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## Traffic Calming in West Europe

by Tim Pharoah

### Introduction

The term 'traffic calming' entered the English vocabulary only a few years ago, yet now it trips off the tongues of ministers, journalists, public servants, academics, and others with alarming frequency, as if everyone knew exactly what it meant. This paper attempts to explain the context of traffic calming, how it came about, how it fits with wider transport policy, and what it can be expected to achieve. The development of traffic calming in West European countries is reviewed, and some issues relevant to Britain are discussed by way of conclusion.

### The challenge of urban transport

Towns and cities face an uncertain future in the face of the rising tide of motor vehicles. Some argue that, unless car access is improved, people and commerce will be driven away to places with more generous road and parking facilities. Others argue that it is precisely the dominating presence of motor vehicles that is driving people and investment away from established urban areas. The latter view is now gaining ground, and authorities throughout Europe are promoting action to improve the urban environment, to reduce the domination of motor vehicles, to limit car-dependent developments, and to promote a rejuvenation of traditional urban centres.

Although Buchanan (1963) and others demonstrated thirty years ago that full motorisation is impossible (at least in the European context), it is only recently that this fact has been widely accepted (Goodwin *et al.*, 1991). The need to limit rather than provide for motor traffic is now underpinned by political and popular concerns about road safety, quality of urban life, and environmental issues.

Borrowed from computer jargon, the term 'user-friendly cities' conveys the aim of the counter-strategies to which an increasing range of authorities now aspire. Such strategies must of course consist of more than isolated traffic and transport policies. These must be developed alongside programmes for housing renovation, employment generation and training, conservation of historic areas, promotion of civic culture and the arts, play and recreation, child care, special needs, health and education, and other physical and social infrastructure. And all of these require healthy systems of government for progress to be made.

The transport contribution to urban rejuvenation should be to emphasise access rather than mobility, and to reduce the adverse impact of motorised travel on the quality of urban life. Much can be done to civilise the motor vehicle, and this is the essential task of traffic calming, but the potential for improvement is limited by the sheer volume of moving and parked motor vehicles, which ultimately will have to be reduced.

What are the requirements of a 'town-friendly' strategy, and how does traffic calming fit in? Topp (1989) has identified three elements:

1. limiting or reducing the amount of motorised travel,
2. shifting traffic to transport modes which preserve the environment and save energy,
3. creating urban-compatible layouts and designs of the traffic systems themselves.

The first element challenges the value of increased travel. The present author has argued (in Roberts *et al.*, 1992) that, since transport is a cost rather than a benefit (that is, a means to an end), we should be planning for its reduction rather than responding without question to increasing demand. The assumed benefits for part of the population of increased motorised mobility must now be set against the benefits for everyone of less traffic. Traffic reduction will produce economic, social, and environmental benefits, yet no local or national authority has yet proposed a traffic reduction policy as advocated by Friends of the Earth (Pharoah, 1992). The town planner's role in this will be to reduce the need to travel by decisions about the density and distribution of activities, currently the subject of research commissioned by the Department of the Environment (Jones *et al.*, 1992).

The second element in Topp's strategy is 'modal shift', and in particular reducing the proportion of journeys made by car. There is no firm evidence that the number of trips people make is increasing. The growth of traffic is mainly the result of people making more of their journeys by car rather than on foot or by public transport. There is precious little experience of car travel being reduced by offering better quality alternatives, and the need for 'sticks' as well as 'carrots' is widely accepted.

The third element, civilising the presence of motor vehicles—both moving and parked—in built-up areas, can be achieved through the management of speed, and the design of streets, now usually referred to as 'traffic

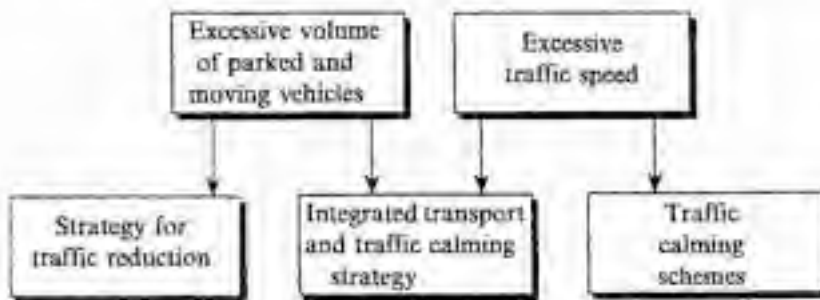


Figure 1. Traffic calming in relation to transport strategy.

calming'. This is the main focus of this paper. The relationship between traffic calming and wider transport strategy is shown in Figure 1.

A further approach is to civilise the motor vehicle itself, by ensuring that vehicle designs are appropriate to and compatible with urban life. In this respect, current trends are not encouraging, for, although engines are becoming more fuel efficient and less polluting, these gains are being 'consumed' by larger cars and higher performance.

