

REDUCING ROAD CAPACITY TO CHANGE TRAVEL BEHAVIOUR

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ABSTRACT

There is evidence that life events (that is, events which are infrequent and interfere with routine behaviour, such as moving house or starting a new job) can be a spur for individuals to change their travel behaviour, including using different modes. Therefore one way to bring on a change in travel behaviour may be to generate a life event.

However, life events are unique to individuals: what is appropriate to one may not be possible for another. Network events, such as new roads or closed roads, apply to all road users and can have the same effect on individuals as life events, with regard to travel behaviour.

This paper describes how some network events involving a reduction in road capacity can be interpreted as life events and why others do not qualify. This has implications for the design of travel demand management schemes. It is important because a reduction in road capacity is an event which can be seen to be effective and fair to all motorists.

Keywords: travel demand management, life events, highway capacity reduction, traffic evaporation

1 INTRODUCTION

Currently, the private motor vehicle (PMV – cars, light vans and motorcycles) is the dominant mode of personal transport in Australia and New Zealand, providing for almost 96% of all road km (both by the operator of the vehicle and the passengers) in New Zealand (NZ MoT 2008) and 90% of motorized passenger transport in the capital cities of Australia (Cosgrove, Gargett & Mitchell 2009).

This is not surprising – PMVs provide independence in travel, personal control (over travel and the immediate environment of the vehicle), convenience, flexibility and the ability to transport several people at once, and more articles than can conveniently be carried by one person.

However, convenient as PMVs are for the individual, they cause problems for society in general. These include (Whitelegg 1993):

- pollution (both air (including greenhouse gases) and noise);
- contributing to other health problems, including obesity, stress, injury and premature death;
- depletion of scarce resources, including fuel; energy and materials for manufacturing; land for infrastructure; road space; and individuals' time;
- financial implications for both the public and the private sphere, including the cost of imported materials and operating costs for both vehicles and the associated infrastructure;
- inequities in mobility between those who have access to a PMV and those who don't.

The population of New Zealand (and with it the use of the PMV) is predicted to grow by about 0.5% to approach 5 million by 2020 (Khawaja & Dunstan 2000) and that of Australia to grow by about 1.5% to around 25 million by 2020 (ABS 2008). This growth will only exacerbate the problems, both environmental and economic.

There is a widespread view that a large part of the answer to the transport aspect of these problems is to reduce the use of PMVs – that is, to change individuals' behaviour so that instead of PMVs, they elect to use other modes (such as public transport, walking and cycling), which cause fewer problems to society (James 2002; Moriarty & Honnery 2008; O'Fallon, Sullivan & Hensher 2004; Rees 2003; Verplanken et al. 2008). However, there is no definitive answer as to how such a change could be brought about.

One method, which could contribute to reduction in the use of the PMV in urban areas, is to reduce the available road capacity.

This paper is set out as follows: sections 2 and 3 discuss the concepts of life events and network events. Section 4 looks at reducing road capacity as a particular case of a network event. Section 5 considers two cases where road space was reduced and contrasts the outcomes. Section 6 relates the concept of reducing road capacity to transport demand management. Section 7 offers some conclusions.

2 LIFE EVENTS AND MODE CHOICE

Several writers have described situations where a change in travel behaviour accompanied a change in circumstances. These life events (or life shocks (Goodwin et al. 2004)), which happen with a low frequency and interfere with routine behaviour (Ampt, Stopher & Wundke 2005) include such occurrences as acquiring a driver's licence, changing school, starting university, moving to a new town and starting or losing a job (Klößner 2004). They are all events out of the norm which happen to individuals.

Klößner (ibid) also found that the occurrence of one of these life events seemed to weaken the tendency to choose car as the habitual transport mode. People who were more stable in their living situation had established stronger habits. Even having one life event in the previous year was enough to distinguish between weaker and stronger habits.

Goodwin et al (2004) found that as time increased, there were fewer people who had not had such a disruption to their routine. The timescale of five to six years for most people to have experienced at least one life event also fitted in with the differences between long and short term elasticities that had been observed in behavioural responses to transport policy changes.

