ISSN 0953-6116

EDINBURGH COLLEGE OF ART/HERIOT WATT UNIVERSITY
DEPARTMENT OF PLANNING AND HOUSING

Research Paper No. 35, 1990

SPEED MANAGEMENT AND THE ROLE OF TRAFFIC CALMING IN ROAD SAFETY

J. Russell and T. Pharoah

ISSN 0953-6116

EDINBURGH COLLEGE OF ART/HERIOT-WATT UNIVERSITY
DEPARTMENT OF PLANNING AND HOUSING

RESEARCH PAPER NO. 35

SPEED MANAGEMENT AND THE ROLE OF TRAFFIC CALMING IN ROAD SAFETY

Abstract

The safety and environmental benefits of slower speeds have been demonstrated. Physical traffic calming measures can achieve these in ways which are popular and affordable. A speed management strategy, it is suggested, should be based on a speed classification of roads not simply on notional traffic hierarchies. The area-wide approach to defining traffic hierarchies is also questioned in congested urban conditions where it provokes public hostility and makes implementation of traffic calming more difficult. An alternative speed management approach in London is described. To be fully effective, speed management and traffic calming require the overhaul of road design standards and guidelines. On main roads a willingness to use sufficiently severe measures to reduce speeds is needed. Radical changes are also needed to limit the production and promotion of cars which have a performance better suited to the race track than to public roads. Britain has as yet taken only hesitant steps towards traffic calming and lacks the necessary speed management policy framework. Although interest is growing amongst local authorities, traffic calming is more talked about than implemented and is often assigned a role in residential areas only.

J. Russell and T. Pharoah, April 1990

1. The Definition and Objectives of Traffic Calming

Traffic calming schemes are associated with a rich variety of policy objectives. Traffic calming is therefore capable of diverse definitions and an accepted definition has yet to emerge. We therefore state a working definition which we believe can serve as a common denominator and apply to most schemes. The main concern is with the achievement of calm and safe conditions on streets, but given the strong association (in much Continental practice at least) with environmental improvements, it seems appropriate and necessary for the definition to encompass this. Accordingly traffic calming may be defined as "the attempt to achieve calm, safe and environmentally improved conditions on streets".

In adopting this definition, it must be acknowledged that there are traffic calming schemes which are almost entirely concerned with improving road safety and for which environmental factors are incidental. An example would be simple schemes involving a few speed control humps, such as are becoming more numerous in the UK. Even so, if a slower driving speed is achieved there are likely to be marginal reductions of noise and pollution, and it should be remembered that in Continental usage the term environment usually embraces the social as well as the physical environment. Since social environmental gains are associated with perceptions of safety in even these simplest of schemes it seems entirely appropriate that environmental improvements enter into any definition of traffic calming. This would apply even if traffic calming were extended to embrace speed management schemes on motorways and similar roads, where the means of inducing calm driving is principally enforcement. Such an extension is logical unless traffic calming is also linked to the use of self-enforcing, road engineering measures; this link is the common perception and it is assumed in the discussion here. So defined traffic calming contributes a set of methods for application within the wider concept of speed management.

The main goals of traffic calming are seen then as fivefold:

(1) to improve road safety;
(2) to reclaim space (from the carriageway) for pedestrians and "non-traffic" activities;
(3) to improve pedestrian mobility and reduce traffic barrier effects;
(4) to promote greater feelings of security, particularly among residents, pedestrians and cyclists;
(5) to create environmental improvements.

Implicit in traffic calming is a shift in priorities to redress the balance in favour of the pedestrian (and cyclist) vis a vis motor vehicles. This orientation and the roots of traffic calming in environmental concerns- epitomised by the Woonerf - has led some commentators to identify traffic calming with an overall transport policy framework embracing both traffic restraint and the promotion of public transport (Hass-Klau C., 1989 and 1990). Although consistent with such a philosophy traffic calming does not necessarily imply any overall reduction in traffic volumes, however. Traffic calming schemes may and often do constitute elements within wider traffic restraint policies, but there are also many schemes where no reduction of traffic is intended. At the other extreme, support for traffic calming has been pressed into service to justify further road construction in order to 'provide the opportunity for traffic calming measures on adjacent local roads' (Department of Transport, 1989) and it is consequently dismissed by some commentators as a 'green smokescreen' (Whitelegg, J., 1990).

Confusion can, therefore, easily arise in discussions of the role of traffic calming in traffic reduction. If speed reductions are achieved locally on one street or within an area by traffic calming measures, this may divert traffic onto alternative routes, or may be sufficient to reduce total traffic. Such local reductions in traffic are unlikely to have a significant impact on the level of traffic overall, unless combined with a comprehensive traffic restraint policy, though they may succeed in containing future traffic growth. This distinction is important to clarity of analysis, and it is for this reason that definitions of traffic calming implying traffic reduction are resisted.