### The traffic calming contribution

The definition of traffic calming depends on the objectives it is intended to serve. The central objective in British practice is the reduction of road accidents, and traffic calming is thus associated mainly with road safety schemes. However, as Hass-Klau *et al* (1992, page 1) points out, the range of objectives is often wider in other European countries, with urban regeneration and environmental improvement often being of equal or even greater importance. The narrow 'accident reduction technique' interpretation of traffic calming in Britain results partly from difficulties in justifying and funding schemes. This might be rectified by the 1992 Traffic Calming Act which specifically includes environmental improvement as an objective of traffic calming. A further difference, however, is the rigid separation of highway engineering and urban design and landscape functions in Britain which can be noticed in the law, in the professions, and in local authority practice.

The full range of objectives that can be pursued by traffic calming measures are discussed later, but first we need to understand what traffic calming consists of.

There are three basic components of traffic calming technique, presented as the 'Three Rs' of traffic calming. These are the

*Reduction of vehicle speeds* and the fostering of a steady driving style,

*Reallocation of carriageway space* for street activities (play, planting, walking, stopping, resting, parking, loading, cycling etc),

*Redesigning the street* and its furniture to encourage the new priorities, to bring about improved appearance, and to create better environmental conditions.

Traffic calming is distinguished from more conventional techniques by its concern with speed and driver behaviour rather than traffic flows and capacity, and with local access rather than through movement. The conventional approach to environmental and safety improvement, as advocated for example, in the *Traffic in Towns* report (Buchanan, 1963), relied on traffic segregation in the belief that motor traffic is inherently incompatible with street life and with the weaker traffic participants (pedestrians and cyclists). Traffic calming, by contrast, recognises that motor traffic, up to a point, can be compatible with urban life. The concept of traffic *integration* therefore replaces traffic *separation*.

The key to achieving this integration of traffic with urban life is the achievement of slow speeds and steady driving. Traffic calming guidelines produced by Devon County Council (1991) describe nineteen different measures that can be taken to moderate driver behaviour and to exploit the potential for safety and environmental improvement. These range from engineering techniques for speed reduction to supporting measures to change the appearance of the street including landscaping and street furniture design.

Only 'vertical shifts' in the carriageway, using humps or ramps, can *guarantee* the desired driving speed, whereas other measures such as lateral shifts or narrowings may reduce speeds but need very careful design. Despite the expertise and experience available from continental (and British) research, many local authorities in Britain are still installing ineffective measures such as strips of brick surface.

The choice and combination of measures must be determined in relation to the particular circumstances of the scheme, and the specific objectives which it is intended to serve. The most popular and effective schemes have been those which tackle multiple objectives using an integrated design, but sadly there are few good examples in Britain.

Traffic calming may be seen as part of a continuum in which conventional and modern techniques are integrated to meet a wide range of objectives. 'Speed management' takes over from 'traffic management' as the central engineering technique which allows safety, environmental, and other benefits to be achieved. An example of a speed management framework applied to a hypothetical town is shown in Figure 2.

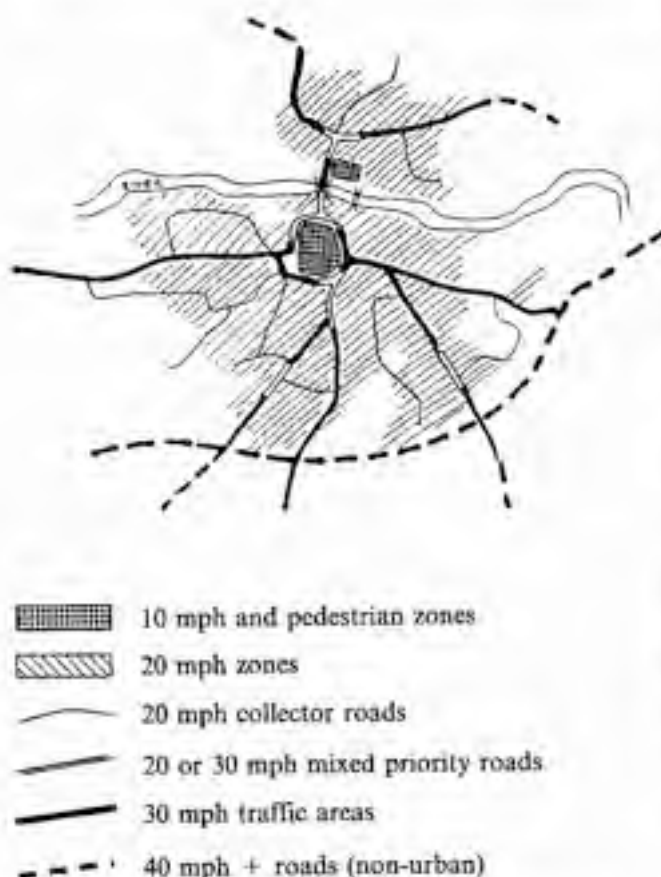


Figure 2. Example of speed management framework.

What is implied in such a model of a traffic-calmed town?