Ampt, Stopher & Wundke (2005) discussed a study of home relocation in Canberra, performed as part of a pilot project for a Travel Smart programme (Travel Smart, the travel behaviour change programme, and in particular, the West Australian implementation of the scheme, is described in greater detail in James (2002) and James & Brög (2003)). Verplanken et al (2008) described a situation whereby university staff who were moving house also changed their mode of travel to work. Stanbridge, Lyons & Farthing (2004) also studied the effect of moving home on people's travel behaviour, including mode choice.

These are all examples where transport habits were disrupted and some car travel was transferred to other modes.

3 NETWORK EVENTS

A related concept is the idea of a network event; that is, an event which affects a major part of the transport network, happens with low frequency and interferes with routine operation of the network. Examples are the opening of new roads (e.g. a freeway) or new rail lines, the introduction of road pricing, road works or the installation of bus lanes. Overall, a network event will affect many people: that is, many people will have their routines disrupted.

4 REDUCING ROAD CAPACITY

A network event of particular interest is reducing the capacity of a road. The word 'event' implies that this reduction happens over a short period and is an obvious occurrence, rather than a gradual change, such as may happen with creeping congestion. Common examples of a reduction in road capacity include pedestrianization, the installation of bus, cycle and turning lanes, and lane closures for road works.

It should be noted that in the context of life or network events, it is the act of reducing the road capacity that is important. Once the capacity has been reduced and motorists have adjusted their routines to take account of that, the change no longer has the same ability to disrupt. For motorists who start to use the network in the vicinity of affected links after the capacity has been reduced, the change will be irrelevant, because they have never known the situation in the area to be any different. Their travel behaviour will be conditioned by the actual circumstances they meet, not the circumstances that existed at some time in the past.

It should also be noted that in the context of travel behaviour, increasing capacity is not the inverse of reducing it. The changes represent two discrete network events which may also act in a manner similar to life events. Although travellers may revert to their previous travel behaviour after capacity is reduced and then increased again, this cannot be guaranteed, because they may have formed new travel patterns in the interval. Knowles (1996) gives a rail example of this, when two discrete heavy rail lines in Manchester (England) were converted to a single, connected light rail line. During the two year (1990-1992) construction period, each line was closed for a period of months and the rail services replaced by buses. The new (light) rail line patronage was greater than forecast, but not all the travellers from the old (heavy rail) lines had transferred. Instead, new users, who hadn't previously used the heavy rail lines, had begun using the light rail line.

Reducing road capacity (RRC) is significant in the search for ways to reduce the use of PMVs because it has been observed that it can lead to a reduction in PMVs on the road network.

(It should be noted that road pricing is also a network event that can lead to a reduction in the number of PMVs, in that it applies throughout a section of a road network. However, it is an example of a regressive tax, in that a flat charge applies to all users, independent of their income. In more general terms, some users have a greater quantity of a resource (in this case money) than others, but the same amount of resource is being abstracted each time the network is used in a particular way.

Reducing capacity is not regressive, because the amount of resource removed and the amount that remains available for use are independent of the user. The reduction in capacity is

independent of the user (within each mode – with bus lanes, for example, buses can use bus-only lanes and general traffic lanes, but other motorists may use only general traffic lanes); every user of that mode is left with the same amount of available capacity.

However, it is not possible to specify exactly which motorists respond to the reduction in capacity by changing their travel patterns (unless all motorists have to, in, for example, a road closure). Therefore it is not possible to say that no other inequity will occur as a result of RRC).

4.1 The ESRC report

In 1998 a report was published in the U.K. entitled *Traffic Impact of Highway Capacity Reductions: Assessment of the Evidence* (the Economic and Social Research Council (ESRC) report) ((Cairns, Hass-Klau & Goodwin 1998); see also (Goodwin, Hass-Klau & Cairns 1998)). After a discussion of the theoretical aspects of closing roads and some discussion of how and why people change their travel behaviour, it described over 60 primary case studies of a reduction in road space in locations worldwide and concluded that, on the balance of probability, there was a real relationship between reduced road capacity and reduced motor traffic.

