Signal design the right way

John Nightingale explains to Carol Debell why signal design should never be an 'afterthought' and why he is banging the drum for concept design and modelling.

John Nightingale joined JCT early in 2008 and has already established himself as a talented front man for the JCT Symposium. Most people would agree that he comes across as a mild mannered man. That is certainly how he sees himself, but his experience since joining JCT has made him feel increasingly frustrated with the 'stick some signals on it' attitude to junction design.

Before joining JCT John was a signal engineer in local government so he's worked at the sharp end of the public interface and he says he knows, from practical experience, just how soul destroying it can be to defend sub-standard junctions which have slipped through the planning net.

So, what is going wrong? The problem, says John, is that far too often signal design is an afterthought. Often by the time a sketch gets to a signal engineer it will have been reviewed and accepted by the client and may even have passed the first stages of planning. 'What the signal engineer is given is an ill-conceived sketch of a junction and he's left either to force a rethink or to try to lever a substandard scheme into the agreed boundaries.' And as we all know, a pint simply does not fit into a half pint pot.

What's missing, he says, is basic preparation. 'I can't think of any other branch of engineering where designs are outlined before any calculations are done so why do transport planners float junction designs without even basic modelling.'

Even when models are provided he says they are often inaccurate or tweaked to provide over optimistic results. 'Tweaking serves no-one, least of all the client. A supermarket chain may be keen to get planning but if a consultant succeeds in getting a sub standard design through planning, are they really serving their client's needs? Not when the end result is unacceptable queuing getting into and out of the supermarket.'

He points out that this is not without cost. 'It is always the Local Authority or Highways Agency who are left to pick up the pieces. This often involves spending considerable amounts of public money to rectify dysfunctional junctions – the price of getting an early stage design right is dwarfed by that of correcting a bad scheme later.'

John Nightingale – frustrated with the 'stick some signals on it' attitude to junction design.

So what does John put this down to – an experience gap? It is certainly true that the age demographic of signal engineers means that a lot of very experienced people are retiring but on the other hand JCT's training arm is working flat out to train the next generation. More likely, thinks John, there is a general misunderstanding of what is required. 'I think perhaps over the years signal engineers have failed to communicate what needs to be done – they are not exactly renowned for campaigning. Perhaps now is the time to start.'

It is certainly a message that JCT tries to push home on all its training courses. 'We have been banging the drum for concept design and modelling for years here and we make it a point to hammer home the need for early modelling.'

It is a policy that JCT's consultancy arm strives to put into practice too, says John. 'All our own signal designs start with a model and it is through the building and testing of these models that we often find out what will and will not work. The real effort is put into this early stage and often all we actually produce for the client is a short technical note, a print out from the model showing key results and a sketch. And by a sketch I mean literally that. Sometimes it is as basic as ink lines overlaid on an aerial photograph. And what's more we don't often produce options. It is quite simply a waste of time tabling four options when only one of them works.'

He adds that clients like this focussed, intelligent cut down approach with simple presentation of results. 'From the feedback we get we know that this approach bears fruit.'

In the accompanying article, John takes a look at what is needed to get the foundations of a good traffic signal design right. If you think he's got it wrong, or has left anything out, let us know.

Traffic signal design – getting the foundations right

John Nightingale outlines the best way to ensure that designs are both practical and deliverable.

In the early part of the 19th century when Isambard Kingdom Brunel began to formulate his design for the Clifton Suspension Bridge we can be sure that before he put pencil to paper he had made comprehensive and thorough calculations. Before the first foundation stone was laid in 1831 Brunel must have been sure that the bridge would withstand the environmental forces, that it was capable of carrying the horse drawn vehicles of the era and that it had strength to spare. Indeed it's a testimony to his careful planning that the bridge still stands today and carries way in excess of what Brunel could have imagined. The principles of calculation, prediction and safety margins are (or should be) embedded in the engineering design process, so why when it comes to signal design are they frequently lacking?

Too often proposals for signalised junctions are presented which are ill conceived, insufficient and unsafe. At best the result is a rejection of the proposal followed by remedial modelling and design, at worst they get built!

SO WHAT GOES WRONG?

