Switching routes to prevent excessive traffic

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Paper presented to Conference of Australian Institutes of Transport Research, held in February 2014 at the University of New South Wales.

Abstract

This study is concerned with motorists’ behaviour when an element of the road network is reduced in capacity.

A knowledge of motorists’ responses is important in light of the increasing incidence of reductions in road capacity, due to road space being reallocated to other modes: pedestrianization, cycle lanes, bus lanes and street running light rail. Capacity is also reduced when infrastructure is unavailable because of natural or man-made actions or lack of action. Authorities need to ensure that traffic can cope with the disruption that reducing capacity brings, whether caused intentionally or unexpectedly.

The field study for this thesis consisted of a qualitative survey of motorists who drove along Epping Road in Lane Cove, Sydney both before and after the reduction in capacity associated with the opening of the Lane Cove Tunnel in 2007.

It has been noticed that traffic reduces after an incident of reduced road capacity, but only to the extent it needs to do so. The results of the study suggest a hypothesis to explain this result. This hypothesis posits that a minority of motorists have a habit of changing routes to avoid delays. This habit, exercised after road capacity is reduced, in combination with a range of responses that have been observed to follow a reduction in road capacity, ensure that the changes that occur in traffic are no more than necessary to maintain traffic at a level that is acceptable to the motorists who make up that traffic.

Key words: travel behaviour; route choice; reduction in road capacity; habit; qualitative study
1. Introduction

It is sometimes assumed that reducing road capacity (RRC) will cause chaos, but the empirical evidence, from case studies, is that traffic in this situation disappears to the extent necessary to prevent unacceptable disruption (Cairns, Hass-Kla & Goodwin 1998, p.57). Any chaos is short-lived (ibid, p. 6). The empirical evidence is that the most frequent (but by no means only) behaviour changes under these circumstances are alterations to route or time of travel (ibid).

This paper is based upon the results of a qualitative study into the effect of reduced road capacity (RRC) on motorists. It concerns the particular behaviour of choosing a route when the network design has changed such that capacity is reduced and drivers are faced with an unfamiliar road layout. In such instances, there may be initial confusion about what motorists should do and where they should go in order to carry out their usual trips.

Although there has been work done on route choice under conditions of uncertain expectations of delay (e.g. Sikka 2012) there has been limited study conducted on the problems of uncertainty in network layout. This paper suggests a reason for any chaos in this situation being short-lived.

Transport planners are interested in motorists’ choice of route because of their desire to ensure efficient use of the road network. Route choice may contribute to congestion if the demand for a route is greater than the capacity of that route or an incident on the road blocks the free flow of traffic. Choosing routes through the network (traffic assignment) is the final element of the four stage gravity model of transportation and therefore route choice is an integral part of transport modelling. Knowledge of the way routes are chosen is also important for travel demand management, traffic control, design of road infrastructure and the development of electronic technology for trip planning.

This paper is divided as follows: Section 2 briefly reviews some of the behaviour changes observed in situations of RRC. Section 3 provides background information on the study on which this paper is based and summarizes some results. Section 4 discusses the findings of the field work and with the aid of two hypotheses and a conceptual model, suggests reasons for any chaos after RRC being short-lived. Section 5 draws conclusions from the work described.

2. Travel behaviour in an instance of reduced road capacity

2.2.1 ESRC report

The effect of reductions in road capacity was first examined closely in a study that was undertaken by the Transport Studies Unit of the U.K. Economic and Social Research Council (ESRC). The report of the study was entitled Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence (the ESRC report) (Cairns, Hass-Kla & Goodwin 1998).

In the ESRC report, it was noted that responses to road closures varied with the passage of time. They will also, of course, vary with the nature of the road closures and whether other changes have also been implemented (e.g. alterations in speed limits or signal timings, or turns banned). The evidence from the case studies did not allow systematic longitudinal examination of motorists’ responses to RRC. However, it was possible to infer behaviour (ibid. p. 33) (see also Meyer 1988).

1 Under English law, the word ‘highway’ refers to a road or other way (e.g. footpath) over which the public may pass and repass as of right (Martin 1994). In the ESRC study, only the carriageway element of highways was considered.
In the very short term (first few days), there is sometimes noticeable disruption (the ‘traffic chaos’ that is sometimes forecast) which resolves itself. However, this does not always occur, even on the first day. It has been suggested that this is because motorists have heeded any advance publicity and altered their behaviour as necessary. This includes changing route, time of travel or mode. Less frequently, there are other changes, such as changing the person who performs the errand.