The main goals of traffic calming identified above generally involve several component objectives. The importance of these objectives will vary from scheme to scheme, just as the emphasis among the main goals shifts with the nature of the scheme. The concern in this paper is with the first of these goals, road safety. Casualty reduction and accident reduction are component objectives of road safety, with casualty reduction often broken down into the reduction of casualty numbers and the reduction of their severity. Certain categories may also be specifically targeted for reduction such as pedestrian, cyclist or child pedestrian casualties. Criteria for scheme evaluation then inevitably centre on individual component objectives and performance measures rather than on aggregate goals. Priorities between component objectives need to be made clear, therefore, prior to scheme design.

2. Speed and Road Safety

Road casualties are known to be due to vehicle speed. The relationship between speed and road safety is fundamental and obvious. At its most trivial level zero speed would mean no accidents. As speeds rise the laws of physics apply. Increased speeds mean increased braking distances which, in turn, means increased risk of collisions and increased seriousness in the consequences of the collisions which occur. The greater the speed the greater the momentum on impact and the greater the risk of and the severity of injuries which result, with fatalities proportional to the third or fourth power of the speed (Cohen J. and Preston B., 1968, pp 197-198).

Speed, when defined as excess speed for the prevailing road conditions, is the single most important cause of road casualties. This is particularly true for casualties involving serious injuries and fatalities, notwithstanding the influence of contributory factors such as alcohol abuse. Speed is the most abused drug of all, and the biggest killer. Recent monitoring by the Tayside Police in Scotland, for instance, gave excessive speed as the principal causal factor in over 42% of the Region's fatalities in 1987 and of one third in 1988 (Tayside Police, Chief Constable's Annual Reports for 1987 and 1988); and particularly large falls in the casualty rates for pedestrians killed and seriously injured in Britain were recorded in 1973-74, the years of the oil crisis and lower traffic speeds (O'Donaghue J., 1988).

Findings that very few injuries occur at speeds of less than 30 kms/h (Netherlands Ministry of Transport, 1984); that drivers do not slow down for pedestrians (Howarth C.I. and Lightburn A., 1980); and that even child pedestrians are nonetheless held principally to blame for the accidents which

occur (Foot M.C., Chapman A.J. and Wade F.M., 1982, p 28), are convincing arguments in support of 30kms/h as a general speed limit on local residential streets, where the majority of child pedestrian casualties take place. They are central reasons for the introduction of 30kms/h speed limit zones in an increasing number of countries; and the wider recognition of the importance of speed management has been a major influence on the development of traffic planning and engineering practice over the past 15 years.

Adjusting driving speeds to those appropriate to the road conditions would drastically reduce serious and fatal injury accidents, a fact long recognised in the imposition of speed limits. Fixed speed limits are crude instruments, however, and inefficient in that they have depended on enforcement, which has been difficult and costly to provide and has usually been absent. They have also been applied in inappropriate ways which contribute to the wide-spread abuse of the limits. The inappropriateness of a particular speed limit to the actual conditions on the road is all too readily apparent to drivers and variations with time of day compound these problems. Widespread anomalies have been allowed to persist since, without effective enforcement, the finer tuning of speed limits has not been seen as a worthwhile option to pursue, especially on minor roads. Yet the need for a clear speed management strategy effectively linked to speed limits throughout the road system remains essential to the success of efforts to improve road safety.

3. Speed Management and Traffic Calming

Traffic calming, as defined above, provides a key means of achieving speed reductions and the effective deployment of speed limits without enforcement. Moreover most categories of road can, to greater of lesser degrees, be re-designed to design speeds which correspond to speed limits appropriate to the surrounding road environment. Successful schemes have now been developed and implemented on everything from local residential streets to national highways. On the highest categories of road such as motorways, enforcement techniques certainly remain essential, but there too the technical means exist to effectively assure compliance with speed limits.

Traffic calming practice to date, however, has been as much or more concerned with other objectives as with road safety. This, allied to the unavoidable difficulties of getting clear-cut evidence of road safety success, in terms of reduced accidents or casualties for individual schemes or even groups of schemes has not made it easy to convince sceptics of traffic calming's road safety merits or governments (in Britain at least) to support it and make resources available.

Insofar as it achieves speed reductions, however, traffic calming is certain to yield accident benefits in terms of casualties; unless that is the risk compensation mechanism were to operate to completely offset such gains. There is no evidence that it does. On the contrary evidence has gradually accumulated that traffic calming schemes are yielding major road safety benefits, and without the necessity for the extensive (and expensive) redesign of streets. The aggregated results from Denmark's 30kms/h 'quiet roads', (illustrated in Table 1 below), indicate this in impressive terms.