The authors noted that traffic in an area will, however, only reduce under certain conditions. That is, the traffic will reduce if the reduction in road capacity is not offset by spare capacity elsewhere or at some other time, and other actions, such as changes in traffic management or motorists' driving style, do not permit the original number of vehicles to fit into the remaining space.

The changes whose effects make driving in an area unacceptable to motorists include a significant reduction in capacity without adequate spare capacity on alternative routes or at acceptable other times due to the nature of the network, the prevailing level of congestion or the comprehensiveness of the road closure scheme (p. 57).

The changes in traffic volume after a reduction in road capacity varied over a wide range. There were cases where the volume of traffic increased. Nevertheless, Cairns et al report that if the outlier results are omitted, 50% of the remaining locations show overall reductions in flow of more than 16% on the roads which have been affected (p. 14).

In summary, the report concluded that

...traffic does 'disappear' in response to reductions in capacity, but only to the extent that it needs to do so. This occurs due to responses by a proportion of drivers who take action to avoid what they consider, in relation to their prevailing experience, to be unacceptable conditions.
(p.57 (emphasis as in the original)).

This phenomenon is sometimes referred to as traffic evaporation.

Two other important observations were also noted (p.58):

- motorists' changes in behaviour include altering route, time of travel, mode of travel, origin/destinations, the frequency of trips and the person who made the trip (these last four responses are all examples of the original trip disappearing);

This is a wider range of responses than is normally allowed for in transport planning.

- analysis of a series of studies shows that a substantial proportion (usually 30-80%) of the traffic observed in an 'after' survey consists of different people from those observed in a 'before' survey, owing to day to day variability in traffic and longer term changes going on in motorists' lives.

That is, traffic consists of both a stable population of users and a changing population. Some will be able to respond to network changes more quickly than others, so the full effect of the network changes may take some time to emerge.

Traffic Impact of Highway Capacity Reductions: Report on Modelling (MVA Ltd 1998), a companion volume to the ESRC report, was published simultaneously, and was concerned with the implications for transport modelling of a reduction in capacity. It concluded that the initial modelling of a proposal for a road network should proceed as if no allowance needed to be made for traffic reduction. Only if the modelling suggested that this would cause significant traffic problems should any further adjustments to the models be considered. It also mentioned the difficulty of deciding the area which the model should cover so that all important effects are captured (including any 'ripple' effect (see section 5)) without being so large that spurious 'noise' effects become significant.

4.2 Unavailability of roads

A particular subset of RRC is (temporary) denial of access to roads which are normally available. Fujii, Gärling & Kitamura (2001) considered the effect on motorists of the closure of a freeway in Japan for eight days while maintenance was carried out. They found an increase in the frequency of travel by public transport among motorists who had their incorrect expectations of travel time on public transport corrected.

An increase in the use of public transport and reduction in the use of roads was also reported as a result of the Loma Prieta earthquake of 1989 (Cairns, Hass-Klau & Goodwin 1998, pp 194-198). This damaged several freeways and the Bay Bridge in the San Francisco area. Most of the roads were repaired over time, except the Embarcadero Freeway, which was demolished. The travellers who used the Bay Bridge appeared to have returned to their former travel patterns after it was restored - there was a rapid decline in ferry use. However, the Bay Area Rapid Transit (BART) reported that about 30,000 new riders were retained after the Bay Bridge was repaired.

A different point came out of a study by Hunt, Brownlee & Stefan (2002). They looked at a bridge that was closed to PMVs for 14 months in order to undertake repairs, in Calgary in Canada. Most of those using cars before the closure continued to use them after, but crossed the river by other bridges. Interestingly, the study found that 15-30% of those people using the other bridges before the closure also changed their route while the Centre Street Bridge was closed for repairs. That is, they changed route due to the new traffic conditions, irrespective of whether their original route was available or not - an example of the 'ripple' effect (see below).

