffic signals operate as now yet with minor timing adjustments to achieve optimum performance if necessary, and
- 'Do Something' which is to remove the traffic signal control and replace it with a conventional form of priority control suited to the traffic demand patterns at particular periods of the day.

For each junction and for both scenarios, the model output included data on average delay per vehicle for the morning peak, inter-peak (ie the time between the morning and evening peaks), the evening peak and overnight.

These delay figures were then converted to financial values using standard transport economic appraisal guidance from DfT. Account was taken of traffic composition, vehicle occupancy rates and journey purpose using data from traffic counts and the London Area Transport Survey. The analysis placed values on the changes, as a result of signal switch-off, in time savings, vehicle operating costs and emissions.

The full results can be seen in the published report, however a summary of the economic impact of removing traffic signal control at all sites is shown below.



The economic impact of removing traffic signals, weighted average of all modelled junctions

The results of the individual junction analysis showed considerable variation. All the junctions showed time savings following switch-off overnight and hence provided an economic benefit. Four of the junctions showed benefits of removing signals during the inter-peak period, but at the Target Roundabout junction (a fully signal controlled grade separated roundabout on London's most congested corridor, the A40) there was a significant disbenefit due to the proportion of conflicting movements taking place. At the East Barnet and Norwood junctions, there would be benefits from removing traffic signal control completely.

The values of removing traffic signal control range from a benefit of around £10,000 a year to a disbenefit of over £800,000 a year, however these figures do not take into account all the relevant costs and benefits, such as accident savings, infrastructure costs, public realm improvements. The study demonstrates that there is clearly, in general, an economic benefit to use of traffic signal control but that there are periods of the day when greater benefit would be achieved by switching off traffic signals, and indeed there are likely to be numerous sites where signal control is not required at all.

In order to achieve part-time control, the signals could simply be disabled for those periods where there is a disbenefit in terms of delay, with the use of the standard part-time signals advance signing. Alternatively, it was recommended that the use of flashing amber should be considered, as this provides greatest flexibility and has the advantage of maintaining controlled pedestrian crossing facilities where appropriate. This, however, might not be considered a viable alternative in the UK (despite wide use around the World) until PELICAN crossings are replaced with PUFFIN crossings.

6. LIVE TRIALS

In order to test the theory of possibly substantial benefits of removing junction controls, it is necessary to undertake live trials and throughout 2009 CB, along with shared space campaigner Martin Cassini, sought LTAs that were interested in undertaking before-and-after studies.

It is clear that there are a number of key issues to consider, namely:

- Impact on road safety, or more importantly the relationship between perceived/actual risks and the number, type and severity of accidents that might occur, and the use of modified road safety audit procedures;
- Impact on equality and inclusion, with regard to the removal of formal crossing facilities that might be considered essential for vulnerable road users such as the visually impaired and children;
- Liability, and the concerns that in the event of accidents the highway authority might be seen as negligent and open to litigation;
- The ability of all road users to understand how to behave at junctions without formal traffic control regulations;
- Whether or not there are design issues that might affect the performance of the junction;
- Impact on traffic capacity, queues, delays, speeds, journey times, reliability and resilience;
- Impact on the environment.

The procedures for dealing with these cannot always be resolved ahead of the trials but most, if not all, the issues were dealt with in the very first of the trails in the UK.

In June 2009, the traffic signals at the Cabstand junction in Portishead, at the end of the A369 Wyndham Way, were out of action for a few hours on a weekday afternoon. Anecdotal and press reports of significantly improved traffic conditions and the disappearance of queues led North Somerset Council (NSC) to consider the possibility of removing the scheme (which was introduced in 2005) altogether. Initially the council was interested in testing a mini-roundabout solution, but high implementation costs meant that this was unlikely to happen.

When presented with the option of trialling a complete removal of formal controls by simply disabling the traffic signal control, they immediately initiated the study and commissioned CB to undertake the monitoring and reporting of the outcomes. Following a period of scheme design, consultation and advance warning, and a week of monitoring typical conditions under the MOVA controlled staggered tee junction, the traffic signals were switched off at 10am on Monday 14 September.

Cabstand junction location, A369 Wyndham Way, Portishead.