Table 1

ACCIDENT AND CASUALTY REDUCTIONS IN DANISH QUIET-STREETS (30kms/hr limits)*

REDUCTION IN ACCIDENTS (over 3 years)	77
REDUCTION IN CASUALTIES	88
% REDUCTION IN ACCIDENTS	24%
% REDUCTION IN CASUALTIES	45%
CASUALTY RATE REDUCTION (after allowing for traffic changes)	72%
CASUALTY RATE REDUCTION FOR SERIOUS INJURIES (after allowing for traffic changes)	78%

* These results include data from a few 'rest and play' areas, i.e. streets with lower (15kms/hr) speed limits.

Source: Engel U. & Thomsen, L.K., 1989

Accident and casualty reduction results, in a three year before and after study, are for an aggregate of 729 streets (223kms) compared with a control group consisting of all urban streets in Denmark. Casualty rate reductions are related to the road-user-kms travelled in each street, for a smaller sample of 44 streets (30kms) compared with a control of 52 streets (35kms), for which traffic flow data was available.

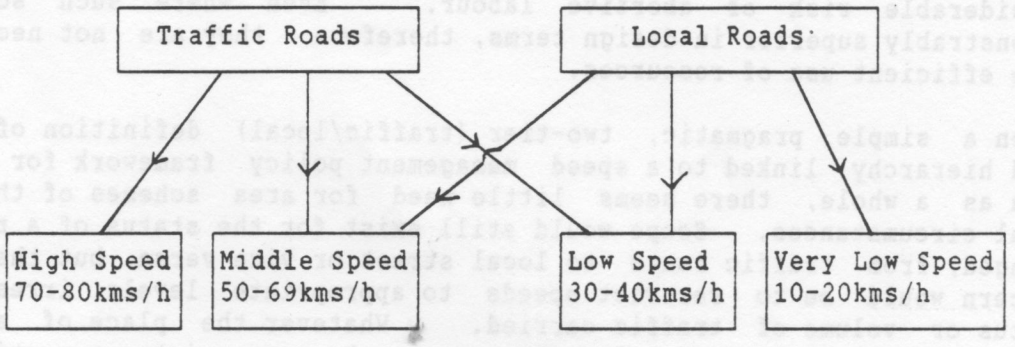
Results from West German Tempo 30 Zones (where less intensive speed reduction measures have been generally employed compared with their Danish counterparts) also suggest that casualty reductions of up to 44% have been achieved (Schleicher-Jester F., 1990).

The reductions reported in casualty rates for these streets, of 72% in the Danish results after allowing for changes in the traffic level, would seem to suggest that levels of safety have been achieved which are comparable to those in residential areas designed for traffic segregation: an OECD study in 1983 concluded that segregated areas safety was 3-5 times greater than in traditional non-segregated areas (OECD, 1983, p 66). Given that a proportion of the schemes included in the Danish studies are known to be sub-standard in terms of design, so that compliance with 30kms/h speed limits is not always guaranteed, this level of success might seem remarkable. Once the central importance of speed to casualty reduction is fully acknowledged, however, such success is not so surprising.

4. Road Hierarchies and Area Schemes

Over recent years, moves have been made to link the definition of the road hierarchy explicitly to speed categories and speed management, rather than traffic functions as such. Denmark for instance has based its roads standards on a simple two-tier distinction between traffic and local roads, and subdivisions into four speed classes (see Figure 1 below). Similar speed category hierarchies are implicit in much traffic calming practice elsewhere.

FIGURE 1 URBAN ROAD CLASSIFICATION, DENMARK.



Source: Danish Ministry of Transport, Road Directorate, 1985.

Such a speed hierarchy approach allows flexibility, and is more realistic in existing built-up areas than attempts to impose a Buchanan-style functional hierarchy. The emphasis is also placed where it is needed for road safety, on speed.

Following the success of area-wide schemes such as those at Ostebro in Copenhagen and Eindhoven and Rijswijk in The Netherlands, the need for area-wide road safety strategies and treatments has often been assumed. In Britain this has been a central thrust of the Urban Safety Project. In the five schemes involved, efforts have concentrated on the better organisation of the road hierarchy on traditional functional lines where this was possible. Some distributor roads were down-graded and modest treatments applied to reduce speeds: these treatments do not seem sufficiently intensive however, and speed reductions have therefore been relatively small. The casualty reductions achieved have been correspondingly modest (estimated at 10-15%). Where capacity restrictions severely limited the possibilities for changes in the hierarchy, as in Reading, results appear to have been disappointing. In Reading there were initially indications of increased accidents and after extensive modifications a statistically insignificant accident savings of 4% was recorded in the following year (Mackie A.M., Ward H.A. and Walker R.T., 1988).