There are three fundamental problems which often manifest themselves in proposals:

(i) Problems with geometry :

Proposals frequently fail to meet basic geometric requirements and in a struggle to remain within the highway boundaries proposers often seriously compromise the physical design. Key areas that frequently fail to receive appropriate attention are:

- Insufficient provision of traffic islands to accommodate the street furniture necessary for delivering the control strategy. A classic example is the omission of traffic islands to accommodate signals for separately signalled right turners
- Islands which are too small to give adequate clearance between traffic and street furniture or to accommodate pedestrians (and cyclists) safely. Small islands also present serious safety issues in relation to optical maintenance
- Failure to consider the swept paths of large vehicles.
- Stop lines which are so removed from the junction that maintenance of an intervisibility envelope becomes impossible. This is a problem which is often exacerbated by the inclusion of advanced stop lines.

(ii) Failure to calculate capacity:

It is still unfortunately not uncommon for proposals to be presented which are lacking even the most basic calculations or modelling and many of these are subsequently found to be fundamentally incapable of delivering adequate capacity. It is clearly impossible to assess any proposal without considering key performance data such as Practical Reserve Capacity and Degree of Saturation.

(iii) Failure to consider safety:

Proposals often include elements which are fundamentally unsafe including:

- Failure to consider vehicle speeds when dealing with opposed right turners in particular the inappropriate allowance of opposed right turns
- Allowing multiple lanes of traffic to give way in the same direction with obvious visibility consequences
- Confusing and often unsafe signal phasing and staging, in particular problems with failing to recognise the problems associated with separately controlling traffic streams from the same arm
- Failure to consider safe progression in double junctions, networks and roundabouts. In many circumstances it can be unsafe to interrupt a platoon of traffic and this can often be avoided by careful design.

AND WHY DOES IT GO WRONG?

I hypothesise that the root of the problem lies a fundamental lack of understanding in both the purpose of traffic signals and in the accepted and safe practices associated with them. And further that many of the problems stem from the pressure associated with the planning process.

So what are signals actually for?

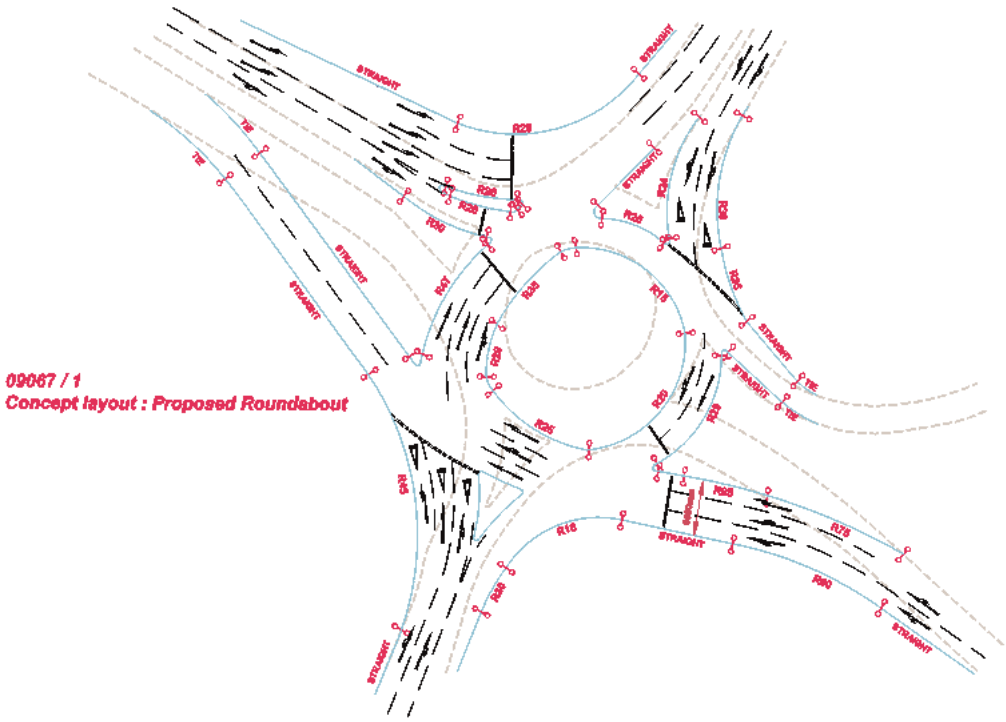
We are too well aware of the headline grabbing calls for the removal of traffic signals. Everyone knows that when the traffic signals fail or are removed 'the traffic flows better', or does it? Well for a start it depends on what you class as traffic, do you include pedestrians and cyclists as traffic and do all the traffic streams flow better? In considering removal of traffic signals we should be asking ourselves why were the signals installed in the first place? In truth it was nearly always down to improve safety and/or a need to redress inequitable balances in traffic flow. In making a decision to install traffic signals there is always a balance to be struck between safety and efficiency. Classic situations which can benefit from traffic signals include:

- Vehicular accidents (particularly associated with vehicles emerging from or turning into side roads)
- Pedestrian accidents (particularly involving children and visually or physically impaired people)
- Long queues on one or more arms
- Physical restrictions requiring traffic movements to be temporally separated

A lack of understanding of the purpose of traffic signals often feeds itself into ill conceived proposals. Some developers and their consultants think that the problem of congested junctions can be solved simply by installing signals, when in fact, unless additional carriageway can found, the installation of signals will inevitably exacerbate the problem. Similarly a

desire to provide signalled pedestrian facilities (particularly on exit arms) often fails to take adequate account of the impact of pedestrian only stages on vehicular traffic delay. Coupled with a lack of signal expertise the result is often inappropriate specification of inadequate junctions.

In terms of the planning process, developers retain the services of consultants who are experts in most of the transport planning disciplines but some consultants have little or no in house traffic signal design and modelling expertise. This is hardly surprising, traffic signal design and modelling is a specialism and smaller consultancies may simply not have the resources (or the work load) to retain a full time in house capability. The result is however that under tight financial constraints and in the rush to meet client deadlines applications are often submitted with vague and untested designs. Post submission, sadly, the problem is sometimes compounded by a lack of signals and signal modelling expertise in Planning and Development Control departments. This result may be poor (or lacking) scrutiny and the approval of a design which is fundamentally flawed. This can cause particular problems at a later date when the problems come to light and it is difficult to re open the approval process.



A simple junction sketch produced by JCT's consultancy arm.

HOW SHOULD IT BE DONE?

The process of traffic signal design should always start with the following data:

1) Traffic flows and turning counts – Whether derived from site surveys or from other predictive models it is impossible to design a traffic signalled junction or network without flow and turning data
2) Accident data – Ideally an historical accident investigation should be undertaken or at the very least details of any particular accident problems considered
3) Constraints – In most cases installation of traffic signals into an existing junction will require an element of new pavement construction or reallocation of carriageway /footway. It is therefore imperative to establish key constraints such as the permitted extents of the maximum footprint and the presence of physical constraints such as bridge parapets
4) Topographical data – ideally in the form of a survey or Ordinance Survey drawings (although increasingly very outline concepts can be produced using satellite imagery)

The traffic signal design process should start with calculations and modelling based on the traffic flow and turn data, and the physical design should evolve naturally from this process. It is impossible to determine fundamentals such as the number of lanes and the signal control strategy without undertaking at least basic calculations. It is also necessary to work towards a design that will accommodate all scenarios (often including future years) and this is where computer modelling becomes an important tool.

Only when the elements of a workable design have been established should an engineer consider any form of drawing. Geometric layouts themselves should start from a position of what is needed, rather than what fits. A good way of doing this is to consider approaches in cross section, starting with preferred lane and island widths. Longitudinal elements such as required lengths for flared approaches will come directly from the modelling process. It is then a relatively straight forward task to construct a drawing on a base and develop the lane and kerb lines. As the design progresses it will naturally be necessary to adjust it to fit the local constraints and elements like stop line and pedestrian crossing positions and crossing lengths will be established. At this point it will be possible to attach more certainty to intergreens and these along with changes in geometry should be transferred back to the modelling process. This iterative process from model to design to model and back again is both efficient and robust and is the best way to ensure that designs are both practical and deliverable.

WHO SHOULD DO IT?

There is quite simply no substitute for experience, traffic signal design is a complex task which requires the designer to think about the problem from many angles and a successful designer is a product of many prior campaigns. If a proposer doesn't have immediate access to the required expertise it should be bought in. Concept design and modelling is relatively inexpensive and by buying in this crucial first stage of work a consultant can go on to use their own resources (such as drafting) to complete more expensive elements of the design.

THE PAYOFF

The most obvious benefit of getting the foundations right is cost. By making informed decisions at an early stage and coming up with robust proposals backed up with performance data a proposer is saving a lot of timely and costly work further down the road. Solid proposals will stand a far better chance of gaining approval and will instil vital early confidence in the scheme from all parties.

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