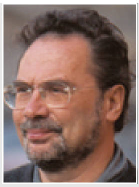
Proceedings of the Institution of Civil Engineers
Municipal Engineer 151
March 2002 Issue 1
Pages 13–22

Paper 12772
Received 06/11/2001
Accepted 06/12/2001

Keywords:
town & city planning/transport planning/urban environment





Sally Cairns
Research Fellow, ESRC Transport Studies Unit, University College London

Stephen Atkins
Visiting Professor, University of Southampton

Phil Goodwin
Professor of Transport Policy and Director of the ESRC Transport Studies Unit, University College London

Disappearing traffic? The story so far

S. Cairns, S. Atkins and P. Goodwin

Reallocating roadspace from general traffic, to improve conditions for pedestrians or cyclists or buses or on-street light rail or other high-occupancy vehicles, is often predicted to cause major traffic problems on neighbouring streets. This paper reports on two phases of research, resulting in the examination of over 70 case studies of roadspace reallocation from eleven countries, and the collation of opinions from over 200 transport professionals worldwide. The findings suggest that predictions of traffic problems are often unnecessarily alarmist, and that, given appropriate local circumstances, significant reductions in overall traffic levels can occur, with people making a far wider range of behavioural responses than has traditionally been assumed. Follow-up work has also highlighted the importance of managing how schemes are perceived by the public and reported in the media, with various lessons for avoiding problems. Finally, the findings highlight that well-designed schemes to reallocate roadspace can often contribute to a multiplicity of different policy aims and objectives.

1. INTRODUCTION

Reducing roadspace for general traffic, and reallocating it to pedestrians or cyclists or buses or trams or other high-occupancy vehicles, could significantly increase the attractiveness of these modes, and facilitate more efficient use of the road network. Yet proposals for such changes are usually controversial. One recurrent issue is whether the displaced traffic will simply divert to neighbouring streets, clogging them up and leading to worse congestion and pollution. This paper reports on findings from research based on over 70 case studies from eleven countries, and the opinions of over 200 transport professionals worldwide. The findings suggest that such problems are, in reality, rarely as bad as predicted, and that, with careful planning and appropriate implementation, reallocating roadspace to more sustainable modes of transport can result in a variety of complementary benefits.

2. CONTEXT

In the mid-1990s, there was a radical shift in UK Government policy on road building. Specifically, the Government clarified that building roads was not always a solution to congestion, as creating new capacity could generate traffic. This was partly due to technical advice from its own Standing Advisory Committee on Trunk Road Assessment (SACTRA),[1] and partly due to the popular recognition that, for example, building the M25 motorway had not produced consistently free-flowing traffic conditions around London (despite having been built with excessive spare capacity according to the traffic conditions before its construction).

However, while it was officially recognised that building roads could induce additional traffic, the opposite proposition, namely that reducing roadspace could reduce traffic, was not widely accepted in either theory or practice. Consequently, numerous proposals for pedestrianisation or bus priority schemes were rejected, due to fears of the problems that they could create on surrounding streets. Examples in London include schemes in the London 'Green Areas' study, and parts of the London Bus Priority Initiative such as the whole route priority proposed for Route 68 between Camden and Camberwell.

To address the issue, a research study was commissioned by London Transport and the Department of the Environment, Transport and the Regions in 1997. Two reports were published—by Cairns, Hass-Klau and Goodwin on the practical evidence,[2] and by MVA[3] on the implications for modelling. This paper summarises and updates the evidence study.

3. THE ORIGINAL STUDY

The original evidence study (by Cairns, Hass-Klau and Goodwin) sought to identify all possible case studies of circumstances where roadspace had been reallocated, whether due to positively planned schemes, temporary road closures for maintenance or renewal of transport facilities, or natural disasters. Although the stimulus for change varied, in each case drivers needed to decide what to do when their normal travel patterns were disrupted, and there were useful insights from all the examples as to how they reacted.

Examples included pedestrianisation schemes in German and other Continental European cities; the City of London 'Ring of Steel' project following IRA bombing; closures of bridges such as London's Westminster Bridge, Tower Bridge and Hammersmith Bridge for repairs and maintenance; city-centre traffic schemes in places like Oxford, Cambridge and Wolverhampton; the introduction of bus lanes in cities such as Cardiff, Bristol and Toronto; the closure of a rural road south of London; the street enhancement projects in Norwegian towns; the Six Towns Bypasses Monitoring Project; the Tasman Bridge collapse in Hobart, Australia; and the effects of earthquakes in

Kobe, Japan, and in California, USA, where transport links were suddenly and unexpectedly removed from the network.

Altogether, evidence from over 200 transport professionals and about 150 published documents was collated to provide information on about 100 case studies from across the world. About 60 provided sufficiently detailed evidence for in-depth analytical review. The key findings were as follows.

(*a*) When roadspace for cars is reallocated, traffic problems are usually far less serious than predicted.
(*b*) Overall traffic levels can reduce by significant amounts.
(*c*) Traffic reduction is partly explained by recognising that people react to a change in road conditions in much more complex ways than has traditionally been assumed in traffic models.

4. FOLLOW-UP RESEARCH

Following the original study, additional innovative schemes of roadspace reallocation have been implemented in practice and further research has been carried out. In February 2000, a conference was promoted by Landor Conferences to discuss further experience.[4] The European Commission, DG Environment, has commissioned a handbook entitled *Traffic Evaporation in Urban Areas*, which should become available soon. Meanwhile, the researchers at University College London have undertaken two main follow-up exercises.

(*a*) An analysis of twelve further UK case studies.[5] This includes an investigation of the M4 bus lane, changes to central Oxford and Cambridge, the Leeds high-occupancy vehicle lane, the Gloucester Safer City project and the redesign of Vauxhall Cross (a major gyratory system in south London).
(*b*) An opinion survey was sent to approximately 400 transport professionals who work on roadspace reallocation issues, or who purchased the original research study. A total of 142 responses were received from a wide range of organisations in different countries. (Some tendency for a self-selection bias was probably inevitable.) This was complemented with a qualitative survey of delegates attending the Landor Conference in 2000, and extensive correspondence with transport professionals, following from the original research study and from a request in *Local Transport Today*, asking for reports of further experience.[6]

One point, which is continuously stressed, is that every scheme to reallocate roadspace is different, and so the effects of any plan will be highly dependent on individual circumstances. This is undoubtedly true and was emphasised in all the original research work. However, while *in theory*, many people recognise that the effects of a scheme 'depend on the circumstances', it is reported that, *in practice*, many work on the basis that traffic levels remain fixed. As one respondent put it, the assumption is that 'nothing will make people get out of their cars—they'll always try and find another way round, and, if necessary, they'll just sit and wait in the traffic'. For future transport policy, it is critical to clarify whether this assumption is correct.