The prospects for major road safety benefits from such restructuring therefore seems remote. Given rising traffic volumes and shrinking areas with substantial surplus route capacities, the capacity will simply not exist

generally to allow substantial changes in the hierarchy. In many areas such changes will not be possible unless they are associated with policies of intensified traffic restraint. Moreover, area schemes involving such restructuring give rise to greater potential for conflicts between interest groups within the area and for corresponding delays. Considerable delays were associated with some of the Urban Safety Project Schemes and with the demonstration project schemes in The Netherlands, even with the added inducement of central government funding. Without such funding and in the face of opposition, mobilising support for the implementation of such schemes at local level is likely to prove difficult if Danish experience is a reliable guide. They are also liable to be costly in staff time for intensive participation processes; and with no guarantee of implementation carry considerable risk of abortive labour. Even where such schemes are demonstrably superior in design terms, therefore, they are not necessarily a more efficient use of resources.

Given a simple, pragmatic, two-tier (traffic/local) definition of the urban road hierarchy, linked to a speed management policy framework for the urban area as a whole, there seems little need for area schemes of this kind in usual circumstances. Scope would still exist for the status of a road to be changed, from traffic route to local street or vice versa, but the principal concern would be to restrict speeds to appropriate levels, irrespective of status or volume of traffic carried. Whatever the place of a road in a hierarchy, speeds lowered below the norm may be appropriate on sections of it, (for example at accident black spots such as sharp bends on trunk roads or in shopping street sections of major urban routes) and the availability of traffic calming techniques make such variable speed limits a more realistic proposition in many circumstances.

Area priorities are readily set within such a policy framework; with size of areas and roads for treatment flexibly selected and defined with a view to ease of implementation and maximal implementation on an incremental basis. Generally this would entail treatment areas much smaller than those featuring in the Urban Safety Project which had resident populations of 30,000 to 50,000 people. Much of continental Europe on practice to date, perhaps most notably so in the case of the Danish 30kms/h 'quiet roads', many of which have been incrementally implemented on a rather ad hoc basis, seems to support such a flexible approach (Russell J.R.E., 1988).

This approach does not, of course, gainsay the need to ensure that the traffic calming of individual streets or routes does not have undesirable consequences in shifting traffic to adjacent streets or routes and to anticipate and plan to deal with such consequences through associated or subsequent stage treatments. However it may well mean, for example, that individual street schemes would be implemented where supported by residents, even though residents on an adjacent street have rejected traffic calming measures which would have been desirable in preventing the displacement of traffic as part of an area treatment: if subsequently significant displacement does occur, the same residents may well modify their views as to the desirability of traffic calming for their own street. For an urban area as a whole the analysis of problems and the definition of priorities will clearly remain essential to a speed management strategy.

Interest and experience in traffic calming is growing amongst local authorities in Britain, but a suitable policy framework is still lacking. For road safety purposes, that policy framework needs to be based on a coherent but flexible and simply comprehended speed management strategy, rather than unrealistic attempts to impose functional hierarchies.

5. Value for Money?

In Britain there has been an over-emphasis on quantification and the use of cost-benefit analysis techniques in order to justify road safety schemes. In application at individual scheme level this has not been helpful to the evolution of traffic calming practice, or indeed to the evaluation of traditional black spot treatments. Given the problems of regression to mean and accident migration effects it seems impossible to justify the vast majority of schemes individually in this way. In a before and after comparison of casualty statistics for black spots treated highly successfully in cost-benefit terms in Hertfordshire with untreated junction sites in Lothian Region the untreated sites gave better results! See Table 2 below for the comparison made by Dr. David McGuigan of Lothian Regional Council.

Table 2

COMPARISON OF 'BEFORE' AND 'AFTER' ACCIDENT TOTALS : HERTFORDSHIRE AND LOTHIAN REGION

	HERTFORDSHIRE	LOTHIAN
NUMBER OF SITES TREATED	189	149
ANNUAL AVE. 'BEFORE' ACCIDENTS	1007	639
ANNUAL AVE. 'AFTER' ACCIDENTS	722.5	426.5
% REDUCTION	28%	33%
FIRST YEAR RATE OF RETURN	197%	∞%
AVE. EXPENDITURE PER SITE	£7528	Nil

Source: D. McGuigan, Lothian Region Highways Department.

Yet traffic calming schemes on local roads, where a more comprehensive approach is required to deal with the more random distribution of accidents than that occurring on main routes, are often regarded as expensive or inefficient compared with such black spot schemes on the basis of just such dubious before and after calculations. In reality such traffic calming on local roads has been demonstrated to be effective even in road safety terms alone, and is readily affordable, especially when implementation is linked to routine maintenance or other programmes such as environmental improvements or urban renewal.