Within the main built-up areas the maximum vehicle speed will be 20 mph (30 kmph) or less, achieved by a combination of self-enforcing measures. This speed management will allow redesigns that are attractive and supportive of local activity. Traffic functions take second place. The exception will be designated through routes which will have a general limit of 30 mph, though this limit will be reduced to 20 mph where such roads pass shopping areas, schools, hospitals, and other important pedestrian generators.

Pedestrians will have large areas of the town and suburban centres given over for their exclusive use, and will also have considerable freedom to cross roads at will within the 20 mph areas. On main roads they will be provided with protected crossing facilities.

Cyclists will also have freedom within 20 mph areas, and their movement along the main corridors will be provided for by a network of safe routes including separate cycle paths.

Public transport services will be provided on routes that are protected from the disruptive effects of traffic congestion, and exempt from severe speed or route restrictions.

## The potential of traffic calming

The potential benefits of such a traffic calming strategy are

1. casualty reduction,
2. more safety,
3. less noise and air pollution,
4. better local access,
5. more attractive and useful public space,
6. more buoyant local economic activity.

### Casualty reduction

The British government has set a target for a reduction of one third of road casualties by the year 2000 (from the average level 1981–1985). There is also an intention to place higher priority on severe and fatal injuries, and on casualties amongst the vulnerable road users (pedestrians, cyclists, children, elderly). In view of the direct relationship between speed of impact and severity of injury (see Figure 3), traffic calming offers great potential for casualty savings, and this has been demonstrated in studies of traffic calming measures in several European countries over the past 10–15 years.

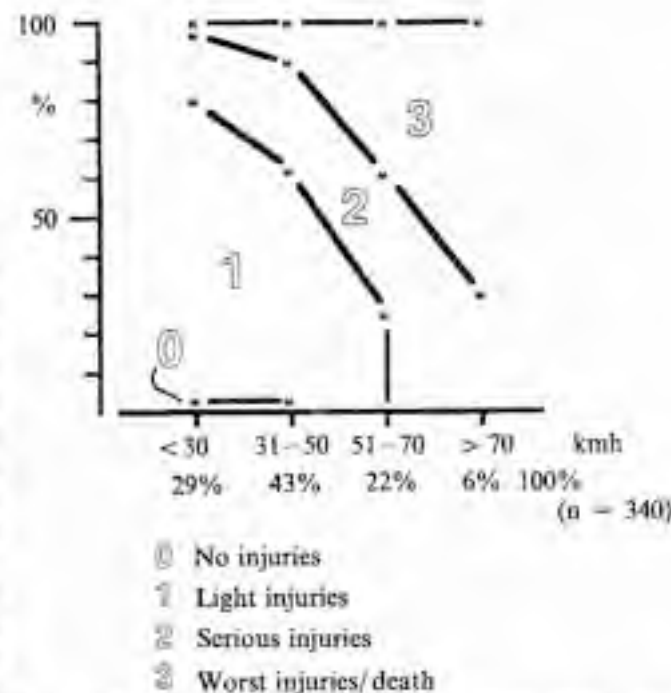


Figure 3. Relationship between collision speed and pedestrian injuries (source: Otte, 1988).

Results from two major Dutch demonstration projects showed casualty reductions of 44% in residential areas and 20% overall. The West German 30 kmph zones also show reductions of 44%, even though many of these zones have no self-enforcing measures. The most impressive results so far have come from a study of 729 streets in Denmark where traffic calming measures have produced a casualty rate reduction of 72% (78% for serious injuries) (Russell and Pharoah, 1990).



Given favourable assumptions about traffic growth and progress of traffic calming schemes, a reduction of 50% of fatal and serious injury accidents may be expected where traffic speeds are reduced to below 20 mph in built-up areas. In the British context this would contribute roughly a one-third reduction of total fatal and serious road accident injuries. This means that urban traffic calming could by itself meet the casualty reduction target, provided sufficient resources were made available for its implementation. Experience suggests that slight injuries are less likely to be reduced.

The importance of area-wide traffic calming is underlined by the fact that residential areas account for roughly two thirds of child pedestrian accidents. Although the general accident rate in Britain compares favourably with most other European countries, the pedestrian accident record is poor (see Jones in Department of Transport, 1990a, page 36). It is this which has prompted the area-wide approach as advocated in the British Urban Road Safety Projects which are claimed to have reduced casualties by 13% (IHT, 1990, page 104).

From before-and-after studies of traffic calming schemes in residential areas, it is usual to find that vulnerable road user groups are the main beneficiaries. For example, child injuries in the Berlin Moabit scheme were reduced by 66%.