5. PERCEPTIONS OF TRAFFIC IMPACTS

The first main finding of the original study was that traffic conditions following a scheme are rarely as bad as expected. Typically, local papers run headlines warning of 'traffic chaos' in advance of schemes. The closure of Hammersmith Bridge in 1997, for example, was expected to bring most of south-west London to a standstill. Yet, those who have implemented schemes rarely report that such consequences result. Instead, typical comments are of the form: 'a lot of the traffic seems to have disappeared, and we don't know where it has gone'. There are reports of short-term 'traffic chaos': where congestion was previously bad, it often stays bad; and there can be increasing problems on particular local streets. (This can be a particular problem where such streets are outside the boundary of the local authority implementing the scheme.) However, widespread, long-term disruption is hardly ever reported.

This finding appears to be robust. To date, the research work has only identified two schemes that have been withdrawn—the introduction of a bus lane in Dunstable (in 1999) and the trial closure of Orpington High Street (in 1996). The closure of Orpington High Street was reversed because there were problems with enforcement, and retailers were not convinced of the benefits. However, alternative means of improving local accessibility to the high street for pedestrians, and other priority groups, are being explored. In the case of Dunstable, some problems with scheme engineering, and an unfortunate combination of circumstances when the bus lane opened, meant that there were significant initial problems which made it politically undesirable to continue with the scheme. The other scheme that should be mentioned is Hammersmith Bridge, London, which was reopened to general traffic in 1999. However, this was never closed as part of a planned policy, and the decision to reopen it was mainly based on a public opinion survey rather than a technical assessment of the traffic conditions. (The importance of managing public opinion is discussed further below.) These examples compare with over 40 cases of planned schemes that have been successfully implemented and are still in place.

The survey of professional opinion confirms this experience. Over 90% of respondents knew of a roadspace reallocation scheme which had 'apparently' or 'definitely' been implemented 'without causing any significant problems for general traffic'. However, less than a quarter had heard of a scheme that had apparently led to long-term traffic problems, and only 7% were definite that there were such cases.

Hence, current experience suggests that it is rare that roadspace reallocation schemes cause substantial and unacceptable levels of congestion and disruption. Of course, in the past, it is only the better-planned schemes that will have been accepted and implemented. It cannot be asserted that every proposal for giving more roadspace to buses, cyclists or pedestrians will be problem-free. However, the findings should provide reassurance for those investigating such options, and suggest that decision-makers can perhaps afford to be less conservative than they are at present.

Controversy, however, is not always dispersed by technical success. Experience from schemes like the M4 bus lane, and the Oxford Transport Strategy, coupled with the problems identified in Orpington and Dunstable, highlight the importance of getting the details of scheme implementation right, and also of managing public and media opinion. One lesson is that 'first impressions count', and can be critically important to the long-term acceptability of a scheme. There are perhaps four implications that follow from this.

(*a*) *Get schemes right at the beginning, and ensure that all the details are implemented correctly.* The experience of Dunstable is salutary.[7] In September 1999, a bus lane was opened on an approach road leading to a major crossroads in the town. It was closed after ten weeks, due to public outcry at the resulting traffic conditions. However, monitoring suggested that, with a different setting of the crossroads traffic signals, it could have brought traffic benefits. There were various reasons why its opening was particularly unfortunate. Construction work was delayed, so that it opened at the end of the summer holidays. This meant that its opening coincided with the return of children to school (when traffic levels are unusually high), roadworks on the A5 (which is one of the other roads leading into the crossroads), and, several weeks into the scheme, changes on the M1, which caused a significant diversion of London-bound traffic through Dunstable. In addition, the crossroad traffic lights were set manually, and the initial settings proved to be inappropriate. They were adjusted, but, by then, as the scheme engineer notes, 'the newspapers had their headlines'. With hindsight, those in charge say that they would have put more pressure on the contractor to finish on time, and would have made sure that the traffic-light settings were more suitable from the beginning.

(*b*) *Monitor all issues of controversy, so that critics can be met with facts and ensure that facts are readily available as soon as possible.* Hammersmith Bridge, the Oxford Transport Strategy and the M4 bus lane are all examples demonstrating the importance of monitoring, and, in particular, of having the right data to hand to respond quickly to criticism. In the case of Hammersmith, there were no measurements of congestion made on any of the key roads around the bridge prior to its closure. Although a number of other measurements were made (and both bridge counts and surveys of bridge users suggested that there were significant reductions in car use overall), congestion proved to be the critical issue, and there was no comprehensive monitoring of delays to highlight whether, in fact, the closure had significantly worsened conditions over a wide area or whether the levels of congestion were largely symptomatic of the heavy traffic that characterises London generally.

With the current Oxford Transport Strategy,[8] a critical issue has been the impact on retail trade. Although pedestrian movements in the centre have increased, and there is a waiting list of shops wanting to occupy retail properties, the evidence about the financial effects for existing traders remains mixed. This is partly because it has proved very difficult to persuade a fully representative cross-section of traders to participate in survey work, and partly because there is a lack of comparable national retail benchmark data, which is critical in the current economic climate.

With the M4 bus lane,[9] which was introduced in 1999, monitoring data have shown improvements in peak hour journey times for both the 300 or more taxis, buses and coaches that use the lane per hour, and for the general traffic, which now remains in two lanes between Junctions 3 and 2 (as opposed to the previous system where it speeded up across a three-lane section and then got delayed in a bottleneck when the road narrowed back to a two-lane elevated section). Indeed, the scheme was favourably reported in all the major broadsheets on 8 November 1999, when the Highways Agency released the monitoring results from the first three months. However, public perception is still influenced by the reports of 'disaster' from around the time it opened, when there were few facts available, so that the media created its own interpretation of events. Moreover, this interpretation is often recycled in subsequent reports. Those in charge of the scheme note that 'any journalist writing a piece will always include in his article what was reported last time, regardless of intervening events', and highlight that, in retrospect, they should have released some preliminary findings as early as possible, to explain how the scheme was operating.