Cabstand/ Wyndham Way/ High Street/ Station Road junction arrangement

6.1 Road safety

In terms of road safety, an internal safety audit was undertaken to assess any potential risks, the main outcomes of which were:

- Introduction of 20mph zone around the junction to minimise traffic speeds;
- Use of advance warning signs to all users informing drivers that there is no priority to other vehicles, but that they should give-way to pedestrians;
- Closure of a pedestrian pen and multiple-lane crossing location, where it was felt that crossing between stationary vehicles would be hazardous (which was actually opened to pedestrians at the end of the first day of the trial).

6.2 Equality and Inclusion

A significant issue at this trial site relates to the 'loss' of formal pedestrian crossing facilities as a result of disabling the green man phase associated with the traffic signal control.

Consultation was held with various stakeholders, including the local association for the blind and visually impaired. It was considered desirable to encourage crossing activity at the existing crossing points, and as such the tactile paving could then be used in a similar manner to that adopted at conventional Zebra crossings. Following initial opposition from disabled groups, North Somerset have now worked with representatives to identify a 'safe route' around the junction and will be introducing formal Zebra crossings at key locations.

Assessment of the behaviour of pedestrians before the signal switch-off showed that the vast majority did not utilise the green man facility, and crossed on opportunity through gaps in the traffic. This included schoolchildren, who were clearly taking risks by crossing against the red man signal. Drivers now have greater responsibility to provide priority and this improves their awareness of the behaviour of pedestrians.

6.3 Liability and litigation

At the mention of the prospect of introducing unregulated junctions, most traffic managers express concerns that this will lead to claims against the highway authority for negligence or a breach of duty of care. As Ben Hamilton Baillie has stated, this is *'a complete myth – there is not a single case of a highway authority being sued for street design'*. Manual for Streets addresses this issue very well, and makes reference to *Highway Risk and Liability Claims*, a report produced by the UK Roads Board and ICE, updated in 2009. In summary, it demonstrates that:

- There are very few cases of litigation relating to defects in design;
- There is an overall presumption that road users are intelligent, able and expected to be responsible for their own safety and have a duty to take roads as they find them;
- It is not necessary for design to take independence of judgement out of the hands of the road user;

- There is no duty under Highways Act to give warnings of obvious dangers;
- There is a need to avoid creating a 'trap' for road users, so the use of advance warning at least in the early stages should overcome this;
- The LTA should not act 'irrationally' and so should be able to demonstrate adequate justification for particular designs
- It is advisable to adopt a 'modified safety audit', which allows for risk impact and probability assessment.

It also includes a rather encouraging message:

> *'This guide hopes to encourage Highway Authorities to take a far more robust stance in developing innovative highway designs that have the interest of the public at their heart. Rather than being held back by some vague fear of liability or prosecution.'*

Current legislation supports these principles. The Road Traffic Act 1988 states that there is a duty of persons to observe the Highway Code, and Section 124 advises how road users should adapt their driving and *'look out for unmarked junctions where nobody has priority'*. Section 125 advises that drivers need to be considerate and to *slow down and hold back if a vehicle pulls out into your path at a junction'*. The RTA also states that the highway authority has a duty to carry out studies into accidents and take measures to prevent such accidents, and if it is demonstrated that unregulated conditions improve safety then this must be considered as an option when considering the form of junction control. There is no case law regarding a breach of duty of care arising from the Road Traffic Act.

Back in the 1980s, the use of 'throughabout' or hamburger signal controlled roundabout junctions became very popular where grade separation on a major road was not an option. These performed very well in terms of traffic capacity but were, in certain locations, notoriously prone to accidents. The 4-arm throughabout on A322 Bagshot Road south of Bracknell experienced a fatality very shortly after opening, and the 5-arm throughabout on A408 Stockley Road/ Cherry Lane just north of M4 Junction 4 at Heathrow is still one of the highest accident blackspots in London. Neither Berkshire County Council nor Transport for London have ever been considered liable for these accidents, nor indeed did they result in the removal of this form of junction control.

6.4 Road user behaviour

As expected, the lack of formal traffic control has resulted in the form of behaviour that might typically be expected at a junction where traffic signals have failed.

Cabstand junction following signal switch-off

Drivers are approaching the junction with caution at low speeds and are prepared to give priority to those vehicles already waiting at the junction. Varying patterns of behaviour that might normally be associated with a mini-roundabout or major/minor junction occur from one moment to the next. It seems that some drivers are hesitant when opposed by traffic on other arms, but they are prepared to wait a little longer for a convenient gap, or for someone to allow them through. This seems to have resulted in courteous behaviour with very little, if any, impatient responses such as use of the horn or revving of engines.