#### More safety

The relationship between accidents and safety is poorly understood. It is erroneous, however, to regard low accident numbers as being synonymous with a safe traffic environment, and particularly so for pedestrians in urban streets. Appleyard (1981) demonstrated in his study of San Francisco that frequency of crossing the road is affected by the intensity of motor traffic. It is therefore possible to describe roads which are so heavily trafficked that no-one dares cross them. In this case extreme danger produces a favourable accident record. There is also a trade-off to be made between safety and convenience. Guard rails and pelican crossings, pedestrian bridges and subways may reduce accidents, but only at the cost of inconvenience for pedestrians. Hillman *et al* (1990) have explored the issue of children's declining freedom as traffic has increased.

Traffic calming should therefore be concerned not just with casualty reduction but with making streets safer and more convenient to use. Reported casualty reductions may imply even greater reductions in the casualty *rate*, where the schemes have resulted in greater intensities of pedestrian and cycle activity. For example, accident reductions in the Berlin Moabit area-wide scheme of 43% for pedestrians and 16% for cyclists must be seen in the context of increases in pedestrian and cyclist traffic of 27–114%.

#### Less noise and air pollution

Road traffic is the most common source of urban noise nuisance. A reduction of traffic speeds from about 35 mph

to 20 mph will reduce noise by 3–5 dBA, which is roughly equivalent to the noise reduction achieved by a halving of traffic volume. The best noise reduction results require the achievement of steady driving (minimum braking and acceleration), and the use of paving materials which do not produce increased tyre noise.

Research into the effect of speed reduction on exhaust emissions as part of the evaluation of the Buxtehude traffic calming project in Germany found that all types of air pollutants can be reduced when speeds are brought down to around 20 mph, especially when 'minimum acceleration' driving styles are adopted (see Figure 4). Petrol consumption, however, may increase at 20 mph unless third gear (low engine revolutions) is selected.

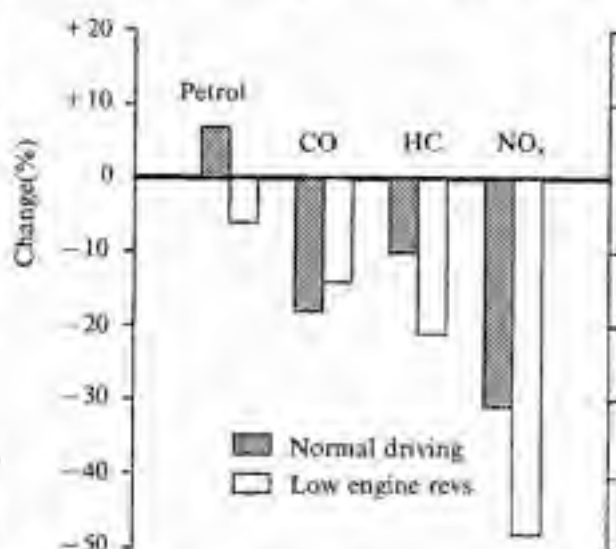


Figure 4. Percentage changes in exhaust emissions and, petrol consumption, with a speed reduction from 30 to 20 mph.

#### More convenient local access

Rat run traffic in residential areas can be reduced by the introduction of self-enforcing speed reduction measures rather than by physical closures and banned movements. This enables traffic with business in the area to take the most direct route.

#### More attractive and useful public space

Lower driving speeds require less carriageway width, and many urban streets have been laid out with over-generous dimensions which encourage speeding. In most streets there is scope to convert carriageway space to one or more of the following:

- larger footways and pedestrian areas,
- cycle paths and parking,
- planted areas,
- parking and loading bays,
- play areas,
- seating and street furniture.



Such measures make the street more 'livable' and attractive, and this is important in getting public acceptance for the speed reduction measures.

#### More buoyant local economic activity

It is well known that the majority of retail businesses benefit from being located in traffic-free areas. Edward Erdman & Partners have demonstrated that prime retail rents are significantly higher in traffic-free areas. According to their studies rents in pedestrian streets were 45% higher than in vehicular streets in 1987, and 80% higher in 1989 (Caton, 1990).

By the same token, traffic calming schemes which improve the pedestrian environment are likely to result in increased trade for businesses located in such areas. Table 1 shows that in all but one of the six Federal German area-wide demonstration projects trade showed improvement after the introduction of the traffic calming measures.

**Table 1.** Changes in business turnover in six German traffic-calmed areas (before and after) (source: Kanzlerski, 1990, page 26).

	Area % of Business		
	Decreased	No Change	Increased
Berlin Mohit	31.3	40.4	28.3
Borgentreich	0.0	60.7	39.3
Buxtehude	6.0	33.7	60.3
Esslingen*	20.5	31.1	32.5
Ingolstadt	18.4	38.8	42.7
Mainz	28.6	30.6	34.7

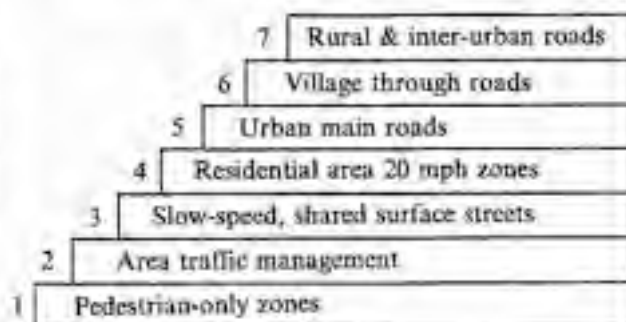
\*No data on remaining % of business.