(*c*) *Use the press and the public consultation work to emphasise that there are likely to be initial problems.* The experience of Vauxhall Cross is interesting.[10] The first phase of the scheme was introduced in June 1999, and has involved removing 10% of the capacity at a major gyratory system in south London, which carried 10 000 vehicles per hour at peak times. There was considerable sensitivity about the plans from neighbouring London boroughs and the Traffic Director for London, so that the trial scheme had to be capable of reversal within 3 hours. The *Evening Standard* carried headlines predicting that it was 'Doomsday for drivers in London'.[11] And yet, the resulting implementation was relatively trouble-free (and current analysis is testing whether the scheme has encouraged gradual traffic reduction in the local area over time). Partly, the lack of problems resulted from the high quality of scheme design. However, successful implementation may also have been helped by signs on all the approach roads for several weeks beforehand, highlighting that there were likely to be problems. Ironically, the *Evening Standard*'s predictions of disaster may also have been effective in preventing problems from actually occurring.

(*d*) *Implement controversial schemes in stages, try to influence any potential side-effects so that they are positive rather than negative, and ensure that the benefits from each stage are obvious.* A number of those attempting to change traffic conditions across a wide area highlight that they have implemented controversial schemes in stages, where each stage can be removed if necessary, and that this approach can help to gain both political and public acceptance. The reversability of the first phase of the Vauxhall Cross scheme helped to win acceptance for its introduction. Wolverhampton is another example of a scheme that was implemented in stages (between 1987 and 1991).[12] Prior to implementation, concerns about the effects on retailing were an issue here, and it is notable that the council acted in partnership with the retailers, paying for radio advertising about park-and-ride availability and distributing information about general access for shoppers. Wolverhampton was subsequently awarded the Town Centre Environment Award by the British Council of Shopping Centres in 1993.

Cambridge is also a good example of a staged scheme, where through-traffic is gradually being excluded from the city centre by the sequential closure of three through-routes.[13] The first, Bridge Street, was closed in January 1997. It has since been relandscaped, which proved popular, and it was considered ‘no longer an issue’ when the second through-route, Emmanuel Road, was closed in August 1999. Indeed, the quality of the subsequent streetscape seems to be highly important in the perceived desirability of a scheme.

In Oxford, limited funding, and ongoing problems with the city’s sewerage system, have prevented the final cosmetic work which might contribute significantly to the popularity of the city centre. In contrast, Shrewsbury[14] received an award from the Royal Town Planning Institute, together with funding from the Department of Transport, to introduce roadspace reallocation measures (such as carriageway narrowing and footpath widening) in a context of generally relandscaping and upgrading the centre, including reducing street clutter and the introduction of granite sett street surfacing (which gives an effect similar to cobbled paving*). The scheme has been successful in improving conditions for pedestrians and other classes of priority traffic, while general traffic entering the treated area has dropped by 34%, without any explicit traffic restrictions.

6. IMPACTS ON TRAFFIC LEVELS

The second main finding from the original research was that taking away roadspace from general traffic can cause overall traffic levels to reduce. Analysis of the twelve new case studies supports this conclusion, and over 90% of transport experts responding to the questionnaire agreed with the statement that, ‘in some circumstances, overall traffic levels† in a local area may reduce following a roadspace reallocation’.

The scale of measured traffic changes is highlighted in Table 1 and illustrated graphically in Fig. 1. These contain the case study results from the original study and, also, the new examples. For each of the case studies quoted, traffic levels were monitored on the treated road, or area, and also on surrounding roads. The change in traffic levels is expressed as the increase or decrease in the proportion of traffic that previously used the treated road/area, as measured across the wider area.‡ (As previously mentioned, within the total change, there are likely to be increases or decreases in traffic levels on particular roads, which are different to the overall effect on traffic levels.)

As shown in Fig. 1, 51 of the overall results showed a traffic decrease while eleven showed a traffic increase (which was sometimes due to traffic-inducing changes made to other parts of the network). For many of the examples (considered separately), it is difficult to say that the result is beyond doubt; for example, there is often the possibility of having an even wider screenline. Moreover, there is always a certain amount of natural variability in traffic levels, which even long monitoring periods may fail to adequately reflect. Those cases which showed a small change in traffic levels could effectively be reflecting relatively stable conditions.

However, given that many of the cases were based on extremely high-quality monitoring data, and given that such a high proportion of cases showed a decline in traffic, it is highly unlikely that all the results of traffic reduction are statistical anomalies. On balance, the data suggest that traffic reduction is a real phenomenon that occurs when roadspace for cars is reduced. Moreover, the scale of reduction can be quite substantial. The mean average was a reduction of 21·9% and the median—which is a better measure of central tendency here, given the variability of results—was a reduction of 10·6%. In other words, in half the cases, over 11% of the vehicles which were previously using the road or the area where roadspace for general traffic was reduced, could not be found in the surrounding area afterwards.

This new figure of 11% is slightly lower than the 14% traffic reduction calculated in the earlier study, though it is still significantly different from zero, and there is a wide variation in results anyway. An early hypothesis was that the nature of the roadspace change might affect the degree of ‘traffic disappearance’. Hence, in the last column of Table 1, changes to central shopping areas and the introduction of bus lanes have been identified separately. Interestingly, the effects of making changes to central shopping areas appear to be as variable as the distribution overall. (Calculated separately, the mean average traffic reduction is 28·3% and the median is 13·7%.) The results from introducing bus lanes appear to cluster more closely around an average traffic reduction of 5%, though there are, as yet, not enough cases to conclude this with any certainty. Further research is planned.