6. Contradictions on Main Roads

Road safety results from traffic calming schemes on main roads appear to have been less impressive to date than those on less important routes, although the pattern is uneven and evaluations are continuing.

A principal reason for any relative lack of success is an apparent reluctance to introduce speed reduction measures of sufficient severity or frequency. Vertical features in particular are frequently ruled out because of the sharper effects of conventional humps or ramps on larger vehicles such as buses. If design speeds are then set to enforce a speed limit for larger vehicles this invariably allows car speeds substantially above that limit. Such schemes often depend for their speed reduction effectiveness on the presence of other vehicles and/or a degree of congestion. This lack of sufficient severity has been observed by the authors in schemes in West Germany, Denmark and The Netherlands, as well as in British practice; in all cases in situations where no obvious impediments exist to the adoption of a more rigorous approach. Despite the tentative nature of many initiatives, however, significant speed reductions and road safety benefits are being realised, in Britain as elsewhere.

More complex main road schemes inevitably bring contradictions with other traffic calming and wider policy objectives. The reduction of barrier effects to pedestrian movement in shopping street schemes is an obvious example. If pedestrians feel more secure and therefore cross the road more frequently, pedestrian casualties may not decrease and could even increase, although a reduction in their severity would still be expected. In situations such as these priorities and expectations need to be clearly established.

Further contradictions arise where there is provision of priority for cyclists. Cycleways can lead to new conflicts between pedestrians and cyclists at crossing points such as bus stops, and these have been a factor in increased casualty rates for cyclists. The degree of priority afforded to cyclists in some schemes is questionable in road safety terms.

The road safety potential of traffic calming on main roads remains largely to be exploited through the resolution of such conflicts. As the speed class of the road increases, however, the self-enforcing power of design features declines, and increasing reliance must inevitably be placed on enforcement techniques.

The following discussion of a proposed speed management approach in London illustrates some of the potential and limitations of traffic calming for speed management.

7. A Speed Management Approach in London

In 1985 private consultants were commissioned by the Department of Transport to carry out several area-wide studies of transport problems and possible solutions. The results were released at the end of 1989. One of these studies, embracing some 50 square kilometres of north-east London, has

presented traffic calming options based on a speed management classification of the road network (Ove Arup and Partners, 1989).

The aim was to tackle a range of problems resulting from high traffic volumes and speeds, including accidents, severance of communities, perceived danger, pedestrian fear and intimidation, environmental degradation, difficult access to properties and poor public transport. Traffic calming could not in itself tackle the further problem of widespread traffic congestion, but new road and rail schemes were also included in the study options.

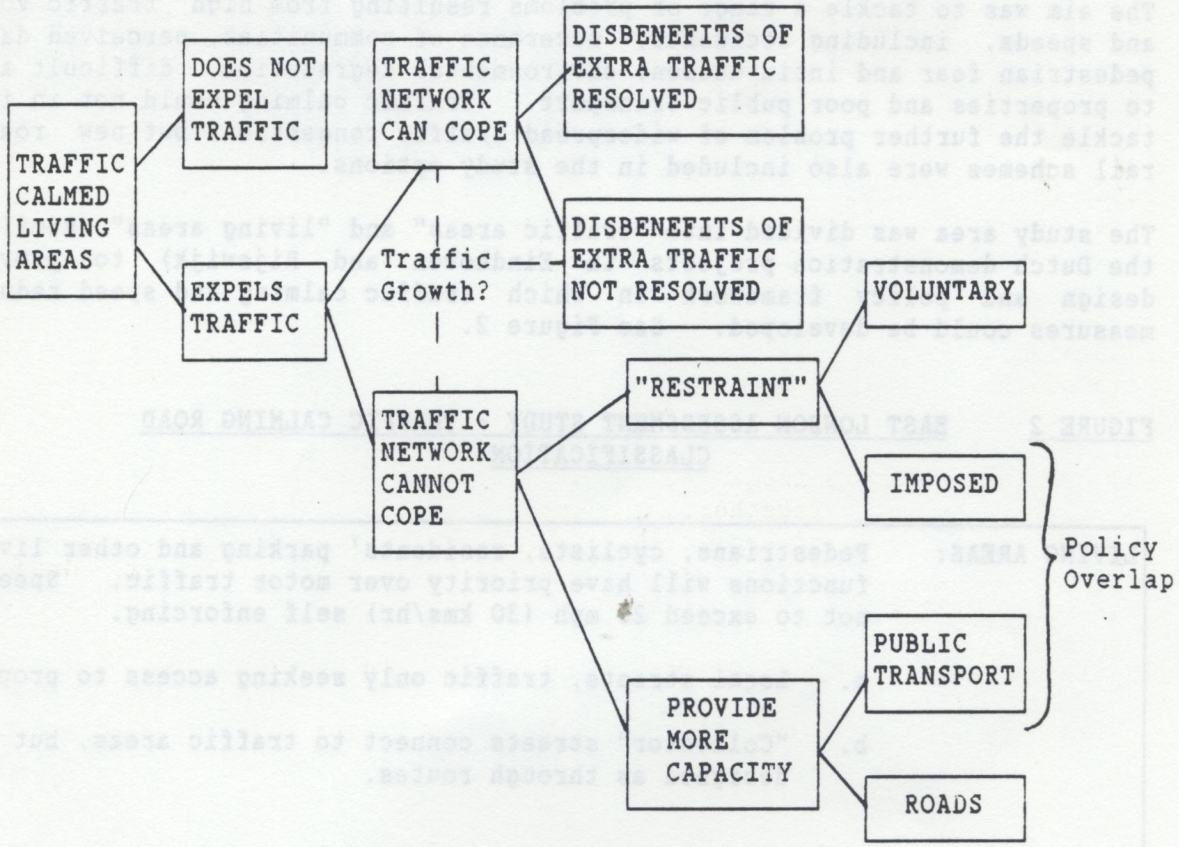
The study area was divided into "traffic areas" and "living areas" (similar to the Dutch demonstration projects in Eindhoven and Rijswijk) to provide a design and policy framework in which traffic calming and speed reduction measures could be developed. See Figure 2.