Hendrickson et al (1982) suggest the process of changing behaviour may begin even before the closure. In some cases, commuters reported that conditions were the same or better after RRC (Ye, Mokhtarian & Circella 2010). In the case of the emergency bridge closure on Brisbane’s Riverside Expressway in October 2006, twice as many motorists who had taken part in a TravelSmart programme not long before the closure were found to have changed mode as were actually affected by the closure (Marinelli & Watson 2009).

In the short term (up to a year), there is a settling down period in which motorists take account of the new situation. This may be affected by other events going on in their lives (e.g. moving jobs or home).

In the longer term (over a year), reductions in flow may be eroded or enhanced. Motorists may start reappearing on the network. These may be the same motorists who initially disappeared, returning; new motorists joining; or general traffic growth due to increased car ownership. Economic conditions which affect the amount of travel that is undertaken may also affect flows. However, the ESRC report (op. cit.) contains reports of an initial reduction in flow becoming larger with time, sometimes because of additional policies which reinforce the reduction.

2.2.2 The ‘ripple’ effect

In addition, Hunt, Brownlee & Stefan (2002) found a ‘ripple’ effect when the Centre Street Bridge, one of six road bridges over the Bow River in Calgary, Canada, was closed to general traffic in August 1999 in order to undertake rehabilitation to extend its life. The works lasted for 14 months. Although some motorists changed modes or discontinued the errand that took them across the Centre Street Bridge, surveys indicated that most of the motorists who had used that bridge before the rehabilitation works moved to other bridges for their journey. In turn, some of the motorists who were originally using these other bridges also moved to a different bridge, thus creating a ‘ripple’ centred on the Centre Street Bridge.

Although narrowed roads are not the same as missing infrastructure, it seems reasonable to assume that a similar ripple effect will occur when roads are reduced in capacity but not eliminated altogether, if there are alternative routes which drivers can use. That is, the process which occurred on the road where capacity was reduced, will be repeated in places which experience the overflow.

3. Reducing road capacity and route choice

3.1 Method

The research upon which this paper is based involved undertaking a qualitative survey of ten motorists affected by the reduction in capacity of Epping Road in Lane Cove which occurred after the Lane Cove Tunnel was opened. The aim was to discover in what ways they had been
affected. Discussions with interviewees included choice of route, destination and mode. Other effects were also mentioned, although choice of route is the only one discussed here.

The ten discussions were supplemented by casual conversations, 18 e-mails and two telephone calls received as a result of publicity about the study in the local papers and the Macquarie University and University of Technology, Sydney (UTS) websites. Information from one relevant web site and four relevant social forums was also considered.

All interviewees were motorists at the time of the reduction in road capacity, although some of them used other modes at times, including bus, train and bicycle.

### 3.2 Lane Cove and Epping Road background

The last link in Sydney’s Orbital Motorway was completed in March 2007 when the 3.6 km Lane Cove Tunnel opened. The tunnel linked the M2 and the Gore Hill Freeway and provided an alternative to, and relief for, Epping Road in Lane Cove, to which it runs parallel.

As part of the Lane Cove Tunnel scheme, Epping Road through Lane Cove was reduced from five through lanes between Tantallon Road and the Pacific Highway, (worked on a tidal flow system) and three lanes in each direction further west, for general traffic, to one (or two, when extra capacity was deemed necessary) in each direction. Bus lanes were installed along its length in both directions. In addition, a shared use path for cyclists and pedestrians was provided on the southern side of Epping Road in Lane Cove, which connects to other shared use pathways at either end.

The capacity of Epping Road in Lane Cove was not reduced as soon as the tunnel was opened; rather, the existing road layout was retained and use of the tunnel was free for the first month. As a result, the capacity of the Epping Road corridor was briefly enhanced. Capacity was reduced when a lane in each direction on Epping Road in Lane Cove was closed in order to construct the bus lanes in August 2007. Until the bus lanes were opened in March 2008, buses had to share the remaining road space with all other vehicles. Space was also taken to build the shared use path. Epping Road in Lane Cove acquired its present layout in July 2008. Thus, there was a five month period during which motorists using the Epping Road corridor had the benefit of extra capacity from the Lane Cove Tunnel, before the capacity of Epping Road was reduced. However, it took a year from the opening of the Lane Cove Tunnel before the buses were removed from the main traffic flow.