Another early hypothesis was that the duration of the policy, and the monitoring, could affect the results. Consequently, where monitoring had been carried out over different time periods, a short-term and a long-term result were included in the table. Two different patterns of experience emerge. In some cases, over time, traffic appears to creep back to its original level, or higher—presumably because the ‘deterrent’ provided by the change in network conditions, the increase in attractiveness of alternatives and the other policies operating in the area are not sufficient to result in long-term changes in travel behaviour. However, in other circumstances, more comprehensive policies appear to result in cumulative reductions in traffic which are greater than those initially triggered by the policy. Notably, in Cambridge,[13] there was no significant change in measured traffic levels in the year following either of the bridge closures. However, over the four-year period 1996–2000, the River Cam screenline has shown an 8% reduction in overall traffic levels. The cumulative effect of policies also helps to explain how it is possible that more than 100% of traffic appears to have evaporated. This was recorded in the cases of

* Technical problems with the granite setts subequently meant that a revised, but still attractive, surfacing solution has been developed.

† ‘Overall traffic levels’ refers to the *total* amount of traffic in the area, while the ‘local area’ was defined as being the network of roads over which traffic counts could potentially have changed due to the roadspace reallocation.

‡ Specifically, column E in Table 1 was calculated using the formula: $[(B + D) - (A + C)]/A \times 100$. An alternative measure to use would have been: $[(B + D) - (A + C)]/(A + C) \times 100$. The second formulation was not used because the measured result becomes critically dependent on the scale of the study area; for example, if a very wide cordon has been drawn, the percentage change caused by the closure of one individual road is likely to be very small, even if all the traffic previously using that road evaporates. Further explanation of how the percentage changes are calculated is given in the original research report.[2]

Description	Vehicle flows on altered route/area		Vehicle flows on parallel/alternative routes		Traffic change	
	Before (A)	After (B)	Before (C)	After (D)	(E)	
Nurnberg Rathausplatz 1988–1993 (5 years)	24 584	0	67 284	55 824	−146·6	*
Wiesbaden city centre and boundary 1990–1992	1303	366	8445	7968	−108·5	*
Southampton city centre 1996–2000	5316	3081	26 522	24 104	−87·5	*
Nurnberg Rathausplatz 1988–1989 (1 year)	24 584	0	67 284	70 692	−86·1	*
Tower Bridge closure 1993 (1 month)	44 242	0	103 262	111 999	−80·3	
Partingdale Lane local area 1997 (6 months)	988	18	2519	2735	−76·3	
Rotherhithe Tunnel closure 1998 (1 month)	40 000	0	245 381	260 299	−62·7	
Hobart: Tasman Bridge collapse (14 months)	43 930	0			−61·3	
Orpington High Street closure 1996 (3 months)	1105	760	7084	6847	−52·7	*
Bologna city centre 1981–1989	177 000	87 000			−50·8	*
Hanshin-Awaji earthquake 1995 (after highways restored)	252 900	103 300	205 900	233 600	−48·2	
Gothenburg CBD 1970–1980	150 000	81 000			−46·0	*
New York highway closure 1973 (2 years)	110 000	50 000	540 000	560 000	−45·5	
Edmonton–Kinnaird Bridge closure 1979 (3 weeks)	1300	0	2130	2885	−41·9	
New York highway closure 1973 (1 year)	110 000	50 000	540 000	560 000	−36·4	
Hammersmith Bridge 1997—local area only (1 month)	30 698	3000	104 698	122 106	−33·5	
A13 closure, 8 June 1996 (same day)	56 000	22 800	50 800	65 513	−33·0	
Partingdale Lane local area 1997 (3 months)	988	21	2519	3190	−30·0	
A13 closure, 1 June 1996 (same day)	56 000	19 722	50 800	71 463	−27·9	
Oxford Street 1972—1st phase	1800	950	4050	4400	−27·8	*
Ring of Steel 'central core' 1992–1994	160 000	120 000			−25·0	*
A13 closure, 15 June 1996 (same day)	54 200	26 804	52 200	67 347	−22·6	
Aarau 1988–1994 (evening peak traffic)	1444	1132	2275	2301	−19·8	
Oxford Transport Strategy 1999 (12 months)	57 186	46 773			−18·2	*
Hamm 1991	21 500	18 000			−16·3	*
York: Lendal Bridge closure 1978–1979 (1 month)	16 290	0	49 100	62 800	−15·9	
Luneberg 1991–1994	106 002	90 597			−14·5	*
Wolverhampton 1990–1996 (within ring road)	81 500	69 750			−14·4	*
Hobart 1975: Tasman Bridge restored 5 months	43 930				−14·0	
Bologna city centre 1972–1974	213 200	185 500			−13·0	*
Leeds HOV 1998 (1 month)	3384	2779	10 824	11 069	−10·6	
Cambridge—Bridge Street closure 1997 (5 months)	23 411	20 931			−10·6	*
Oxford bus lanes 1974–1975 (1 year)	60 684	54 820			−9·7	#
Cambridge Core Traffic Scheme 1996–2000 (4 years)	76 155	69 792			−8·4	*
Loma Prieta earthquake 1989 (after restoration)	245 000				−7·5	
A104 Bridge Road bus lane 1994 (1 year)	34 070	31 102	81 609	82 121	−7·2	#
Freiburg ring road 1996–1997 (10 months)	34 200	22 600	64 500	73 700	−7·0	*
Oxford city centre 1974–1984 (10 years)	60 684	56 599			−6·7	
York bus lane (7 weeks—50% signal capacity)	681	650	600	594	−5·4	#
York bus lane (1 week—67% signal capacity)	681	645	600	606	−4·4	#
Cardiff bus lanes 1993–1996	156 299	149 596			−4·3	#
Gothenburg central urban area 1975–1980	320 000	307 200			−4·0	*
Leicester ring road—am peak 1999 (2 months)	4575	3972	6059	6511	−3·3	
Edinburgh—Princes Street closure 1997 (3 months)	221 953	215 011			−3·1	*
M4 bus lane 1999 (1 year)	52 800	51 300			−2·8	#
Northridge earthquake 1994 (after restoration)	698 000	670 000			−1·7	
Nottingham traffic collar 1975–1976 (9 months)	13 380	13 150			−1·7	
Wolverhampton 1990–1996	222 900	220 300			−1·2	*
Cambridge—Emmanuel road closure 1999 (7 months)	70 030	69 792			−0·3	*
Ring of Steel 'Square Mile' 1992–1994 (1 year)	254 192	253 613			−0·2	*
Edinburgh—Princes Street closure 1997 (1 year)	221 953	221 834			−0·1	*
Munich bridge closure 1988	32 000	0	71 000	103 000	0·0	
Vauxhall Cross area 1999 (3 months)	537 543	539 704			0·4	
Orpington High Street closure 1996 (1 year)	1105	744	7084	7461	1·4	*
Frankfurt am Main bridge closure 1989	29 500	0	162 500	192 500	1·7	
Westminster Bridge 1994–1995	41 739	41 284	90 276	91 626	2·1	
M4 bus lane 1999 (2 months)	52 800	54 000			2·3	#
Cambridge—Bridge Street closure 1997 (2 months)	31 869	28 781	44 286	48 338	3·0	*
Norway—Street enhancement 1991–1995	15 300	15 800			3·3	*
Leicester ring road—am peak period 1999 (2 months)	10 935	11 212	7542	7918	6·0	
Aarau 1988–1994 (24 h traffic)	18 292	17 244	26 512	30 093	13·8	
Six Towns Bypass Project (1992–1995)	38 212	30 968	51 697	66 808	20·6	
Leeds HOV 1998 (13 months)	3384	3438	10 824	11 634	25·5	