Despite the presence of advance warning signs advising drivers to provide priority to pedestrians, it is apparent that many do not adhere to this request. This is particularly evident at the exit crossing points around the junction and on the crossing over the link between Cabstand and Wyndham Way. As a consequence, pedestrians tend to defer priority to vehicle drivers, unless the drivers show an obvious willingness to slow or stop to allow them to cross. It is evident that vehicle drivers will tend to avoid giving priority if they can, and this depends on whether or not the pedestrian seeks eye contact with the driver, or makes a gesture to cross. There is a good proportion of elderly pedestrians, and lone or groups of mothers with buggies throughout the day, and they do appear understandably hesitant at crossing points. On the other hand schoolchildren seem to be adapting to the change in control remarkably well, taking good responsibility for their crossing behaviour. There are regular pedestrians who seem to be adapting their behaviour to the new arrangements and finding that with an appropriate amount of assertion, drivers will respect their right to cross.

Pedestrians crossing at Cabstand junction following signal switch-off

Pedal cycle flows are extremely low at Cabstand junction, only around 10 cycles per hour were recorded during the morning and evening peaks. As a consequence it is difficult to assess typical behaviour. Nevertheless, it seems that cyclists simply flow through the junction pre-empting the gaps that occur in the traffic or drivers appear courteous where it is evident that a cyclist is slowing, and will allow them to pass.

Motorcycle flows are extremely low at Cabstand junction, only around 20 motorcycles per hour were recorded during the morning and evening peaks. Rider behaviour is similar to other vehicle driver behaviour and it does not seem unduly hazardous for this vulnerable road-user group.

Bus drivers were fore-warned of the Cabstand Junction Trial and are aware of the possible hazards, especially with pedestrians. There appear to be no extraordinary issues with bus drivers, despite the obvious difficulties of negotiating the junction with a large vehicle.

A criticism of the scheme from some has been the lack of public awareness regarding the expected behaviour of the various road user groups. This was a dilemma during the lead-up to the trial. Do we prescribe behaviour based on what we think the hazards might be, with the danger that we will end up with a pre-determined and possibly conventional form of behaviour, or do we provide sufficient information to warn road users that conventional controls are being removed and then assess how they respond to the lack of conventional controls?

NSC chose the latter option, yet acknowledged that there are likely to be considerable benefits in demonstrating to the public beforehand how these schemes can work.

6.5 Design issues

Another concern for traffic managers is the issue of junction design. Surely, if a junction has been geometrically designed for traffic signal control then removing the control means that the junction would have to be completely redesigned, to take account of, for example, visibility requirements?

This, of course, is another reason why the trials are required. Other than that given in Manual for Streets regarding residential areas, there is simply not enough data or guidance on how particular geometric characteristics might or might not affect the capacity or safety of a busy junction that is unregulated. The general approach would be to engineer an environment that made drivers feel as if they were intruding onto a public, shared space with the aim of discouraging high vehicle speeds. Restricted visibility, for example, might discourage high speeds but it could also present reaction time issues.

The main concern at Cabstand was the treatment of pedestrian crossing facilities. At present the crossings have the appearance of a controlled crossing that is out of order, which does not send appropriate messages to pedestrians and drivers alike. It is evident from driver behaviour throughout the trial that the message to give priority to pedestrians is not always working. Treatment of pedestrian priority needs to be considered on a case by case basis, as it is possible that at some sites providing overall priority to a heavy volume of pedestrians would have significant impact on vehicular traffic flow. At Cabstand, however, this is unlikely to be the case – there are up to 300 pedestrian crossing movements per hour on the various arms of the junction.

A ‘safe space’ route has been identified and Zebra crossings are soon to be introduced at key locations.

The continued success of the trial may also facilitate a complete redesign of the public realm to create a properly developed ‘shared space’, by removing the existing traffic islands and central reservations, and considering use of alternative pavement materials to redress the current segregation between road users. These urban design issues have been adequately addressed by others and a wealth of design guidance, including LTN 1/08 and possibly the eagerly awaited *Manual for High Streets*.

The trial seems to have demonstrated that, in a traffic engineering sense, there is no need to consider any significant geometric design alterations to the junction in order for it to successfully and (so far) safely accommodate the levels of traffic that pass through the junction.