A German study of thirty-seven towns which tested the view that "parking is extremely important for trade" could find no evidence which confirmed this opinion. Indeed, the available evidence has rather shown the opposite: "a positive development impulse for the inner city can be expected not by enlarging parking provision, but by a transport policy which favours the more city-friendly modes of travel" (Apel and Lehmbruck, 1990, page 71).

#### Traffic calming: how far have we got?

An account of traffic calming in Britain up to 1991 is to be found in Hass-Klau *et al's* (1992) survey of local authorities. This indicated a total of about 280 schemes of varying size, quality and location. Progress in Britain generally can be discussed in the context of wider European practice, which has followed a series of fairly

discrete steps. These are shown in Figure 5 and represent a rough chronology of traffic calming development.



**Figure 5.** Seven steps of traffic calming.

Pedestrianisation of shopping streets (Step 1) was perhaps the earliest measure aimed at avoiding the adverse impact of traffic. Britain has tended to rely on purpose-built pedestrian malls and arcades, whereas other European countries have more commonly created pedestrian zones out of former traffic streets.

Environmental traffic management (Step 2) was also based on the idea of segregating traffic, and relied on the definition of a hierarchy of traffic networks. There are many examples, the earliest in Pimlico dating from 1967, and this approach is still advocated in Britain through the Urban Safety Management Guidelines (IHT, 1990).

Slow-speed, shared-surface (Woonerf) schemes (Step 3) were developed for quiet residential areas in the Netherlands and became the dominant technique during the 1970s in Germany and a few other European countries. British towns, with very few exceptions, have skipped this Step, unless one includes the 'mews court' housing developments of the 1980s.

On mainland Europe in the 1980s, 20 mph (30 kmph) zones (Step 4) replaced the Woonerf as the main traffic calming technique, with large parts of German and Dutch towns now subject to the lower speed limit. An example of how a residential street can be converted to reduce speeds and improve the local environment is shown in Figure 6.

Such zones are also common in Austria, Switzerland, and Scandinavian countries. The first 20 mph zone regulations in England and Wales were issued in 1990. Although humps and other speed control measures have reduced speeds to 20 mph or less in many residential areas, local authorities mostly have not sought formal 20 mph zone status. By the end of 1991 only twenty-five schemes had been approved or requested for zone status (Hodge, 1992). Meanwhile, new housing areas are being constructed with conventional access and distributor roads which will need to be 'retrofitted' with traffic calming measures. Some county authorities are revising their residential design guides to incorporate traffic calming features, encouraged by the publication of revised Government guidelines for residential roads (Departments of Environment and Transport, 1992).