Where the third and fourth columns are shaded, traffic has usually been counted crossing a cordon around an area-wide scheme (typically a town centre), such that there are no 'alternative routes' into the affected area.
Dates refer to scheme dates. Monitoring period after scheme opening is given in brackets. * = town centre scheme; # = bus lane.

Table 1. Recorded changes in traffic levels for individual case studies

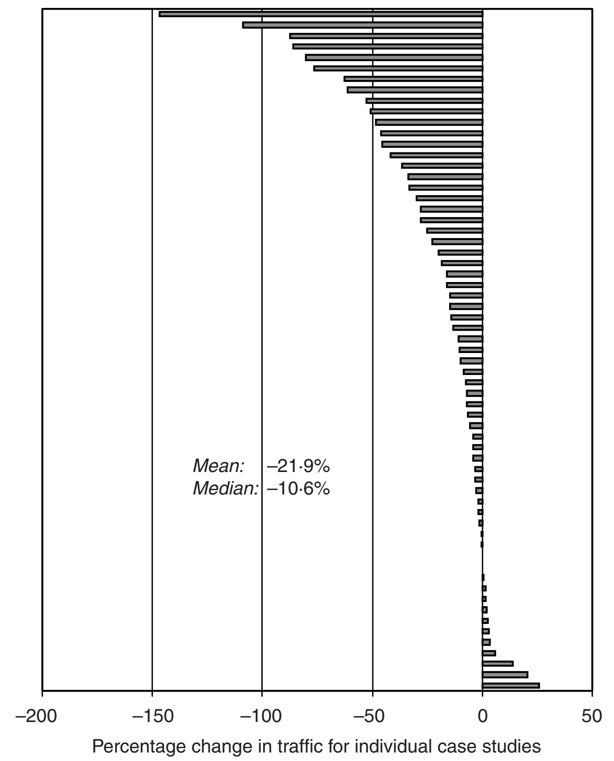


Fig. 1. Distribution of recorded changes in traffic levels for individual case studies

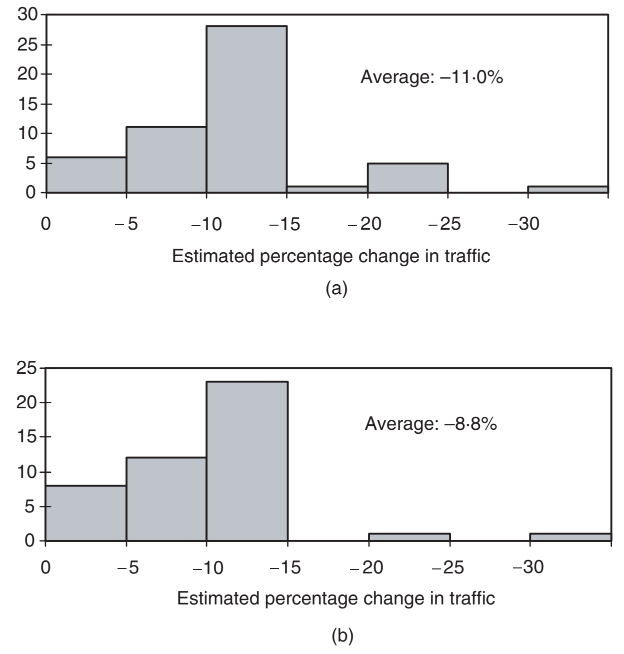


Fig. 2. Number of respondents giving estimates about the likely impact on traffic levels of: (a) a general roadspace reallocation; and (b) a bus lane

Nurnberg and Wiesbaden, where more traffic disappeared from the networks as a whole than previously used the particular roads that were closed. In these cases, the specific changes implemented have formed part of a wider programme of measures, which have had a cumulative effect on how people choose to access the city.

As a cross-check on the credibility of the case study evidence, professionals were asked what they would consider to be an appropriate assumption for traffic changes following a roadspace reallocation in their area. About two-thirds were not prepared to comment, either because they did not know or because they felt it was inappropriate to generalise. However, a third were prepared to give an opinion and the results are shown in Fig. 2. Averaged out, these suggest that professionals think that an 11% traffic reduction might be achieved by a general roadspace reallocation scheme in their area (Fig. 2(a)), and an 8·8% traffic reduction might be achieved by introduction of a bus lane (Fig. 2(b)). It is notable that only 3% of professionals said that they thought the most appropriate assumption would be zero traffic reduction for either general roadspace reallocation or the introduction of a bus lane in their area.

Hence, the case study results suggest that traffic reduction is a real phenomenon, and that the levels of traffic reduction that occur from reallocating roadspace can be quite high. Most transport professionals support the concept of traffic reduction and their opinion of its impact is broadly in line with the collective results from the monitored studies. In particular, both sources highlight that, when implementing roadspace reallocation schemes, the most appropriate assumption is not usually that traffic levels will remain fixed. However, both sources also highlight the variability of results and the importance of the context in which policies are implemented. Consequently, those involved in schemes will always need to consider local circumstances, and comparable experience elsewhere. To this end, website databases of examples—such as www.eltis.org—are of value, and a specific compendium of places that have reduced roadspace for general traffic could be an important resource. The original study report[2] and the update of case studies[5] may provide some useful information of this nature for practitioners.