Epping Road continues westwards from Lane Cove over the Lane Cove River through Ryde and into Epping. These western sections contain bus lanes and transit lanes.
Figure 1 Epping Road runs between Epping in the north-west and the Gore Hill Freeway in the south-east

Source: Bing Maps
3.3 Results

3.3.1 Introduction

As has been the experience elsewhere, there was disruption for motorists after the closure of lanes on Epping Road in Lane Cove to begin construction of the bus lanes and shared use path, albeit short-lived. At this point the Lane Cove Tunnel had been open for five months. Some of the traffic that had previously used Epping Road had disappeared. Some motorists would have transferred from Epping Road to the Lane Cove Tunnel. There was some resistance to using the tunnel, principally because people felt they were being forced into it. Interviewees also felt that the narrowing of Epping Road in Lane Cove affected Epping Road further west. Motorists had to adjust their driving to cope with the new situation.

In the course of describing the way they had been affected by the reduction of road capacity on Epping Road, interviewees mentioned five methods of determining a route for a given trip, either as used by themselves or perceived to be used by other motorists:

1) using the road authority’s recommended route between two points;
2) selecting from a palette of routes between two points based on pre-trip information;
3) switching route at junctions or at the site of disruptive incidents;
4) random use of the network;
5) accepting a route determined by means of electronic aids.

The results are summarized in the following paragraphs. To see the original comments, see Sharples (2013) or Sharples (2014).

3.3.2 Principal route

A principal route, as recommended by the road authority, fulfils some criteria for the traveller travelling between two points. It may offer ease of use, speed or directness. It may also be the only route of which the traveller is aware. In this study, Epping Road was the principal route.

It was observed that some people can tolerate congestion and find a use for the delays.

3.3.3 Selection from a palette of routes

Some people have a set of alternate routes between their origin and destination. They can choose the most appropriate one for the conditions. Motorists decide at different stages whether they are going to try a different route.

3.3.4 Route switching

For the section of the flow which consisted of motorists who are prepared to use an alternative route at some stage of their journey (and who therefore are likely to have a good knowledge of the surrounding area) the presence of congestion or an incident such as a road traffic accident is a signal to take note of their surroundings and actively seek out an alternative route.

3.3.5 Random use of network

Desperation could result in motorist trying any route to bypass congestion.
3.3.6 Electronic aids

Electronic aids mentioned by interviewees included:

- broadcast traffic reports (radio, television);
- variable message signs;
- GPS (global positioning satellite) units.

Smart phones, although not mentioned, can also provide traffic information. Interviewees discussed only well known trips, for which they knew (alternate) routes. However, if there were alternatives, the electronic aids were sometimes used to decide which route to take when the trip started (TV) or whether a (later) diversion was in order (radio).

None of the interviewees mentioned using electronic devices to provide them with an entire route, although the CARR website does suggest using an on-board navigation system to plot a trip to avoid toll roads (Zapata 2012). One person was unimpressed with GPS and therefore did not use it.

4. Discussion

4.1 Introduction

From the comments of the interviewees, it can be seen that route-switching (whether on a junction by junction basis or a day by day basis), is normal behaviour for some motorists and therefore part of their coping mechanism when driving.

Hence, it is not surprising that this habit was invoked after Epping Road was narrowed, when motorists experienced congestion that they perceived was due to the reduction in number of lanes on Epping Road.

4.2 Route switching hypothesis

4.2.1 Introduction

Bearing these results in mind, it may therefore be hypothesized that there is a continuum of route-switching behaviour amongst motorists.

At one extreme, some motorists will disappear from the road if they perceive a problem. At the other, some motorists will not change (this may be because they don’t know any alternative; it may be because they prefer to leave experimentation to other people or that they feel other people should change rather than them (“wait a while and it will sort itself out”, “somebody else’s problem”). Some will move if they are given explicit instructions about where to go.

In between are people with differing propensities for experimentation. Some may be prepared to try something different after one experience of the new situation (e.g. different route, travel at a different time of day). Those who wait before attempting any changes may also have different thresholds for change. They may change after two days, or a week. There are motorists who will change slowly (e.g. they will keep using a route until convinced that the situation will never improve) through to motorists who will change frequently (i.e. at every junction if necessary).
Some people have many alternate routes and use them to take action on their own initiative. They actively find ways to solve traffic problems. RRC is just another cause of congestion. This does not necessarily imply that the motorists have a good local knowledge of the area. They may instead have sufficient self-confidence to be sure that they can find an adequate route (perhaps by following other people or navigating by landmarks or compass directions).