FIGURE 2 EAST LONDON ASSESSMENT STUDY - TRAFFIC CALMING ROAD CLASSIFICATION

LIVING AREAS:	Pedestrians, cyclists, residents' parking and other living functions will have priority over motor traffic. Speeds not to exceed 20 mph (30 kms/hr) self enforcing.
	a. Local streets, traffic only seeking access to property
	b. "Collector" streets connect to traffic areas, but not designed as through routes.
TRAFFIC AREAS:	Through traffic routes where vulnerable road users are protected. Maximum speed 30 mph (50 kms/hr) not self enforcing, signposted routes.
	c. Sections of through routes where (subject to maintenance of existing traffic capacity) priority is shared between Living and Traffic functions.
	d. Through routes where traffic takes priority.

Many residential streets in the area carry through as well as local traffic, about 70 kilometres carrying peak volumes of 1000 vph or more. Diversion of this unwanted traffic onto established main traffic roads is problematic, because the main roads are mostly congested and already account for the major proportion of road accidents and traffic/environment conflicts. Two alternative levels of traffic calming have been put forward, the first retains the existing volume and distribution of traffic; the second seeks to reduce overall peak hour traffic volumes and thus has wider implications. The consequences are shown in Figure 3.

FIGURE 3 CONSEQUENCES OF TRAFFIC CALMING IN CONGESTED URBAN ROAD NETWORKS



In both levels parts of the "traffic areas" with the most intense conflicts would be redesigned to achieve shared priority between through traffic and pedestrians, cyclists, parking, loading and amenity space (category c in Figure 2). In these sections, mainly shopping streets, vehicle traffic would move more slowly because of the need to give way to other users. The existing 30 mph limit would remain. Overall network speeds would be unchanged, however, because these are determined by the capacity of critical junctions whose capacity would be retained.

Reduction of speeds in the "living areas" to 20 mph would be likely to divert some traffic in some combination of the following ways:

- diverted onto "traffic area" streets, especially at off peak times when they have spare capacity;
- diverted onto new or upgraded roads (if built);
- diverted to other modes of travel;
- diverted to alternative destinations or times;
- trips shorter or no longer made.

There was no method of estimating the relative importance of these possibilities. Traffic calming would, however, be easier to implement (from a political and a technical point of view) if traffic reduction could be achieved by an integrated programme of strategic traffic restraint and/or investment in rail transport capacity and quality. An evaluation of the

Traffic Calming options against the problem solving objectives of the study showed a good performance compared to other more expensive (road building) options (see Ove Arup and Partners, Summary Report pp 6 & 7, 1989).

8. Wider Contradictions and Conclusions

The traffic calming philosophy is gaining ground in Britain as elsewhere, but there remain many contradictions and inconsistencies. On major roads for instance, the "road safety" strategy is generally still the straightening of bends rather than slower speeds. Effective techniques exist (video, radar, speed governors, helicopter surveillance, stiff penalties) for effective speed limit enforcement but are rarely used even on busy motorways.