5 THE RELATIONSHIP BETWEEN NETWORK AND LIFE EVENTS

To any one individual, a network event may or may not have an effect comparable to a life event, depending on its particular characteristics. What is devastating (or liberating) to one user may have no effect on another, either because the second user has no contact with the part of the network affected or because the network event was managed so as to cause minimal disturbance

to users. However, because the effects of one event may ripple out to affect others (e.g. a bridge closure may divert motorists to adjacent bridges, which then become too busy for some of these adjacent bridges' original users, so the latter change their driving patterns by moving to the next bridge out, and so on, as observed in Calgary and described above) it may be difficult to say what the radius of influence of a network event actually is (and hence the size of the population for whom it is potentially a life event), particularly in large urban areas.

Two Australian examples illustrate how a network event may or may not represent a life event.

5.1 Hobart, Tasmania

In Hobart in 1975, a large ship veered off course when passing under the Tasman Bridge and collided with it, destroying two piers and three spans (Director of Public Works Department 1976). This cut off the direct communication between the eastern shore (with one third of the population of the metropolitan area but only 5.3% of the employment) and western shore (with most of the employment, shopping, tertiary education, health and formal recreation and entertainment facilities) of Hobart (Lock & Gelling 1976). The damage took almost three years to repair. In the meantime, the residents of Hobart had to find alternate ways to travel across the river or carry out their errands (Scott 1978).

The event caused considerable interference with routine behaviour. The difficulties in crossing the river by motor vehicle as a result of the sudden, unexpected loss of infrastructure and the inadequacy of the available alternative roads, meant that motorists (and those who had previously used the buses) were forced to think consciously about their travel, because they could no longer continue to travel in their usual manner. Many took note of the information that was distributed about alternative ways of crossing the river, and turned to forms of transport other than cars and buses (e.g. ferries), or made alternative arrangements to carry out their errands, such as moving to the western shore or doing more shopping on the eastern shore (Lee & Wood 1978). Nevertheless, motorists were not expected to do anything other than return to their cars after the Tasman Bridge reopened; and they did so.

The reconstruction of the Tasman Bridge was used as an opportunity to add an extra traffic lane; with the improvement of roads leading to the bridge on the eastern shore and elements of the road network on the western shore, and an extra bridge upriver (a (temporary) Bailey bridge from the end of 1975, which was replaced by the (permanent) Bowen Bridge in 1984) there was a greater capacity on the road network after the collapse than before. The volume of traffic crossing the river returned to pre-collapse levels within a few years of the re-opening of the Tasman Bridge and continued to rise at a steady rate thereafter. The traffic using the ferries peaked just before the Bailey bridge was opened. After the Tasman Bridge was reopened, the ferries withdrew regular passenger services for lack of patronage (Lock & Gelling 1976; Luk et al. 1998; Scott 1978).

5.2 Melbourne, Victoria

In 1992, Swanston Street, one of the major north-south routes in the centre of Melbourne, was closed to most motor vehicles in the central city area. It remained open to trams, emergency vehicles, commercial vehicles including taxis (at specified times), cyclists and pedestrians. At the same time, 225 traffic management measures were installed in the rest of the city area, in order to manage the cars diverted because of the closure (VicRoads nd).

'Before' and 'after' traffic counts indicated a general increase in traffic in the survey area of between two and four percent (2-4%). However, control sites, analysed as a group, showed no change in overall traffic volumes throughout the metropolitan area (Wells & Strickland 1993).

There had been suggestions that traffic would disappear when Swanston Street was closed, based on European experience of pedestrianization (Vic Roads nd). Surveys were undertaken to test this hypothesis, using motorists who were observed to have used Swanston Street before the closure. These motorists expected that they would continue to drive after the closure. This was confirmed in a follow-up survey. One respondent who did change to public transport only did so because she had lost use of the company car park (Grover & Richardson 1993).