7. EXPLAINING TRAFFIC REDUCTION

The final finding from the original study was that the *reason* traffic reduction is observed is that the behavioural responses that people make following a change in road conditions are much more complex than has previously been assumed, or allowed for in traditional transport modelling. A three-level model of behaviour was developed.

(*a*) At the first level, there is the perception that road capacity for general traffic has been reduced. However, any changes are offset, or more than offset, by capacity increases on other routes, or changes in traffic management, or changes in driving style, which pack more vehicles into the same space. In other words, not all examples of roadspace reallocation reduce road capacity. For example, during the Nottingham Zones and Collar experiment in 1975–1976,[15] it was reported that more cars were getting through the traffic-lights on the approach roads to the centre, even though the green times allocated were shorter, presumably because drivers were sitting waiting, with their foot on the accelerator, ready to leap off the lights as soon as possible.

(*b*) Second, there may be a real reduction in capacity on the treated road or area, but this may be offset by adequate spare capacity on alternative routes or at other times of the day. Consequently, people may change their route or journey time, but the overall number of trips and vehicle mileage is likely to remain relatively unchanged. This appears to have been the case following changes to the west side of the ring road in Leicester,[16] where traffic has reduced in the peak hour, but there have been compensating traffic increases in the shoulders of the peak and on the eastern side of the ring road.

(*c*) The third situation is where there is not adequate additional capacity on other routes, or at other times, either due to the nature of the network, the prevailing level of congestion or the comprehensiveness of the scheme. In these circumstances, as well as rerouteing or retiming their trips, a wide range of other responses were reported in surveys. These included people changing their mode of travel, choosing to visit alternative destinations, changing the frequency of their journey, consolidating trips for different purposes, altering the allocation of tasks within a household to enable more efficient trip-making, car-sharing, or no longer making journeys (e.g. by working from home occasionally). Longer-term responses included changes in job location, changes in household location and changes in developers' choice of location for new development. These responses differed from individual to individual and from place to place. It is these cases where conventional assumptions about behavioural change are likely to be most inappropriate.

In understanding how such complex reactions can result from a change in road conditions, the study highlighted that many of these changes are being made all the time anyway, for other reasons. Underlying aggregate traffic patterns, there is a complex 'churn' of individual turnover. Hence, for example, surveys of number-plates have shown that as many as 50% of cars on a major commuter route on two subsequent days can be different, even though overall traffic levels remain similar.[17] This means that when road conditions change, a range of travellers are affected. Some are people who are used to making a particular journey in the same way every day, who are likely to be relatively resistant to changing their behaviour. However, many others will in any event be making a mixture of minor and major changes to their journey patterns. Hence, a roadspace reallocation may simply tip the balance in a decision that is being made for other reasons. For example, people moving job or moving house are very unlikely to do so solely because the roads change. However, if they are doing so anyway, it may be a factor in when and where they choose to relocate. It also means that some travellers are affected who have little prior experience of using the route at the time chosen. They will have limited expectations of what journey times or conditions might be, and their behaviour will be conditioned by their new experience, rather than any past history. Consequently, they may be more amenable to changing travel behaviour, as they will make their travel arrangements without preconceptions.

The range of potential responses identified was drawn from individual case study reports. As a cross-check, transport professionals were asked which of these responses they thought were credible changes that some people would make following a significant roadspace reallocation. The results on short-term responses are shown in Fig. 3. Clearly, the responses which are conventionally recognised in transport planning, such as changing the route or mode of the journey, also receive the greatest support from professionals as being plausible changes that people make. As responses become less commonly considered in transport planning, there is less agreement that people are likely to make such changes, but there is also greater uncertainty, with more professionals saying that they simply 'don't know'. Significantly, all the responses listed get at least 30% of professionals saying that they think some people would make those changes, and over 55% saying that people would either normally make such changes or might do so in

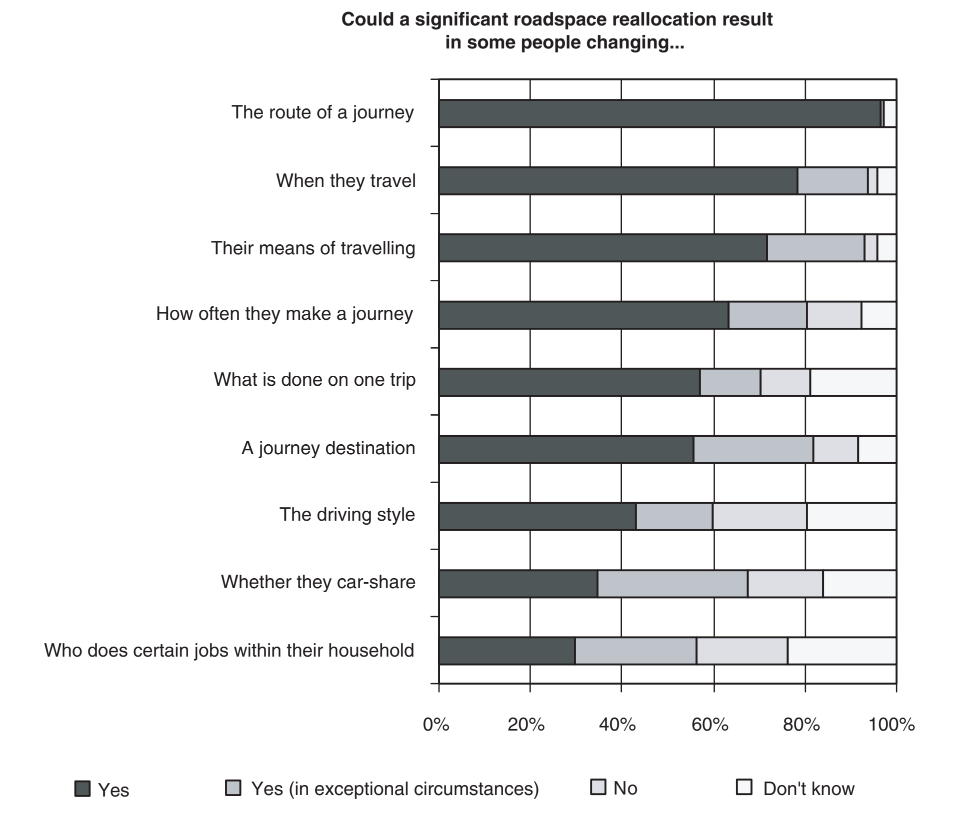


Fig. 3. Professional opinions about plausible behavioural responses to a change in road conditions

exceptional circumstances. In addition, nearly 60% of professionals agreed with the statement that 'roadspace reallocation, or its effects, could 'tip the balance' in a decision mainly being made for other reasons (such as whether to move job or where to move house)'.