Attempts to promote safety consciousness and compliance with speed limits are consistently undermined by developments in vehicle design and car advertising. Although in France, for example, there is a ban on advertisements which exploit the speed of cars, in the UK and elsewhere the "machismo" image is still central to car promotion, with advertisements emphasising speed, power and performance more frequently than all other themes (such as safety, style or practicality) put together. Car design is seriously out of line with road safety objectives and policies. In all European countries except West Germany, maximum legal speeds range from 100 kms/h (Denmark, Greece) to 130kms/h (Austria, France, Italy). Yet out of 422 models of car on sale in the UK in 1989, 97% were capable of speeds higher than 130kms/h. 84% of models can exceed 150kms/h and 27% can exceed 200kms/h. Half of all models have acceleration of 0 - 100kms/h in 10 seconds or less. The latest Jaguar, the XJ 220, is promoted as its fastest road going car ever, at speeds over 200 mph. Such performance leads to unnecessary danger and intimidation of other road users, and is wasteful of fuel and other resources.

Of course, in order to achieve integrity of design, vehicles capable of high speeds must have excellent braking, cornering, stability and comfort features built in. The more that these features are improved, the more difficult it becomes to persuade people to drive more slowly. The design of traffic calming measures such as humps and chicanes must become more severe as money is spent developing vehicle technology which counteracts their effectiveness! The Citroen, for example, seems less affected by the standard UK speed hump than many other makes of car. Computer controlled suspension systems which can 'second guess any hump and make instant compensations' are reported to be under development by several major manufacturers, having been originally developed for the race track (Henry A., 1990). In short, car design and promotion is undermining road safety and traffic calming efforts.

There are strong road safety and environmental arguments for an international code of practice on vehicle design and performance which limits maximum speeds and other performance features. For driving in built-up areas, speed governors fitted to vehicles could be activated according to the prevailing speed limits. This has been suggested in the UK, and apparently a prototype vehicle with different speed modes has been developed in Nordrhein-Westfalia. In the longer term the development of such technology could reduce the need for expensive physical speed control measures in urban streets. Even so, it would not supplant but compliment the need for extensive traffic calming.

In the meantime, for road safety reasons alone, and irrespective of its other justifications, traffic calming should be widely applied: in principle everywhere where it is practicable and where speeds are found to be excessive.

The vast majority of urban roads, main traffic routes as much or more so than local streets, would benefit from some degree of traffic calming. The task of adapting our road environments for greater safety is a major one. If the potential safety benefits of traffic calming are to be realised in Britain over the next few decades, it requires greatly increased commitment and funding by both central and local governments.

In the UK there has been a fundamental and positive change in public attitudes to drinking and driving. What is needed now is a comparable shift of attitudes about the dangers of speed. The present contradictions in policies will not be fully eradicated until such a shift in attitudes has been realised.

REFERENCES

Hass-Klau C., April 1989, International Experience of Traffic Calming: The Solution to British Transport Problems?, Traffex '89 Conference, PTRC

Hass-Klau C., January 1990, An Illustrated Guide to Traffic Calming: The Future Way of Managing Traffic, Friends of the Earth

Department of Transport, December 1989, East London Assessment Study: The Department of Transport's Initial Views and Request for Comments, Department of Transport

Whitelegg J., 1990, Paper presented to Ealing Borough Council's Conference, Traffic Calming: The Way Forward, January

Cohen J., and Preston B., 1968, Causes and Prevention of Road Accidents, Faber and Faber

Tayside Police, 1988 and 1989, Chief Constable's Annual Reports for 1987 and 1988

O'Donaghue J., October 1988, Pedestrian Casualties, Department of Transport Statistics Bulletin (88)52, Department of Transport, STD Division

Netherlands Ministry of Transport, 1984, Residential Neighbourhoods and Traffic Zones

Netherlands Ministry of Transport, 1984, 30kms/h Measures : a Handbook

Howarth C.I., and Lightburn A., 1980, How Drivers Respond to Pedestrians and Vice Versa - or Close Encounters of the Fourth Kind, in Human Factors in Transport Research, Vol 2, User Factors: Comfort, the Environment and Behaviour (eds., Osborne D.J., and Levis J.A.) Academic Press

Foot H.C., Chapman A.J., and Wade F.M., 1982, Pedestrian Accidents: General Issues and Approaches, in Pedestrian Accidents (eds., Chapman A.J., Wade F.M. and Foot M.C.), John Wiley

Engel U. and Thomsen L., 1989, Notats 1 and 2, §40 Gaders Sikkerhed, Danish Council for Road Safety Research, with English language summaries

OECD, 1983, Traffic Safety of Children, OECD

Schliecher-Jester F., 1990, Tempo 30 in Towns - Results of a German Experiment, Paper to the International Congress 'Living and Moving in Cities', Paris, January

Vejdirektoratet (Danish Road Directorate), Vejregelsekretariatet, 1985, Byernes Trafikarealer (Town Traffic), Haefte I (Part I), Introduktion og Forudsaetninger

Mackie A.M., Ward H.A., and Walker R.T., 1988, Urban Safety Project 2. Interim Results for Area Wide Schemes, TRRL, Research Report No 154