6.6 Impact on junction performance

The Cabstand junction was monitored 24/7 for 7 days before and then for 4 weeks following the signal switch-off using 7 CCTV cameras located around and on the approaches to the junction. Numerous site visits were also carried out. The study considered:

- Vehicular traffic demand and turning movements;
- Vehicle journey times and delays;
- Vehicle queue lengths;
- Degree of saturation;
- Pedestrian crossing demand;
- Pedestrian journey times and delays;
- Vehicle speeds;
- Accidents and incidents

The Cabstand junction operated under MOVA traffic signal control. Due to the need to incorporate a number of pedestrian crossing phases and extended clearance times throughout the junction, it ran with an average cycle time of 130 seconds when capacity maximising, sometimes extending to 160 seconds. Before the trial:

- Traffic demand through the junction was around 1600pcu/hr and 1700pcu/hr during the morning and evening peaks respectively;
- Traffic queues were typically between 15-20pcu on most approaches during the peaks;
- Average journey time through the junction was around 90 seconds, with maximums of over 3½ minutes;
- Degree of saturation around 90% in peaks;
- Pedestrian crossing demand was 260 per hour and 150 per hour during the morning and evening peaks respectively;
- Crossing times from kerb to kerb were, on average, around 20 seconds with maximums up to 1½ minutes;

- Average vehicle speed through the junction was 15mph (24kph);
- There were 2 slight personal injury accidents in the 3-year period to August 2009, none of which involved pedestrians or cyclists.

Following switch-off, an analysis of data was undertaken at the end of the first week in order to provide NSC with information that would enable them to decide whether the trial should continue or be adjusted in any manner. Needless to say the trial continued and indeed the traffic signal control is still disabled while NSC undertake further longer term monitoring of conditions. The results from Week 4 showed:

- Traffic demand through the junction has increased by up to 20% to 1860pcu/hr and 2060pcu/hr during the morning and evening peaks respectively;
- Traffic queues, which initially had all but disappeared, have reduced by around 50% to on average no more than 10pcu on any approach during the peaks;
- Average journey time through the junction has reduced by 50% to around 45 seconds, with maximums of around 2 minutes;
- Not able to determine saturation levels yet as maximum capacity not reached, but degree of saturation estimated to be no more than 60-70%.
- Pedestrian crossing demand fluctuated from week to week, but was as high as 280 per hour and 200 per hour during the morning and evening peaks respectively;
- Crossing times from kerb to kerb are still, on average, around 20 seconds but with maximums typically no more than 45 seconds;
- Average vehicle speed through the junction is still 15mph (24kph);
- There have been no injury accidents in the 6 months since switch-off, yet there have been two known damage-only incidents (including a minor shunt recorded live during a BBC Points West news programme).

The trial did not have the benefit of the use of a 'control' junction, which would have provided some basis against which to assess the issue of increased traffic demand and the possibility that was a seasonal fluctuation as we entered wet and dark peak periods. NSC have, however, ATC data for a known rat-run along Slade Road to the west of Cabstand. This showed that there had indeed been a 20% drop in traffic in one direction after the first week. It is therefore very likely that the significant performance improvements at the junction have attracted vehicles away from residential rat-runs in the area.

The fact that average pedestrian crossing times have not altered at all as a consequence of disabling formal signal control simply demonstrates that the vast majority of pedestrians have not altered their crossing behaviour. They crossed on opportunity through gaps before the signals were switched off, and they do the same now, perhaps with some assistance from courteous drivers. What is interesting is that the maximum wait times have reduced considerably.

Although vehicle queues have reduced significantly, the lack of traffic management between the two junctions at Cabstand has resulted in longer queues forming on the link between them. At the moment, this is not a serious problem and blocking back is not occurring, however NSC will be monitoring this closely over coming weeks to determine whether or not this one issue might jeopardise the trial and result in the need to re-establish traffic signal control.

It is also clear that an element of pedestrian amenity has been removed by disabling the controlled pedestrian crossing facilities and this design issue is currently being considered in detail by NSC.

In terms of reliability, the bus operators have made *'many positive comments'* and bus journey times through the junction are consistently lower than before switch-off. Resilience was tested shortly after switch-off when temporary shuttle-working under traffic signal control was installed at roadworks only some 50m north of the junction. This had no impact on the performance of the junction, largely due to the significant reserve capacity that is now apparent.