4.2.2 Statement of hypothesis

In summary, the route switching hypothesis states that:

| there is a continuum of route-switching behaviour amongst motorists, which varies from none, through occasional, to switching routes whenever the situation exceeds a personal threshold of difficulty. |

4.3 Minimal-chaos hypothesis

If it is assumed that all motorists lie somewhere along this continuum of propensity to change route, it is possible to offer an explanation of why traffic chaos either does not happen, or if it does, does not last long, in a case of a reduction in road capacity involving the narrowing of roads. It is helpful to divide the traffic flow in these situations into three groups, as follows:

4.3.2 Those who make significant changes

It has been observed that a seemingly steady flow of traffic is in fact changing all the time. Surveys “…have suggested that no more than half the vehicles present on a given day will be present at the same point on the following day.” (Bonsall et al 1984). Therefore, it seems reasonable to assume that some of the traffic that might normally use the narrowed route will not be there when the road changes. The new layout is not immediately relevant to these motorists. They can wait and observe the changes. When the flow has settled down, they can re-enter the traffic.

Alternatively, if the motorists have chosen to avoid the route to be narrowed because of publicity (e.g. Marinelli & Watson 2009; Ye, Mokhtarian & Circa 2010), these absentees may have, for example, taken a completely different route, used a different mode, reassigned the errand to someone else or travelled at a different time. They have a low threshold for route change; that is, a high propensity to change.

4.3.3 Those who make no change

However, not everyone who is going to be affected by a reduction in road capacity will realize it at the time. Some people will not realize what it means for them. Some motorists (possibly from outside the area) may not be aware of the impending road narrowing. Some people are not able to avoid the route along which capacity has been reduced because they have origins or destinations there. Therefore, a certain element of the traffic will not leave the area of reduced capacity.

4.3.3 Those who make changes if necessary

Some of the motorists who do use the road with reduced capacity will have a route switching habit of greater or lesser strength. These people form a minority of the traffic. However, given the other absences, this minority, with a tendency to leave a route which is uncomfortable for
them, may be sufficient to prevent the long term confusion so often predicted, but not experienced, in these situations (Cairns, Hass-Klau & Goodwin 1998).

4.3.4 Statement of hypothesis

Interviewee comments suggest that the disruption that was experienced after lanes on Epping Road in Lane Cove were withdrawn from use occurred because motorists were unsure about the actions they should be taking at any particular point.

Motorists may be unsure of what to do and where to go (in spite of road authority information), because the conditions to which they have become accustomed no longer hold (e.g. the network layout has changed). Their usual behaviour has been disrupted. Because the network layout has been changed, their routes, in particular, will have been affected.

The minimal-chaos hypothesis states that

**route switching by a percentage of motorists, in combination with other motorists leaving the route or changing their time of travel, results in changes which tend towards the minimum necessary required to avoid on-going disruption.**

4.4 Conceptual model

If these two hypotheses are combined, a model can be proposed to explain why traffic which uses a road that has been reduced in capacity, reduces in quantity, but only to the extent that it needs to:

**no changes + significant changes + fine tuning**

⇒ **traffic disappears to the extent that it needs to**

5. Conclusion

This paper has discussed five different methods of designing a route, using data from a qualitative study of an incident of reduced road capacity. This information helps to explain why traffic is this situation disappears only to the extent that it needs to.

It may be seen that changing route is a normal, albeit not necessarily widespread, part of the process of making a trip.

Two hypotheses have been proposed, in order to explain the empirical observation that any chaos is short-lived (if it happens at all) when road capacity is reduced. The first is that all motorists lie on continuum of tendency to switch routes; the second is that route switchers fine tune the changes that result from reducing capacity, so that no more changes are made than necessary to avoid on-going disruption.

Further research is required to verify these hypotheses and determine whether they are only valid in the case of narrowing roads or whether they can be applied to changes on a wider scale, such as those that result from disruptive events (e.g. earthquakes) which cause long term damage.
Acknowledgements

Thanks to John Huff for comments on the text and for the map.

References