8. THE DESIRABILITY OF TRAFFIC REDUCTION

An underlying issue of the transport debate is whether traffic reduction is, in itself, a desirable aim. The Government's Response to the 1998 Road Traffic Reduction (National Targets) Act was entitled 'Tackling Congestion and Pollution', and focused on ameliorating the impacts of motor traffic, rather than reducing it.[18] Consequently, the survey of professional opinion specifically asked respondents whether reducing traffic levels should be an explicit aim of policy. Over two-thirds felt that it should. Some who added comments clarified that they thought that it was an underlying prerequisite to achieving other goals, since other measures, such as cleaner vehicles, smaller cars and vehicle routeing technology would not be sufficient, in themselves, to achieve the levels of congestion and pollution reduction that are desirable. Others emphasised that, even if heavy traffic could be made clean and free-flowing, having significant vehicle flows passing through residential or commercial areas could result in neighbourhood severance, make an area unattractive for investors, and restrict the movements of children and other vulnerable groups. The consensus seems to be that traffic reduction should be an explicit aim, since its achievement is commensurate with achieving a range of other benefits.

However, this finding needs to be placed in the context that, for most of the cases studied, the overall objectives were much wider, and aimed at improving the quality of the environment for people living, working and visiting. Reducing casualties (Gloucester), improving town centre quality (Cambridge/Oxford), community regeneration (Vauxhall Cross) or creating environmental conditions appropriate to stimulate business investment (Leicester) all provided objectives for roadspace management projects which were about far more than simply the passage of vehicles.

Moreover, those who implement schemes often find they have to defend themselves on a variety of grounds, and traffic reduction can even be seen as a negative result. For example, the Oxford Transport Strategy[8] has resulted in a 20% reduction in vehicles entering the central area. There is a danger that this would be interpreted as having deterred people from visiting the centre, were it not for other monitoring data. These suggest that, while the number of people arriving and parking has declined by about 700–800 a day, the number arriving on buses has increased by about 2000—such that the overall number of people visiting the centre has actually increased (Fig. 4).

Focusing on the number of *people* involved in a scheme seems to be critical to many arguments. As another example, a local newspaper quoted a member of Westminster Council as criticising plans for bus priority on Hammersmith Bridge on the basis that 'thousands of cars would be forced to give way to 76 buses in the peak'. However, this is misleading as to the balance of the proposals. An assessment of 'people numbers' shows that, at peak times, there are approximately the same number crossing the bridge by bus as by car. It is important that debate is not distorted by focusing solely on vehicle numbers. (Recent proposals partly stem from a recognition of the improved conditions for bus passengers, cyclists and pedestrians during the bridge closure in 1997–1999, Fig. 5).

Fig. 4. Oxford Transport Strategy: introducing traffic restrictions in the central area has reduced through-traffic, while the number of people visiting has increased. (Photograph courtesy of Sally Cairns)

A further example of proposed roadspace reallocation is the World Squares for All project, which will include the pedestrianisation of the north side of Trafalgar Square, London. The current situation is shown in Fig. 6(a), while Fig. 6(b) is a projected view. Again, this project aims to achieve a multitude of benefits, including increasing the attractiveness of London as a 'world city' for residents, visitors and tourists.

9. CONCLUSIONS

Overall, all follow-up work has broadly confirmed the findings of the original study. When pedestrianisation schemes or wider pavements or cycle lanes or bus (and other priority vehicle) lanes or road closures are introduced, pre-scheme predictions of what will happen are usually excessively pessimistic. In practice, it is rare that schemes result in a significant deterioration of traffic conditions. Traffic levels can reduce by significant amounts, with the average being that perhaps 11% of the traffic on the treated road or area cannot be found in the area afterwards. However, all schemes are different, and each will need to be considered according to its own circumstances.

Fig. 5. Hammersmith Bridge: conditions for buses, cyclists and pedestrians were improved during the bridge closure of 1997–1999. (Photograph courtesy of Sally Cairns)

The corollary is that it is not appropriate to assume automatically that traffic levels will remain fixed. The public are likely to react in a range of ways to changing conditions, and, if there are no easy alternative options, there are a variety of responses that people may make which, taken together, can result in the measurable loss of traffic from a network.