6.7 Impact on the environment and sustainability

The limited scope of the trials at Cabstand did not provide the opportunity to assess environmental impact in any detail. Anecdotal evidence from local residents seems to suggest that noise and air pollution has reduced not only around the junction itself, but also along the rat-run routes previously used by traffic.

It is certainly evident that the removal of the traffic signals has eliminated the conventional stop-wait-start behaviour of vehicles throughout most of the day despite the increases in traffic demand and considerably reduced the likelihood of having to come to a complete stop during the peak periods. This minimises the need for idling and accelerating from a standing position, which is the primary cause of high emissions.

There have been obvious, if perhaps small, reductions in energy consumption as a result of disabling the traffic signals at Cabstand. The junction had the highest energy consumption of all sites in North Somerset, and the values, and savings, are:

- Daylight hours = 9,820.9 kWh per annum
- Dimming hours = 4,311.2 kWh per annum
- Total consumption saving = 14,132.1 kWh per annum
- Carbon footprint benefit = 7.5889 tonnes CO2 per annum (typical household carbon footprint = 9.8 tonnes CO2 per annum)
- Energy bill saving = £1,164.34 per annum

There are also obvious savings in terms of installation and maintenance costs, though of course these would need to be set against costs of the alternative form of junction arrangement.

It is still too early to tell whether or not the accident savings can be maitained, but it is perhaps possible that unregulated arrangements might actually be as safe as, if not safer, than conventional arrangements despite the obviously greater risks.

Using a very broad time value of £6 per person per hour, and an average occupancy rate of 1.2 persons per pcu, the vehicle and pedestrian journey time savings at Cabstand amount to an annualised figure of over £450k per annum. The improved accessibility is also likely to have a positive benefit in terms of economic development in the area, not least as a result of the number of traffic and transport experts travelling down to Portishead to spend a day watching the junction in full swing.

7. WHAT NEXT?

It cannot, of course, be concluded that the very positive results coming from Cabstand provide overwhelming evidence for removing conventional traffic management controls at any other traffic signal controlled junction. The benefits at Cabstand have largely been accrued as a result of removing a particularly inefficient (in vehicle delay terms) installation. Analysis of the likely performance of mini-roundabouts at Cabstand showed that these would generate excessive queues and oversaturation during the peaks, but these might provide as worthy an alternative at other locations.

The success at Portishead prompted the Bristol Evening Post to start a lights-off campaign for Bristol, which received a tremendous response and support from the Executive Member for Transport and Sustainability Dr Jon Rogers and Shadow Secretary of State for Transport, Theresa Villiers. This has led to further trials that got underway in Bristol on 8 March (as this paper was being written). It is hoped that results of the trial will be available at the conference, but so far the trial seems to have resulted in reduced delays and following a preliminary on-site public consultation, the project is receiving good support. Generally, pedestrians crossing at the junction reported that they feel less safe, but that it is quicker and more convenient without the traffic signals.

We are constantly in discussion with highway authorities to determine whether or not they are interested in the research, participating in the trials and if they have any junctions where they believe improvements could be made through the removal of formal traffic control regulations. There is a considerable amount of research required to demonstrate that this form of unregulated traffic management offers a viable solution and alternative to conventional controls, not least in terms of safety, design, psychology and application – particularly in closely managed networks. I believe that the shared space scheme in Ashford, Kent and now the Cabstand Junction Trial shows what might be possible and I encourage the industry to consider these issues urgently.

BIBLIOGRAPHY

Colin Buchanan and Partners (November 2009) *Economic Impact of Traffic Signals,* GLA, London.

Department for Transport (1988) *Road Traffic Act 1988,* HMSO, London.

Department for Transport (1988) *Road Traffic Act 1988,* HMSO, London.

Department for Transport (2004) *Traffic Management Act 2004,* HMSO, London.

Department for Transport (2007) *Manual for Streets,* Thomas Telford Publishing, London.

Department for Transport (2008) *Local Transport Note 1/08: Traffic Management and Streetscape,* TSO, Norwich.

Euser, P. (March 2006) *The Laweiplein: Evaluation of the reconstruction into a square with roundabout,* Noordelijke Hogeschool Leeuwarden, Netherlands.

Greater London Authority (October 2009) *Mayor's Transport Strategy Public Draft*, GLA, London

Quimby, A. and Castle, J, (January 2006) *PPR 292: A Review of Simplified Streetscape Schemes,* TRL Limited, Crowthorne.

UK Roads Board, (July 2009) *Highway Risk and Liability,* ICE, London.