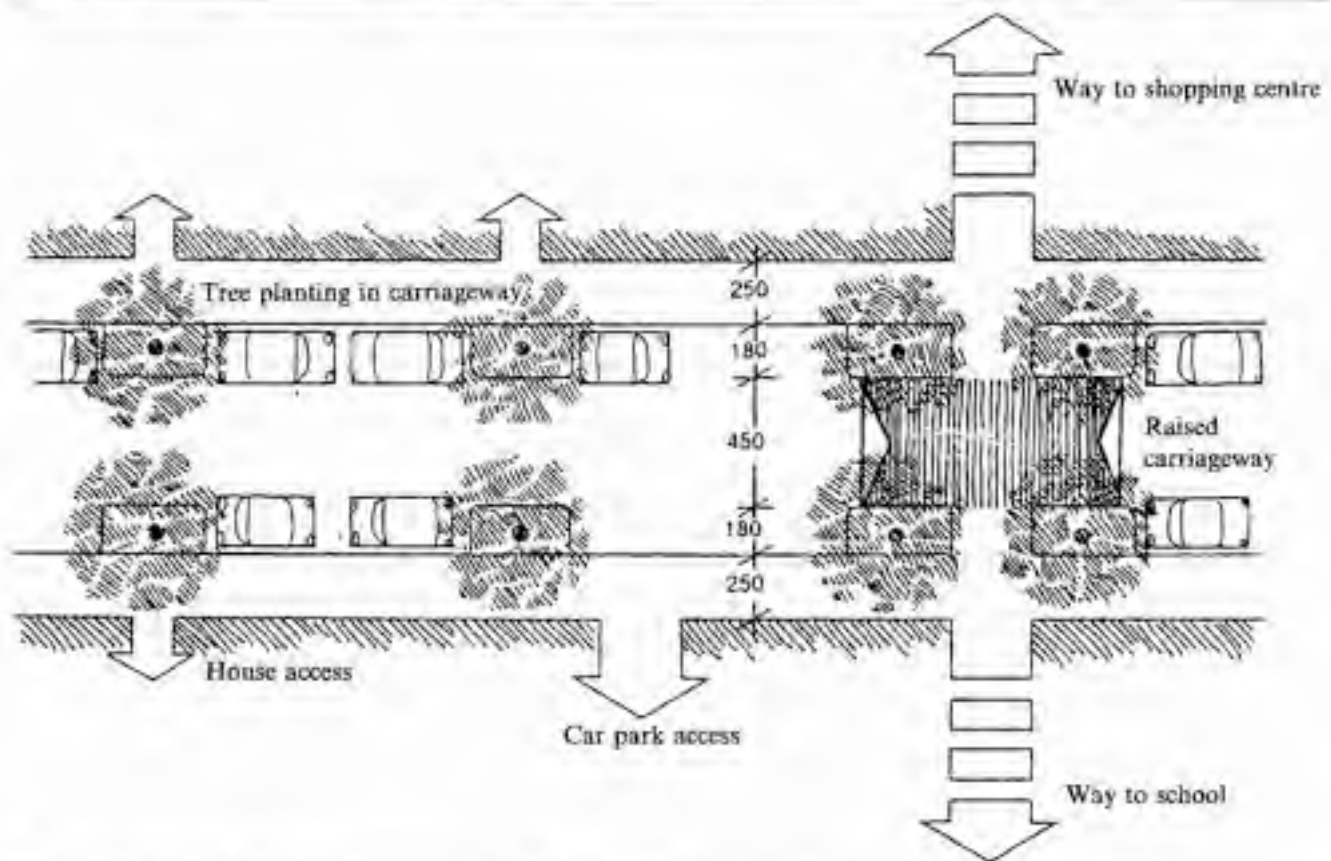


Figure 6. Example of physical measures in a 30 kmph (20 mph) zone (source: Stadt Kassel).

The search for bigger casualty reductions and economic regeneration opportunities means that main road traffic calming (Step 5) should provide the main focus of attention throughout Europe in the 1990s. One of the most radical schemes yet implemented is to be found in Borehamwood, Hertfordshire, where speed control ramps have been installed on an 'A' class road carrying 18,000 vehicles a day including buses and heavy goods vehicles. But there remains a widespread reluctance to enforce slow speeds on main roads using vertical shifts in the carriageway. The 'Red Route' concept in London which aims to rationalise and then rigorously enforce parking and stopping on main roads, offers considerable potential for main road traffic calming, but only if objectives are pursued other than simply improved traffic flow. An example of main road calming is shown in Figure 7.

Most villages will never get a by-pass and, even where one is provided, there is no guarantee of safer and better conditions on the former through route. A recent study of East Grinstead, for example, suggested that the proposed by-pass would be irrelevant to 75% of existing traffic. Increasingly, therefore, traffic calming techniques are being applied in villages (Step 6). The Department of Transport is monitoring projects in six towns as part of its Trunk Road by-pass programme, and also is monitoring speed-control schemes in twenty-five villages without by-passes (County Surveyors' Society *et al.*, 1992). As with schemes in Germany and Denmark (where monitoring

research has been undertaken), the general reluctance to use vertical shifts in the carriageway means that speed reductions are often modest. France probably has the most experience with schemes on village and urban through roads, and local autonomy has led to a wide variety of design solutions.

Traffic calming in built-up areas still leaves considerable problems on roads in non-built-up areas, including a quarter of all road casualties in Britain. Accidents to pedestrians and cyclists on rural roads are also more severe than on urban roads. So far traffic calming techniques have rarely been applied outside urban areas (Step 7). On motorways the debate as to the most appropriate speed limit rages on in almost every country. The British government decided not to raise the 70 mph limit, but lower limits could be enforced, as demonstrated on many USA freeways. Meanwhile, this seventh step towards comprehensive traffic calming remains to be climbed.

### Where do we go from here?

There are advantages to not being first in the field, in that one can learn from others' experience. In Britain, therefore, we have avoided the rather costly excesses of the early 'shared space' developments which, though sometimes impressive in themselves, never offered more than a very limited and localised solution.