In comparison with the damage to the Tasman Bridge, the closure of Swanston Street was expected and planned. Changes had been made elsewhere in the vicinity to cater for extra traffic and motorists had been warned of the closures and offered alternative routes. When congestion occurred during the initial stages of the scheme, motorists were told how they could circumvent it (Vic Roads nd). Motorists were not required to think for themselves (that is, plan their behaviour) because the authorities had organized the situation so that they could continue to traverse the centre of Melbourne with only small changes (suggested by the authorities) with respect to the way they had driven in the past. Grover and Richardson's 1993 focus group study suggested that motorists did not expect to change their mode of travel because of the Swanston Street closure and in the majority of cases, they did not have to.

5.3 Network event or life event?

The changes to Swanston Street were organized and managed so that, as far as possible, they did not interfere with motorists' routines in traversing the central area of Melbourne. Thus for most of the motorists who had previously driven along Swanston Street, the network event generated by the closure did not act like a life event; it did not cause significant changes to their travel behaviour in the centre of Melbourne.

By contrast, the experience in Hobart was one of coping with significant disruption to daily life.

6 REDUCTION IN ROAD CAPACITY AND TRAVEL DEMAND MANAGEMENT

The evidence collected in the ESRC report (Cairns, Hass-Klau & Goodwin 1998) suggests that there is scope to use a reduction in road capacity as a way to manage transport demand. However, experience also suggests that if RRC is to be used in this way, it will be necessary to cause enough disruption to users to force them to think about their travel behaviour. The prospect of disruption is likely to be unpopular with motorists and politicians. However, where support is forthcoming, the results can be very successful (e.g. *ibid*, pp. 153, 170, 198, 212).

A more recent example of where political support was forthcoming, where both road capacity and the amount of road traffic in the area were reduced, and which received widespread publicity (Baker 2009; Lee, Lee & Lee 2006; Shin & Lee 2006; Walsh 2006), is Seoul in Korea. As a result of a campaign promise by the new mayor, a 10 lane highway, supporting a four lane elevated road, built in the 1960s and 1970s, was demolished in 2003. By 2005 the river underneath the freeway, which had been culverted to make way for the roads, had been restored and landscaped (Shin & Lee 2006; Lee, Lee & Lee 2006). As part of the scheme, a new transportation policy was introduced, which focused on public transport.

It is not possible to predict how much traffic will disappear after RRC. However, in order to use RRC as a tool for travel demand management, it will be necessary to understand it – to know how and why it has the effect on road users that it does. Because it is not possible to predict over how wide an area the former users of a road which has been reduced in capacity will disperse, nor how the other events going on in their lives will affect their travel, nor how the new traffic conditions will affect other road users, it is not practicable to come to any conclusions on the basis of, for example, simple before and after surveys (Cairns, Hass-Klau & Goodwin 1998).

My research is concerned with identifying candidate trips; that is, those trips which could disappear when motorists find traffic conditions unacceptable as a result of road capacity being reduced. In order to develop criteria against which motorists' and trips' characteristics can be judged, I intend to consider how motorists' travel behaviour has changed under Travel Smart, or similar revealed preference, studies and programmes. I also intend to studies which have investigated time of day and route changes.

7 CONCLUSION

It is well accepted that the current levels of use of the PMV are causing problems and projected growth is likely to exacerbate these problems.

It has been demonstrated that life events, which occur with a low frequency and interfere with routine behaviour, can lead to changes in travel behaviour. Network events – events which affect a major part of the transport network, occur with low frequency and interfere with routine operation of the network – can act like life events for the individuals involved, if the network events cause sufficient disruption to those individuals.

Reducing road capacity is an example of a network event that can act like a life event for some individuals. Whether this happens or not depends on the characteristics of the network event, how much the individual is affected (directly or indirectly), and how the authority manages it, both at the time of the actual event and in the follow-up. In particular, the reduction in road capacity need not be long term to have an effect on travel behaviour.

RRC can be used for travel demand management but further research is necessary to better understand the responses of motorists to it.

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