Russell J.R.E., 1988, Traffic Integration and Environmental Traffic Management in Denmark, Transport Reviews Vol 8, No 1, pp 39-58

McGuigan D., unpublished PhD thesis, University of Newcastle

Ove Arup and Partners et al, 1989, East London Assessment Study, and Summary Report of same

Henry A., 1990, Motor-racing and Saloon Cars, The Guardian, 5.1.90

Disk 1A

RESEARCH PAPER SERIES

This paper is one of a series, to which new titles are added at intervals. The list of titles available at the date of publication of this paper is:

1.	Self-Help Housing in Mexico: Who Benefits?	J. Makin	1981
2.	Underdevelopment and Change: Centre Periphery Relations and the Spatial Dimension of Labour	P. Wiberg	1982
3.	Planning Law and Ideological Disorder	M. MacEwen	1982
4.	An Introduction to the Work of Sir Frank Mears	G. Purves	1983
5.	Regional Policy and Spatial Planning in Norway 1952-80	P. Wiberg	1984
6.	Scotland's Conservation Areas: Retrospect and Prospect	K. Campbell	1986
7.	Entrepreneurship and Regional Development: Some Conceptual Issues	P.N. O'Farrell	1986
8.	Education for Implementation: Working with Community Groups	C. Hague	1986
9.	Inter-Firm Comparisons in Industrial Research: the utility of a matched pairs design	P.N. O'Farrell & D. Hitchens	1986
10.	Industrial Restructuring & Planning Practice: Some Issues for Planning Theory	C. Hague	1986
11.	Racial Harassment, Council Housing and the Law	M. MacEwen	1986
12.	An Analysis of Entrepreneurial Behaviour from Male Work Histories	P.N. O'Farrell	1986
13.	Traffic Integration: Environmental Traffic Environmental Traffic Management in Denmark	J. Russell	1986
14.	Housing Allocations, Race and Law	M. MacEwen	1987
15.	Alternative Theories of Small Firm Growth: A Critical Review	P.N. O'Farrell & D. Hitchens	1987
16.	Implementation Concepts for Planning Practice: Towards Improved Understanding for Effective Action	A. Prior	1987
17.	A Production Oriented Explanation of Small Firm Growth: Towards a Conceptual and Policy Framework	P.N. O'Farrell & D. Hitchens	1987
18.	The Relative Competitiveness and Performance of Small Manufacturing Firms in Scotland and the Mid-West of Ireland: An Analysis of Matched Pairs	P.N. O'Farrell	1988
19.	When Blackspots become Grey Areas: A Procedure for Ranking Areas for Accident Remedial Treatment	A.D. Watt	1987

20.	Entrepreneurial Behaviour within Male Work Histories: A Sector-Specific Analysis	P.N. O'Farrell A.R. Pickles	1988
21.	The Economic Implications and Planning Opportunities of the Bathgate Rail Link	D.J. Queripel J. Russell	1988
22.	The Relative Competitiveness and Performance of Small Manufacturing Firms in Scotland and the South of England: An Analysis of Matched Pairs	P.N. O'Farrell & D. Hitchens	1988
23.	Community Relations Councils: Scotch Mist, Domestic Colonialism or What?	M. MacEwen	1988
24.	The Development of Tenant Participation	C. Hague	1988
25.	Planning in the Material World: Implementation Ideologies in Theory and Practice	A. Prior	1988
26.	Small Manufacturing Firm Competitiveness and Performance: An Analysis of Matched Pairs in Ireland and England.	P.N. O'Farrell & D. Hitchens	1988
27.	A Vision for the Clyde Valley: A Biography of a Development Project 1946-1986.	A. Prior	1988
28.	Redundant Church Buildings in Scotland	K. Campbell	1988
29.	Land Policy in the People's Republic of China	Y-P. Wang & C. Hague	1989
30.	Vis-a-Vis Visas	M. MacEwen	1989
31.	Hidden Homeless Amongst Single Women "Care-of" in Glasgow.	S. Webb	1989
32.	Cross-National Comparative Analysis of Planning Systems: An Approach to a Comparison of Planning in China and Scotland	Y-P. Wang & C. Hague	1989
33.	Fair Housing: Lessons from the USA?	M. MacEwen	1990
34.	Independence in Scotland? - The Barriers to Housing for Single 16 & 17 Year Olds.	M. Gibbs	1990
35.	Speed Management and the Role of Traffic Calming in Road Safety.	J. Russell T. Pharoah	1990
*	Public Housing and Ethnic Minorities in Edinburgh NB: £5 per copy.	D. Hancock & M. MacEwen	1989

The papers are available at a price of £3.00 each, post free, from:

The Department of Town & Country Planning, Edinburgh College of Art/Heriot-Watt University, Lauriston Place, Edinburgh EH3 9DF.