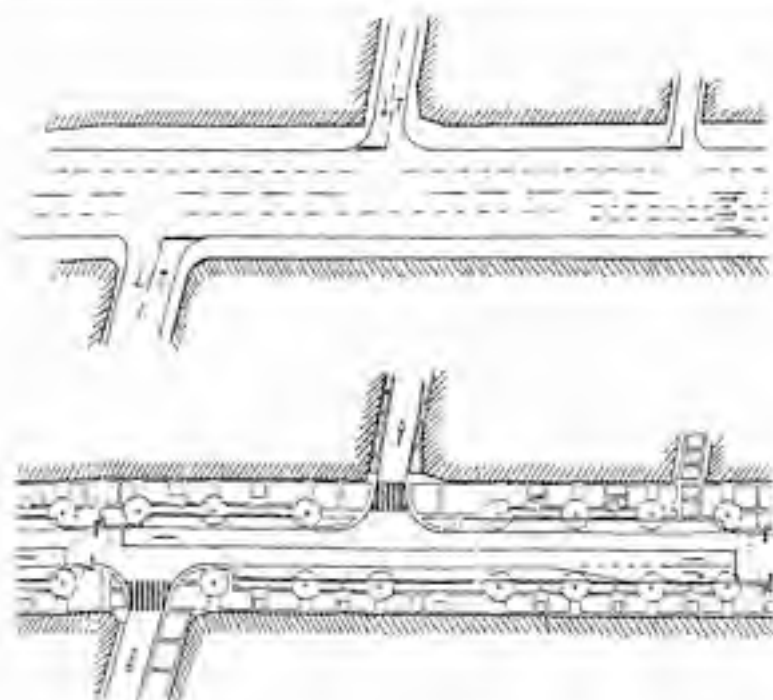


Figure 7. A main road before and after calming.

The new 20 mph zone regulations also insist on the lower speeds being self-enforcing through sufficient physical measures. This seems to be a sensible response to the rather poor performance of 'legal limit' only schemes common in other European countries.

Insistence on self-enforcing physical speed reduction measures, however, means that progress towards fully-traffic-calmed towns will be slow. In Germany, many cities (e.g. Hamburg, Nuremberg, West Berlin) have almost blanket 30 kph zones in all residential areas, but physical speed reduction measures are used only selectively in specially sensitive locations such as outside schools and hospitals. With insufficient money for street reconstruction, more emphasis is now being given to publicity campaigns advocating the merits of slow driving. It may be that Britain, with its rapidly spreading speed-hump schemes, already has more self-enforcing speed control measures than any other European country.

Nevertheless, progress in Britain has been unnecessarily cautious and penny-pinching. Research effort has also been lamentable. Following evaluation of the Dutch *Woonerf* schemes of the mid-1970s, extensive studies were carried out of similar schemes in Northrhine-Westfalia (Germany) as well as in the Netherlands. During the 1980s national or federal demonstration projects were carried out in Denmark, France, Germany, and the Netherlands. These projects (covering area-wide, local, main road, and village schemes) have yielded a mass of information on the effectiveness of techniques and aspects of implementation. (Accounts of the Danish, Dutch, and German projects may be found in Pharoah and Russell, 1989, and Tolley, 1990.) No such demonstrations have been mounted in Britain, and only the Dutch manual has been translated into English (Lines

and Castelijns, 1991). As a consequence central guidance to local authorities on how best to achieve traffic calming is thin.

Problems for the future of traffic calming in Britain lie in three main areas: firstly, the relationship between central and local government; secondly, the acceptance of environmental as well as accident reduction objectives; and thirdly, funding.

The central-local relationship is crucial in understanding British practice. The Department of Transport apparently welcomes the opportunity to monitor local authority traffic calming schemes in order to provide future advice and guidance on the best practice. Yet many local authorities are reluctant to introduce engineering features which do not conform to existing regulations, for fear of prosecution should an accident occur. Ironically, measures without Department of Transport approval are often keenly monitored in research sponsored by the Department of Transport!

There is concern also that the present 20 mph zone regulations (see Department of Transport, 1990b) are too complex and time-consuming to allow rapid implementation of the lower limit. There are many road hump schemes in Britain which could qualify for 20 mph zone status which remain as 30 mph limit areas.

After three attempts, and the passage of nearly twenty years since the first investigations by the Transport and Road Research Laboratory (Watts, 1973) the regulations governing speed humps are still unsatisfactory (HM Government, 1990). The justification for insisting on strict engineering regulations which produce ugly schemes of dubious effectiveness is obscure. An evaluation of the research into hump and ramp design already undertaken in various countries is long overdue.



The second problem is that British traffic calming is too often characterised by schemes that are poorly designed and constructed, with minimal attention to townscape or landscape. Public involvement is often lacking. As a consequence, traffic calming often fails to contribute to environmental enhancement or to the social and economic improvement of an area. It is to be hoped that the 1992 Traffic Calming Act (which specifically includes environmental improvement) will lead to schemes with wider objectives, in line with best Continental practice.

There is an urgent need to break down the barriers in Britain between street engineering and urban and landscape design. It may not always be easy to assemble multi-disciplinary teams, or to integrate street tree planting with engineering designs, or to coordinate street paving and furniture with other townscape features. Yet these aspects are the hallmark of the best schemes. There are important implications here for the future of the professions, for training, and for local authority management and working practices, all of which at present create obstacles to better traffic calming.

The third problem is that of funding. Some local authorities have set aside specific traffic calming budgets, though none are yet of sufficient scale to achieve comprehensive calming of towns by the end of the century. However, there are other budgets that can be and are used, for example housing improvement, environment enhancement, urban programme, road safety, and road maintenance. But, given the tight restrictions on local finance, central funds will need to be diverted on a much larger scale. Most government money for roads is currently spent on capacity provision, but the 'town-friendly' strategy outlined at the start of this paper will require money to be switched to traffic calming, to local programmes, and from roads to public transport and cycle provision.