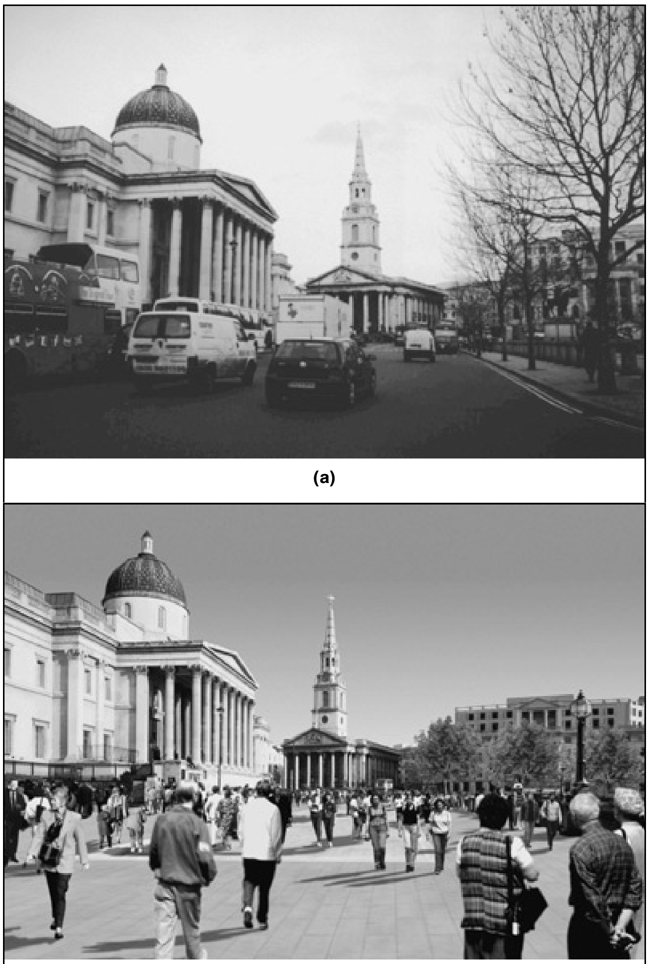


Fig. 6. Photographs showing: (a) the current state of Trafalgar Square; and (b) the plans for its future. (Photograph courtesy of Fosters and Partners)

In addition to the original findings, the follow-up work has highlighted some further issues. First impressions of schemes count, such that it is very important to get the details of scheme implementation correct, and to manage public and media perceptions. Monitoring of key issues is critical and facts need to be available fast, so that debate is informed. Pre-warnings of initial problems may result in pre-emptive behavioural changes, which can help to avoid difficulties. Controversial schemes can be introduced in (easily reversible) stages; it is important to ensure that the benefits of schemes are obvious, and any 'side-effects' need to be managed. The quality of resulting streetscape may be critical to its acceptability, and budgets should aim to provide the often expensive relandscaping that may be required. Many transport professionals highlight that traffic reduction should usually be an explicit aim of policy, although the objectives of schemes are usually far broader than altering vehicle flows. It is important that scheme monitoring includes counts of people as well as vehicles, to balance debate about issues of social equity or how attractive an area has become.

Finally, the findings reinforce the overall conclusion of the original study—namely, that well-designed and well-implemented schemes to reallocate roadspace away from general traffic can help to improve conditions for pedestrians, cyclists or public transport users, without significantly increasing congestion or other related problems. Moreover, schemes can help in achieving a wide variety of benefits including accident reductions, air-quality improvements, reduced neighbourhood severance, increased business investment, more attractive living and working surroundings and improved retail vitality. The feasibility of scaling up the successes of local schemes into more comprehensive initiatives is currently unclear. However, this is a critical issue for future exploration, given the potential opportunities that such schemes offer to achieve traffic reduction, urban regeneration, more efficient use of economic resources and other national policy objectives.

10. ACKNOWLEDGEMENTS

The authors wish to gratefully acknowledge the substantial help and expertise that they have received from many other transport professionals during the course of this research.

REFERENCES

1. Standing Advisory Committee on Trunk Road Assessment. *Trunk Roads and the Generation of Traffic*. DETR, London, 1994.
2. Cairns S., Hass-Klau C. and Goodwin P. B. *Traffic Impact of Highway Capacity Reductions; Assessment of the Evidence*. Landor Publishing, London, 1998. (With an annex by Ryuichi Kitamura, Toshiyuki Yamamoto and Satoshi Fujii.)
3. MVA. *Traffic Impact of Highway Capacity Reductions: Report on Modelling*. Landor Publishing, London, 1998.
4. *Proceedings of a Landor Conference: Reallocating Roadspace: Putting Theory into Practice*, London, 10/2/2000.
5. Atkins S. and Cairns S. *Reallocating Roadspace: An Update of Case Study Evidence and Related Research*. ESRC TSU working paper, Transport Studies, UCL, London, 2002.
6. Cairns S. and Goodwin P. B. *Traffic Impact of Highway Capacity Reductions: What Transport Professionals Think*. ESRC TSU working paper, Transport Studies, UCL, London, 2002.
7. Environment Strategy Department, Bedfordshire County

COUNCIL. Pers. comm. 23/11/99, 31/01/2000 and 20/12/2001.

8. OXFORDSHIRE COUNTY COUNCIL. *EMITS Project—Fourth Annual Report 1999–2000*. Oxfordshire Council, Oxford, 2001.
9. MELLORS A. The M4 bus lane: facts and fiction. *Proceedings of a Landor Conference: Reallocating Road-space: Putting Theory into Practice,* London, 10/2/2000.
10. OSCAR FABER. *Vauxhall Cross Traffic Survey Data Analysis, vols 1 and 2*. London Borough of Lambeth, 1999.
11. WILLIAMS D. Doomsday for drivers in London. *Evening Standard*, 25 June 1999.
12. READ M. Wolverhampton: a way ahead. *Traffic Engineering and Control*, 1992, Oct., 552–557.
13. WS ATKINS. *Core Traffic Surveys—Interpretation and Analysis*. Cambridgeshire County Council, Cambridge, 2000.
14. SURL R. Improving the environmental and economic performance of an historic town through downgrading traffic prioritisation. Shrewsbury's scheme to reduce carriageways. *Proceedings of a Landor Conference: Reallocating Road-space: Putting Theory into Practice*, London, 10/2/2000.
15. VINCENT R. A. and LAYFIELD R. E. *Nottingham Zones and Collar Study—Overall Assessment*. TRRL, Crowthorne, 1977, Laboratory Report 805.
16. DOWSON J. *The Effects of the Vaughan Way/Burleys Way (Phase 1) Capacity Reduction Scheme, and Proposals for Phase 2. Report to Planning and Transportation Committee.* Leicester City Council, Leicester, 1999.
17. BONSALL P., JONES C. and MONTGOMERY F. *Who Goes There? A Disaggregate Look at the Stability of Traffic Flows*. Institute of Transport Studies, Leeds, 1983, Internal paper.
18. DEPARTMENT FOR THE ENVIRONMENT, TRANSPORT AND THE REGIONS. *Road Traffic Reduction (National Targets) Act 1998: Tackling Congestion and Pollution—The Government's First Report*. DETR, London, 2000.

Please email, fax or post your discussion contributions to the secretary: email: kathleen.hollow@ice.org.uk; fax: +44 (0)20 7799 1325; or post to Kathleen Hollow, Journals Department, Institution of Civil Engineers, 1–7 Great George Street, London SW1P 3AA.