## Conclusion

Traffic calming, like any other new policy, requires political willingness to act, and this depends on public pressure and acceptance. In continental Europe, traffic calming grew from environmental concerns about urban traffic in the 1970s and 1980s and was embedded in the 'green' political movement. In Britain, where traffic calming has resulted mainly from road safety concerns, public opinion is often running ahead of local authorities' ability to respond.

There is an urgent need to encourage a change of attitude towards speed. The Department of Transport "40,30,20" campaign which highlights the degree of risk to children when struck by vehicles at these speeds is an example of such action. Major changes in attitude can be achieved as demonstrated by the success of the drink-drive campaigns. Speed is the next frontier to be conquered, and the quicker the better!

A major problem is that attempts to promote safety consciousness and compliance with speed limits are constantly undermined by car advertising and car journalism. Car design is also at odds with safety objectives, with almost all models on sale capable of speeds well in excess of what is legal, and a performance which is incompatible with safe urban driving. New vehicle construction regulations will be needed for traffic calming policy to be fully effective in the long term.

Finally, traffic calming is about changed priorities. Real progress will be hampered until money, planning, and promotion are shifted away from conventional policies and practice to develop the new approach.

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## References

- Apel D, Lehmbruck M, 1990, "Stadtvertragliche Verkehrsplanung: Chancen zur Steuerung des Autoverkehrs durch Parkraumkonzepte und -bewirtschaftung", Deutsches Institut für Urbanistik, Berlin
- Appleyard D, 1981 *Liveable Streets* (University of California Press, Berkeley, CA)
- Buchanan C, et al, 1963 *Traffic in Towns* (the Buchanan Report), (HMSO, London)
- Caton L, 1990, "The impact of a traffic-free shopping environment on rents", paper to PTRC conference "New Approaches to Pedestrianisation and Traffic Calming", 6th March 1990, London
- County Surveyors' Society, Department of Transport, et al, 1992, "Village speed control working group, interim report", May
- Department of Transport, 1990a *Road Accidents in Great Britain 1989: The Casualty Report* (HMSO, London)
- Department of Transport, 1990b, "20 mph speed limit zones", Circular 4/90
- Departments of Environment and Transport, 1992, "Residential roads and footpaths", Design Bulletin 32, second edition, (HMSO, London)
- Devon County Council, 1991, "Traffic calming guidelines", Devon County Council, Exeter
- Goodwin P, Hallet S, Stokes G, 1991, "Transport: the new realism", Transport Studies Unit, Oxford
- Hass-Klau C, Nold I, Böcker G, Crampton G, 1992, "Civilised streets", Environmental Transport Planning, Brighton
- HM Government, Statutory Instrument 1990 No. 703, The Highways (Road Humps) Regulations, 1990
- Hillman M, Adams J, Whitelegg J, 1990, "One false move", Policy Studies Institute, London
- Hodge A, 1992, "A review of the 20 mile/h speed zones: 1991", *Traffic Engineering & Control* 23(10) 545-547
- IHT, 1990, "Guidelines for urban safety management", Institution of Highways and Transportation, London

- Jones G, Goodwin P, Hallett S, Kenny F, Stokes G, (ECOTEC Research), 1992, "The potential contribution of planning to reduce travel demand", paper presented at PTRC Summer Annual Meeting, Manchester, September
- Kanzlerski D, 1990, "Verkehrsberuhigung und Belange von Handel und Gewerbe", paper presented to "5th Kolloquium Flachenhafte Verkehrsberuhigung", 17th May, Ingolstadt
- Lines C, Castelijin H, 1991, "Translation of Dutch 30 kph zone design manual", Paper PA 2046/91, Transport and Road Research Laboratory, Crowthorne, Berks
- Otte D, 1988 *Geschwindigkeit und Unfallfolge* (Technische Universitat, Berlin)
- Pharoah T, Russell J, 1989, "Traffic calming: policy and evaluations in three European Countries", Occasional Paper 2/1989, South Bank Polytechnic
- Pharoah T, 1992, "Less traffic, better towns", Friends of the Earth, London
- Roberts J, Cleary J, Hamilton K, Hannah H (Eds), 1992 *Travel Sickness* (Lawrence and Wishart, London); see chapter by James and Pharoah
- Russell J, Pharoah T, 1990, "Speed management and the role of traffic calming in road safety", Research Paper 35, Edinburgh College of Art/Heriot Watt University
- Tolley R, 1990 *Calming Traffic in Residential Areas* (Brefi Press, Tregaron, Dyfed)
- Topp H, 1989, "Perspectives for the moderation of traffic in Germany", paper to conference "New Ways of Urban Traffic Management", CETUR, Paris, June
- Watts G R, 1973, "Road humps for the control of vehicle speeds", Report 597, Transport and Road Research Laboratory, Crowthorne, Berks